MAINSTREAM ECONOMIC THEORY OF CAPITAL - LABOR SUBSTITUTION – ITS CRITIQUE FROM THE NEORICARDIAN POINT OF VIEW, MICRO AND MACRO CONTEXT

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Abstract

The paper focuses on the not well-known critique of neoclassic capital theory. This critique was made with the help of Professor Ian Steedman. Steedman concentrates himself on the problematic conclusion about the capital/product ratio dependence on the interest rate evolution. The neoclassic approach assumes that the higher interest rate is a reason for substitution of labor for capital in the production process. The mainstream economics speaks of a higher amount of the negative substitution effect than the amount of the prospective positive income/production effect. The Steedman critique weakens the conclusion about the efficient management of the interest rate to provide an optimal structure of the inputs of the firms. Although this critique is achieved with the neoclassic technique, it weakens the general solution of any firm or industry, which is proposed with the economic theory. The recommendation based on this critique is to concentrate on the industry specification and to think about potential individual industry policy. The Steedman critique belongs to both microeconomics and macroeconomic theory. Steedman in the way of modern neoclassic approach, which builds macroeconomy models (DSGE) based on the individual optimizing agents, argues against the whole macroeconomic policy based on the representative agent/ representative firm approach. His arguments are based on the most simple models.

Keywords: interest rate, consumption-industry production model, substitution, capital-to-product ratio

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Introduction

In this paper, we describe for many contemporary researchers a forgotten critique of the mainstream theory of firms, also with its impacts to DSGE modelling to macro-economy. Mainly it is about the assumption of substitution in the neoclassical theory of capital, as it represents for a long time, but lastly, for example, in Steedman (2008). The approach to the issue is not entirely new, but it is not a completely presented critique of conclusions of the neoclassical theory about the impact of changes in the prices of factors of production on the possibilities of substitution of capital. Let us add that the Neoricardian critical approach to mainstream and "Austrian" economics is seen not only by Steedman but also by other European authors in particular. The list of these authors should include Kurz (1997), the older literature being named Joan Robinson (Robinson, 1975). With regard to the focus of this comparison on Steedman's work, we include the literature in his coauthoring. These are Opocher and Steedman (2009) or Salvadori, Steedman (1985) and Metcalve and Steedman (1977). A Neoricardian critique of mainstream economics has been derived since Sraffa (1932). Nevertheless, with regard to the theory of capital, Steedman (1981, 1983, 1985, 1999) is particularly concerned with the literature review. Ian Steedman is the most known still living member of the so-called post-Ricardian approach. Ian Steedman was born in London in 1941 and graduated from Cambridge University (1961-1964) and Manchester University (1964-1967). He also attended an internship at the University of Florence under the Nuffield Foundation grant (1970-1971). He personally joined the two Cambridge discussions on the theory of capital. Furthermore, in 1972 he criticized the original Jevons theory of capital and interest. At that time, he was a strong proponent of neo-Ricardianism.

His lifelong work is a typical "Sraffian" critique of Heckscher-Ohlin-Samuelson theory of international trade. However, criticism of the law of substitution in the theory of capital is also very significant. Steedman points out that in a model where we assume two inputs and two outputs, the laws of the effect of changes in the volume of the relatively more expensive input may not hold as predicted by the neoclassical world (Arestis and Sawyer, 2001).

1 The microeconomic model of specific sectors with the assumption of fixed capital

The aim of the model is to point out the alternative conclusions obtained by the neoclassical method even when preserving standard assumptions. We will focus on the neoclassical model of the two-factor production function, namely the possibility of increasing the capital-to-

product ratio in a representative production system, which is caused by the growth of interest rate. This production system consists of only two sectors, the consumer goods industry and the capital goods sector. This is a very simplified model, but its expansion would certainly not be complicated. Neoclassical microeconomic theory presents a conclusion on the impact of a reduction in the capital-to-product ratio and the growth of the labor-to-product ratio, depending on the growth of the interest rate (growth of alternative capital costs). In other words, the substitution effect outweighs the potential positive production effect in the two-factor produced function presented (Gravelle, Rees, 2004). Steedman's idea, based on the Hicks-Samuelson-Spaventa approach, brings a very interesting extension of the standard neoclassical conclusion. This conclusion argues for active interest rate management in order to optimize employment in the economy (primarily by using inflation targeting).

We will focus on the principles of Garegnani (1970). Consider the input to output ratios; these are, the labor to product ratio and the capital-to-product ratio. We show that when the interest rate (price of capital) rises and the labor-to-product ratio is then first rising and the capital-to-product ratio declining. But from a certain level of the ratio the described dynamics is weaken and the ratios are also moving the opposite way. The decrease in the labor to product ratio as a result of the increase in the interest rate. In other words, it can even be argued that the labor-to-product ratio is very small for very small and very high interest rates, while the capital-to-product ratio is slightly lower for high interest rates than for low. Let us add that we absolutely look beyond the problem of reswitching. We do not consider possible transitions to more efficient technologies, which is certainly a very strong assumption. The problem of reswitching is the product of two Cambridge disputes (Sraffa, 1975). In this dispute, the usability of the aggregate production function was argued for and against. Based on criticism by Pierro Sraffa and Joan Robinson, P. Samuelson in his "*A Summing Up*" (Samuelson, 1966) recognizes the arguments of the opponents but does not preclude the applicability of aggregate production function as such. These functions are used in economics today without limitations. In addition, their logic implicitly limits the possibilities of conclusions obtained on the basis of DSGE modelling. The reasons for not closing the two Cambridge discussions after Samuelson's recognition of opponent's arguments are basically three (Garrison, 2006).

First, these paradoxes are not as controversial as the consequences are fully understood. Second, the specific temporary profiles of technologies susceptible to reswitching are sufficiently unpredictable to justify forgetting the fundamental principles of aggregate supply. Third, we do not see any other current paradoxes that would be identified with "European" Cambridge.

Nevertheless, Joan Robinson does not accept such a problem solving, and even weakens the method of comparative statics in economics (Robinson, 1975). Let us now return to the problem Ian Steedman presents on the convincing model of a corn tractor economy. The very simple production model of the Corn Tractor assumes that for a given technology, a certain amount of machinery and human work is needed to manufacture these machines (Tractor) or consumer goods (Corn). We consider constant returns from scale, and further we assume that machine production requires a units of machines and b units of labor. For the production of consumer goods, there is a need α units for machines and β units of work. The national product of such a simple economy would be determined by the standard rule $\gamma = \alpha\beta$. We also assume that the share of capital to work is the same in both sectors. Therefore, $\alpha b = a\beta$ (Hicks' assumption for the model). In the first step, we assume the participation of fixed capital only, not the involvement of circulating capital (intermediate products in production). Of course, we must assume constant production efficiency and a short life period of the machines involved in production in both sectors. We can even assume different degrees of capital depreciation in the sectors, which makes the analysis more complicated, but the qualitative conclusion will be the same. We must realize the premise that old machines cannot be mobile between sectors.

The value of the income paid (production value) in the first sector (tractor) is observable according to (1). We assume that the value of production in the first sector, in the industrial sector (the value of the flow, for example, per year), is equal to the cost of labor and the cost of capital |(income approach). The second part consists of the physical volume of capital and the capital cost. We assume that the capital is being financed by a loan. We assume the standard time value of money and also the interest calculations. The life span of capital in the industrial sector is for years.

$$p = bw + ap_k \frac{r(1+r)^n}{(1+r)^n - 1} \tag{1}$$

Analogously, the output value is realized in the second sector (in the consumer sector). Again, the cash flow of the physical product per year is calculated according to formula (2). We assume that the value of production is also equal to the amount of income paid in the consumer sector. As in the case of industry, capital is also financed by the loan in the consumer sector. On the contrary, the life span of capital in consumer sector is in the years.

$$\pi = \beta w + \alpha p_k \frac{r(1+r)^\nu}{(1+r)^\nu - 1} \tag{2}$$

We see that we consider the different lifetimes of capital in different industries in the model, but we emphasize once again that we do not expect the possibility of reselling older capital equipment between industries. Incorporating such a precondition would again make the model complicated. Recall once again that the assumed share of capital to work is the same in both sectors.

$$\alpha b = a\beta \tag{3}$$

How will the capital-to-product ratio in both sectors evolve, depending on the *r*? We first show the concrete periods *n*. Moreover, we make a generalization.

2 Specific conclusions of the fixed sector specific sector model

We will now deal with the model in the case of set specific parameter values. These are parameters of the model time in terms of valuation of the value of capital in both the core and noncore sectors. Within the specific parameter values, we will then follow a qualitative change in the conclusions.

First, we analyze the life of capital in the sectors of n = 2 and v = 1. The capital-to-product ratio *k* is in the basic sector ("machine industry") in this situation equals the expression.

$$k = a\frac{(1+r)}{(2+r)} \tag{4}$$

Examining this functional dependence, we find that *k* grows with *r*. It is the determination of the values of the first derivative *k* to *r*. This is always positive. In the second step, we will focus on the consumer industry. The share of capital in the product in this sector is the same as in the machinery industry. We will examine this share of capital in the second sector in terms of interest rate developments analogously to the previous procedure.

$$\kappa = \frac{a(2+r)}{(2+a)+(1+a)r} \tag{5}$$

The derivative of Equation (5) according to *r* is always negative using the derivation rule. As *r* rises, κ always falls, following the standard neoclassical conclusion of substitution.

However, we see that there is at least one sector in which this conclusion appears to be invalid. On the machinery side, we are considering that the decrease in *r* causes a decrease in the share of capital on the product (increase in the share of work on the product). Let us sum up a bit, in the very simple economy of two sectors where there is a certain interaction between them, it is proved that option of substitution between the input factor due to change in factor prices is different in those two sectors. In the consumption, good industry standard assumptions to

production functions is confirmed. The same rule is rejected in the machinery sector. This is why neo- Ricardians see the DSGE modelling approach as unsatisfactory. Economic agents and their characteristics change among industries. The reason is that the economy surely does not consist only of good consumption and good industries. Moreover, a good consumption industry is not conceivable without the machinery industry. Furthermore, the DSGE approach assumes a common labor market and capital market for all industries in the economy. We could continue with other arguments against the DSGE principles.

Of course, we have to add that we do not consider the possible existence of price discrimination, and we are considering standard assumptions of neoclassical microeconomics, especially those with a large number of companies (perfect competition).

We will now deal with the model if we introduce other parameter values.

Second, we perform the analysis assuming that n = 1 and v = 2. In this particular case of the model, we calculate the share of capital on the product in sectors a. These shares acquire values (6) and (7).

$$k = a \tag{6}$$

$$\kappa = \frac{a(1+r)}{(2-a)+(1-a)r} \tag{7}$$

Assume that the amortization period of capital in the supposed sectors does not respond to *r* (the share of capital in the product in the industry is independent of the interest rate). The share of capital in the product grows with growth *r*. What is important is again the weakened neo-classical conclusion of the substitution of input factors in response to a relative change in their prices. Let us examine the extension of the model to a longer period of amortization of capital in both sectors.

Third, we will provide an analysis of capital life expectancy in the sectors of n = 2 and v = 2. In the case of the same lifetime period of capital in the sectors, the share of capital in the product in both the industrial and consumer sectors is identical in the amount of Equation (8).

$$k = \kappa = a\frac{(1+r)}{(2+r)} \tag{8}$$

We have shown that the value of this first derivative is always positive. Therefore, the share of capital in the product is positively affected by the change in the interest rate *r*. In the previous case, we considered six examples of capital shares for the product. From these cases only in one case was an expected response of the capital/product volume.

In other words, the relatively more expensive capital was replaced by relatively cheaper labor (the share of capital on the product declined with interest rate growth). For the other four situations, we see a positive impact on the share of capital in the product (and therefore there is necessarily a negative impact of the change in the interest rate on the share of the work on the product). From the presented point of view, the DSGE approach seems very weakened with its forecasts.

In this article, the model presented considered six possible sectors (production systems). The negative impact of the interest rate on the capital-to-product ratio is observed in only one production system. In the other five sectors, the positive effect of the interest rate on the capital-to-product ratio is observed.

Repeat the assumptions of the previous analysis. We assume the participation of only fixed capital (not circulating capital. Circulating capital means the volume of capital inputs in the form of intermediate products). Furthermore, we do not consider the sale of fixed (physical) capital between sectors (we assume the short-term durability of fixed capital) and we have assumed the same value of the share of capital and labor in different sectors.

When we leave the last-mentioned assumption and when we assume longer time horizons (both at level *n* and level *v*), a existence of the positive influence interest rate *r* to the capital product ratio *k* will not be definitively eliminated.

3 The microeconomic model of specific sectors with the participation of circulating capital

Circulating capital means the possibility of reselling older capital equipment in production systems (Steedman, 2005). Moreover, we also assume the option of capital appearance in the form of intermediate products (change in inventories, goods in progress). Consider a system of production where we assume the value of the products as

$$p = we + (1+r)\,p_A A \tag{9}$$

where *e* is the employment vector. All other variables are standard. Let us add that for all modes of production, we assume the same character of the yields from the scale. The share of capital to work (vector) in the *j*-sector is as follows.

$$k_j = \frac{p_a^j A_j}{p_j} = (1+r)^{-1}\left[1 - e_j\left(\frac{w}{p_j}\right)\right] \tag{10}$$

Steedman (2009) presents at least three options to prove the expected conclusion of this problem. First, for the *j*-th branch, the share of the estimated capital for the product depends on the following sum.

$$k_j = \sum_i a_{ij} (p_i / p_j) \tag{11}$$

It is quite certain that the change in *r* will cause changes in all production prices. We will certainly be able to build an order by the percentage of price changes in our production system.

$$\hat{p}_1 \succ \hat{p}_2 \succ .... \succ \hat{p}_n \tag{12}$$

Based on this inequality, we can deduce that k_1 decreases with increasing *r*, while k_n increases with increasing *r*. At least one share of capital for the growth of the product grows with the interest rate ($dk_j / d_r > 0$) for any interest rate. Of course, it is inevitable that *j* depends on *r*.

The second way of proof is based on the condition of general solvability of the system of equations. Steedman refers to the conclusions of the Perron-Frobenius theorem, which assumes the solvability of the following matrix equations (13) and (14).

$$pAx = \alpha(px) \tag{13}$$

$$p\hat{k}x = \alpha(px) \tag{14}$$

where the diagonal matrix is created from elements k_j. For any *r,* the weighted average k_j is equal to α. Therefore, at least one k_j and at least one k_j. Similarly, if $w = 0$, and $\alpha (1 + R) = 1$, then all $k_j = \alpha$. Therefore, as *r* grows to *R*, there must surely be at least one $dk_j / dr > 0$.

The third and last way to prove the invalidity of the neoclassical law of substitution lies in the necessary validity of equations (15) and (16). Of course, as in standard economic theory, we assume only positive values p.

$$p(\hat{k} - A) = 0 \tag{15}$$

$$\left|\hat{k} - A\right| = 0 \tag{16}$$

In this case, matrix **A** defines a set of k_j. For any real *e* different from the condition $e\mathbf{A} = \alpha e$, the vector *k* after the set **A** moves with growth *r*. However, how can we say that at least one $dk_j / dr > 0$? Let us suppose that the matrix of positive elements (a_{n1}, a_{12}, a_{23}, ..., $a_{n-1,n}$) is not primitive and the other a_{ij} are zero.

It is a fact that

$$k_1 k_2 k_3 ... k_n = (1 + R)^{-n} \tag{17}$$

for all possible *e* and for all possible (1 + *r*). Again, there must exist at least one $dk_j / dr > 0$. However, this conclusion can be even more pronounced. The following property share of the capital to the product will be very beneficial.

Valid

$$\dot{k}\hat{p} = \dot{p}(A - \hat{k}) \tag{18}$$

and with Equation (9) with $w = 1$, we import the following relationship.

$$p = e + (1+r)\, p_A A \tag{19}$$

respectively

$$\hat{p}\left[I - (1+r)A\right] = pA \equiv p\hat{k} \tag{20}$$

or

$$\dot{k}\hat{p} = p\hat{k}B - pB\hat{k} \tag{21}$$

where

$$B \equiv \left[I - (1+r)A\right]^{-1} A = A\left[I - (1+r)A\right]^{-1} \tag{22}$$

For the *j*-th element (branch), we observe the shape [23].

$$\left(\frac{p_j}{pB_j}\right)\dot{k}_j = \left(\frac{p\hat{k}B_j}{pB_j}\right) - k_j \tag{23}$$

Since $B_j > 0$ we see that it is positive / negative as the weighted average kB_j minus k_j. Let us add that there must be a tendency for certain k_j to converge as soon as *r* grows. In other words, for each value *r*, for a high k_j, k_j will decrease as *r* increases. This is true vice versa. For each value *r*, the low k_j increases as the *r* increases. Let us add that it is not quite clear how the average high k_j will behave.

Let us also consider a very special case where the rows of matrix **A** are linearly dependent on each other (but not linearly dependent on the vector *e*). For any vector *e*, the share of capital in the product must be a simple linear function of the interest rate, which is at least one growing and at least one decreasing. Therefore, it is possible for all $k_j(r)$ to be monotone functions.

The second conclusion of the model is the consequence of the assumption of nonmaturity of the matrix **A**. The rows in this matrix are mutually orthogonal. Such an assumption causes a contradiction to the conclusion from the previous paragraph for at least one k_j. Therefore, it is proved that inevitably in an economy with circulating capital with fixed coefficients for each

size of the interest rate, we have at least one *j* that we observe in reaction (dk_j / dr)> 0 in this branch.

Conclusion

In conclusion to the presented analysis, we add that Steedman (2008) additionally proved that the conclusions are valid even in an environment where the change in the interest rate leads to a change in technology. We describe evidence about the production function with circulating capital (possible resale of older capital in any proportion), but also on the model of specific sectors with fixed capital.

Let us summarize the conclusions presented by controversial criticism of the neoclassical theory of substitution at the microeconomic firm and industry (moreover, the impact to the DSGE agent-based modelling). First, in contemporary microeconomic theory and practice, greater attention should be paid to the specifics of companies and industries and their interconnections. The simplifying of the assumptions considered by homogeneous companies, industries, consumers, and firms is the driving force behind contemporary economic theory. It is true that the new Keynesian economy approach brings about a certain departure from virtually incompatible models (rigidities, efficiency wages, etc.). However, in the field of microeconomics, homogeneity assumptions for industries and their firms are still advocated.

On the basis of the findings, it turns out to be a very distorting assumption of the "black box" for the general firm and more industry. Thus, it is necessary not only practically but also theoretically to introduce sectoral differences to understand the functioning of the influence of prices on the volumes of factors of production. In other words, we are able to weaken the possibility of generalizability (time, local, product), as assumed in standard neoclassical microeconomics, specifically for the conclusions of the input substitution theory.

Second, we have succeeded in demonstrating the usefulness of replacing both current microeconomic models of capital ratios with the work of a capital indicator relative to the product. This indicator provides a better understanding of the capital intensity of the production system. With regard to constant yields on a scale, which is a standard assumption, especially in macroeconomics, replacement of the indicator should not have negative effects.

Third, we have raised the debate about the need to start looking at rather simple fixed-capital production models. Therefore, do not automatically accept the standard neoclassical assumption of variable capital over a long period (not to focus primarily on a long period).

Now, to summarize, whether we consider the existence of a single, a few, or infinite number of input techniques in outputs, it is shown that the capital-to-product ratio might grow as the interest rate increases. Of course, in some cases the positive relationship is impossible, but at least in one sector a positive relationship is always observed. So why should we insist on the conclusion of the neoclassical input substitution theory that a higher interest rate will lead to a decrease in the share of capital on the product?

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