Mankiw's attempted resurrection of marginal productivity theory

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Part 1 of this paper (http://www.paecon.net/PAEReview/issue59/Moseley59.pdf) argued that the marginal productivity theory of distribution has fundamental and insoluble logical problems: (1) the aggregate production function is not a legitimate concept, because capital consists of diverse buildings and equipment that cannot be reasonably aggregated into a total quantity for the economy as a whole; (2) the marginal product of capital (or of labor) is not a legitimate concept, because output in goods-producing industries cannot be increased by adding one unit of capital and holding all other inputs constant, because raw material inputs must also increase if output is to increase; (3) the derivation of the demand for capital (or for labor) is invalid, because it is based on the illegitimate concept of the marginal product of capital; and (4) the return to capital is included in the price of capital, as the "opportunity cost" of the owners of capital, and the opportunity cost is taken as given, like all other costs of firms. Therefore, marginal productivity theory takes as given the main variable that should be explained – the return to capital.

Because of these and other fundamental problems (e.g. the "inseparability problem" emphasized by Hobson and others, and the "reswitching problem" emphasized by Sraffians), it is not surprising that the marginal productivity theory of distribution is quietly disappearing from microeconomic textbooks, both undergraduate and graduate, without mentioning to students this important omission, and this important weakness compared to classical economics and Marx's theory. The leading undergraduate microeconomic textbook in the US (Varian) presents parts of this theory in separate chapters (the supply of labor is presented in Chapter 9, related to consumer theory; and the demand for labor and capital is presented in Chapter 19, related to the theory of the firm), but there is only one point in the book where the supply and demand for labor are briefly put together to determine the price of labor (in the Appendix to Chapter 26 in a discussion of the minimum wage), and the supply and demand for capital are never put together to determine the price of capital – indeed the supply of capital is never discussed at all. The leading graduate microeconomics textbook (Green, Mac-Collel, and Whinston) is 1000 pages thick, and there is no discussion whatsoever of the marginal productivity theory of distribution, not even the marginal productivity theory of labor and wages.

However, bucking this trend in microeconomics (where the theory of distribution has traditionally been located), Gregory Mankiw has attempted to resurrect marginal productivity theory in his best-selling intermediate *Macroeconomics* textbook (Chapter 3). Mankiw presents marginal productivity theory as if there were no logical problems whatsoever. Not a word is said to students about these logical problems, not even the very well known "aggregation problem". This paper will examine in detail Mankiw's presentation of marginal productivity theory, and will point out its many logical flaws.

Early in this chapter, Mankiw takes the obligatory superficial swipe at Marx:

> Karl Marx, the noted nineteenth economist, spent much time trying to explain the incomes of capital and labor. The political philosophy of *communism* was in part based on Marx's *now-discredited* theory. (49; emphasis added)

And he compares Marx's theory with modern marginal productivity theory:

This theory, called the neo-classical theory of distribution, is *accepted by most economists today as the best* place to start in understanding how the economy's income is distributed from firms to households. (49; emphasis added)

We can see that Mankiw uses familiar rhetorical tricks to bully students into accepting his judgment of Marx's theory and marginal productivity theory: *guilt by association* (Marx's theory is associated with communism, even though Marx's theory is about capitalism (the title of his book is *Capital*!), and has nothing to do with communism); and *appeal to authority* (Marx's theory is "now discredited" and marginal productivity theory is "accepted by most economists today as the best theory", without telling us why). (Edward Fullbrook (2007) has also called attention to Mankiw's bullying tactics: "rational people think at the margin", so you better too!; and "economists are like scientists", so what we say has been proven to be true).

I argue, to the contrary, that Marx's theory of surplus-value is far superior to marginal productivity theory, in terms of both logical consistency and empirical explanatory power. Marx's theory is able to explain many important phenomena in capitalism – the fundamental conflicts between capitalists and workers in capitalist economies (conflicts over wages, the length of the working day, and the intensity of labor), the increasing concentration of capital, increasing income inequality, recurring crises, etc. In striking contrast, marginal productivity theory is filled with logical problems, and cannot explain any of these important phenomena in capitalist economies. (See Moseley 1995 for an extensive discussion of the impressive explanatory power of Marx's theory.)

I turn now to an examination of Mankiw's presentation of the marginal productivity of distribution.

1. Factors of production and the production function

The fundamental concept in marginal productivity theory is the production function, so Mankiw's exposition begins with the production function and factors of production. Factors of production are defined as "inputs used to produce goods and services". (47) Two factors of production are discussed: capital and labor. Capital is defined as the "set of tools that workers use: the construction worker's crane, the accountant's calculator, and this author's personal computer." One important omission from this set of inputs is *raw materials* (or intermediate goods in general). But in all goods-producing industries, raw materials are an essential input to the production of outputs. Thus there is a gaping hole in the foundation of marginal productivity theory – raw materials are missing in the production function. This important omission will be discussed further below.

The production function is defined as the relation between the quantity of inputs of capital (K) and labor (L) and the quantity of outputs (Y) (48):

$$Y = f(K, L)$$

It should be noted that all of these quantities are supposed to be physical quantities, not monetary quantities.

As an example of a production function, Mankiw discusses a bakery (this bakery example is used throughout the chapter).

> The kitchen and its equipment are the bakery's *capital*, the workers hired to make the bread are its *labor*, and the loaves of bread are its *output*. (48, emphasis added)

But how is bread is supposed to be produced without the raw material inputs of flour and yeast, etc.? Mankiw does not explain.

2. Factor prices

According to marginal productivity theory, the distribution of income is supposed to be explained in terms of the prices of the factors of production. The price of labor is wages and the price of capital is "rent". Why is the price of capital called rent, and not profit? Because this theory assumes that firms *rent their capital* (buildings and equipment), and the price of capital is the rent firms pay to the owners of the capital buildings and equipment.

This assumption that firms rent their capital equipment is of course extremely unrealistic; most firms own their own capital buildings and equipment (Mankiw makes the even more unrealistic assumption that firms rent their equipment from households!). The assumption of renting is made in marginal productivity theory in order to make it appear as if firms actually make a rental payment to the owners of capital, as one of the firms' costs, and thus to *re-conceptualize the return to capital as a "cost"*, rather than as a residual of price over cost, or a surplus, as the classical economists and Marx conceptualized the return to capital. But this unrealistic assumption does not turn an actual surplus into an actual cost.

As discussed in Part I of this paper, the price of capital (P_K) consists of two components: an explicit *depreciation* component (this period's cost of capital goods) (dP_G) and an implicit *interest* component (rP_G), which is the "opportunity cost" of investing in these capital goods rather than in alternative investments:

$$\mathbf{P_K = dP_G + rP_G}$$

Thus, the price of capital is not an actual market price, but is instead a hypothetical price constructed by adding an *implicit* "opportunity cost" to the actual cost of the capital goods. It is not clear why anyone would want to explain this unreal artificial price, which no one ever observes in capitalist economies.

Even more important, the redefined return to capital as "opportunity cost" is *taken as given* (both r and P_G), and not explained. Therefore, marginal productivity theory ultimately takes as given what is supposed to be explained – the return to capital.

Mankiw does not say anything about these components of the price of capital. Students are not told that the price of capital includes the *opportunity cost* of the rental capitalists (in Mankiw's case, of households), which is taken as given in the theory. Students are led to believe that this theory determines the return to capital by the supply and demand for capital, but that is not true; the return to capital is taken as given in this theory.

Mankiw also takes the supply of capital (and also the supply of labor) as given, and thus provides no theory at all of the supply side of the capital (or labor) market. In marginal productivity theory in general, there is no satisfactory theory of supply, either of capital or of labor. (The "theory" of the supply of labor makes the completely unrealistic assumption that workers in capitalism can *choose* the number of hours they want to work. And the supply of labor is in terms of hours, which is inconsistent with the demand for labor, which is in terms of workers; see below) Therefore, marginal productivity theory is at best a theory of the *demand*

for the factors of production (it has been called a "pseudo-distribution theory"). The next section will examine Mankiw's presentation of the marginal productivity theory of the *demand* for capital and labor.

3. Demand for factors of production

The demand for capital and labor is a decision made by individual firms; therefore the analysis is at the micro level. The main objective of firms in making these decisions it to maximize their profit, where profit is defined as:

$$\Pi = PY - [WL + RK]$$

where P is the price per unit of output, W is the wage rate per unit of labor, and R is the rental rate per unit of capital (whatever that is). Notice again that the cost of raw materials is missing from this definition of profit.

Mankiw starts with the demand for labor, which is supposed to be derived from the "marginal product of labor", which is defined as the extra output that results from adding one worker (not one hour) and holding all other inputs constant (including raw materials). However, as explained Part 1 of this paper, the marginal product of labor is not a legitimate concept, because output cannot be increased if raw material inputs are held constant. Therefore, the derivation of the demand for labor, based on the illegitimate marginal product of labor, is itself invalid.

Mankiw again uses the example of a bakery:

> "As a bakery hires more labor, it produces more bread." (52)

However, Mankiw does not explain how the additional worker is supposed to produce more bread without more flour and yeast. The additional bakery worker is a miracle worker! Jesus would be jealous.

Mankiw then explains how the demand for labor is supposed to be derived from this (illegitimate) concept of the marginal product of labor: firms hire workers up to the point where the wage per worker is equal to the marginal revenue product of labor (i.e. the marginal product of labor *times* the price of the output; i.e. MRPL = P x MPL). In other words, the cost of hiring an additional worker is compared with the marginal revenue generated by the extra output.

However, if real-world capitalists actually followed this profit maximization rule, *they would lose money*; because capitalists would not have taken into account the extra cost of the raw materials required in order to produce the additional output. Therefore, the actual marginal costs would be greater than the marginal revenue, and the capitalists would lose money on the extra output. Thank goodness that real-world capitalists don't follow the rules of marginal productivity theory![1]

The same logically contradictory theory is then applied by Mankiw to capital (based on the illegitimate concept of the marginal product of capital and a money-losing profit maximization condition), so the same criticisms apply and need not be repeated.

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[1] In the *General Theory,* Keynes commented in a footnote on the usual Marshallian practice of "equating wages costs and prime costs" (i.e. assuming no raw material costs):

> The results of such an analysis *have almost no practical application* since the assumption on which it is based is *very seldom realized in practice*. (p. 272; emphasis added)

4. From micro to macro and "economic profit"

In the next subsection ("The Division of the National Income"), Mankiw suddenly jumps from individual firms at the micro level to the economy as a whole at the macro level, without mentioning to students the well-known impossibility of this aggregation (i.e. the "aggregation problem"). If the many different kinds of capital buildings and equipment are to be aggregated, their quantities must be reduced to some common unit of measure. What is the common unit in terms of which the many different kinds of capital are supposed to be measured and aggregated? One can excuse Mankiw for not answering this question, since there is no answer; but there is no excuse for not even mentioning to students this fundamental logical requirement. It teaches students to memorize, not to think.

In this section, Mankiw introduces the following idiosyncratic definition of "economic profit":

Mankiw's economic profit = Y - (MPL x L) - (MPK x K)

Mankiw's definition of "economic profit" is a *macroeconomic* concept, which has to do with the distribution of the total national income.

However, the usual definition of economic profit is a *microeconomic* concept in the theory of the individual firm:

usual economic profit = accounting profit – opportunity cost

where "opportunity cost" is the prevailing interest that could be earned on alternative investments. This usual micro definition of economic profit has no meaning at the macro level, since there are no alternative investments at the macro level. Another important difference is that this usual micro definition of economic profit is in money terms and Mankiw's definition is in terms of real physical quantities of output.

It is very confusing and unfair to students to use the same term "economic profit" in a way that is different from what students have learned in their micro courses, and to not even call attention to this important difference. Good students will notice this inconsistency; what will they think? Will they ask questions, or will they just accept and memorize on Mankiw's authority? I hope not the latter.

Who gets this macro "economic profit", since it is not a return capital nor a return to labor? Mankiw's answer: a third "agent" called "firms". However, this odd innovation is logically inconsistent with marginal productivity theory, according to which incomes are determined by the marginal products of the factors of production. But "firms" are not a factor of production, and "firms" do not have marginal products. Instead, according to Mankiw, the macro "economic profit" depends on the *returns to scale* of the "aggregate production function" (the usual micro definition of economic profit has no relation to macro returns to scale, or to any production function for that matter). According to Mankiw, if returns to scale are constant (i.e. if the production function is linear and homogenous), then "economic profit" = 0. But according to micro theory, competition enforces economic profit = 0 in the long-run, no matter what the returns to scale of the "aggregate production function".

It is ironic that Mankiw attempts to rescue marginal productivity theory by appealing to returns to scale, because another important criticism of marginal productivity theory over the last century (starting with Pareto) has been precisely that is it logically inconsistent unless the "aggregate production function" has constant returns to scale. This criticism has come to be known as the "exhaustion problem". If the production function has constant returns to scale, then the total product is "exactly exhausted" by the returns to the factors, and the theory is

consistent in this respect. However, if the production function has non-constant returns to scale, then either the product is "not exhausted" (a surplus due to increasing returns to scale) or the product is "more than exhausted" (which is physically impossible). Therefore, Mankiw's attempt to add a third "agent" to receive economic profit – or to pay it! – is not a solution to the exhaustion problem. It only adds contradictions on top of contradictions.

Mankiw states that constant returns to scale is the most likely scenario, in which case economic profit = 0. Mankiw then asks: how do we explain profit in the real world and in the NIPA's (National Income and Product Accounts)? (good question!) Mankiw's answer: profit in the real world is *accounting profit*, not economic profit; and because most firms actually own their own capital (rather than renting capital from households, as assumed in the theory), accounting profit includes both rent (from capital) and economic profit (from somewhere). What capitalists and NIPA statisticians call "profit" is really mostly rent, and in the case of constant returns to scale, it is all rent.

It is interesting that, in order to explain the apparent contradiction between marginal productivity theory (economic profit = 0) and the existence of profit in the real world, Mankiw drops the unrealistic assumption that firms rent their capital equipment, which was supposed to help us understand the distribution of income, and assumes instead that firms own their own capital. But if firms own their own capital, why is income from capital called "rent", and why is it pretended that firms pay rent to themselves?

At the end of this section, Mankiw states:

> We can now see the answer to the question posed at the beginning of this chapter about how the income of the economy is distributed from firms to households. Each factor receives its marginal product and these factor payments exhaust the output. (56)

I argue, to the contrary, that the question of the distribution of the national income has in no way been satisfactorily answered by this chapter (nor by marginal productivity theory in general), for the following reasons: (1) the theory cannot be reasonably be aggregated, and thus there is *no theory* of the macro distribution of income; (2) the concept of marginal product is *physically impossible* in goods-producing industries, because output cannot be increased by an increase of labor or capital without also an increase of raw material inputs. (3) the theory *takes as given* what is supposed to be explained – the return to capital – which is renamed "opportunity cost" and taken as given by firms, like all other costs; and (4) aside from these fundamental and insoluble logical problems, the theory is also logically contradictory if returns to scale are not constant.

5. Cobb-Douglas aggregate production function

Mankiw's last two sections on marginal productivity theory have to do with empirical data related to the distribution of income that Mankiw claims provides confirmation of the empirical validity of marginal productivity theory. The first of these two sections is about the familiar (but non-existent) Cobb-Douglas "aggregate production function":

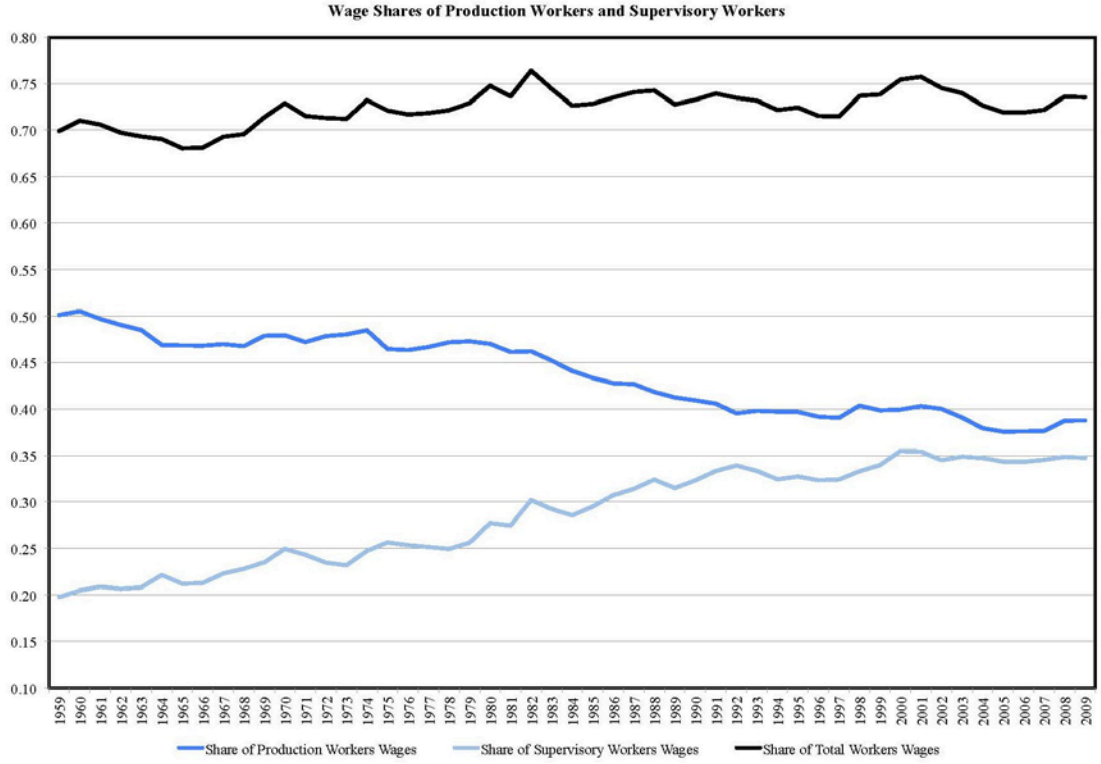
$$Y = A K^{\alpha} L^{1-\alpha}$$

Again, no mention is made about the units in terms of which the aggregate K is supposed to be measured and how the many different kinds of capital buildings and equipment are

supposed to be added up into a single aggregate quantity. Mankiw treats K as if it were an aggregate quantity, and thus pretends that marginal productivity theory provides a quantitative macro theory of the distribution of income; but this is not true. (A similar "aggregation problem" also applies to Y, which consists of many different kinds of goods and services). Also, again, no mention is made of raw materials and how physical outputs are supposed to be produced without raw material inputs.

Mankiw emphasizes that a Cobb-Douglas production function predicts that the *income shares of capital and labor will remain constant over time*. He presents data on the wage share of income in the US from 1960 to 2010, which remains roughly constant over this whole period at around 0.70, which Mankiw argues "confirms" marginal productivity theory.[2]

Figure 1



Note: For private economy
Source: National Income and Product Accounts, Bureau of Labor Statistics

However, Mankiw's definitions of labor and the wage share are too aggregate, and this misspecification hides important recent trends in the distribution of income in the US economy. If total labor is disaggregated into production workers and supervisory employees, some very interesting and important trends are discovered. The wage share of production workers has decreased significantly since 1980 (from 50% to under 40%), and the wage share of supervisory employees has almost doubled over this same period (from 20% to

[2] 50 years ago, Robert Solow (1958) expressed "skepticism" about marginal productivity theory's prediction of constant shares. The main reason Solow was skeptical was that marginal productivity theory is a micro theory, and the relation between micro production functions and macro relative shares depends "on a whole string of intermediate variables (elasticity of substitution, commodity demand and supply, degree of competition and monopoly in markets, etc.), so that "it is *hard to believe that the theory offers any grip at all* on relative shares," which "may be viewed by some as a *symptom of its emptiness*." (p. 620; emphasis added). Count me among the critics. Nothing but emptiness in this theory.

35%). These divergent trends can be seen in the following graph (the data for this graph was provided by Simon Mohun).

These divergent trends have contributed greatly to the widely-discussed and disturbing sharp increase of inequality in the distribution of income in the US in recent decades.

However, these important recent trends cannot be explained by marginal productivity theory with a Cobb-Douglas "aggregate production function" (even if we ignore all the insoluble logical problems discussed above), because this theory concludes that wage shares should remain constant.

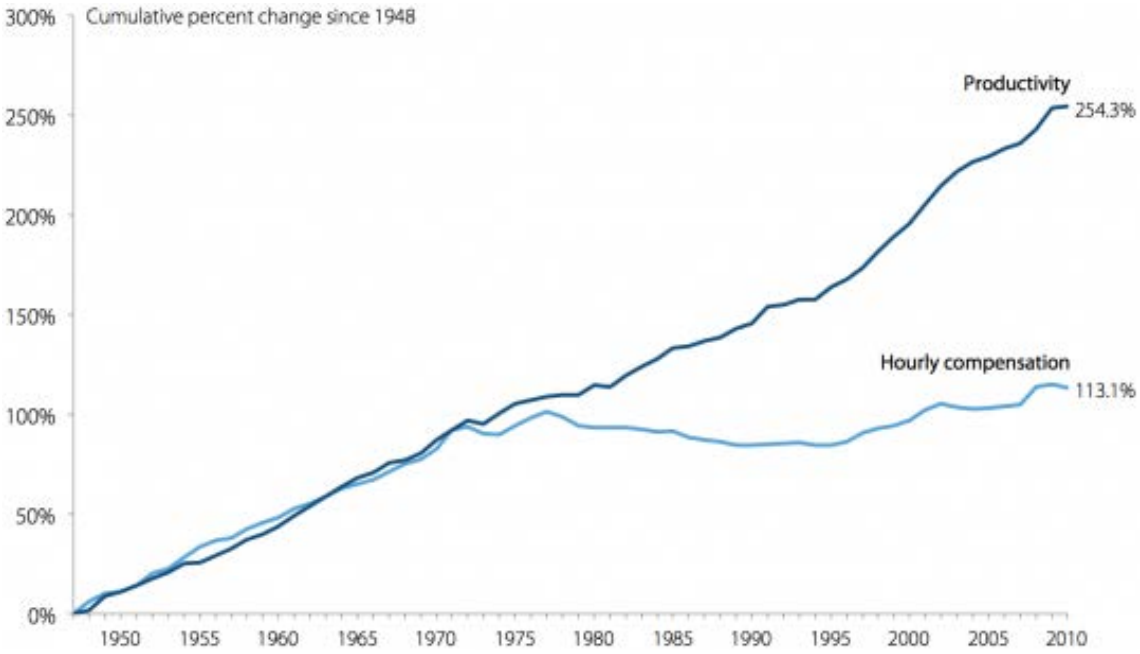
Marxian theory, on the other hand provides a cogent explanation of these important recent trends. According to Marxian theory, the main cause of these trends was the weakening bargaining power of production workers in recent decades, due to slow GDP growth and relatively high unemployment, to globalization and out-sourcing, and the threat of more. In addition, government policies have been more strongly pro-capitalist (anti-unions, reduced real minimum wage, etc.), which has further reduced the bargaining power of production workers. As a result, production workers have produced more and more output and more and more value, but they have not received the extra value they have produced. Instead, this extra value has been appropriated by the capitalists and top executives. The distribution of income in capitalism is not determined by "marginal products" (which don't exist), but instead is determined by class conflict, i.e. by the balance of power between capitalists and workers, which depends mainly on the rate of unemployment, government policies, and the degree of organization of workers.

6. Labor productivity and the real wage

Mankiw's section presents data on the productivity of labor and the real wage in the US economy from 1959 to 2007. Mankiw emphasizes that marginal productivity theory with a Cobb-Douglas "aggregate production function" predicts that the trend in the real wage will be similar to the trend in the productivity of labor (this is a condition for a constant wage share). Mankiw divides the whole period into three sub-periods, and presents a table of estimates (Table 3-1) which shows that the real wage and the productivity of labor had similar trends in all three subperiods.

However, once again, Mankiw's estimates are too aggregate and hide important recent trends. If we disaggregate these estimates again into production workers and supervisory employees, and calculate the real wage and productivity separately for the two subgroups, we arrive at different and interesting results. Figure 2 shows the real wage and productivity of production workers over this period, and is a familiar graph in recent discussions of rising income inequality (this particular graph comes from Mishel 2012)

Figure 2
Growth of Real Hourly Compensation for Production/Nonsupervisory Workers and Productivity, 1948-2011



Note: Hourly compensation is of production/nonsupervisory workers in the private sector and productivity is for the total economy.
Source: Author's analysis of unpublished total economy data from Bureau of Labor Statistics, Labor Productivity and Costs program and Bureau of Economic Analysis, National Income and Product Accounts public data series

Thus we can see that since the early 1970s, the real wage of production workers has hardly increased at all, while their productivity has continued to increase roughly 2% a year. Over this whole period, the productivity of production workers increased 50% more than their real wage. This divergence explains why the wage share of production labor declined significantly over this period. The real wage and productivity of supervisory employees showed essentially the opposite trends over this period. Once again, these important divergent trends cannot be explained by marginal productivity theory, because this theory predicts that there should be no divergences.

Mankiw concludes this section with the following "lesson" for students:

> Theory and history confirm the close link between labor productivity and the real wage. This lesson is key to understanding why workers today are better off today than workers in previous generations. (60)

I argue, to the contrary, that if labor is disaggregated into production workers and supervisory employees, there is no close link between productivity and the real wage in recent decades. For both subgroups of labor, the real wage diverges significantly from productivity since 1980. And the lesson we learn from the data is that marginal productivity theory is not able to explain these important divergent trends. In particular, marginal productivity theory is not able to explain why the real wage of production workers has remained stagnant in recent decades, in spite of continuing and significant increases in their productivity. In other words, this theory cannot explain why production workers are no better off today than they were a generation ago.

Conclusion

I noted in the introduction that Mankiw asserts that marginal productivity theory of distribution is "accepted by most economists as the best theory of distribution". After this review of Mankiw's presentation of marginal productivity theory, one can only say, "I hope not!" If marginal productivity theory were the best theory of distribution that economists could come up with, then we would be doomed to ignorance forever. This theory is filled with logical contradictions and has no explanatory power. There is no macro theory of the distribution of income at all.

Fortunately, marginal productivity is *not* the best theory of the distribution of income. The Marxian theory of distribution is far superior to marginal productivity theory, both in terms of logical consistency and in terms of empirical explanatory power. So is the post-Keynesian theory of distribution. Therefore, we should continue to challenge marginal productivity theory every chance we get (on these objective scientific grounds), and we should teach and develop these more promising alternative theories of distribution. The emperor (mainstream economics) has no clothes (no theory of distribution, especially profit), and we should continue to shout out its nakedness, and continue to make our own clothes (alternative theories of distribution and profit).

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