Technical progress, capital accumulation and income distribution in Classical economics: Adam Smith, David Ricardo and Karl Marx

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The past is a foreign country, where we come from.
(David Lowenthal)

1. Introduction

The problem of endogenous technical change, its causes, forms and effects, has been high on the agenda of economic analysis ever since its systematic inception in the second half of the seventeenth century and its full blooming at the time of the English classical political economists. This is hardly surprising, since around the same time Western Europe experienced what has been called the beginning of the ‘great divergence’ (Pomeranz 2000); that is, its take-off on a path of sustained growth of income per capita. Technical change played an important role in the works of Adam Smith and David Ricardo and an even more important one in that of Karl Marx, who developed his own analysis in no small degree from a critical account of the analyses of Smith and especially Ricardo. Marx, as is
well known, saw capitalism as a hotbed whose historical function was to increase productivity ‘geometrically’.

However, the prevailing view in the history of economic analysis appears to be that although Smith and Ricardo lived through the Industrial Revolution, they misread its significance and under-rated vastly the importance of technical progress for economic development and growth. In my view this assessment cannot be sustained. While it is true that Smith and Ricardo erred in some respects in regard to the problem under consideration, they can hardly be accused of having downplayed the importance of technical progress, as is often maintained. In particular, Ricardo’s respective thinking was not overwhelmed, as is frequently contended, by a concern with diminishing returns in agriculture in combination with Malthus’s law of population. In fact, these authors anticipated, and analysed, with the analytical tools they elaborated, what was not yet to be openly seen; that is, some of the characteristic features and long-term trends of the process of incessant technological and organisational change that had seized the Western European economies. Smith foresaw, for example, the emergence of a separate industry or trade engaged in what we would today call research, development and innovation as a part and parcel of the process of the deepening of the social division of labour. And Ricardo even contemplated the end-state of the process of mechanisation that took place before his eyes: a fully automated system of production, and reasoned about its implications for the distribution of income. While the classical authors may be criticised for not having correctly described the present and forecast the future development in sufficient detail, they deserve to be credited with having elaborated a framework and analytical concepts that allow us to describe and analyse almost any such development. They have enriched and deepened our understanding of the technological and economic dynamism inherent in

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Principles, Mill boldly expressed the view that this progressive change brings about ‘the unlimited growth of man’s power over nature’ (Mill 1965: 706) and thus dispels the specter of decreasing returns in agriculture, which had bothered authors such as Thomas Robert Malthus a great deal.

2 With regard to Smith, see, for example, Rostow (1990: 34). However, later in his discussion of Smith’s contribution and the latter’s reference to major discontinuous (i.e. non-incremental) inventions, he insists that ‘Smith clearly foreshadows Schumpeter’ (Rostow 1990: 41). With regard to Ricardo, Rostow (1990: 87) maintains that with the passage of time, and especially since the decline in grain prices after 1812, Ricardo became ‘increasingly optimistic’ that technical progress could overcome diminishing returns in primary production.

3 For a recent pronouncement of this view, see Blaug (2009); for critical remarks on it, see Kurz and Salvadori (2009). See also Robert Solow’s views on the matter in his contribution to this issue.
the capitalist mode of production and have forged powerful analytical tools
to deal with it.

This paper provides a critical account of the contributions of Smith,
Ricardo and Marx to the problem at hand. The emphasis is on continuity
and change in their views; that is, the gradual elaboration of an ever more
sophisticated analytical framework to deal with consecutive forms of
technical change and their varied implications for the distribution of the
product between wages, profits and rents. Marx elaborated on Ricardo’s
analysis as Ricardo had elaborated on Smith’s. However, understanding
what the three classical political economists had to say about these
problems is also a useful perspective within which to judge modern
theories. Due to space constraints, a few incidental remarks must suffice.

The composition of the paper is the following. Section 2 summarises
Smith’s view on the division of labour and the corresponding growth in
labour productivity. Using a concept first developed by Ricardo, the related
effects will be translated into shifts of the constraint binding changes in the
distributive variables, wages and the general rate of profits. Section 3 turns
to Ricardo’s treatment of different forms of technical change, focusing
attention on the newly added chapter ‘On Machinery’ in the third edition
of the Principles. There Ricardo discusses also the case in which changes in
income distribution and relative prices entailed by the accumulation of
capital and the growth of population vis-à-vis diminishing returns in
agriculture may eventually render a machine that originally could not be
employed profitably eligible for use by cost-minimising producers (so-called
‘induced’ technical change). Section 4 provides a summary account of
Marx’s views on the matter and how his hypothesis of a rising ‘organic
composition of capital’ for the system as a whole relates to Ricardo’s
analysis. Contrary to the received interpretation of Marx’s law of the falling
tendency of the rate of profits, it is argued that Marx – in some of his
manuscripts on the issue – appears to have had in mind not so much fresh
technical inventions, but induced technical change in the sense of Ricardo.

4 The paper benefitted greatly from reading Piero Sraffa’s hitherto unpublished
papers at Trinity College, Cambridge. For an account of what is to be found
there that is also relevant to the present study, see Gehrke and Kurz (2006).
5 Ideas similar to those of the classical authors were the origin of an important
twentieth-century literature on induced technical change. To it contributed,
inter alia, John Hicks, Charles Kennedy, Paul Samuelson, Robert Solow and Carl
Christian von Weizsäcker; for a summary account, see Foley (2003). For an
assessment of the treatment of technical change in the more recent ‘new’ or
‘endogenous’ growth theories against the background of classical theory, see
Kurz (2009).
In this case, his argument is shown to be straightforward. Section 5 contains some concluding remarks.

As has already been alluded to, in the following we make use of the concept of the \( w-r \) relationship, or wage frontier, where \( w \) is either the real wage rate or the share of wages in the social product and \( r \) is the general rate of profits. The roots of this concept, which is designed to describe the distribution side of the system of production as a whole, can be traced back to the classical economists. This powerful analytical tool belongs to the long-period method these authors elaborated, which focuses attention, in conditions of free competition, on a uniform rate of profits and the associated system of ‘natural’ (relative) prices, or ‘prices of production’. The wage frontier allows us: (i) to reduce complex chains of reasoning concerning technical changes to a transparent geometric form; (ii) to illustrate the problem of the choice of technique of cost-minimising producers; (iii) to discriminate between technical invention and economic innovation; (iv) to distinguish between different forms of technical change; and (v) to trace the impact of a given form of technical change on one of the distributive variables, given the magnitude of the other one. Technical change is reflected by a change in the position and shape of this relationship in \( w-r \) space.

There is of course a huge literature on the problem investigated in this paper. Here it suffices to mention the books by Hicks (1969), Eltis (1984) and Rostow (1990), which provide detailed studies of the classical economists’ approaches to the problem of economic growth and the role technical change plays in them. Schefold (1976) deals with different forms of technical change by a change in the position and shape of this relationship in \( w-r \) space.

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6 With heterogeneous types of labour (for simplicity, assume only two of them) the \( r = f(w) \) relationship would give way to a \( r = g(w_1, w_2) \) relationship, with \( w_i \) as the wage per unit of labour of kind \( i (i = 1, 2) \). The classical economists typically assumed that the structure of wages does not change very much over time, so that one can focus attention on just one kind of wage; see Kurz and Salvadori (1995: ch. 11).

7 By an invention we mean new knowledge, which may, or may not, be introduced in the economic system and then used widely. If it is, we speak of an innovation. The economy-wide diffusion of innovations typically presupposes imitation.

8 For recent empirical studies of economic growth and technical change in terms of shifting wage frontiers, see, for example, Foley and Marquetti (1999) and Degasperi and Fredholm (2009). While Foley and Marquetti use a macro-economic framework, Degasperi and Fredholm discuss the problem within a multi-sector framework using input–output tables from four major OECD countries between 1970 and 2000.

9 While Hicks devotes his attention essentially to Ricardo’s discussion of machinery, Eltis and Rostow cover not only the three authors under consideration in this paper, but also several other economists of classical orientation.
of technical progress within the framework of classical long-period analysis and illustrates his argument in terms of cases contemplated especially by Smith and Marx. Kurz (1998) discusses Marx’s view as to which form of technical change can be expected to dominate the development of the capitalist economy and how his argument relates to Ricardo’s analysis. Similarly, Foley and Michl (1999) discuss in some detail and with the help of the $w-r$ relationship what they call ‘Marx-biased’ technical change. In the following it will be made clear where the interpretation provided here differs from interpretations found in the literature.

2. Adam Smith on the social division of labour

2.1 Social division of labour

Right at the beginning of *The Wealth of Nations*, in the ‘Introduction and Plan of the Work’, Smith insists that the social product of a nation, or rather its surplus product (the social product minus the necessary consumption of workers), is regulated by two different circumstances, only one of which is of crucial importance in the long run, because it can be increased with no obvious limits: it is ‘the skill, dexterity, and judgment with which its labour is generally applied’ (Smith 1976: I. 3). The main task of his *magnum opus* Smith thus identifies as consisting of an investigation into ‘The causes of this improvement, in the productive powers of labour, and the order, according to which its produce is naturally distributed among the different ranks and conditions of men in the society’ (Smith 1976: I.5; see also II.iii.32). The work is about growth and income distribution.

The type of technical change Smith describes is an ever deeper social division of labour. He understands this concept in a very wide sense, so that it covers many aspects and forms of technical change and thus offers a rich picture of purposeful human activities that increase labour productivity. It also encompasses a major theme of classical economic thinking; namely, that in addition to the intended consequences of such purposeful activities there are typically also non-intended ones, some positive, some negative. These, in turn, induce further activities and thus engender further consequences. There emerges the picture of an ongoing flow of technical

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10 Eltis (1984: 69) contends that ‘in modern growth theory, Arrow comes nearest to Smith’s results with his “learning by doing” model’. In my interpretation Smith’s concept is much broader than Arrow’s and actually attempts to include all kinds of improvement, technical and organisational; see on this Kurz (2008).
and organisational change, which on the one hand solves certain problems, but on the other creates new ones. Hence, what is at issue is the total ensemble of economically-relevant processes of learning and the creation of new useful knowledge. These processes are both a source of and an effect of the incessant transformation to which the market system is subjected.

Smith (and before him others) attributed the division of labour to the impact of three elements that increase productivity:

1. improvement of the dexterity of workers as a gain from specialisation;
2. the time saved through avoidance of shifts from one activity to another and, we may add, the related improved utilisation of ever more costly plant and equipment; and
3. innovations proper; that is, the invention of machines that take over larger and larger parts of an increasingly complex labour process (i.e. replace labour power by machine power) (see Smith 1976: I.1.6–8).

It is interesting to note that while Smith saw that successful innovations give rise to ‘extra profits’ of the innovating firm and introduce some temporary monopoly elements into the system, free competition would, in the long run, establish a tendency towards a uniform rate of profits. We might say, using modern terminology, that in Smith dynamic increasing returns are external to firms – that is, the overall size of markets, measured in terms of gross output levels, matters in determining the methods of production available to single firms. Such returns do not spell trouble for the hypothesis of a uniform rate of profits. Smith’s argument can thus be said to be implicitly based on the hypothesis that each single firm operates under constant returns, while total social production is subject to increasing returns.

2.2 Accumulation of knowledge

Even though some examples Smith provides appear to relate more to the division of labour within firms than to the division of labour among firms, he seems to be correct that certain activities that were originally a part of the division of labour within the firm may eventually become a different ‘trade’

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11 See in this regard also the discussion in Aspromourgos (2009: 91–3) and in his contribution to this issue (Aspromourgos 2010).
12 In the chapters on the division of labour, Smith talks about ‘trades’, but not explicitly about firms. But it appears to be obvious that his argument implies the division of labour both within and between firms.
or ‘business’, so that the division of labour within the firm is but a step towards the division of labour among firms. In the example of pin-making at the beginning of Chapter I, Smith points out that ‘in the way in which this business is now carried on, not only the whole work is a peculiar trade, but it is divided into a number of branches, of which the greater part are likewise peculiar trades’ (1976: I.i.3). Most significantly, this process of subdividing the labour process ever more deeply leads also to what today is dubbed Research, Development and Innovation or, for short, RDI. In Chapter I of Book I, Smith notes that improved and new machinery is owed not only to ‘learning by using’, to use Nathan Rosenberg’s concept:

All the improvements in machinery … have by no means been the inventions of those who had occasion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines, when to make them became the business of a peculiar trade; and some by that of those who are called philosophers or men of speculation, whose trade it is, not to do anything, but to observe every thing; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects. In the progress of society, philosophy or speculation becomes, like every other employment, the principal or sole trade and occupation of a particular class of citizens. (Smith 1976: I.i.9; emphases added)

It deserves to be noticed that Smith uses explicitly the combinatoric metaphor in order to characterise the process of the creation of new, economically useful knowledge. Combining reconfigured fragments of existing knowledge is a means of gaining new fragments. At each stage of development, there are particular alternatives available for the future course of development. All of them build on what has gone before: the process is path dependent.

In Smith’s perspective the tendency for the rate of profits to become uniform thus does not presuppose an invariant set of technical alternatives from which producers can choose, but makes itself felt also in circumstances in which there is technological change; that is, in which new products and new methods of production become available and are actually introduced. Interestingly, Smith emphasises that technical change is economy wide and affects the conditions of production in all major three

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13 Basically the same idea can be found in Marx’s concept of ‘new combinations’ (Marx 1959: 255). This concept is nowadays closely associated with the name of Schumpeter (1912), who held Marx’s analysis of the endogenous technical dynamism of capitalism in high esteem and may have borrowed the concept from Marx. The idea recurs also in Weitzman’s (1998) concept of ‘recombinant growth’ and in Boulding’s (1956: 95) concept of a ‘tree of knowledge’. The latter can be traced far back in history. It was used, for example, by Comenius, a contemporary and friend of the polymath Samuel Hartlib.
sectors of the economy, primary production (agriculture, etc.), manufactures and trade and services (commerce):

The establishment of any new manufacture, of any new branch of commerce, or of any new practice in agriculture, is always a speculation, from which the projector promises himself extraordinary profits. These profits sometimes are very great, and sometimes, more frequently, perhaps, they are quite otherwise; but in general they bear no regular proportion to those of the other old trades in the neighbourhood. If the project succeeds, they are commonly at first very high. When the trade or practice becomes thoroughly established and well known, the competition reduces them to the level of other trades. (Smith 1976: I.x.b.43)

Not least because of product and process innovations income distribution and relative ‘natural’ prices are bound to change in the course of time (Smith 1976: I.vii.33).

2.3 Moving the w–r relationship outwards

We may now illustrate Smith’s vision of technical change as division of labour with the help of the convenient diagram giving the relationship between the real wage rate, $w$, and the general rate of profits, $r$, for a given system of production in use.¹⁴ In Smith we do not yet encounter this concept, and while there are hints that point in its direction it is doubtful that Smith had a clear idea of it (see Vianello 1999; Aspromourgos 2009: 100 and 180, esp. n. 68).¹⁵ In Figure 1 let $T$ represent the ‘old’ system of production – that employed prior to one particular and significant step forward in the social division of labour – and let $D$ represent the ‘new’ one, reflecting the step. The characteristic features of Smith’s concept of division of labour can now be illustrated in the following way. The new system of production exhibits larger labour productivity and thus a larger maximum level of the real wage rate corresponding to a zero rate of profits, $W$; that is,

¹⁴ We assume that the $w$–$r$ curve corresponding to a given system of production is convex to the origin. This need not be the case. One argument in its favour is that, in the classical economists and Marx, wages are typically taken to be paid at the beginning of the uniform period of production (i.e. ante factum), and are thus discounted forward: wages belong to the capital advanced at the beginning of the production period. As is well known, the concept can be extended to allow for several wage rates and thus heterogeneous labour (see Kurz and Salvadori 1995: ch. 11). The classical economists typically assumed that relative wage rates can be taken to be fairly constant over long periods of time.

¹⁵ Smith’s concept of profits as a ‘deduction’ from wages points in the direction of the relationship, but not more. Much of Ricardo’s criticism of Smith’s theory of value has to do with the fact that Smith had no clear grasp of the constraint binding changes in the distributive variables.
This follows directly from elements 1 and 2 and indirectly from element 3 of Smith’s characterisation of the division of labour (see above). A slight counteracting tendency results from the fact, noticed by Smith, that introducing a deeper division of labour within the firm requires a greater number of overseers and generally people employed with monitoring and enforcing work discipline. However, all in all productivity of labour can be taken to increase substantially. Hence \( W \) will unequivocally become larger, as illustrated in Figure 1.

As regards the maximum rate of profits of the system, \( R \) (i.e. the rate that corresponds to an hypothetically vanishing wage rate), Smith’s argument may be translated as implying a rise or at least no fall in it: \( R_D \geq R_T \). This follows directly from element 2 above, which implies essentially a better utilisation of the existing plant and equipment and thus a lower capital-to-output ratio. However, there is also element 3, the replacement of labour power by machine power, which may go in either direction: it may be accompanied by a rising as well as a falling capital-to-output ratio. Since I am not aware of any evidence from Smith’s works

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16 See on this Eltis (1984: 91–100), who translates some of Smith’s ideas into a ‘Wealth of Nations’ growth model’ and distinguishes between the three possible cases of a falling, constant and rising capital–output ratio. Historically, the capital-to-output ratio tended to rise during the early phases of the industrial revolution, whose beginnings Smith experienced.
that speaks clearly in favour of the contrary, I shall assume that his view can be represented by a tendency of the maximum rate of profits to increase slightly. If this interpretation is accepted, then Smith’s analysis involves a \( w-r \) relationship that tends to move outwards and at the same time gets steeper as the social division of labour proceeds.\(^{17}\) Technical change in the form of a deeper division of labour is unequivocally cost reducing and will be realised.

This movement of the \( w-r \) relationship over time may explain why Smith was on the whole very optimistic as to the nature and amount of blessings generated by the ‘system of natural liberty’ and its capacity to yield higher incomes per capita for ever larger parts of the population. Starting from a point like A in Figure 1, the growth and development of the wealth of a nation may lead to rising levels of real wages without necessitating a fall in the general rate of profits.\(^{18}\) This does not mean that the rate of profits could not fall: it all depends on the precise form of technical progress experienced and on how the increasing surplus product will be shared out between the various claimants to it – workers, ‘masters’ and landlords – which in turn depends on a multiplicity of factors, including the relative speeds at which capital accumulates and the workforce grows.

### 2.4 Technical progress: not a universal blessing

There is no need to enter into a discussion of the much disputed question of whether Smith’s analysis of accumulation, division of labour and income distribution was consistent or not (see most recently Sinha 2010). Some of the issues at hand will be touched upon in the following Sections 3 and 4, which deal with Ricardo and Marx and their criticisms of elements of Smith’s analysis. Here it suffices to draw attention to the fact that in Smith, as well as in many earlier and later authors, technical progress is not seen as a universal good, beneficial to all strata of society in terms of all possible

\(^{17}\) In case the maximum rate of profits was to be reduced in the course of an ever deeper division of labour, the following argument would still be essentially the same, provided the \( w-r \) relationships corresponding to the new and the old techniques, respectively, intersect at a level of wages that is lower than the minimum (or subsistence) level. This means that the new technique will always be superior to the old one irrespective of the actual level of wages (above the minimum just mentioned).

\(^{18}\) See also Aspromourgos (2010) in this issue; he shows \textit{inter alia} that in Smith higher real wages may be accompanied by a smaller wage share, which is the case when labour productivity grows more swiftly than the real wage rate.
dimensions. While he is on the whole optimistic that the ‘labouring poor’ would benefit in terms of rising levels of real income and employment, he decrives the negative impact of the division of labour on the kind of work performed – the deskilling and degradation of large parts of the working classes, a theme that Karl Marx was later to develop on the basis of a much richer historical evidence. This is the main reason why Smith is in favour of introducing public schooling.

3. David Ricardo on improved machinery

Before we enter into a discussion of Ricardo’s views on the matter at hand, we must first briefly deal with what is known as his ‘fundamental law of income distribution’; that is, the inverse relationship between the general rate of profits and wages.

3.1 The fundamental law of distribution

This inverse relationship was first discovered, although not consistently demonstrated, by Ricardo: ‘The greater the portion of the result of labour that is given to the labourer, the smaller must be the rate of profits, and vice versa’ (Ricardo 1951–1973, VIII: 194). He was thus able to dispel the idea that wages and the rate of profits could be determined independently of one another. In much of his analysis of value and distribution, Ricardo assumed a given real wage rate, conceived as an inventory of well-specified quantities of certain commodities, reflecting some social and historical level of subsistence, and this is the assumption generally attributed to him in the literature. However, it is frequently overlooked that, depending upon circumstances, a given real wage rate may be reflected in different money wage rates and, correspondingly, in different shares of wages in the social product. With decreasing returns in agriculture, this is the case of ‘a rise of wages . . . from a difficulty of procuring the necessaries on which wages are expended’ (Ricardo 1951–1973, I: 48). Perhaps even more important, it is also frequently overlooked that Ricardo contemplated the case in which workers are ‘more liberally rewarded’ (1951–1973, I: 48) and thus participate in the sharing out of the surplus product. In this case the concept of a given real or commodity wage rate and that of subsistence lose much of their former appeal and a new wage concept is needed, because it can no longer be assumed that workers’ consumption and thus ‘wage goods’ could be ascertained independently of income distribution (and relative prices). Both cases can, however, be dealt with in terms of wages conceived as ‘the proportion of the annual labour of the country . . . devoted
to the labourers’ (Ricardo 1951–1973, I: 49; emphasis added); that is, in terms of what Sraffa called ‘proportional wages’.¹⁹

Ricardo in fact felt justified to state as a general principle that the rate of profits depends on wages (whether real or proportional), and on nothing else. This principle, he thought, covered both the case in which labour productivity decreases due to diminishing returns in primary production and the case in which it increases due to ‘improvements’ in the methods of production.

Yet, as Marx was to point out, this principle is not true in general: within a circular flow framework the rate of profits depends not only on the share of wages, but also on the ‘organic composition of capital’. In Marx’s labour value-based accounting, the latter gives the inverse of the maximum rate of profits, \( R \): the amount of living labour expended in production, \( L \), relative to the amount of ‘dead’ labour incorporated in ‘constant capital’, \( C \). Marx therefore had to go beyond Ricardo’s analysis by investigating thoroughly the implications of the circular flow character of social production (see below, Section 4).

Ricardo’s above dictum is only true in very special conditions, which in his observations on the wage–profit relationship he for the sake of simplicity typically assumed to hold true: the social capital consists only of wages or can be fully reduced to wages in a finite number of steps, so that the rate of profits, \( r \), is given by the ratio of profits, \( P \), to the sum total of (direct and indirect) wages, \( W \):

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r = \frac{P}{W} = \frac{1 - w}{w},
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where \( w \) designates proportional wages; that is, the wage share. Here, production is no longer envisaged as a circular flow as, for example, in the *Tableau Économique* and in much of the rest of Ricardo’s analysis. We shall come back to this problematic assumption, but in the following we will at first set it aside; that is, start from the premise that commodities are produced by means of commodities.

### 3.2 Different forms of technical change and their different effects

Ricardo was clear that technical change was an essential part of the development of modern society, that different forms of it have to be distinguished and that these typically have different effects. However, he refrained from speculating, as others did, which form will dominate the

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¹⁹ Gehrke (2003) provides a careful account of Ricardo’s concept of proportional wages.
development. The future was uncertain and open, and it made no sense to claim otherwise. Like Adam Smith he saw the historical development of an economy as largely shaped by two opposing forces: the ‘niggardliness of nature’ (i.e. the scarcity of natural resources), on the one hand, and man’s ingenuity and creativity reflected in new methods of production and new commodities, on the other.

Ricardo is frequently presented as a technological pessimist, who believed in the overwhelming importance of diminishing returns in agriculture in combination with the Malthusian law of population and who saw the stationary state around the corner.20 This interpretation does not do justice to him. As early as in *The Essay on Profits* of 1815 he expressed the view that there are no signs pointing in the direction of a falling rate of profits in the foreseeable future: ‘we are yet at a great distance from the end of our resources, and ... we may contemplate an increase of prosperity and wealth, far exceeding that of any country which has preceded us’ (see Ricardo 1951–1973, IV: 34). This view is confirmed in a letter to Hutches Trower of 5 February 1816, in which he concluded from the fall in grain prices since 1812 that ‘we are happily yet in the progressive state, and may look forward with confidence to a long course of prosperity’ (Ricardo 1951–1973, VII: 17). And in his entry on the ‘Funding System’ for volume IV of the *Supplements to the Encyclopædia Britannica*, published in September 1820, he stressed that ‘the richest country in Europe is yet far distant from that degree of improvement’ (i.e. the stationary state) and that ‘it is difficult to say where the limit is at which you would cease to accumulate wealth and to derive profit from its employment’ (Ricardo 1951–1973, IV: 179).21

Ricardo studied various cases and scenarios in order to figure out the range of possible consequences of different forms of technical change. He even contemplated the limiting case of a fully automated production and pointed out:

If machinery could do all the work that labour now does, there would be no demand for labour. Nobody would be entitled to consume any thing who was not a capitalist, and who could not buy or hire a machine. (Ricardo 1951–1973, VIII: 399–400)

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20 See, for example, Blaug (2009) and Solow (2010) in this issue.
21 Samuelson (1957: 884) characterised Marx as ‘Ricardo without diminishing returns’. While Ricardo took pains to understand and formulate the principle of diminishing returns, he cannot be accused of having seen that principle as the only one at work in the course of the actual development of the economy. As the above quotations show, he saw other factors at work that effectively counteract and may even overwhelm that principle.
He was also aware of the fact that certain forms of technical change met with the stiff opposition of some strata of society, because these forms were seen to be detrimental to their interests. In Chapter 2 of the *Principles* Ricardo discussed both what we may, for short, call ‘land saving’ and ‘capital (alias labour) saving’ technical progress, and showed that the former had the effect of reducing the rents of land; no wonder, then, that landlords were often opposed to them.\(^{22}\)

The most important form of technical change, and its varied effects, which is associated with Ricardo’s name, is, however, the problem of ‘machinery’. This form, and its negative impact on workers, Ricardo analysed in a newly added chapter in the third edition of the *Principles*. There he established the fact that the construction and introduction of improved machines into the production system can frequently be expected to lead to the displacement of workers and thus what was later called ‘technological unemployment’.\(^{23}\)

### 3.3 Machinery that reduces the gross produce

The discussion in this subsection focuses attention on this case, not because Ricardo thought that it was the only case to be studied, but because of the following reasons.\(^{24}\) First, it was a case the possibility of which Ricardo had at first disputed and which he now admitted. The fact that an authority like Ricardo had to change his mind with regard to a crucial question like this is interesting in itself and deserves to be scrutinised carefully. Secondly, the progressive replacement of labour by fixed capital is a characteristic feature of modern economic development. Ricardo was one of the first authors to deal with the emerging trend of a growing fixed capital intensity of production and its implications. Third, Ricardo’s discussion has met with severe misunderstandings in the literature. Here we attempt to provide a coherent explanation of Ricardo’s argument that is faithful to what he wrote. Last, but not least, Marx’s idea of a rising organic composition of capital can be shown to consist essentially of an adaptation to Marx’s own analytical framework of Ricardo’s case (see Kurz, 1998: 119). In order to understand Marx in this regard, one needs first to understand Ricardo.

\(^{22}\) On Ricardo’s discussion, see Gehrke et al. (2003). For statements that the landed gentry frequently tried to suppress agricultural improvements, see, *inter alia*, William Petty (1986: 249–50); see also Ricardo (1951–1973, IV: 41).

\(^{23}\) As Rostow (1990: 81) stressed, ‘it was the analytic basis for Marx’s famous prediction of a reserve army of the unemployed under capitalism’.

\(^{24}\) For a comprehensive study of Ricardo’s propositions concerning machinery, see Jeck and Kurz (1983).
This is corroborated by Sraffa’s unpublished notes on the matter (see Section 4 below).

In the third edition of the Principles, published in 1821, Ricardo retracted his former opinion on machinery, according to which:

the application of machinery to any branch of production, as should have the effect of saving labour, was a general good, accompanied only with that portion of inconvenience which in most cases attends the removal of capital and labour from one employment to another. (Ricardo 1951–1973, I: 386; emphasis added)

Ricardo’s original position can be summarised as follows. As early as in the Essay on Profits of 1815, he had stressed that ‘it is no longer questioned’ that improved machinery ‘has a decided tendency to raise the real wage of labour’ (1951–1973, IV: 35; see also VIII: 171; Jeck and Kurz 1983). This is possible without a fall in the general rate of profits, because improved machinery reduces the quantity of labour needed directly and indirectly in the production of the various commodities: it reduces ‘the sacrifices of labour’ (Ricardo 1951–1973, IV: 397). Hence labour productivity will increase. If the demand for the commodity does not rise in proportion to the increase in labour productivity, some workers will be discharged. However, ‘as the capital which employed them was still in being … it would be employed in the production of some other commodity, useful to the society, for which there could not fail to be a demand’ (Ricardo 1951–1973, I: 387). This is, in a nutshell, the theory of automatic compensation of any displacement of workers. It relies on Say’s Law in the special form advocated by Ricardo: ‘there is no amount of capital which may not be employed in a country, because demand is only limited by production’ (Ricardo 1951–1973, I: 290). Technical change will at most lead to (some extra) frictional unemployment.

In the third edition Ricardo qualified his earlier view explicitly as erroneous. Say’s Law, he had convinced himself by that time, could not, in each and every case, prevent the net displacement of workers and (extra) unemployment. He concluded: ‘I am convinced, that the substitution of machinery for human labour, is often very injurious to the interests of the class of labourers’ (Ricardo 1951–1973, I: 388). He expounded:

My mistake arose from the supposition, that whenever the net income [profits and rents] of a society increases, its gross income [net income plus wages] would also increase; I now, however, see reason to be satisfied that the one fund, from which landlords and capitalists derive their revenue, may increase, while the other, that upon which the labouring class mainly depend, may diminish, and therefore it follows … that the same cause which may increase the net revenue of the country, may at the same time render the population redundant, and deteriorate the condition of the labourer. (Ricardo 1951–1973, I: 388)
How does he substantiate his new view?  

3.4 Cost-minimisation and extra profits

A newly invented machine will be adopted, Ricardo stressed, if it allows the innovator to reduce the unit cost of the commodity and, given its price in the market, thus reap ‘extra profits’ (see Ricardo 1951–1973, I: 387). As the new method of production gradually becomes used in the system as a whole and replaces the older method, a new system of relative prices will be established and competition will wipe out extra profits. As regards the new level of the general rate of profits, towards which the system can be expected to gravitate, Ricardo was clear that technical progress, taken alone, can never be responsible for any tendency of the rate of profits to fall. For a given real wage rate and given gross output levels, technical change will either increase the rate of profits or leave it unaffected. Profitability will increase, if the technological change takes place in industries that directly or indirectly contribute to the production of commodities that enter the real wage rate, so-called ‘necessaries’, whilst it will remain constant if the technological change takes place in industries that contribute to the production of ‘luxuries’. Ricardo drew a parallel between improved machinery and foreign trade: ‘If . . . by the extension of foreign trade, or by improvements in machinery, the food and necessaries of the labourer can be brought to the market at a reduced price, [the rate of] profits will rise’ (Ricardo 1951–1973, I: 132).

25 In this paper we do not enter into a discussion of the criticism levelled at Ricardo that (an increase in) unemployment will lead to a reduction in the real wage rate, which will either increase employment again or lead to the extinction of the superfluous part of the work force. The former possibility follows from the wage fund doctrine (which Ricardo did not advocate) and then marginalist theory, whereas the latter has recourse to a narrow concept of the Malthusian law of population (which Ricardo certainly did not share). Ricardo counted instead upon an acceleration of capital accumulation in the case of an increase in profitability. He was criticised by authors from Knut Wicksell to the early Nicholas Kaldor and defended, with radically different arguments though, by authors from Marx to Hicks and Samuelson. Hicks (1969: ch. 9) actually argued that Ricardo’s chapter on machinery could be used to explain economic history in England since the Industrial Revolution and especially the delayed increase in real wages. On the debates mentioned, see Jeck and Kurz (1983) and Hagemann (2009).

26 Ricardo thus anticipated the essence of what is known as the Okishio–Shibata Theorem.
3.5 Increasing labour productivity and a falling maximum rate of profits

We now look more closely at Ricardo’s case for the gross produce-reducing form of technical progress. Comparing the levels of gross income in two subsequent periods (i.e. before and (immediately) after the economy-wide diffusion of improved machinery), the case under consideration is characterised by:

\[ Q_1 + P_1 \geq Q_0 + P_0 \]

and

\[ L_1 = Q_1 + P_1 + W_1 < Q_0 + P_0 + W_0 = L_0, \]

where \( Q \) designates the rents of land, \( W \) now total wages and \( L \) the total amount of direct (or fresh) labour expended in production (total value added); the subscripts zero and one refer to the period before and after the introduction (and diffusion) of the machine. Hence, whilst ‘neat income’ (i.e. the sum total of property incomes (rents and profits)) may be increased, ‘gross income’ (i.e. ne(a)t income plus wages) may fall. Assuming total rents to be unaffected by the change (\( Q_1 = Q_0 \)), and taking (with Ricardo) the value of the capital stock of the system, \( K \), as given and constant (\( K_1 = K_0 = K \)), it follows that:

\[ r_1 = \frac{P_1}{K} \geq r_0 = \frac{P_0}{K}. \]

Obviously, despite a fall in gross produce (\( L_1 < L_0 \)) there are ‘motives enough . . . to substitute the fixed for the circulating capital’ (Ricardo 1951–1973, VIII: 389); that is, the machine for wages and thus workers. Competitive conditions will in fact enforce cost-minimising behaviour. The general rate of profits will rise in the case of a cheapening of wage goods (\( r_1 > r_0 \)), given the real wage rate (and will remain constant otherwise (\( r_1 = r_0 \))).

3.6 An illustration

We may illustrate the kind of technical change under consideration in the familiar \( w-r \) diagram. In Figure 2, \( T \) represents again the ‘old’ technique and \( M \) the ‘new’ one that produces and utilises the machine. The latter exhibits a higher productivity of labour – it has ‘the effect of saving labour’ – and therefore a higher maximum real wage rate in terms of some given bundle of commodities, illustrated by a higher point of intersection of the
wage curve with the ordinate. It also exhibits a lower maximum rate of profits, since with a given value of capital and a lower gross income it follows that:

$$R_M = \frac{L_1}{K} < R_T = \frac{L_0}{K},$$

where subscripts $M$ and $T$ refer to the new and old technology. Translated into the $w$–$r$ diagram, Ricardo’s case involves a movement of the curve away from the origin as regards its point of intersection with the ordinate and towards the origin as regards its point of intersection with the abscissa.

What was perhaps not clear from the outset is now put into sharp relief by the intersection of the two curves at $w = w^*$ ($r = r^*$). This means that the invention of the machine under consideration does not ipso facto also involve its automatic adoption, and thus an innovation. The reason is that whether it can profitably be introduced is not independent of the level of real wages and the associated system of relative prices. Cost-minimising capitalists seeking the largest rate of return on the value of invested capital will adopt technique $M$ if and only if $r$ will be larger at the given wage rate; otherwise they will stick to technique $T$. If $w > w^*$ the new technique will be introduced, whereas if $w < w^*$ it will not. Hence, whether a new method of production will be adopted depends not only on its own physical characteristics, but also on the characteristics of the world into which it is
born. With \( w = w_0 \), technique \( M \) will be adopted and gradually replace technique \( T \) until the latter has been eliminated. At first the innovator will pocket ‘supernormal profits’, which in the course of the diffusion of the new technique competition will gradually erode. For a given and constant real wage rate, \( w_0 \), in the case illustrated the general rate of profits will rise from \( r_T \) to \( r_M \). A falling maximum rate of profits \( (R_M < R_T) \) is obviously compatible with a rising actual rate. This rise in the actual rate is accompanied by a change in relative (‘normal’) prices. The price of the commodity in which the technical change has taken place falls relative to the prices of the other commodities. The ratio of any two of the latter will generally also change, depending on the direct and indirect differential cost-reducing effects involved.

3.7 The tendency of the rate of profits to fall and a counter tendency

Like Adam Smith before and Marx after him, Ricardo held that under certain conditions there is a tendency of the rate of profits to fall. Setting aside technical progress for a moment, as capital accumulates and the population grows, diminishing returns in agriculture shift the \( w-r \) frontier towards the origin. The frontier is an expression of the processes of production employed directly or indirectly in the production of necessaries, including the method(s) of production employed on no-rent (or marginal) land.\(^{27}\) (Intramarginal lands would get its proprietors differential rents due to cost differentials between different qualities of land.) Since in the course of the development less and less fertile land would have to be cultivated, with the real wage rate taken as given and constant, nominal wages would have to rise, reflecting, as we have heard, the ‘difficulty of procuring the necessaries on which wages will be expended’. With every inclusion of a less fertile quality of land in the system of production, the general rate of profits will fall until it reaches a minimum level at which accumulation stops.

In the conditions contemplated, ‘the natural tendency of [the rate of] profits then is to fall’, Ricardo concluded. Yet the picture changes once technical change is taken into account:

This tendency, this gravitation as it were of profits, is happily checked at repeated intervals by the improvements in machinery, connected with the production of necessaries, as well as by discoveries in the science of agriculture which enable us to relinquish a portion of labour before required, and therefore to lower the price of the prime necessary of the labourer. (Ricardo 1951–1973, I: 120; similarly V: 125–6)

\(^{27}\) The above argument applies *cum grano salis* also in the case of intensive diminishing returns. For a discussion of both cases, see Kurz and Salvadori (1995: ch. 10).
The use of scientific methods may lead to the discovery of improved methods of production that reduce unit costs. In this case the \( w \rightarrow r \) frontier will change position and shape. Ricardo stresses that technical change will typically be associated with a reduction of the sum total of the direct and indirect quantity of labour needed to produce the commodity, in which the change takes place, and also of the commodities, in which the former commodity enters directly or indirectly as an input, and so forth. Such technical change may, but need not, be accompanied by an increase in the maximum rate of profits. What, if it is accompanied by a fall in it? This is obviously the case of improved machinery that reduces the gross produce.

### 3.8 Induced technical change

In the above we have pointed out, and illustrated in terms of Figure 2, that the case at hand involves a *choice of technique problem* that cannot be decided independently of the level of wages. A new method of production may not be eligible at the going wage rate (and the corresponding prices) because it is unprofitable. Ricardo was well aware of this possibility. He also saw clearly that the conditions may change from within the economic system (i.e. *endogenously*), as capital accumulates and the population grows. For a given real wage rate, the money wage rate and relative prices will have to change. Yet such changes may render a new method of production, whose employment at first would have incurred extra costs, eventually profitable. As Ricardo emphasised:

> Machinery and labour are in constant competition and the former can frequently not be employed until labour rises. (Ricardo 1951–1973, I: 395)

Ricardo’s reasoning behind this dictum can be summarised in the following way. According to him, ‘The same cause that raises labour [money wages], does not raise the value of machines, and, therefore with every augmentation of capital, a greater proportion of it is employed on machinery’ (Ricardo 1951–1973, I: 395). In the course of the development of the economy, the bundle of wage goods constituting the real wage tends to become more expensive relative to the machine until cost-minimising producers eventually may have a motive to replace labour power by machine power. A rise in the money wage rate, given the real wage rate, may (but need not) lead to a rise in proportional wages.\(^{28}\)

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\(^{28}\) Whether it will, depends on the precise technical specification of the set of methods of production at the disposal of producers, the quantities of the different qualities of land available in the economy and on the inventory of...
3.9 An illustration

We may illustrate Ricardo’s case of induced mechanisation again with the help of the \(w-r\) relationships associated with different techniques or systems of production. In Figure 3 techniques \(T_0\) and \(T_3\) refer to two different stages in the development of the economy in the purely hypothetical case in which the accumulation of capital is carried out without any further improvements in the methods of production. \(T_0\) relates to an early stage, \(T_3\) to a later one, in which the no-rent quality of land is less fertile than at the previous stage. This is reflected, among other things, in a lower rate of profits: with a given and constant real wage rate, \(w = w^*\), the rate of profits will fall from \(r = r_{T0}\) to \(r = r_{T3}\). This decline will be accompanied by a rise in the money wage rate that is just sufficient to counterbalance the corresponding rise in the money prices of wage goods.

The question of whether it is profitable to introduce a newly invented machine, or of a machine that has been made available already some time ago but was not introduced then on grounds of cheapness, will be asked by cost-minimising producers at any moment of the development of the economy. And at any such moment the technique using the machine can be represented analytically by a \(w-r\) relationship that is alternative to the technique that does not use it. In Figure 3, \(M_0\) is the corresponding wage curve in the initial situation (i.e. when the machine became an option). However, at the given real wage rate \(w^*\) it was not profitable to switch over to the new method(s) of production, because whoever would have adopted the novelty would have incurred extra costs and thus obtained an individual rate of profit that is lower than the current general rate, \(r_{T0}\). (The inferiority of the new method at the wage rate and prices the producer encounters in the markets is also reflected in a lower level of commodities constituting the real wage rate. Here we follow Ricardo in assuming that the share of wages is either constant or rises and the share of rents increases. Accordingly, the share of profits and, given Ricardo’s special assumption, the rate of profits are bound to fall.

Ricardo’s above statement has been severely misunderstood: ‘In this passage’, Ferguson (1973: 6), contended, ‘one must interpret “labour rises” as meaning an increase in the real wage rate’. Yet we have just seen that what is at issue is a rise in money (or nominal) wages, with the commodity wage rate being constant. As is well known, marginalist theory faces the problem of distinguishing between factor substitution and technical progress (i.e. between movements along a given production function and the setting up of a new function). Apparently, Ferguson took Ricardo to have been concerned with the former problem, whereas in fact he was concerned with a case of induced technical change.
the general rate of profits associated with $M_0$ compared with that of $T_0$: $r_{M0} > r_{T0}$.

The question remains whether and when will the new machine be introduced into the economic system? In order to answer this question we have to trace the switch-point between the $w-r$ relationships corresponding to the with-machine and the without-machine techniques, $M_i$ and $T_i$ ($i=0, 1, 2, \ldots$), across the various stages of economic development, where each stage is characterised, in descending order, by a different quality of land that is marginal and different relative prices, and so forth. The basic idea is illustrated schematically in Figure 3, in which points 0, 1, 2 and 3 give such switch-points. Through each such point pass two wage curves, one that represents the with-machine system and the other that represents the without-machine system of production. Points 0, 1 and 2 lie above the line that is parallel to the abscissa at the level of the given real wage rate $w = w^*$ and thus represent situations in which the machine will not be adopted.

Figure 3 Induced technical change

29 In view of this, Joseph Schumpeter’s following statement in the context of a discussion of Ricardo’s chapter on machinery comes as a surprise. Schumpeter (1954: 679 n. 94) contends that none of the major classical authors, including Ricardo, saw the possibility that machines may be introduced ‘that are no novelties to producers and, sofar as technological knowledge is concerned, could have been introduced but were not introduced before, because it would not have been profitable to do so’. It is precisely this possibility that Ricardo dealt with.
However, point 3 lies below the line. The corresponding wage curves are given by $M_3$ and $T_3$. In the then prevailing economic conditions, the machine using technique is superior to its alternative and will be adopted by cost-minimising producers. The general rate of profits in the new situation will be $r_{M3}$, which is larger than the rate that would be obtained in the without-machine case, $r_{T3}$.

With a ‘rise in labour’ (money wages), the falling tendency of the rate of profits can be decelerated by means of a switch to the technique that produces and employs improved machinery (whether freshly invented or known already for some time). While the switch is beneficial to capital owners, it is prejudicial to the interests of the labouring classes.\footnote{The rate of profits and the wage rate may fall together, as Ricardo pointed out with reference to a situation in which some law of population is assumed to hold; see on this Kurz and Salvadori (2006).}

The above analysis expounds and confirms, by and large, Ricardo’s propositions in the chapter on machinery, and shows that Ricardo had a remarkably sophisticated understanding of different forms of technical change and their interaction with the socio-economic environment. Ricardo’s analysis had a considerable impact on the subsequent discussion, as will become clear with respect to Karl Marx in the next section.

4. Karl Marx on a rising organic composition of capital

4.1 Preliminary remarks

With reference to the chapter on machinery, Marx praised Ricardo’s ‘scientific impartiality and love of truth’ (Marx 1954: 412) and the ‘honesty which so essentially distinguishes him from the vulgar economists’ (Marx 1969: 555; original emphasis). Scrutiny shows that Part III of Volume III of Capital, ‘The Law of the Tendency of the Rate of Profit to Fall’, consists essentially of a critical discussion of Ricardo’s views on the matter (Marx 1959). Marx in fact sought to establish the case of technical progress Ricardo had contemplated in the chapter on machinery as the dominant form shaping the long-run trend of the capitalist economy. It was responsible for the falling tendency of the general rate of profits, ‘the stimulating principle of capitalist production, the fundamental premise and driving force of accumulation’ (Marx 1959: 259), and thus the eventual ‘breakdown’ of the system. The problem of technical change thus assumed centre stage in Marx’s analysis of capitalism.
Analytically Marx went beyond Ricardo by studying the problem consistently within the framework of a circular flow of production, as he had developed in terms of his schemes of reproduction in Volume II of *Capital*. Empirically, Marx had access to much larger illustrative material than Ricardo as regards the introduction of machinery and large industry. There could no longer be any doubt that capitalism revolutionised continually the system of production from within. This is well reflected in Marx’s notebooks on technology and technical change. Marx understood perfectly well that the problem he was confronted with – namely, grasping the technological dynamism of capitalism and its implications for the long-term trend of the general rate of profits – was extremely complex and that is was not clear whether a correct answer could be elaborated. There are signs that he was not sure about whether the validity of the alleged ‘law’ could be established beyond reasonable doubt. It was Friedrich Engels who, after Marx’s death, when preparing the edition of Volume III of *Capital* sought to do away with Marx’s uncertainty and vacillations in terms of interpolations and additions to the manuscripts that expressed certainty and firmness. It is beyond the scope of this paper to enter into a discussion of this important aspect of Marx’s works and Engels’s intervention as editor. The following argument is therefore based on Volume III of *Capital* as it was edited by Engels, with only occasional remarks on the edition.31

To be clear about the **differentia specifica** of Marx’s analysis relative to Ricardo’s, we first summarise his view of the system of production and the proximate determinants of the general rate of profits.32

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31 I am grateful to Regina Roth, who works on the Marx-Engel – Gesamtausgabe (MEGA) edition, and to Christian Gehrke for drawing my attention to Engels’s interventions in Marx’s manuscripts when preparing them for publication. There is evidence that Engels in places changed the intended meaning of Marx’s arguments or shaped it in ways which Marx may not have approved. For details, see MEGA (vol. II: 4.2).

32 The anti-Ricardian starting point of Marx’s approach to the law of the falling tendency of the rate of profits is clearly expressed in the following statement: ‘We intentionally present this law before going on to the division of profit into different independent categories [i.e. industrial profit, commercial profit, interest and ground-rent]. … The drop in the rate of profit … expresses the falling relation of surplus-value to advanced total capital, and is for this reason independent of any division whatsoever of this surplus-value among the various categories’ (Marx 1959: 214). It is not entirely clear whether Marx’s argument is intended to apply to an economic system in which ground-rent (etc.) is set aside and the focus is exclusively on industrial capital or whether the amount of surplus-value he talks about is taken to include ground-rent (etc.). In the latter case the reference would be to the value of the surplus product as a whole relative to the value of capital as a whole, including, of course, the value of what Marx called ‘la terre-capital’. However, in his discussion of ‘The Law as Such’ the latter value plays
4.2 The system of production and the general rate of profits

Marx’s system of accounting, like Ricardo’s, is in terms of (labour) values. In the tradition of Quesnay’s Tableau Économique, he started from the premise that in modern times commodities are generally produced by means of commodities (see Gehrke and Kurz 1995). He rejected the view encountered in Ricardo (and later advocated by Eugen von Böhm-Bawerk) that production could, for simplicity, be envisaged as a unidirectional process of finite duration in which a sequence of dated labour inputs eventually result in a final output. This view contradicts the fact that in modern economies any productive activity requires the presence of some previously produced means of production; that is, there is no ‘unassisted labour’, to use Ricardo’s term. In Marx’s schema this is reflected by a ‘constant capital’ needed in each line and at each stage of production. The important implication of this is that the maximum rate of profits of the system, \( R \), is finite and not infinite: even with vanishing wages and thus a vanishing ‘variable capital’ \((V=0; \ S=L)\), the rate of profits would have an upper limit given by the inverse of the ‘organic composition of capital’ of the system as a whole. The organic composition, \( k \), is equal to the ratio of ‘dead’ \( C \) and ‘living labour’ \( L \):

\[
k = \frac{C}{L} = \frac{1}{R}.
\]

The actual rate of profits, \( r \), is instead given by:

\[
r = \frac{S}{C+V} = \frac{S/L}{(C/L)+(V/L)} = \frac{1-w}{R} + w = \frac{R(1-w)}{1+Rw},
\]

where \( S/L \) is the ratio of surplus value to total labour (or rate of surplus value), which translates into the share of profits in the social product, which in turn equals unity minus the share of wages, \( 1-w \).

According to Marx, the long-run trend of the rate of profits thus depends on two magnitudes, instead of only one, as Ricardo had contended: in addition to the share of profits (or rate of surplus value, \( (1-w)w^{-1} \), or share

no role. I therefore adopt the first reading of Marx’s intention, which fits well the anti-Ricardian thrust of his argument. This interpretation receives some support from the fact that the problem of scarce natural resources is mentioned only towards the end of Part III of Volume III of Capital. (On the intended composition of Volume III, see Marx’s letter to Engels of 30 April 1868.)

33 Marx typically calls \( S/V \) the rate of surplus value; a given \( S/V \) implies, of course, a given \( S/L \).
of wages) it also depends on the organic composition of capital or its inverse, the maximum rate of profits. The second determinant reflects the circular flow character of production in the modern economy. The capacity of the economic system to generate a surplus product over and above what is being used up in production is expressed by $R$.

It should come as no surprise, then, that Marx focused attention on what happens to $R$ as the system of production changes from within as a consequence of the introduction and diffusion of new techniques and the reorganisation of the labour process. Differentiating $r$ partially with respect to $R$ gives:

$$\frac{\partial r}{\partial R} = \frac{1 - w}{(1 + Rw)^2} > 0.$$ 

If the maximum rate of profits (the organic composition of capital) falls (rises) in the course of the accumulation of capital and technical change, and if proportional wages (the rate of surplus value) remain constant, the actual rate of profits is bound to fall.\footnote{Even moderately falling proportional wages (a rise in the rate of surplus value) could not prevent this fall of the general rate of profits.}

The ground is now prepared to turn to Marx’s discussion of the long-run trend of the rate of profits. As Engels pointed out in his preface to Volume III of *Capital*, he collated manuscripts and notes that Marx had composed at different times. These reflect different degrees of understanding on Marx’s part of the problem at hand. Whenever Engels felt that the pieces did not fit together, he took the liberty of interpolating and bridging the gaps. Hence, what the reader encounters in Volume III is a sort of *pasticcio*. There is no presumption that Marx would have authorised all the views expressed there. Here we cannot settle the question of which of the published statements express Marx’s mature view on the matter, and which do not. Our aim is twofold. First, we draw the attention to the fact that several of Marx’s statements reflect a strong direct impact of Ricardo’s ideas on his thinking. Some of the ideas he accepted, while others he rejected. Second, we collect some evidence relating to the question of whether over time Marx’s position may be said to have converged in some respects towards the one entertained by Ricardo in the chapter on machinery. We begin with a brief summary account of the influence Ricardo had on Marx’s thinking, as is evidenced by Part III of Volume III of *Capital*. 
4.3 Ricardo’s influence on Marx

Political economy’, Marx maintains, ‘has until now been unable to explain the law of the tendency of the rate of profit to fall’ (1959: 223). The reference is (explicitly or implicitly) to Adam Smith’s erroneous argument that due to the accumulation of capital competition will intensify, which will erode profitability (Marx 1959: 225 and 256), and to Ricardo’s slip regarding constant capital in the formula giving the rate of profits (Marx 1959: 241). What remained of Ricardo’s respective doctrine if reformulated in a circular flow framework? Ricardo is the only author who is frequently referred to, and even when he is not referred to, his ideas are often present. Marx scrutinised carefully what Ricardo had to say, corrected the latter’s propositions, if necessary, and absorbed what he considered sound into his own analytical schema. Traces of Ricardo’s views are clearly discernible in the following views Marx held.

1. The introduction of machinery involves a substitution of the fixed part of constant capital for variable capital, whereas the amount of the circulating part of constant capital (raw and auxiliary materials, etc.) worked can be expected to move in proportion to the output generated, which will be increased due to the increase in productivity (see Marx 1959: 227 and 261).

2. The introduction of machinery involves a saving of labour expended directly or indirectly in the production of commodities, where the saving of direct (or ‘living’) labour more than compensates for any increase of indirect labour; that is, the labour that enters the product via the used up circulating capital and the wear and tear of fixed capital. This saving of labour implies a cheapening of commodities (Marx 1959: 229 and 262). 37

3. Contrary to Ricardo’s doctrine, the general rate of profits can fall, even if the rate of surplus value (proportional wages) remains constant. This is necessarily the case, when the organic composition of capital rises.

35 Marx at first was apparently extremely fond of what he considered to be his achievement and wrote to Engels on 30 April 1868: ‘This is one of the greatest triumphs over the pons asini of all previous political economy’.

36 As regards John Stuart Mill’s probable influence on Marx’s law of the falling rate of profits and especially his exposition of ‘counteracting influences’, see Balassa (1959: 158–60). (It should be noted that the term ‘counteracting influences’ was added by Engels when regrouping the material and preparing it for publication.)

37 It may imply the ‘moral obsolescence’ of existing fixed capital, which can no longer be used profitably due to the invention and introduction of improved fixed capital.
The rise of the organic composition expresses the particular form technical change takes in capitalism (Marx 1959: 212–13).

4. The introduction and generalisation of machinery displaces workers and gives rise to a ‘relative over-population’ (Marx 1959: 249 and 251) – a ‘reserve army of the unemployed’. This is the necessary consequence of the replacement of labour power by machine power. The displaced workers cannot be expected to be absorbed by the industries producing machines, because of the overall labour-saving character of machinery. The reserve army exerts a downward pressure on wages.

5. Although Ricardo’s case of gross-produce-reducing improved machinery is never explicitly mentioned, it is implicit in several passages. In two places especially (Marx 1959: 227 and 267) – which, however, reflect Engels’s editorial intervention – the specification provided is largely in accordance with Ricardo’s reasoning.

6. Also the possibility is stressed that an invention does not eo ipso become an innovation. The passage, however, comes from Engels (see Marx 1959: 262). We get back to it below.

7. Marx also touches upon Ricardo’s view that what matters with regard to the trend of the general rate of profits, given the real wage rate, is what happens in those ‘spheres of production, whose product passes … directly [or] indirectly into the consumption of the labourers, or into the conditions under which their necessities are produced’ (Marx 1959: 265). He adds that competition generalises the ensuing change in the rate of profits to those spheres to which the above characterisation does not apply. However, contrary to Ricardo, he thinks that the fall in the values of commodities that accompanies the general adoption of cost-reducing methods of production is eventually responsible for a fall in the general rate of profits (Marx 1959: 265) – a view that contradicts the Okishio–Shibata Theorem.38

8. There are several passages in which Marx stresses that a full picture of what is happening presupposes taking into consideration the role of scarce natural resources: the reference is explicitly to renewable resources, such as land and forests (Marx 1959: 252 and 260), and to exhaustible resources, such as minerals (Marx 1959: 260). This would

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38 Marx’s view is somewhat perplexing and contradicts what he has written in other places. He could perhaps have seen the untenability of it by contemplating the opposite case: that of technical regression. In this case, the values of commodities would have to rise. Would he, in these circumstances, advocate the view that the general rate of profits is bound to rise, given the real wage rate? Christian Gehrke has drawn my attention to the fact that in the index of his book Sraffa (1960: 99) has an entry ‘Wage … rises with fall of the rate of profits 40, even if methods of production change as a result 85–6’; this may perhaps be interpreted as an implicit criticism of Marx.
involves an analysis of the trend of rents, which absorb a part of the overall surplus value.

While Ricardo’s overall impact on Marx was significant, it would be interesting to know whether Marx’s mature view as to when precisely the law of the falling rate of profits applies, and when not, corresponds to Ricardo’s case of induced technical change. This Sraffa had asked himself when critically investigating Bortkiewicz (1906–1907) against the background of the works of Ricardo and Marx. The evidence available in Part III of Volume III of *Capital* does not admit a clear-cut answer, but it contains a number of hints that point in the direction of the puzzle to which Sraffa drew attention.\(^{39}\)

### 4.4 When does the law apply?

This question boils down to asking: What happens to \( R \) and \( w \) (see Marx’s expression for the general rate of profits) in different circumstances, expressing *inter alia* different forms of technical progress? In Part III, Marx vacillates between two concepts of wages: the traditional one of a given real wage rate, on the one hand, and that of an economy-wide given rate of surplus value, which is the equivalent of Ricardo’s *share* concept, on the other. The coexistence, side by side, of these two concepts has been a source of confusion and misinterpretation. With an *economy-wide* increase in labour productivity and a given and constant real wage rate, the overall rate of surplus value will rise; whereas with a given and constant rate of surplus value, the real wage rate will rise. This follows from the fall in the values of commodities due to an increase in labour productivity. Marx was well aware of this.

He was also aware of the fact that an increase in labour productivity affects the values of the produced means of production, and thus the numerator in the expression of the organic composition of capital, \( k = C/L \).

‘The increase in the productiveness’, he stressed, ‘always goes hand in hand with a depreciation of the available capital’ (Marx 1959: 248). The question is, therefore, under which conditions does an accumulation of physical capital lead to an increase in the value of constant capital (relative to the workforce employed)? As Marx emphasised:

> The same development which increases the mass of the constant capital in relation to the variable reduces the value of its elements as a result of the increased productivity of labour, and therefore prevents the value of constant capital . . . from increasing at the same rate as its material volume, i.e., the material volume of the means of production set in motion by the same amount of labour power. (Marx 1959: 236)

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\(^{39}\) For references to Sraffa’s unpublished papers, see Gehrke and Kurz (2006).
Interestingly he added:

*In isolated cases the mass of the elements of constant capital may even increase, whilst its value remains the same, or it falls.* (Marx 1959: 236; emphasis added)

In what he calls ‘isolated cases’, the organic composition therefore need not rise and may even fall. In combination with a constant or even rising rate of surplus value, the general rate of profits would remain constant or rise, rather than fall. There is clear evidence that Marx saw that, in order to establish the law of the falling tendency of the rate of profits as the law of motion of the capitalist economy, two things were necessary. First, he had to identify the forms and the sectoral patterns of technical change, which, interacting with the natural conditions of production, implied the law. Second, he had to provide sufficient reason that these forms and patterns can actually be expected to dominate capitalist development. Let us see, how Marx approached these two huge tasks.

### 4.5 Different forms of technical progress

Writing a few decades after Ricardo, Marx had access to a much larger evidence regarding the technical change experienced up until then. He in fact characterised the stages of economic history in terms of a sequence of phases, each of which had its own dominant pattern of technical and structural change; namely, cooperation; division of labour and manufacture; and machinery and modern industry (see Marx 1954: part IV).

‘Considered abstractly’, he distinguished between a number of different forms of technical change. In Chapter XIII of Volume III of *Capital*, ‘The Law as such’, he discussed not only the case he took to be the most important one, but also the case (a) in which the rate of profits ‘may remain the same’ and the case (b) in which it ‘could even rise’ (Marx 1959: 230). He had to deal with these cases, if only for the negative purpose of sustaining that strong reasons spoke against their assuming a prominent role in the development of capitalism.

In case (a), Marx, observed:

> the increase in productiveness of labour acts uniformly and simultaneously on all the elements of the commodity, so that its total price falls in the same proportion in which the productivity of labour increases, while, on the other hand, the mutual relation of the different elements of the price of the commodity remains the same. (Marx 1959: 230)

If this is interpreted as referring to an *equiproportional* reduction in the amount of *direct* labour needed per unit of output in *all* industries, then the
The rate of profits remains constant if and only if the share of wages remains constant, which, however, implies that real wages rise pari passu with labour productivity. The case under consideration anticipates with respect to a multi-sector economy what is known as Harrod-neutral technical change. Its characteristic feature is that it moves the wage frontier clockwise, with a given and constant maximum rate of profits, $R$, as its pivot. (With a constant real wage rate the rate of profits would rise, and the case would have to be grouped under the following one.)

Case (b) comes in two sub-cases. The first is characterised by an increase in the productivity of labour that ‘uniformly cheapens all elements of the constant, and the variable, capital’ (Marx 1959: 226). The second sub-case is introduced as corresponding to ‘a substantial reduction in the value of the elements of constant, and particularly of fixed, capital’ (Marx 1959: 230). Both cases involve an increase in labour productivity (and thus in the maximum level of the real wage rate) and an increase in the maximum rate of profits. Hence the wage frontier is to move outwards (similar to Smith’s case of the division of labour; see Figure 1). For a given real wage rate, but also for a given share of wages, the general rate of profits is bound to increase.40

Interestingly, Marx admits that the two cases cannot be excluded on a priori grounds. Engels, when editing Volume III of Capital, apparently was not content with the fact that this was left in the open and added the apodictic statement: ‘But in reality . . . the rate of profit will fall in the long run’ (Marx 1959: 230).

It is interesting to note that the need to establish the practical unimportance of cases (a) and (b) had been on Marx’s mind already from an early time onwards. In the Grundrisse, for example, he had characterised case (a) as based on a ‘malicious [bösertige] assumption’ (Marx 1966: 293). If case (a) involves a malicious assumption, how much more malicious must have been, in his view, the assumption underlying case (b)? What made him think that way?

4.6 A ‘malicious assumption’

In the long run, Marx was convinced, the organic composition of capital was bound to rise. In Chapter 25 of Volume I of Capital, ‘The General Law of Capitalist Accumulation’, he expounds the main reasons and the endogenous economic mechanism that in his view speak in favour of such a

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40 We assume that the capital-to-output ratio falls in the cases under consideration irrespective of whether we reckon in labour values (à la Marx) or in production prices (which would be the correct approach).
rise. He begins his argument in the first section of the chapter by initially assuming that the accumulation of capital takes place without a rise in the ‘technical’ and ‘organic composition’ of capital. In other words, the attention focuses on extensive growth. In this section he anticipates what is commonly considered an important doctrine of Kaleckian and Keynesian descent; namely that it is the rate of capital accumulation that determines the rate of profits (and the wage rate), and not the other way round.  

Marx in fact stressed: ‘To put it mathematically: the rate of accumulation is the independent, not the dependent, variable; the rate of wages, the dependent, not the independent, variable’ (1954: 581). Yet with high rates of accumulation and rising levels of employment, capitalists will eventually bid up real wages.  

Rising real wages, Marx insisted, direct technical change in a labour-saving and productivity-enhancing way. This is the theme of Section 2, which is devoted to intensive growth. Marx argues: ‘Once given the general basis of the capitalistic system, then, in the course of accumulation, a point is reached at which the development of the productivity of social labour becomes the most powerful lever of accumulation’ (1954: 582–3). An increasing productivity of labour has two interrelated effects that render it the said ‘powerful lever’. First, it allows capitalists to accommodate rising wages, and, second, it entails a displacement of workers and fills the reserve army of the unemployed that constrains any such rise. Yet an increase in the productivity of labour generally presupposes an increase in the ‘technical composition of capital’, which in turn is taken to be ‘reflected’ in an ‘increase of the constant constituent of capital at the expense of its variable constituent’ (Marx 1954: 583). Because of a rising labour productivity, the

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41 However, whereas Nicholas Kaldor and Joan Robinson were of the opinion that the argument applies to a full employment economy, Marx, more sensibly, assumed that it applies to an economy with unemployed labour, as did Michal Kalecki.

42 In the literature, Marx is occasionally accused of having advocated at the same time a falling tendency both of the rate of profits and of the real wage rate; see, for example, Samuelson (1957). (A falling tendency of the real wage rate is said to be implied by Marx’s view as to the immiseration of the working class. We cannot enter here into a discussion of this problematic interpretation.) Samuelson then demonstrates in terms of a linear two-sector model and a given technique that if one of the two distributive variables falls, the other one cannot fall too. There is clear evidence that this was well known to Ricardo and Marx. The problem they tackled in the context under consideration was rather whether in the presence of scarce natural resources, such as land, and thus shifting \( w-r \) frontiers, one or even both distributive variables could fall. It can easily be shown that this is indeed possible; see Kurz and Salvadori (2006).
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(labour) values of the majority of commodities will fall. Therefore, as we have already learned, the organic composition will typically increase by less than the technical one.\textsuperscript{43} In short, machine power will progressively replace labour power, which, in Marx’s view, of necessity leads to a rise in the organic composition of capital, $k$.

This point of view is reiterated in Section 3 of the chapter. There Marx insists:

The accumulation of capital, though originally appearing as its quantitative extension only [extensive growth], is effected, as we have seen, under a progressive qualitative change in its composition, under a constant increase of its constant, at the expense of its variable constituent. (1954: 589)

The view recurs variously in Volume III of Capital (see, for example, Marx 1959: 260–1) and elsewhere in Marx’s writings. It is the upshot of his analysis and was designed to supply the crucial link in the sought scientific demonstration that capitalism was only a transient mode of production.

What made Marx so confident that $k$ was bound to rise? Put differently, what made him think that the increase in labour productivity due to the progressive mechanisation of production could not, \textit{à la longue}, reduce the values of commodities at a rate that is equal to (or even larger than) the rate at which more of the capital goods (measured in some way) are employed per worker? In this case, the organic composition would remain constant (or even fall) despite a rise in the technical composition.

The answer to this question is that in Marx’s view the particular bias of technical progress contemplated was ‘\textit{just another expression peculiar to the capitalist mode of production}’ (Marx 1959: 213; Engels added the emphasis). It is the antagonism between capital and wage labour that directs technical change towards a rising organic composition. In the conflict over the distribution of the product, capitalists try to replace the element that cannot be fully controlled and disciplined, the worker, by the element that can, the machine.\textsuperscript{44} Marx apparently counted upon a ruse of history. By replacing labour power by machine power, capitalists in the short run were able to ward off threats to their profit position. However, in the long run they thereby unconsciously undermined that very position

\textsuperscript{43} Marx does not tell the reader how to measure the technical composition of capital. In the course of time there will be a change both in the quantities and qualities of capital goods employed, and it is unclear in which sense one can speak of a higher (or lower) composition without aggregating heterogeneous capital goods by means of some value-based or price-based device.

\textsuperscript{44} Interestingly, Ricardo had dubbed machines ‘mute agents of production’. 

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because profits come out of (surplus) labour, which is progressively made redundant.\footnote{Nathan Rosenberg indirectly supports Marx's point of view for the period in which Marx wrote: 'The apparent recalcitrance of nineteenth-century English labor, especially skilled labor, in accepting the discipline of factory employment provided an inducement to technical change. ... The most important point is that the threat of worker noncompliance ... was a powerful force in directing energies in a search for labour saving machines' (Rosenberg 1969: 12).}

Marx's argument is not without appeal, and, as we have seen, for a fairly constant share of wages a rising organic composition will indeed entail a falling actual rate of profits. Yet a constant share of wages may imply a rising (real) wage rate. This possibility sits uncomfortably with Marx's dictum: 'Nothing is more absurd ... than to explain the fall in the rate of profit by a rise in the rate of wages' (Marx 1959: 240). The dictum was obviously directed at Ricardo's doctrine that it is only an increase in wages that can depress profitability, and, as we have seen, Marx's respective criticism of Ricardo was sound with respect to a circular flow of production. This leads naturally to the question: in which conditions can the general rate of profits fall without being accompanied, or caused, by a rise in the real wage rate?

In Section 3 above, when dealing with Ricardo's chapter on machinery, we encountered a case that fits the requirement and which was well known to Marx (see Marx 1969: ch. XVIII). In it the accumulation of capital, diminishing returns in agriculture and the introduction of machines that have been invented some time ago, but at first could not be used profitably, interact in a complex manner. Is there reason to presume, following Sraffa's conjecture, that Marx in his later writings on the subject may have considered the need to limit the applicability of his law to Ricardo's case of what we called 'induced technical change'? As was already stressed in the above, it is doubtful that this question can be unambiguously decided on the basis of Marx's published writings. Here it suffices to direct the reader's attention to remarks by Marx that may perhaps be read as lending some support to the conjecture.

4.7 Marx's retreat to Ricardo's position

To the extent to which capital accumulation increases labour productivity in the production of capital goods, it fails to add to the value of constant capital. Interestingly, there are numerous passages in Marx's writings in which he points out that it is the uneven development of productivity in the
different sectors of the economy that is responsible for a rising organic composition. In Volume 3 of the *Theories of Surplus Value* we read:

The development of productive power is not even. It is in the nature of capitalist production that it develops industry more rapidly than agriculture. This is not due to the nature of land, but to the fact that, in order to be exploited really in accordance with its nature, land requires different social relations. Capitalist production turns towards the land only after its influence has exhausted it and after it has devastated its natural qualities. (Marx 1971: 300–1)

In this passage, land is seen as an exhaustible resource that will actually be exhausted in the course of its capitalistic use. This case is more serious with respect to the long-run trend of the rate of profits than Ricardo’s case of extensive and intensive diminishing returns, because in Marx the use of ever more types of land goes hand in hand with their successive deterioration.

The issue of uneven development recurs in the ‘Supplementary Remarks’ Engels appended to Chapter XV, ‘Exposition of the Internal Contradictions of the Law’, in Volume III of *Capital*. The first remark is truly striking, when read against the background of Ricardo’s argument:

The fact that the development of the productivity in different lines of industry proceeds at substantially different rates and frequently even in opposite directions, is not due merely to the anarchy of competition and the peculiarity of the bourgeois mode of production. Productivity of labour is also bound up with natural conditions, which frequently become less productive as productivity grows – inasmuch as the latter depends on social conditions. Hence the opposite movements in these different spheres – progress here, and retrogression there. (Marx 1959: 260; emphasis added)

What Marx describes here fits precisely the special constellation Ricardo had analysed: a growing labour productivity in industry (and in the system as a whole) and a falling one in agriculture. Whether, and by how much, productivity grows in the former depends on ‘social conditions’, which decide if improved machinery, whether known for a long time or newly invented, will actually be introduced.46

We may conclude by saying that Marx’s thinking on the problem of technical change and its impact on distribution was strongly influenced by

46 Taking into account Ricardo’s optimistic expectations as to the long-term prospects of profitability and capital accumulation, which were largely based on continual improvements in agriculture (see Section 3 above), one might even tinker with the idea of characterising Ricardo as ‘Marx without diminishing returns’. But this is perhaps going too far.
Ricardo’s treatment of these questions. The arguments Marx puts forward in support of his claim that the tendency for the rate of profits to fall is inherent in capitalist social relations in the same sense that exploitation of labour or cost-reducing technical change are is inconclusive.

5. Concluding remarks

This paper shows how much the classical authors Smith, Ricardo and Marx considered technical change to be at the heart of the development of the advanced capitalist economy. They elaborated a sophisticated typology of different forms of technical progress and the different implications these can be expected to have. The implications could generally not be decided independently of the natural conditions of production; that is, the amounts of land and deposits of exhaustible resources available at a given moment of time. They also forged a most useful concept by means of which the salient features of different forms of technical progress can be expressed in a compact way: the wage frontier. It gives the constraint binding changes in the general rate of profits, $r$, and the real wage rate, or share of wages, $w$, for a given system of production.

Different forms of technical change shift that frontier over time in different ways. Translating an ever deeper division of social labour, Smith’s *thema probandum*, into $w-r$ space implies a shift away from the origin and a steeper slope of the curve: while the maximum rate of profits can be expected to rise only moderately (or even fall a little), the maximum wage rate will rise considerably over time, reflecting a sustained growth in labour productivity. Ricardo focused attention on the process of the mechanisation of production, whereby labour power was successively replaced by machine power. This form implied a rise in labour productivity, but at the same time a fall in the maximum rate of profits; that is, a rise in the capital-to-output ratio, expressing an increasing fixed capital intensity of production. Ricardo also showed that an invention will not *eo ipso* become at once an innovation: it may be born into an environment (i.e. prices and wages) that do not allow for its profitable employment. However, with a change in the environment due to capital accumulation and a growing population *vis-à-vis* diminishing returns in agriculture, the situation may eventually turn favourable to the invention (‘induced’ technical change). Marx developed his own view of the role of technical change first and foremost from a critical account of Ricardo’s and formulated it in terms of an analysis firmly based on the concept of production as a circular flow. He tried to establish the fact that the form that dominates the development of capitalism is characterised by a growing organic composition of capital,
which corresponds to a falling maximum rate of profits. This is the case Ricardo had investigated in his chapter on machinery.

The three authors focus a good deal of their attention on the impact of capital accumulation and technical change on the general rate of profits. While each of the three comes up with the view that the general rate of profits is bound to fall, the explanations they give and the qualifications they add differ in important respects. In Ricardo the falling tendency of the rate of profits is conditional upon the absence of a sufficient flow of improvements and technical innovations. In Marx, originally the tendency is taken to be ‘just another expression peculiar to the capitalist mode of production’ (as Engels put it). However, reconsidering the issue Marx appears to have become increasingly aware of the fact that natural conditions of production also play an important role in the story. Following up a conjecture by Sraffa, it is argued that in his mature writings Marx came close to adopting Ricardo’s case of induced technical change as the one to which his law of the falling tendency of the rate of profits applies.

The three authors under consideration contributed in important ways to a better understanding of the dynamism of the capitalist economy and its incessant drive from within to revolutionise the system of production and increase the productivity of labour. They elaborated a framework of the analysis and forged concepts that allow us to analyse different forms of technical progress and their impact on income distribution, the pace at which the system grows and the structural change that comes with it. They may be criticised for having mastered only imperfectly the complex system of coordinates within which the problem under consideration was to be investigated. However, many of the questions they raised and tried to answer have been dropped in later times because of their difficulty. The analysis has for a long time been limited to studying the problem in hypothetical one-good worlds, which are uniquely ill-suited to study the complexities at hand. It is only recently that some of the old questions have been rediscovered (or rather formulated anew). Sooner rather than later, it is to be hoped, the classical economists’ approach to tackle them will also be rediscovered.

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References


Abstract

The paper discusses the analyses of technical progress, capital accumulation and income distribution elaborated by three major classical economists: Adam Smith, David Ricardo and Karl Marx. The interpretation given is partly inspired by Piero Sraffa’s studies in his hitherto unpublished papers. It will be argued that in the classical authors we encounter a sophisticated typology of different forms of technical change and an analysis of the different effects these have. These forms can be analysed in terms of shifts of the inverse relationship between the general rate of profits and wages, or wage frontier. The emphasis will be on Adam Smith’s concept of the division of labour, Ricardo’s analysis of the substitution of machine power for labour power, and Marx’s adaptation of Ricardo’s argument to his own analytical framework in terms of a rising organic composition of capital.

Keywords

Classical economics, technical change, income distribution, Adam Smith, David Ricardo