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Thomas Piketty's Capitalism Revisited

Summary: Thomas Piketty's international best selling *Capital in the Twenty-First Century* lays out his theory of a long-run rise in income inequality under capitalism. It is written as a manifesto urging reintegration of social sciences. A number of reviewers judged it on ideological grounds, labeling it either as a revolution in economic thinking, or dismissing it offhandedly. Piketty's theory of rising inequality is based on the two Fundamental Laws of Capitalism, developed after the Solow growth model. However, this model is inconsistent with Piketty's own characterization of modern capitalism. Moreover, his sole justification for the constant discrepancy between rate of return and rate of income growth ($r > g$) is based on the high elasticity of substitution between capital and labor. However, that is just one factor that can have an influence on factor income shares. By failing to offer a consistent theory of rising inequality, his piece can hardly be considered as a useful founding stone for a new social science.

Key words: Income distribution, Production function, Elasticity of substitution, Economic growth.

JEL: D33, O12, P17.

Immediately after its publication, Thomas Piketty's *Capital in the Twenty-First Century* (Thomas Piketty 2014a), attracted a lot of attention. It has received some flattering reviews, such as reviews by the Nobel-Prize winners: Robert Solow in the *New Republic* (Robert Solow 2014) and Paul Krugman in *The New York Review of Books* (Paul Krugman 2014). Solow presents it as a "serious book" that gives a "new and powerful contribution to an old topic", while Krugman hails it as "a revolution in our understanding of long-term trends in inequality". Branko Milanović in the *Journal of Economic Literature* (Branko Milanović 2014) goes so far as to say that the book is "one of the best books on economics written in the past several decades", and "one of the watershed books in economic thinking".

Some other reviewers were not so generous. For example, Debraj Ray states that Piketty's Fundamental Laws of Capitalism can be "dismissed out of hand" as "devoid of explanatory power" (Debraj Ray 2014, p. 3). Similarly, Acemoglu and Robinson conclude: "Piketty goes wrong for exactly the same reasons as Marx, and before him Ricardo, went astray" (Daron Acemoglu and James A. Robinson 2014, p. 30).

In this paper we will concentrate on Piketty's theory of rising capital income share in modern economies, i.e. on his Fundamental Laws of Capitalism. First, we

are going to explore the inner structure of the Laws, their relationship to the Solow growth model, and then we will investigate whether those Laws really represent a deep-rooted cause for the rise in income inequality. However, the theory of rising inequality is incomplete without a reference to the production function and the value of elasticity of substitution, which will be the subject of the next section. Finally, we will offer an overall assessment of logical consistency of Piketty's views.

1. The Two Fundamental "Laws"

Piketty starts his presentation with a rather caustic characterization of modern economic theory. His teaching experience at "a university near Boston" convinced him that "economists are all too often preoccupied with petty mathematical problems of interest only to themselves" (Piketty 2014a, p. 32). What is needed, in his opinion, is a unified approach that would integrate all social sciences in order to penetrate into the essence of the present economic order. As he puts succinctly on the same page: "(T)he discipline of economics has yet to get over its childish passion for mathematics and for purely theoretical and often highly ideological speculation, at the expense of historical research and collaboration with other social sciences". Therefore he tries to present economic concepts as simply as possible, in order to be comprehended by other social scientists.

In the best Marxian tradition, Piketty is mainly interested in revealing the inner structure of modern capitalism, and the laws of its development. Accordingly, "this book is as much a work of history as of economics" (Piketty 2014a, p. 33). After thorough investigation, claims he that has discovered at least two main features of market economies, which could be dubbed as Fundamental Laws of Capitalism.

The First Fundamental Law states that the share of capital in national income must be equal to:

$$\frac{\text{Capital Income}}{\text{National Income}} = \frac{\text{Capital Income}}{\text{Capital Stock}} \times \frac{\text{Capital Stock}}{\text{National Income}}. \quad (1)$$

As one can see, this is just a tautology, giving little insight into the workings of modern capitalism. Using Piketty's notation, capital share in national income α is the value of capital (K) multiplied by the annual rate of return (r), which includes rents, profits, dividends, interest, and other income from capital, divided by the national income (Y):

$$\alpha = r \times \frac{K}{Y}. \quad (2)$$

However stated, it is clear that this "law" is nothing more than an identity. Piketty is aware of this fact, but nevertheless revisits the First Fundamental Law of Capitalism throughout the book. He often uses the Greek letter β for the ratio between capital and income, in order to summarize the First Law as:

$$\alpha = r \times \beta. \quad (3)$$

An explanation of this strange labeling of an identity as the Law is offered by Milanović (Milanović 2014, p. 3, n. 3). He writes that Piketty desired to distinguish privately owned economies from other institutional arrangements. In capitalism some individuals draw their incomes from the ownership of resources, while the rest live from their labor. In a perfectly egalitarian state-owned economy returns could be distributed to all citizens and capital would lose its influence on personal income distribution. Unfortunately, Piketty does not offer such an explanation, though it clearly reflects his intention.

The Second Fundamental Law of Capitalism is also given in the introductory chapter of the book. It states without much justification that the ratio between capital and income must be equal to the ratio between savings rate and rate of income growth:

$$\frac{\text{Savings rate}}{\text{Growth rate}} = \frac{\text{Capital}}{\text{Income}}. \quad (4)$$

Or, if we take s for savings rate and g for growth rate, then:

$$\beta = \frac{K}{Y} = \frac{s}{g}. \quad (5)$$

In a sense, this is also a definitional statement (Ray 2014). If we assume that saving in the certain period (t) is sY_t , and is equal to investment, i.e. to the difference between capital in this and in the next period, then:

$$sY_t = K_{t+1} - K_t = \frac{K_{t+1}}{Y_{t+1}} Y_{t+1} - \frac{K_t}{Y_t} Y_t. \quad (6)$$

Moreover, if we assume that the ratio between capital and income is constant, then the savings rate can easily be obtained as:

$$sY_t = \beta(Y_{t+1} - Y_t) \Rightarrow s = \beta g. \quad (7)$$

However, this reasoning bears too many ifs. Are we allowed to assume that saving in this year will increase capital in the next year by the same amount? Maybe some individuals prefer to keep their savings in mattresses, instead of in a bank or some other financial institution. Or, what is to guarantee that the ratio between capital and income will remain the same between periods. Obviously, we need a theory behind this simple formula. Unfortunately, Piketty postpones the explanation until chapter five (one hundred and fifty pages after the first mentioning of this Law). Even then, a curious reader could come away unsatisfied, as Piketty gives just a numerical example and concludes that “a country that saves a lot and grows slowly will ... accumulate an enormous stock of capital” (p. 166). This is a fairly trivial statement, without much of a theory.

At this point, one cannot miss how closely he follows Solow's argument (Solow 1956) on the stability of steady-state equilibrium.

“First, it is important to be clear that the second fundamental law of capitalism, $\beta = s/g$, is applicable only if certain crucial assumptions are satisfied. First, this

is an asymptotic law, meaning that it is valid only in the long-run: if a country saves a portion s of its income indefinitely and if the rate of growth of its national income is g permanently, then its capital/income ratio will tend closer and closer to $\beta = s/g$ and stabilize at that level. This won't happen in a day, however: if a country saves a portion s of its income for only a few years, it will not be enough to achieve a capital/income ratio of $\beta = s/g$ " (Piketty 2014a, p. 168).

And a little later:

"Even more important was Solow's introduction in 1956 of a production function with substitutable factors, which made it possible to invert the formula and write $\beta = s/g$. In the long-run, the capital/income ratio adjusts to the savings rate and structural growth rate of the economy rather than the other way around... It was not until the 1970s that Solow's so-called neoclassical growth model definitively carried the day" (Piketty 2014a, p. 231).

In order to convince his readers, Piketty gives a lot of numerical examples. However, as numerical examples and story-telling are not substitutes for a theoretical argument, he states that all the details can be found in his online Technical Appendix.

Unfortunately, in the Technical Appendix one can find just a statement that "wealth grows at rate s/β , thus wealth/income ratio increases if $s/\beta > g$, and decreases if $s/\beta < g$ " (Piketty 2014b, p. 28). Supposedly, a more detailed economic analysis, apart from this trivial statement, can be found in his previous articles. Although the relationship between the savings rate and the rate of growth via the capital intensity ratio is simply a characteristic of the steady-state growth model developed by Solow, Piketty does not explain it. More importantly, readers must be puzzled over the connection between savings and growth, on the one hand, and some fundamental laws of capitalism, on the other!

The Solow model is frequently represented in textbooks on economic growth, and at this stage we can recall its main assumptions and limitations.

1.1 Solow Growth Model

The steady-state model of economic growth (Solow 1956) is based on standard neoclassical assumptions. First of all, the model deals with the economy characterized by perfect competition in all its aspects. An economy produces just one good that can be either used in consumption or stockpiled as capital for future consumption. Total production of the good (Q) is a function of the utilization of capital (K) and labor (L):

$$Q = f(K, L).$$

There is full employment of both capital and labor, but also the possibility of substitution among factors of production. The latter distinguishes Solow's model from its predecessors. As the production function is subject to constant returns to scale, its partial derivatives according to factors of production, i.e. the marginal products of capital and labor, are positive and diminishing: $f_K = \partial f / \partial K > 0$, $f_L = \partial f / \partial L > 0$ and $f_{KK} = \partial^2 f / \partial K^2 < 0$, $f_{LL} = \partial^2 f / \partial L^2 < 0$.

Having in mind constant returns to scale, one can equally represent the production function as:

$$Q = Lf'(k, 1) = L\varphi(k), \quad (8)$$

where capital intensity is given as $k = K/L$. Therefore, the marginal products of capital and labor are functions of capital intensity. For example,

$$f_k = L \frac{d\varphi}{dK} \frac{1}{L} = \varphi'(k). \quad (9)$$

As those are usual neoclassical assumptions, Solow gives his own additions: capital can be obtained through saving a part of production, where the savings rate (s) is parametrically given, and the rate of growth of the labor force in the economy is an exogenous variable (λ), i.e.

$$\dot{K} \left(\equiv \frac{dK}{dt} \right) = sQ \quad (10)$$

$$\frac{\dot{L}}{L} \left(\equiv \frac{dL/dt}{L} \right) = \lambda.$$

Following the definition of capital intensity, we are able to write $K=kL$, which means that the additional capital is:

$$\dot{K} = \dot{k}L + k\dot{L} = \dot{k}L + k\lambda L. \quad (11)$$

As additional capital is equal to the savings of the good, and having in mind that the production function can be represented as a function of capital intensity, we are able to write:

$$s\varphi(k) = \dot{k}L + k\lambda L; \quad \Rightarrow \dot{k} = s\varphi(k) - k\lambda. \quad (12)$$

This differential equation is in the variable k and has two parameters, the savings rate and the rate of population growth. It cannot be solved before those rates are known. Solow's implicit assumption is that there is a set of capital intensity values for which the first term is greater than the second, i.e. which give a positive value to the right-hand side of the equation. Once the equilibrium capital intensity rate is attained, capital grows at the same rate as labor, λ . As net investment is equal to the saving, they both increase at the rate of labor force growth. However, as capital intensity does not change, production must change at the same rate as labor does. Therefore, all relevant variables grow at the same rate and such a situation is called a steady state.

As perfect competition prevails in the Solow economy, factors of production are remunerated according to their marginal productivity. This argument cannot be separated from the assumption of the constant returns to scale, i.e. the value of production is equal to the national income (Euler's Theorem). Formally, Solow's findings can be summarized: in equilibrium, the rate of growth of capital is equal to the rate of growth of labor force (λ), and the national income grows at the same rate (g):

$$\frac{\dot{K}}{K} = \frac{\dot{Y}}{Y} = \lambda, \text{ or } \frac{sY}{K} = g. \quad (13)$$

Of course, the last relation may be written in a Piketty's manner, as $s/g = K/Y$. He calls this the Second Fundamental Law of Capitalism, in order to impress less informed readers who may not know where this *deus ex machina* comes from.

If we multiply both sides of the expression by the rate of return on capital, r , we would get:

$$\frac{rs}{g} = \frac{rK}{Y} = \alpha, \quad (14)$$

i.e. the First Fundamental Law of Capitalism. Therefore, both Fundamental Laws are simply a play on words derived from the steady-state economic growth model.

Incidentally, Solow's critical assumptions, such as constant returns to scale and perfect competition in the economy, can hardly be considered applicable to an existing economy. This fact was already stressed by Solow, who objected to a possible implementation of his results to monopolistic competition (Solow 1956, p. 79, n. 7). Contemporary economies are prone to rising as well as diminishing returns to scale, and one cannot prove that income distribution follows the marginal factor productivity.

2. Which Capitalism?

Many times Piketty emphasizes that modern economies are a far cry from the perfect competition model. Actual income distribution is the result of relative bargaining power, and usually does not reflect the marginal productivity of factors. For example, he states on page 212: "In more complex models, which are more realistic, the return on capital also depends on the relative bargaining power of the various parties involved. Depending on the situation, it may be higher or lower than the marginal productivity of capital (especially since the quantity is not always precisely measurable)".

Concerning labor, he is also skeptical about the relevance of marginal productivity to wage determination: "This theory (i.e. marginal productivity) is in some respects limited and naïve. (In practice, a worker's productivity is not an immutable, objective quantity inscribed on his forehead, and the relative power of different social groups often plays a central role in determining what each worker is paid.)" (Piketty 2014a, p. 305).

Market imperfections may further detach income distribution from marginal factor productivity. Limited supply of some factors creates rents for their owners: "there can be situations in which the landlord is in a monopoly position when it comes to renting land and tools or purchasing labor (in the latter case one speaks of "monopsony" rather than monopoly), in which case the owner of capital can impose a rate of return greater than the productivity of his capital" (p. 214).

Having in mind all these qualifications it is surprising that Piketty accepts the results of a model that is firmly based on perfect competition, full employment of

labor and capital, constant returns to scale and income distribution according to marginal factor productivity. It is no mystery that monopoly and monopsony market power is easily associated with rising returns to scale. Or, limited supply of arable land goes hand in hand with decreasing returns to scale. In both cases, value of production would be different from the total of factor incomes calculated according to their marginal products (Euler's Theorem).

Even with constant returns to scale and no bargaining power of the parties involved, market imperfections create a wedge between the value of marginal products and factor incomes. For example, a producer may sell his products on a competitive basis, but hires labor on a monopsonistic market. Then he will hire less labor and pay a lower wage than a competitive employer, with a substantial difference between the value of marginal product and the effective wage. Or, if he sells his products on an imperfect market, with a downward-sloping demand function, he will hire factors according to their marginal revenue products, and pay for their services according to their supply functions. By and large, all market imperfections make marginal factor productivity inapplicable to income distribution.

In reality, the value of production would be different from the sum of factor incomes calculated according to their marginal productivity, and the steady-state equilibrium is just an intellectual construct. Consequently, the Second Fundamental Law of Capitalism has a very shaky theoretical foundation. One can either be realistic and accept varying returns to scale, market imperfections and the role of political power in the distribution process, or believe in the Second Fundamental Law of Capitalism, as a consequence of perfect competition, constant returns to scale and no bargaining strength of parties involved in the income distribution. To hold both positions simultaneously, is logically inconsistent.

This section may be closed with a reference to the Cambridge Capital Theory Controversies. Piketty believes the debate to have had "a marked postcolonial dimension (as American economists sought to emancipate themselves from the historic tutelage of their British counterparts...)" (Piketty 2014a, p. 232). However, the use of the neoclassical macro production function, as Piketty does, reflects a circularity of reasoning: one needs to know the rate of return in order to aggregate the capital, and the rate of return is the consequence of the marginal productivity of capital (Avi Cohen and Geoffrey C. Harcourt 2003).

Moreover, a question of the measuring rod for capital has been raised right from the beginning of the debate (Nicholas Kaldor 1955). Whether one uses its market or real value in calculating its rate of return is not an irrelevant issue. In the Solow model capital has just one price, as the economy produces one good that can be used either for consumption or for furthering production. The use price of capital is given in the very same units and with perfect competition it must be equal to the marginal product of capital.

However, in a disaggregated world capital goods are distinct from their products, and one does not know how to collect them all in one entity called capital. Market prices are not suitable for this purpose, as they are subject to changes in monetary policy, quite independently of capital productivity. For example, current discount rates in much of the developed world are compressed toward zero by central bank

policies. And with thus depressed rates the value of assets tends to be high. As we have been witnessing in the last couple of years, market capitalization is constantly high, despite the fact that many countries of the group face very sluggish economic growth and also bleak prospects for future profits. Piketty is aware of variations in the ratio of the market capitalization to the book value of individual firms, but nowhere stresses the importance of monetary policy.

In the last thirty years high discrepancy between market values and fundamentals, as it seems, is not just a temporary aberration in either direction, but a consequence of central bank policy. Usually, the policy of low interest rates is defended on anti-cyclical grounds, but other explanations abound as well. David Stockman, a long-term Washington insider, forcefully pursues the other channel of inflating asset prices: “(T)he Fed’s constant injection of high-powered reserves into the banking system,..., had fostered a financial chain reaction: newly minted central bank money stimulated rapid private debt extensions, which was used to bid-up asset prices, which elicited more collateralized credit, which drove asset prices still higher” (David Stockman 2013, p. 337).

Similar policies have been followed by central banks in other developed economies for at least a quarter of a century, with consequent substantial rise in asset prices. “The top eight central banks, including the ECB, Bank of Japan, and the People’s Printing Press of China, had combined balance sheet footings of \$5 trillion before the financial storm erupted in 2007. Now they total \$15 trillion and are expanding at explosive rates” (Stockman 2013, p. 703).

Cheap credit boosted asset inflation, creating substantial capital gains, which are totally unrelated to capital productivity. Therefore, Piketty’s option for market values in capital aggregation is hardly warranted, as asset inflation must necessarily come to an end. A part of it has already happened with the housing market collapse, even without any change in monetary policies. With expected rises in prime interest rates, stock market prices will inevitably fall, with a consequent fall in capital-income ratio, without change in fundamentals.

If one excludes capital gains from the value of capital in Piketty’s dataset, a completely different trend is revealed: as shown by several authors (Matthew Rognlie 2014), for the eight countries under examination the value of capital to income has decreased or remained about the same from 1970 to 2010. Rognlie contends that in the same period the ratio of capital to income in the US increased 22 percentage points, if taken at market value, but actually decreased 111 percentage points if capital gains are excluded (it fell from 445% to 334%). On the average, the capital/income ratio increased for the forty-year period by 35 percentage points, without capital gains, and actually fell by 69 percentage points if taken at book values.

3. Relationship between α and β

We have already seen that capital’s share can be either expressed as its remuneration divided by national income ($\alpha = r \cdot KY$), or, by implementing the Second Fundamental Law, as the product of rate of return and the savings rate divided by the growth rate ($\alpha = r \cdot s/g$). Piketty is interested in the long-run trends of these variables, in or-

der to predict the future income distribution between capital and labor. After collecting and reconstructing three hundred years' worth of evidence from several developed countries, he found that the rate of return is fairly constant through the ages (between 4% and 5%), as well as the savings rate. By contrast, growth rate varies a lot, and he is ready to suggest that there is a long-term tendency of its decline. Consequently, as the numerator is constant ($r \cdot s$) and the denominator (g) is falling, the capital share in national income (α) must rise. However, with a constant rate of return this process is possible only with a rising capital-income ratio (rising β).

Indeed, Piketty found both β and α rising before the First World War, and after the Second World War. The current capital-income ratio approaches values achieved at the end of the nineteenth century, so Piketty predicts further rise in the income that goes to capital. As capital is inherited by too few people, he expects a rise in personal income inequality, or, as he calls it, a rise in patrimonial capitalism.

One of the questions that immediately come to mind is how to reconcile a rising capital-income ratio with a constant rate of return? That is contrary to the standard neoclassical scarcity assumption, which lies in the very foundations of the Solow model. More and more capital must result in a falling marginal product, i.e. a falling rate of return, which may counterbalance rise in the β . Or more substantially, Piketty's empirical findings contradict the Solow model, which expects a long-run constant capital-labor ratio and due to constant returns to scale an equal rate of growth of capital and income (constant capital share).

How can one use a model that gives predictions permanently falsified by one's own empirical findings? Piketty's answer is that the rise in capital is accompanied by a rise in the elasticity of substitution between capital and labor. According to him, the coefficient currently takes values greater than one, which solves the apparent contradiction.

3.1 Piketty Illustrations

In the online Technical Appendix Piketty gives an illustration with the Cobb-Douglas production function, but, as is widely known, in that case capital share α is constant and independent of capital-income ratio. As for the second example, he gives a production function with a constant elasticity of substitution (CES) (Piketty 2014a, pp. 37-39). Then, capital share in national income is a function of the elasticity of substitution (σ):

$$\alpha = r \cdot \beta = a \beta^{\frac{\sigma-1}{\sigma}} . \quad (15)$$

With positive and constant distribution parameter a , a high elasticity of substitution, $\sigma > 1$, gives a rising share of capital (α) with a rising capital-income ratio (β).

However, Piketty does not explain the limitations of the example. First of all, the CES function is linearly homogeneous, and consequently exhibits constant returns to scale. If one also takes perfect competition as a starting point, where distribution of income is determined by the marginal productivity, then the value of production is equal to the total factor incomes:

$$Q = f_K K + f_L L = Y. \quad (16)$$

Therefore, the symbol Y can be substituted for Q in the production function, which is essential for obtaining the former result. Namely, if the CES function is given as:

$$Y = f(K, L) = \left[aK^{\frac{\sigma-1}{\sigma}} + (1-a)L^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (17)$$

then the marginal product of capital f_K is:

$$f_K = a \left(\frac{K}{Y} \right)^{-\frac{1}{\sigma}}. \quad (18)$$

As the marginal product of capital under present assumptions must be equal to the rate of return, it can be substituted in the formula for the capital share of income (α), with the already given result. So, if factors are easily substitutable in the production process, $\sigma > 1$, capital share will rise with the rising capital-income ratio. Piketty is convinced that factors can easily replace each other in modern production, so a rise in β must have a detrimental effect on the labor share in the process of income distribution.

4. What Is Missing?

At this point we may say that Piketty's theoretical claim is on a weak foundation. Surprisingly, he sticks to this explanation in his later works (Piketty 2015a, b). A simple CES production function is not capable of explaining all the nuances of the long-run economic growth. Its use is in contradiction with Piketty's claims that modern capitalism is characterized by imperfect competition. In such a state there is a wedge between price and marginal cost, as firms exert market power. The wedge is usually called the markup ratio, and labeled by the Greek letter μ , after the thorough examination by Robert Hall in his seminal paper (Robert Hall 1988). By all accounts, the wedge is substantial in modern economies. A recent comparison of the US and Spanish economies found the average discrepancy between prices and marginal costs in each country on the scale of 35% and 31%, respectively (Xavier Raurich, Hector Sala, and Valeri Sorolla 2012).

As Piketty is interested in the long-run trends of income distribution, technical progress must be taken into account too. Productivity of both capital and labor sometimes rise at an equal rate, but sometimes marginal products rise unequally. An enormous literature on neutral and biased technical progress has been developed, and even the authors of the CES function discuss some of the issues (Kenneth Arrow et al. 1961).

If we assume that there are both neutral and factor-augmenting technological changes, the CES function may be represented as:

$$Q = A \left[a (A_K K)^{\frac{\sigma-1}{\sigma}} + (1-a) (A_L L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (19)$$

where A stands for neutral technological change, in contrast to factor-augmenting changes (A_K, A_L). The marginal product of capital is then given as:

$$f_K = a (A A_K)^{\frac{\sigma-1}{\sigma}} \left(\frac{Q}{K} \right)^{\frac{1}{\sigma}}. \quad (20)$$

As already stated, we have to bear in mind that modern economies are a far cry from perfectly competitive, and that almost every industry experiences discrepancy between price and marginal cost. This fact must have a repercussion on factor employment, as markup has to be explicitly introduced into the necessary conditions for profit maximization. Also, a decision on capital employment cannot be taken without reference to the depreciation rate (δ). Consequently, an optimizing firm would try to equalize the marginal product of capital with its price augmented with the depreciation rate, multiplied by the markup ratio (Jordi Gali 1994), $f_K = \mu(r + \delta)$. Concerning our CES production function, this would lead to:

$$r = \frac{a}{\mu} (A A_K)^{\frac{\sigma-1}{\sigma}} \left(\frac{K}{Q} \right)^{-\frac{1}{\sigma}} - \delta. \quad (21)$$

When we multiply this expression by capital/production ratio, the outcome is capital's share in the value of production (α). With constant returns to scale (as the CES function is linearly homogeneous), this is an adequate measure of capital share in national income:

$$\alpha = \frac{a}{\mu} \left(A A_K \frac{K}{Q} \right)^{\frac{\sigma-1}{\sigma}} - \frac{\delta K}{Q}. \quad (22)$$

Now we see that the elasticity of substitution coefficient is just one of several factors determining capital share in the long-run with the CES production function. Technical progress tends to increase the share, provided $\sigma > 1$, but markup, as well as the depreciation rate, work in the opposite direction. The depreciation rate tends to be higher in industries with heavy IT load, as capital must be quickly replaced. Modern economies, in general, are increasingly dependent on those technologies.

Higher markup diminishes capital share. There is an ample evidence for countercyclical movement of the markup (Julio Rotemberg and Michael Woodford 1999), as during an economic upturn marginal costs usually rise faster than prices, squeezing the markup, while during economic hardships the opposite process takes place.

Finally, an elasticity of substitution, greater than one, will produce a rising capital share with a rising capital-GDP ratio. That is the crucial Piketty argument. Undoubtedly, there is a rising trend of this ratio, at least since the Second World War and measured by market prices. However, there is inconclusive evidence regarding

the trend of the elasticity coefficient. The authors of the CES production function expected this coefficient to be less than one, and one of their preferred estimated values for the coefficient was 0.56 (Arrow et al. 1961). The majority of subsequent empirical investigations confirmed its value in the range of 0.40-0.60 (Robert Chirinko 2008). More recent research confirmed the value of the coefficient for the US economy to be stable since 1970 at 0.7 (Ezra Oberfield and Devesh Raval 2014). An international comparison has confirmed the US elasticity to be less than one, but found that its value is higher than that of the Spanish economy (Raurich, Sala, and Sorolla 2012).

Therefore, Piketty has no satisfactory explanation for the rising capital share. His theoretical foundation is sketchy, and misses some important factors that must be taken into account in the long-run analysis of income distribution. Capital share can go either way, despite a rising capital-income ratio, and despite the higher rate of return in comparison to the income growth rate. His predictions for a rising share of capital are based on a spurious claim that there is a trend towards a higher rate of return in comparison to the growth rate of income. With a constant rate of saving, this must lead to the rising capital share.

Many critics have raised the issue of diminishing marginal productivity of capital (Rognlie 2014). According to the neoclassical view, a higher capital/income ratio must lead to a lower value of f_k , and consequently to a lower rate of return. That may be true, but in this context the argument is superfluous. The relation between the savings rate, rate of growth and rate of return is established by the means of the Solow model. As we have seen from the introductory presentation of the Solow model, the savings rate and population growth are the parameters of the model, and the growth of capital and income are endogenous variables. Later on, Solow allowed the savings rate to be dependent on the capital-labor ratio, $s(k)$, but eventually capital and output also grow at the same rate as the labor force. With changing parameters endogenous variables change, and not the other way round. Growth of capital, income, and marginal products are all outcomes of the model and cannot explain each other.

5. Conclusion

This is a dangerous book. It gives an impression to readers that they can discuss economic problems competently without any training in economic theory, just by using simple logic. As we have seen, one of its opening statements is that there must be an integration of social sciences. However, the author's efforts do not make a contribution in that direction. He builds his argument on unduly simplified economic models, which can lead less informed researchers from other social sciences into believing that economic problems are simpler than actually is the case. Although an economist by vocation, Piketty writes in the Marxian tradition that shows a lot of disdain toward honest intellectual effort. At the same time, he has no coherent theoretical justification for his statements. Recently, under criticism from different angles, he has retreated to a more modest position. His book is not a new dawn of social sciences anymore, but it is "primarily about the history of the distribution of income and wealth" (Piketty 2015a, but also in 2015b).

The Piketty Fundamental Laws of Capitalism are only identities that are in wide use in micro as well as macro analysis, and do not reveal any capitalist specifics. The First Law is simply a definition of capital share in income, and the Second Law is a steady-state economic growth identity developed by Robert Solow, but without labor growth impact. Both Laws are equally applicable to any form of economic system, from a Robinson Crusoe economy, to state socialism, to competitive capitalism. However, Solow built his model assuming perfect competition, constant returns to scale, full employment, distribution according to marginal factor productivity, and equality between savings and investments, whereas Piketty emphasizes the role of monopolies and oligopolies, price discrimination, and the bargaining power of actors involved in income distribution negotiations. It is inconsistent to use results of one model in a completely different economic setting, without any thorough justification.

In order to reconcile Solow's growth model with rising capital share in income, Piketty assumes that elasticity of substitution between capital and labor takes values greater than one. Together with the simple CES production function, that really would produce a rising capital share. However, the assumption of a substitution elasticity greater than one is in contrast with expectations of the authors of the CES function. It is also contrary to the bulk of empirical evidence that shows the elasticity of substitution to be less than one (Chirinko and Debdulal Mallick 2014).

Piketty argues in his book that the elasticity of substitution definitely tends to be greater than one in modern technological processes and in the online Technical Appendix uses a simplified CES function to show the impact of the elasticity coefficient. In his analysis there is no room for technological progress, no markup, and implicit assumptions include perfect competition and distribution according to marginal productivity, as the linearly homogeneous CES function displays constant returns to scale.

In connection with the last point, one has to emphasize that empirical investigations falsify a lot of Piketty's claims. First of all, his definition of capital that includes all forms of assets is dubious. It must be disaggregated, as some forms of assets, like securities, works of art, and real estate, experience a long-run inflation in values, which has nothing to do with their productive capacity. As we have seen, the deduction of capital gains leads to an almost constant ratio of capital to income. Several authors have emphasized the very strong impact of US housing prices on the rising capital-income ratio (Rognlie 2014; Alan Auerbach and Kevin Hassett 2015). Moreover, by failing to take into account taxation, Piketty got a higher rate of return than the rate of income growth, while "for every year in the chart for which there are both data and a modern tax system, the after-tax rate of return is lower than the rate of growth" (Auerbach and Hassett 2015).

Piketty's book *Capital in the Twenty-First Century* has not proven that a rising capital-income ratio is the primary cause for the rise in income inequality. He offers no theory behind his claims. His open or implicit references to the literature have pointed to economic models different from his own vision of modern capitalism. In that respect his book is inconsistent, logically contradictory and misleading. However, the growing public interest in the book has helped economists to reconsider issues associated with income inequality, which is a positive outcome.

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