

An Essay on Marxian Economics¹

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1. Introduction

In this essay we propose to discuss some aspects of Marxian economics in the light of modern economic theory. In particular, we want to lay stress on the types of technical change implied in Marx's thinking. In order to arrive at some rigour of the analysis we shall start from a model developed by Samuelson², which has been used to harmonize neoclassical and Marxian conclusions to some extent. Although, we do not base our considerations on the view that a capitalist economic system adjusts itself to technical change in the smooth way, as Samuelson assumed, we employ his model as a starting point for our analysis. The plan of the paper is as follows. In section 2 we describe the main features of Samuelson's model. Section 3 is devoted to a compact synopsis of Marx's opinions on technical change. In section 4 we describe in short Marx's position with respect to the compensation theory of labour. In sections 5 and 6 we study the relations between the accumulation process, labour productivity and the organic composition of capital. Types of technical change are discussed in section 7. Section 8 is devoted to an analysis of the relations between technical change and the labour market. Then we make some remarks on the impact of technical change on the market form. In section 10 some conclusions are formulated.

2. Samuelson's model of Marx

Following Samuelson's interpretation of Marx, we introduce two industries I and II. Industry I produces homogeneous capital goods called K and industry II produces homogeneous consumption goods called Y. Production in both industries requires homogeneous labour $L_1 + L_2 = L$ and capital goods $K_1 + K_2 = K$. We restrict ourselves to the case of simple reproduction. We assume that the production functions are of the Leontief type and that the capital stock adjusts itself to the fixed quantity of labour L.

So we deal with the following set of relations:

$$\begin{array}{ll} L_1 = a_1 K & K_1 = b_1 K \\ L_2 = a_2 Y & K_2 = b_2 Y \end{array}$$

Where (a_1, a_2, b_1, b_2) are technical coefficients, all > 0 . The system can be summarized by:

$$\begin{aligned} a_1 K + a_2 Y &= L \\ b_1 K + b_2 Y &= K \end{aligned} \quad (1)$$

Now K and Y can be expressed in terms of the given quantity of labour L .

$$\begin{aligned} Y &= \frac{1-b_1}{a_2(1-b_1)+a_1b_2} \cdot L \\ K &= \frac{b_2}{a_2(1-b_1)+a_1b_2} \cdot L \end{aligned} \quad (2)$$

Samuelson now introduces a price system (p_1, p_2, w, r) , where p_1 is the price for capital goods, p_2 the price for consumption goods, w the wage rate and r the rate of interest. Assuming perfect competition the following price relations hold:

$$\begin{aligned} p_1 &= (w a_1 + p_1 b_1) (1+r) \\ p_2 &= (w a_2 + p_1 b_2) (1+r) \end{aligned} \quad (2')$$

For the relation of p_1 and w we find the following expression:

$$\frac{p_1}{w} = \frac{a_1(1+r)}{1-b_1(1+r)} \quad (3)$$

It is also possible to calculate the real wage rate w/p_2 from the model. Now the following money flows can be calculated for the two sectors:

$$\begin{aligned} p_1 K &= (w L_1 + p_1 K_1) (1+r) \\ p_2 Y &= (w L_2 + p_1 K_2) (1+r) \end{aligned} \quad (4)$$

Samuelson proposes to interpret $p_1 K_1$ as the Marxian constant capital C_1 and $p_1 K_2$ as the Marxian constant capital C_2 . Furthermore, it has been suggested that we consider $w L_1$ and $w L_2$ as the Marxian variable capital V_1 and V_2 respectively, so that the surplus values S_1 and S_2 are the differences between the receipts of industry I or industry II and the sum of the constant and variable capital $C_1 + V_1$, or $C_2 + V_2$ respectively. For S_1 and S_2 we get:

$$\begin{aligned} S_1 &= (C_1 + V_1) r \\ S_2 &= (C_2 + V_2) r \end{aligned} \quad (5)$$

As we shall make extensive use of the concept of the "organic composition of capital" we derive an expression for it in terms of Samuelson's model. Let us define the organic composition of capital as C_1/V_1 , we then have:

$$\frac{C_1}{V_1} = \frac{p_1 K_1}{w L_1} = \frac{a_1(1+r)}{1-b_1(1+r)} \cdot \frac{b_1}{a_1} = \frac{b_1(1+r)}{1-b_1(1+r)} \quad (6)$$

$$\frac{C_2}{V_2} = \frac{p_1 K_2}{w L_2} = \frac{a_1(1+r)}{1-b_1(1+r)} \cdot \frac{b_2}{a_2} = \frac{a_1 b_2(1+r)}{a_2[1-b_1(1+r)]} \quad (7)$$

$$\frac{C}{V} = \frac{C_1 + C_2}{V_1 + V_2} = \frac{p_1 K}{wL} = \frac{a_1(1+r)}{1-b_1(1+r)} \cdot \frac{b_2}{a_2(1-b_1)+a_1b_2} = \frac{a_1b_2(1+r)}{\{1-b_1(1+r)\}\{a_2(1-b_1)+a_1b_2\}}$$

The condition for the equality of the organic composition of capital in both sectors reads $a_1b_2 = a_2b_1$.

Some of the typical conclusions of Marx are consistent with this model of Samuelson and others are not. The next sections give some attention to this matter.

3. *Technical change in Marxian economics*

In the sketch Marx gives of the development of manufacturing which can be conceived of as the starting point for industrial capitalism, the influence of the changes in the structure of production on the division of labour has been made clear repeatedly. Marx illustrates the interwovenness of the relations that characterize the continuously changing conditions of production by looking at the division of labour as a consequence of dynamics. As soon as manufacture reaches a certain size, it becomes the typical form of the capitalist mode of production, but at the same time its own narrow technical basis conflicts "... mit den von ihr selbst geschaffnen Produktionsbedürfnissen"³.

Manufacture creates the field of application for the construction and production of machines: "Dieses Produkt der manufakturmässigen Theilung der Arbeit produzierte seinerseits – Maschinen⁴." The end of manufacture is the beginning of big business, of mechanisation and of accumulation of capital. Each movement, even the smallest one, is a fundamental change. Capital "... muss die technischen und gesellschaftlichen Bedingungen des Arbeitsprozesses, also die Produktionsweise selbst umwälzen, um die Produktivkraft der Arbeit zu erhöhen..."⁵. We note that Marx, in order to explain the main lines of the evolution and to relate them to micro-economic details, devotes much more attention to the factual aspects of machinery than his predecessors. It seems as if Marx uses a magnifying glass in order to improve the position of the telescope. His description runs from tools to automatic systems and leads to the conclusion that the technical basis of big business is the production of machines by machines. The new type of division of labour depends on the nature of the machines. Machinery overthrows the old system of division of labour. In the manufacture the workman was a tool, "in der Fabrik dient er der Maschine"⁶. The accumulation of capital consists of the transformation of surplus value in dead production factors and living labour. The first category Marx calls constant capital, the second category he calls variable capital. Surplus value only springs from variable capital. The composition of constant and variable capital in Marxian terminology is the "organic composition of capital". Marx starts from the assumption that the organic composition of capital remains constant, so that "... eine bestimmte Masse Produktionsmittel oder konstantes Kapital stets dieselbe Masse Arbeitskraft erheischt, um in Bewegung gesetzt zu werden..."⁷. The demand for labour then is in proportion to the growth of capital. In this case it is possible that the demand for labour is greater than its supply, so that "... die Arbeitslöhne steigen"⁸. Although this situation may be considered favour-

able for the workmen, it does not bring to an end "...das Abhängigkeitsverhältnis und die Exploitation"⁹. As long as the increase of wages does not slow down the rate of accumulation, the increase of wages may continue. As soon as pessimistic profit expectations play their part, however, the wage increase and its effect disappear together. The capitalist mechanism "...besiegt also selbst die Hindernisse, die er vorübergehend schafft"¹⁰.

Marx now considers the case in which the "böartige Voraussetzung"¹¹ that the organic composition of capital remains constant, does not hold. Capitalism always produces a phase in which the accumulation of capital implies a permanent change in the organic composition of capital. These changes are related to the increase of labour productivity: "Die Massen der Produktionsmittel, womit er (the labourer, A.H.) funktioniert, wächst mit der Produktivität seiner Arbeit"¹².

As a consequence of the increase of labour productivity constant capital increases and variable capital declines, so that the organic composition of capital rises. The accumulation goes hand in hand with the concentration of more capital in the hands of many individual capitalists. On this footing large-scale industries can be built in order to raise the productivity of labour again. This type of concentration is limited by the rate of growth of the "...gesellschaftlichen Reichtums"¹³ and is also characterized by a uniform distribution of capital over many capitalists, who as producers compete with each other. Concentration in this sense should be clearly distinguished from centralization: "Es ist Konzentration bereits gebildeter Kapitale, Aufhebung ihrer individuellen Selbständigkeit, Expropriation von Kapitalist durch Kapitalist, Verwandlung vieler kleinerer in wenige grössere Kapitale"¹⁴. Centralization is not limited by the growth of production and accumulation. Competition expels the producers who hesitate to introduce new methods of production because they are not able to lower their prices, a price cut being made possible by an increase of labour productivity. Labour productivity does not only depend on improved technology but also on the scale of production. "Die grösseren Kapitale schlagen daher die Kleineren"¹⁵. This again implies a fundamental change in the structure of production, because the centralization indicates the period in which large-scale industry came up in order to deal with big projects, such as the construction of railroads.

Centralization embodied in the form of innovations, increases the social power of capital. During the process of accumulation, the capitalist has been modified from a powerless object to a subject with power.

4. The labour market

Marx underlines the well-known opinion of Ricardo: "Machinery and labour are in constant competition"¹⁷. Marx also distinguishes between sudden and evolutionary forms of mechanization, but in both cases labour is on the wrong side of the table. The kind of optimism one finds in the different types of the compensation theory is not shared by Marx. If labourers thrown out industry A can find work in industry B, this is due to new investment, but not to a change in the existing structure of capital.

Only new capital formation can create employment. If accumulation takes place with a constant organic composition of capital, the demand for labour rises. These periods are periods of rest in capitalistic development, but with the progress of accumulation they become shorter, the organic composition of capital augmenting as a consequence of the increase of labour productivity and centralization becoming more important. The industrial reserve army increases while the substitution of capital for labour overcompensates the demand for labour due to accumulation, to "Luxusproduktion" and to the use of labour in unproductive jobs. Wages going down, the demand for consumption declines, which again weakens the motive to invest. "Die Akkumulation von Reichtum auf den einen Pol ist also zugleich Akkumulation von Elend, Arbeitsqual, Sklaverei, Unwissenheit, Brutalisierung und moralischer Degradation auf dem Gegenpol, d.h. auf Seite der Klasse, die ihr eigenes Produkt als Kapital producirt¹⁸."

5. Accumulation, labour productivity and organic composition of capital

Let us try to study more carefully the relations between accumulation, labour productivity and the organic composition of capital. To this end we start from the stationary variant of Samuelson's model, which makes clear the Marxian division of the economy in two sectors and defines Marxian concepts in a straightforward way. Our procedure does not imply a judgement on the adequacy of Samuelson's model as a good description of Marx's theory.

In the following table the data we need for our investigation are summarized. For each sector we have calculated labour productivity, the capital-output ratio and the organic composition of capital. The quantities have also been determined for the economy as a whole. We shall consider the rate of interest as a constant.

	Sector I	Sector II	Total
Labour productivity	$\frac{1}{a_1}$	$\frac{1}{a_2}$	$\frac{1-b_1+b_2}{a_2(1-b_1)+a_1b_1}$
Capital-output ratio	b_1	b_2	$\frac{b_2}{1-b_1+b_2}$
Organic composition of capital	$\frac{b_1(1+r)}{1-b_1(1+r)}$	$\frac{a_1(1+r)b_2}{a_2-a_2b_1(1+r)}$	$\frac{a_1b_2(1+r)}{\{1-b_1(1+r)\} \{a_2(1-b_1)+a_1b_1\}}$

Now, Marx starts with the assumption that during the process of accumulation the organic composition of capital remains constant. Let us first assume that the partial organical compositions of capital are equal. In terms of the model this means $a_1b_2 = a_2b_1$ and the organic composition of capital everywhere in the economy then is $b_1(1+r)/1-b_1(1+r)$. The constancy of this expression then means that the technical coefficient b_1 is a constant. In other words the capital-output ratio of sector I remains constant. Now, it seems reasonable to assume that Marx had in mind that the

capital-output ratio of sector II, the input coefficient b_2 , remains constant. In this particular case a constant organic composition of capital implies constant capital-output ratios. With respect to the coefficients a_1 and a_2 we still have a choice. Again, it seems probable that Marx considered these labour input coefficients as constants, but it is by no means necessary to make this assumption. It does not contradict the Marxian assumption of a constant organic composition of capital to suppose that labour productivity in both sectors increases at a uniform rate k , so that $a_1(t) = a_1(o)e^{kt}$ and $a_2(t) = a_2(o)e^{kt}$ with $k > 0$. In this situation we are confronted with technical change which does not effect the partial and total organic composition of capital. Assuming a constant rate of growth, in Marxian terminology a constant rate of accumulation, it depends on the ratio of this rate and k whether labourers are thrown out or not. It appears that Marx did not reflect on this case, as according to him a constant organic composition of capital combined with the given rate of accumulation provokes an increasing demand for labour. To this end the assumption is necessary that all coefficients (a_1 , a_2 , b_1 , b_2) remain constant.

Let us now suppose that the partial organic compositions of capital are not equal, so that $a_1b_2 = a_2b_1$ does not hold. In that case all four coefficients enter in the expression for the total organic composition of capital. The most simple procedure would be to assume that all coefficients remain constant, that is all capital-output ratios and productivities of labour remain constant. Then there is no question of technical change. However, it is possible to introduce several types of technical change which do not alter the organic composition of capital. A first case may be to assume a uniform increase of labour productivity in both sectors with a rate k . This type of technical change does not affect the three capital-output ratios, and the situation on the labour market again depends on k and the rate of accumulation.

A second interesting case may be that the coefficients a_2 and b_2 decline at a uniform rate k , viz. $a_2(t) = a_2(o)e^{-kt}$ and $b_2(t) = b_2(o)e^{-kt}$.

This second type of technical change, which only refers to the second sector, also does not effect the partial and total organic composition of capital. Labour productivity in sector II rises, while it remains constant in sector I. The capital-output ratio in sector I remains constant, but this ratio declines in sector II, which is also the case with the ratio for the whole economy. Unemployment may arise in sector II depending on the rate of accumulation and the rise of labour productivity.

So far the conclusion can be drawn that technical change can be distinguished from accumulation. Some types of technical changes are compatible with the Marxian assumption of a constant organic composition of capital, others are not. Finally, it is shown that the constancy of the organic composition of capital does not necessarily imply that the capital-output ratio is also constant.

From this point of view it is not correct to state that Marx assumed a constant capital-output ratio¹⁹, although it should be added that Marx did not reckon with types of technical change that influence the capital-output ratios. That the identification of a constant capital-output ratio and a constant organic composition of capital may lead to confusion can be illustrated by means of a treatment of the typical Marxian case of a changing organic composition of capital.

6. Increase of organic composition of capital

In the Marxian literature an increase of the organic composition of capital and an increase of the productivity of labour are twins. Our procedure now is to assume an increase of the productivity of labour and to analyse whether an increase of the organic composition of capital can be derived from this assumption.

Now, the first difficulty we encounter regards the choice of the input coefficient we want to alter. The expression for the productivity of labour contains all four technical coefficients, so from a formal point of view we could choose at will one of these. However, it hardly needs emphasis that the Marxian way of thinking obliges us to consider the change of the coefficients a_1 and a_2 , which determine labour productivity in sectors I and II. Let us assume again that the relations $a_1(t) = a_1(o)e^{kt}$ and $a_2(t) = a_2(o)e^{kt}$ with $k > 0$, hold and that b_1 and b_2 remain constant.

We first consider the case in which the organic composition of capital in both sectors is equal, so that $a_1b_2 = a_2b_1$. The organic composition of capital then equals $b_1(1+r)/(1-b_1(1+r))$. It follows immediately that the rising productivities of labour do not influence the organic composition of capital. So, we have to conclude that Marx did not mean this state of things. Of course, this does not imply that it is not a real case.

Let us now assume that the organic compositions of capital in the two sectors differ from each other and that also labour productivities in the sectors increase at different rates, so that rate $a_1(t) = a_1(o)e^{kt}$ and $a_2(t) = a_2(o)e^{lt}$ with $k > 0$ and $l > 0$.

The expression for the total organic composition of capital now reads:

$$\frac{a_1(o)b_2(1+r)}{(1-b_1(1+r))\{a_2(o)(1-b_1)e^{(k-l)t} + a_1(o)b_2\}}$$

The condition for a rising organic composition of capital is $k < l$. If the increase of labour productivity in sector I is smaller than the increase of labour productivity in sector II, the implied type of technical change indeed happens to coincide with a rising organic composition of capital. An interesting feature of this typical Marxian case is that the partial organic composition of capital in sector I remains constant, while that in sector II rises. We should add at one stage Marx creates the impression that he considered a rate of growth of labour productivity in sector I higher than that in sector II to be the normal state of things: "Aber auf einem gewissen Höhepunkt der Industrie muss die Disproportion abnehmen, das heisst die Produktivität der Agrikultur sich relativ rascher vermehren als die der Industrie"²⁰.

Now, we are in a position to understand the incorrectness of the view that "Marx erwartete, dass der technische Fortschritt zu einer fortwährenden Zunahme des Kapitalkoeffizienten führen werde"²¹. While the assumptions introduced are fully in accordance with the Marxian hypotheses, the conclusion can be derived that the capital-output ratios remain constant.

The situation on the labour market again depends on the rate of accumulation on one side and the values of k and l on the other side. If unemployment occurs it will be first in sector II. Marx assumed that in the long run unemployment resulting from the rise in labour productivity is higher than the number of labourers which find em-

ployment as a consequence of the demand for labour which follows from accumulation. This position is based on the supposition of "...a given trend rate of accumulation"²² as Steindl justly observes.

7. Technical change and the labour market

In this section we shall study the effects of accumulation and rising productivities of labour on employment more carefully, explicitly assuming a growing economy. The essence of Marx's employment theory concerns the interchange between the given quantitative rate of accumulation and the qualitative nature of accumulation. The fact that a constant organic composition of capital is compatible with a change in the technical structure of the economy can warn us not to relate the number of unemployed exclusively to a change in the organic composition of capital, as is done by Gottheil²³. Although Marx did not assume qualitative changes in the case of a constant organic composition of capital, we should nevertheless specify the type of technical change in order to derive precise conclusions in case of a rising organic composition of capital.

Let us assume that labour productivity in sectors I and II obeys the laws $a_1(t) = a_1(o)e^{-kt}$ and $a_2(t) = a_2(o)e^{-lt}$, with $k < l$, so that the organic composition of capital rises. The supply of labour grows at a constant rate n in both sectors according to $L_1(t) = e^{nt} \cdot L_1(o)$ and $L_2(t) = e^{nt} L_2(o)$. A given rate of accumulation m is assumed so that $K_1(t) = e^{mt}K_1(o)$ and $K_2(t) = e^{mt}K_2(o)$. Furthermore the Leontief type production functions are assumed and initially everybody is at work, so that $L_1(o) = a_1(o)K(o)$ and $L_2(o) = a_2(o) \cdot Y(o)$.

We introduce a measure of employment, being the ratio between the demand for labour and its supply. For sector I we find:

$$\mu_I = \frac{\frac{a_1(o)}{b_1} K_1(o)e^{(m-k)t}}{\frac{a_1(o)}{b_1} K_1(o)e^{nt}} = e^{(m-k-n)t}$$

and for sector II:

$$\mu_{II} = \frac{\frac{a_2(o)}{b_2} K_2(o)e^{(m-l)t}}{\frac{a_2(o)}{b_2} K_2(o)e^{nt}} = e^{(m-l-n)t}$$

The condition for full employment in sector I reads $m = k+n$ and for sector II $m = l+n$. As $k < l$ in sector II unemployment emerges if there is just full employment in sector I. Both sectors show unemployment if $m < k+n$, the rate of accumulation being too small to provide employment for everybody.

Marx's theory of unemployment rests on two basic postulates. In the first place on a given rate of accumulation and in the second place on a special type of technical change that does not affect the technical coefficients b_1 and b_2 , so that the capital-output ratios remain constant. With other types of technical change, such as a decrease of the coefficients a_2 and b_2 or b_1 and b_2 , less pessimistic conclusions can be derived, depending on the influence of those types of technical change on the rate of accumulation m and the so far given rate of interest r . The distinction between embodied and disembodied technical change then also becomes necessary.

8. Types of technical change

It seems useful to classify the types of technical change we meet in Marxian economics, according to modern criteria. The two types of technical change that are a natural consequence of Marxian reasoning are the well-known Harrod-neutral technical change and the even better known Hicks-neutral technical change. The combination of constant capital-output ratios, a constant rate of interest and declining coefficients a_1 and a_2 corresponds to Harrod's definition of neutral technical change²⁴. The conclusion may be drawn that Marx assumed most of the time Harrod-neutral technical change. This is especially striking in his theory of employment. As is well known, Harrod-neutral technical change is labour-augmenting and compatible with a growth of labour supply. Unemployment therefore is the result of the given rate of accumulation of capital and the labour-augmenting type of technical change. We have tried to make clear that the Marxian assumptions are also compatible with another type of technical change, viz. a uniform decline of the coefficients a_2 and b_2 of sector II. Now, we are confronted with the Hicks²⁵ version of neutral technical change, applied to sector II. The ratio of the marginal products of labour and of capital remains constant if a_2 and b_2 decline at a uniform rate.

Putting aside for a moment the case of Hicks-neutral technical change, the conclusion may be drawn that Marx's theory is a consistent piece of analysis if Harrod-neutral technical change is assumed. The important implication then is a spread of technical change over the economy, which changes in different ways the labour coefficients a_1 and a_2 . It is natural to look at the Marxian theory of capitalism as "...a mere accident of technique"²⁶. In this connection also Blaug may be quoted, who states that Marx's theory "...results in a theory of economic growth in which investment prospects dry up not because there have been too few labour-saving improvements but because there have been too many"²⁷. So far Samuelson's model produces results which are to a large extent compatible with Marx's conclusions.

At this point of our essay it seems appropriate to call attention to a wider concept of technical change implied in Marxian economics. According to Marx accumulation brings about a refinement and a revaluation of the division of labour, it stimulates large-scale production, it leads to concentration and in the end to centralization. Samuelson's model can be used, as we have tried to make clear, to grasp both the case of a constant and that of a rising organic composition of capital. To this end it

is a highly elegant and useful model. However, it is not suited to describe the effects of technical change in the narrow sense of the word on technical change in a broader sense. The model describes the role of technical change given a certain structure, but not how this structure is broken down by technical change. It needs no emphasis that it is highly ambitious to think of a model that is capable of describing and perhaps of forecasting the influence of technical change on the structure of the economy. Nevertheless, it is the main task of economic theory in our day.

9. Technical change and market form

One aspect of such a model may be brought to the fore, viz. the influence of technical change on the market form. Samuelson explicitly assumed perfect competition reigning everywhere in the economy. It is not difficult to produce quotations of Marx's work that seem to justify this assumption²⁸. To us it seems highly questionable whether Marx actually had in mind a market form in which the individual producer has no power at all with respect to price setting. In this whole system the concentration of power on the side of the capitalists plays so important a role, that the idea of powerlessness in case of perfect competition is hardly compatible with the general tenor of Marx's opinion. Marx's description of market processes is more in line with oligopolistic market forms. In particular in this respect we think of Marx's proposition that the innovations are introduced under influence of competition, a phenomenon which is accompanied by heterogeneity insofar as there are pioneers and followers. Such a pattern of behaviour is more compatible with oligopoly, of which also quality competition is an aspect, than with the uniform world of perfect competition, in which no initiatives are being taken. Meek also observes that "...social polarization is accentuated by the growth of monopoly"²⁹.

But even if one would like to hold that Marx started from perfect competition, one cannot deny that the monopolization of the relations of production is essential to his theory of accumulation. The causes that are responsible for large scale production are not randomly distributed, but are deeply rooted in the technique of production and its changes. To a certain extent Fellner did recognize this as he accounted for a "...degree of monopoly power"³⁰ in his Marxian model.

Of course, a formalization of Marx's theory in which the relation between technical changes and the power structure on the market, especially on the side of the producers, is accounted for is hampered by the fact that instead of one theory we are confronted with a whole set of oligopoly models. The supply of oligopoly models is differentiated with respect to the methods used, the type of maximizing behaviour, the weapons of competition considered and the interpretation of empirical data. This circumstance however is no foundation for the illusion that Marx is being integrally dealt with by formalizations that are based on perfect competition.

10. Conclusion

It is hardly possible to evade the conclusion that Marx was the first economist who saw and foresaw the significance of technical change for economic development³¹. This conclusion is hardly weakened by the fact that most of the time he assumed a specific type of technical change.

That the refinement of analysis makes room for the opinion that technology has a complex and not a uniform character is a confirmation of Marx's intuition more than a contradiction of the internal logic of his system. Nevertheless it is true that the forecasts of the industrial reserve army, the decline of real wages and the rate of profit have to be corrected in view of other types of technical change in the narrow sense of the word. The analysis would undoubtedly have to go into the details of embodied technical change and would also have to reconsider the assumption adhered to in this paper, that the rate of interest r is constant during the accumulation. Again it should be stressed that technical change in the broad sense changes the power structure of producers among themselves and of entrepreneurs and labourers. This last development, which also biased Marx's forecast on the decline of the real wage rate, has perhaps been provoked by Marx himself. The influence of different types of power structures in society on the main economic quantities is by no means clear. From Marx we can learn that for the analysis of such a problem the study of the concrete features of technology and technical change is essential.

Notes

¹ I like to express my gratitude to Prof. Dr. P. Hennipman, who suggested several improvements of an earlier draft and to Dr. J.B. Polak who corrected my English.

² P.A. Samuelson, *Wages and Interest: A Modern Dissection of Marxian Economic Models*, *American Economic Review*, 1957, p. 884 ff. Also in *Collected Economic Papers I*, p. 341 ff.

³ K. Marx, *Das Kapital, Book I*, second edition, 1872, p. 383.

⁴ *Das Kapital*, p. 383.

⁵ *Das Kapital*, p. 321.

⁶ *Das Kapital*, p. 444.

⁷ *Das Kapital*, p. 637.

⁸ *Das Kapital*, p. 638.

⁹ *Das Kapital*, p. 643.

¹⁰ *Das Kapital*, p. 645.

¹¹ K. Marx, *Grundrisse der Kritik der politischen Ökonomie*, Berlin 1953, p. 293.

¹² *Das Kapital*, p. 647.

¹³ *Das Kapital*, p. 650.

¹⁴ *Das Kapital*, p. 651.

¹⁵ *Das Kapital*, p. 651.

¹⁶ Book I, fourth edition, p. 593.

¹⁷ D. Ricardo, *The Principles of Political Economy and Taxation*, London 1817, p. 479.

¹⁸ *Das Kapital*, p. 671.

¹⁹ See for example R. Güsten, *Bemerkungen zur Marxschen Theorie des technischen Fortschrittes*, *Jahrbücher für Nationalökonomie und Statistik*, 1965, Vol. 178, p. 112.

Even J. Robinson agrees that in Marxian Analysis "... technical progress normally takes forms

which raise the ratio of capital to output", *The Model of an Expanding Economy, Collected Economic Papers I*, London, 1964, p. 83, originally published in *The Economic Journal*, 1962, p. 42 ff.

²⁰ K. Marx, *Theorien über den Mehrwert*, fifth edition, Berlin 1953, II, p. 280.

²¹ R. Güsten, loc. cit., p. 109.

²² J. Steindl, Karl Marx and the Accumulation of Capital, in: *Marx and Modern Economics*, London 1969, p. 252.

²³ F.M. Gottheil, Increasing Misery of the Proletariat; an Analysis of Marx's Wage and employment Theory, *The Canadian Journal of Economics and Political Science*, 1962, p. 103 ff.

²⁴ R.F. Harrod, *Towards a Dynamic Economics*, London 1948, p. 24 ff.

²⁵ J.R. Hicks, *Theory of Wages*, London 1932, p. 130.

²⁶ J. Robinson, Marx and Keynes, *Collected Economic Papers I*, p. 144.

²⁷ M. Blaug, Technical change and Marxian Economics, *Kyklos*, 1960, reprinted in: *Marx and Modern Economics*, p. 235.

²⁸ For example, *Book III*, second edition, Hamburg 1904, p. 173.

²⁹ R.L. Meek, *Economics and Ideology and other Essays*, London 1967, p. 108.

³⁰ W.J. Fellner, Marxian Hypothesis and Observable Trends under Capitalism, A "Modernised" Interpretation, *The Economic Journal*, 1957, p. 17.

³¹ See also P.M. Sweezy, Karl Marx and the Industrial Revolution, in: *Events, Ideology and Economic Theory*, edited by R.V. Eagly, Detroit 1968, p. 107–127.

Ein Aufsatz zur marxistischen Ökonomie

Zusammenfassung

Der vorliegende Aufsatz behandelt einige ökonomische Aspekte der marxistischen Theorie. Als Grundlage dient ein von Samuelson entwickeltes Modell. Im besonderen wird die Marxsche Vision über technische Änderungen untersucht und modernen Konzepten der neutralen technischen Änderungen im Sinne von Harrod und Hicks gegenübergestellt. Der Autor zeigt, dass Marx einen ganz besonderen Typ der technischen Änderungen annahm und dass dadurch die Bedeutung seiner Schlussfolgerungen durch die spezielle Interpretation seines Begriffes der technischen Änderung eingeschränkt wird.

Die Bedeutung von Marx als Ökonom wird durch diese Feststellungen keineswegs herabgesetzt, denn es darf nicht vergessen werden, dass Marx als erster die Bedeutung der technischen Änderungen für die wirtschaftliche und soziale Entwicklung überhaupt erkannte.

Un essai sur l'économie marxiste

Résumé

Sur la base d'un modèle développé par Samuelson, cet article traite quelques aspects économiques de la théorie marxiste. Il analyse, en particulier, la vision de Marx sur les changements techniques et la confronte avec des conceptions modernes des changements techniques neutres dans le sens de Harrod et Hicks. L'auteur montre que Marx admettait un type de changements techniques tout particulier et que la signification de ses conclusions est en conséquence restreinte par l'interprétation particulière de sa définition des changements techniques. Cependant, l'importance de Marx comme économiste n'est aucunement touchée par ces constatations, car

il ne faut pas oublier que Marx fût le premier à reconnaître l'importance des changements techniques pour le développement économique et social.

An Essay on Marxian Economics

Summary

On the basis of a model developed by Samuelson, this article deals with some economic aspects of Marx's theory. In particular, Marx's vision on technical change has been explored and related to modern concepts like neutral technical change in the sense of Harrod and Hicks. The author shows that Marx assumed a specific type of technical change and that the significance of the conclusion derived from his system is to a large extent restricted by the special interpretation of technical change. However, this in no ways declines the importance of Marx, being the first economist who saw and foresaw the role of technical change for economic and social development.