The notion of progress and the historical evolution of wage-curves

A comment on the debate between 'Sraffians' and Blaug on the labor theory of value in classical economics

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Abstract: This paper deals with the question whether (and if so, in which sense and for what purposes) classical political economists like Smith, Ricardo and Marx hold a labor theory of value. Starting from a critical discussion of the respective answers put forward in a recent debate between post-Sraffian authors and M. Blaug, the paper develops an alternative answer through a dialogue with each side of the debate. It argues – like Blaug does, but for different reasons – that the role of the labor theory of value in Ricardo and Marx is not reducible to that of a tool for solving the problem of the determination of production prices and the profit rate. Rather, the labor theory of value in Ricardo is an answer to a problem permeating Smith's theory of progress: Ricardo identifies the idealized condition of possibility for 'natural progress' in the Smithian sense and argues that this condition is approximately satisfied by systems of production prices. Since Ricardo's interpretation of systems of production prices is capable, unlike the predominant post-Sraffian interpretation of the same systems, to generate substantial and empirically falsifiable propositions concerning the historical evolution of wage-curves, those propositions are confronted with empirical evidence: to this end, actual wage-curves are estimated, based on Sraffa's price equations and input-output data, for twelve countries in the period from 2001 to 2007. The paper concludes that the post-Sraffian dismissal of the labor theory of value as a 'redundant tool' is a mere artefact of the abandonment of progress as an object both capable as well as in need of theory, and emphasizes the relevance of the weak notion of progress encountered in classical economists.

Keywords: Adam Smith, David Ricardo, Karl Marx, Piero Sraffa, technical progress, wage-curves, labor theory of value

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Introduction

The question whether – and if so, in which sense and for what purposes – classical political economists like Smith, Ricardo and Marx hold a labor theory of value has been extensively discussed, not only in the literature specialized on Smith (e.g., Peach 2009), on Ricardo (e.g., Peach 1993) and on Marx (e.g., Heinrich 1999), but also in the literature on classical economics as such (e.g., Cartelier 1976), and in entire studies devoted to the labor theory of value (e.g., Meek 1956; Dooley 2005; Foley 2016). Whereas interpretations specialized on single classical authors identify, by their very nature, idiosyncratic elements (the labor theory of value in Smith, the labor theory of value in Ricardo, the labor theory of value in Marx), contributions on classical political economy as such, or on the labor theory of value as such, are capable of identifying common elements (the labor theory of value in classical economics). The present article belongs to the latter type of approach; it is hoped, however, that the answers suggested are acceptable also from the particular point of views characteristic of Smith scholarship, Ricardo scholarship and Marx scholarship, even if idiosyncratic elements (i.e., notions or problems which are specifically Smithian, specifically Ricardian or specifically Marxian) are deliberately left aside in what follows.

Among those contributions which deal with the labor theory of value in classical political economy in general, there is no commonly accepted answer to the question raised above. A recent debate between 'Sraffians' and the late Blaug (Blaug 1999; Kurz and Salvadori 2002; Garegnani 2002; Blaug 2002; Blaug 2009; Garegnani 2011; Kurz and Salvadori 2011) is a case in point: Blaug criticized the (post-)Sraffian interpretation of classical economists for not being capable of explaining Ricardo's and Marx's insistence on the labor theory of value and claimed that the labor theory of value played not an instrumental but a substantial role in their analyses; post-Sraffian authors replied to this criticism by simply reaffirming their interpretation according to which the role of the labor theory of value in Ricardo and Marx was purely instrumental ("it was simply a useful tool at a certain stage of the development of the analysis that could be dispensed with as soon as the role performed by it could be assumed by a more correct theory"; Kurz and Salvadori 2002, 233). Albeit this debate remained fruitless in the sense that no consensus whatsoever emerged, a reflection on the reasons as to why it remained fruitless may turn out to be fruitful. In this sense, the present article takes the debate between 'Sraffians' and Blaug as a starting point and develops its alternative interpretation of the role of the labor theory of value in Ricardo and Marx in a constant critical dialog with each side of the debate.

The first section renders explicit the four premises supporting the post-Sraffian conclusion that the labor theory of value is a 'redundant tool' and identifies the main shortcoming of Blaug's critique: instead of rejecting one or more of these premises, Blaug accepts the post-Sraffian conclusion as an appropriate 'rational reconstruction', but rejects the very same conclusion as an inappropriate 'historical reconstruction', thus reducing his critique to a meta-debate on the most appropriate methodologic approach to the history of economic thought. Since post-Sraffian authors simply do not share the late Blaug's dismissal of 'rational reconstructions' in favor of 'historical reconstructions', his criticism misses its very object and the opponents, lacking common ground, confront themselves in a non-debate. The second section develops an alternative interpretation of the role of the labor theory of value in classical economics through a criticism of the post-Sraffian interpretation. In contrast to Blaug, the criticism consists in a critical discussion of the premises themselves: while some of them are accepted such that the critique and its object share common ground, some others are rejected. The critique of the post-Sraffian interpretation and the alternative interpretation are developed in three steps: in a first step (in section 2.1), it is argued that one of the four premises, concerning the specific difference between pre-Smithian and (post-)Smithian classical economics, is correct, but incomplete: what distinguishes pre-Smithian and (post-)

Smithian classical economics is not only the absence of a classical system of production prices in the former and its presence in the latter, but also the absence of a notion of historical progress in the former and its presence in the latter. This difference, in turn, is due to the fact that Smith shifted technical change – more precisely, progressive technical change as an ongoing, economy-wide and endogenous process – to the center of economic theory. In a second and third step (in sections 2.2 and 2.3), it is argued that, due to the incompleteness of the afore-mentioned premise, another premise, concerning the role of labor values and of the labor theory of value in classical economics, is incorrect: to this end, section 2.2 discusses two possible ways of defining progressive technical change by means of wage-curves – the crucial concept in the analysis of technical change from a classical-Sraffian perspective – and contends that only one of them can be ascribed to Smith (and also to Ricardo and Marx). Section 2.3 then argues that Ricardo's labor theory of value is not an attempt to answer Sraffa's problem, but an answer to a problem permeating Smith's theory of 'natural progress.' Ricardo identifies the ideal condition under which profit-maximizing technical changes are indeed progressive and contends that this condition is approximately satisfied by a system of production prices, since deviations of relative production prices from relative labor values are quantitatively limited to the point of being insignificant in their effects. While Ricardo thus interprets the theory of production prices as an empirical labor theory of value on the grounds that production price-labor value deviations are slight, post-Sraffian authors discard the labor theory of value on the grounds that production price-labor value deviations exist. Section 3 argues that these different ways to look upon a system of production prices become relevant once a sequence of equilibrium positions in historical time is considered (i.e., the 'moving equilibrium' whose analysis, according to Blaug, constitutes the 'essential core' of classical economics): the Ricardian interpretation of a system of production prices does, while the post-Sraffian interpretation does not, generate substantial and empirically falsifiable propositions concerning the evolution of production techniques (or wage-curves) in historical time. Section 4, therefore, confronts those propositions, in particular that of an upward-shift of the vertical intercept of wage-curves, with the historical evolution of actual wage-curves: to this end, the wage-curves of twelve countries are estimated for the period between 2001 and 2007, based upon input-output data and Sraffa's price equations. These estimations show, firstly and against Blaug, that Sraffa's 'logical rigor' does not come at the cost of being empirically irrelevant; they show, secondly and against the post-Sraffian interpretation, that actually observed technical changes exhibit a progressive pattern as predicted by the labor theory of value. The concluding remarks emphasize the relevance of the classical, i.e., Smithian, Ricardian and Marxian, theory of progress.

1. The role of the labor theory of value in Ricardo and Marx: the post-Sraffian interpretation and the shortcoming of its criticism by Blaug

The post-Sraffian "reconstruction" (Aspromourgos 1996, 4), "reformulation" (Kurz 2003, 168), "revival" (Garegnani 2018, 620) or "rehabilitation" (Meek 2013, 462) of the approach of classical political economists considers the labor theory of value to be a 'redundant tool'. The post-Sraffian argument as to its purely instrumental role and its redundancy in that approach is based on four premises. The first premise consists of an interpretation of theorists like Cantillon, Quesnay, Smith, Ricardo, Marx and Sraffa as exponents of the 'surplus approach to value and distribution'. According to the canonical post-Sraffian reading, the theories of Cantillon, Quesnay, Smith, Ricardo, Marx and Sraffa converge insofar as a "classical system of prices" (Cartelier 2015, 807) is present, i.e., a price system the basic elements of which are a technique of production and a rule of imputation of the value of the surplus (Cartelier 2015). The second premise states that, beyond their common affiliation to the generic surplus approach to value and distribution, there is a specific difference between

pre-Smithian and post-Smithian exponents of that approach: in contrast to the former, the latter deal with the same particular classical system of prices, characterized by the same particular rule of imputation of the value of the surplus, namely the rule of the uniformity of the rate of profit. Hence, in contrast to pre-Smithian authors (like Cantillon and Quesnay), Smith, Ricardo, Marx and Sraffa share the same object: production prices (prices that guarantee a uniform rate of profit across sectors). According to the third premise, the role of the labor theory of value in Ricardo and in Marx is exclusively that of a tool for solving the problem of determining production prices and the uniform rate of profit, starting from given socio-technical conditions of production (or, alternatively, for demonstrating the inverse relation between wages and profits). The fourth premise states that Sraffa's (1960) simultaneous equations provide, without having recourse to labor values, a general and correct solution to the problem of determining production prices and the uniform rate of profit, starting from given socio-technical conditions of production (or, alternatively, to the problem of demonstrating the inverse relation between wages and profits).

Hence, Ricardo's and Marx's labor theory of value is a 'redundant tool' – their approach to value and distribution is *aufgehoben* in Sraffa (1960) in the threefold Hegelian sense of 'negated' (with regard to the labor theory of value), 'preserved' (with regard to the common substance of the surplus approach, i.e., the common classical system of production prices) and 'elevated' (with regard to the determination of production prices and profit rate by means of simultaneous equations). Accordingly, it "can scarcely be overemphasized that the project of providing a materialist account of capitalist societies is dependent on (...) value magnitude analysis *only* in the negative sense that continued adherence to the latter is a major fetter on the development of the former" (Steedman 1977, 207); that "labour value magnitudes have no role to play in this determination [of production prices and the uniform rate of profit] and are *therefore* at best superfluous in developing a *materialist analysis of history*" (Kurz and Salvadori 2010, 210; emphasis added); that a "*materialist analysis of history* (...) does not stand or fall with the analysis of capitalist society based on value magnitudes" and that, "on the contrary, the development of *a materialist understanding of the history of capitalist economies* is now seriously hampered by the continued attention paid to such theory" (Steedman 1977, 67; emphasis added).

Obviously, the third premise – whose plausibility is a matter of pure text interpretation – plays a crucial role for the post-Sraffian characterization of the labor theory of value as a redundant tool. It seems therefore appropriate to present it in more detail. According to this premise, the classical authors, notably Ricardo and Marx, faced exclusively the problem of determining the uniform rate of profits on the basis of a particular set of exogenous variables, namely the technique(s) of production, the quantities produced and the real wage. Within the framework of a one-sector corn-model, this problem takes a simple form: since both output and the inputs technically and socially necessary to produce the former consist of corn (the homothetic commodity), the rate of profit is a ratio of two physically homogeneous quantities, i.e. a purely physical ratio. According to the (post-)Sraffian reading, this 'corn-ratio profit theory' was the solution to the problem of determining the profit rate proposed by Ricardo in his *Essay* of 1815 (Sraffa 1951). The solution to the same problem in a multi-sector economy, where output, produced means of production and wage goods are vectors whose elements are heterogeneous commodities, is obtained by the construction of Sraffa's standard commodity. This generalized homothetic commodity shows the uniform rate of profits (which appears in Sraffa's system of n simultaneous equations with n prices as a ratio of economic surplus to advanced capital in *value* terms) to be determined as a purely physical ratio, too. However, due to "a mismatch between analytical concepts and tools" (Kurz and Salvadori 2010, 198), Sraffa's solution was not yet available to Ricardo and Marx: "The indispensable tool – simultaneous equations – alas! was not at the disposal of the classical authors and Marx who therefore tried to solve the problems they encountered in a roundabout way, typically by first

identifying an 'ultimate measure of value' by means of which heterogeneous commodities were meant to be rendered homogeneous (...). [Ricardo and Marx] had then reached the conclusion that 'labour' was the sought standard (...). This was understandable in view of the unresolved tension between concepts and tools" (ibid.). "Ricardo and Marx adopted the so-called labor theory (...) as a way of rendering outputs, inputs and wage goods commensurable in order to calculate and explain the profit rate" (Mongiovi 2017, 497). The importance of labor values for classical authors, in particular Ricardo and Marx, is thus explained by post-Sraffian interpreters as the expression of a *lack of adequate mathematical tools*: given the absence of the necessary mathematical knowledge, classical authors had to resort to labor values as an expedient in order to generalize to a multi-sector economy the 'corn-model' solution to the problem of the determination of the rate of profits. According to this interpretation, the only substantial theoretical role of labor values in the thought of classical political economists was that of a tool, however imperfect, for the homogenization of heterogeneous commodities with regard to the determination of the rate of profits on the basis of the given set of exogenous variables (notably techniques of production and real wages).[1]

Just like the first two premises, the third premise on the role of the labor theory of value in Ricardo and Marx proposes one possible interpretation of the writings of classical political economists and belongs, as such, to the history of economic thought. Since it posits that the *explanandum* of Ricardo and Marx consists *exclusively* in the determination of production prices and the uniform profit rate (the *explanandum* of Sraffa 1960), i.e., that the scope of their theories does not go beyond the scope of Sraffa's *Production of Commodities by Means of Commodities*, it appears as a rather narrow and reductionistic interpretation – a typical example of a retrospective approach to the history of economic thought (in the sense of Lapidus' typology which distinguishes 'extensive', 'retrospective' and 'intensive' approaches to the history of economic ideas).[2] Once this retrospective approach is adopted and it is admitted that the 'core' of the economic theories of Ricardo and Marx can be *reduced* to the problem of finding a solution to Sraffa's (1960) problem, the conclusion that "Sraffa's solution deprives labor values of their principal *raison d'être*" (Mongiovi 2017, 499) is hardly surprising. It is therefore only consequent that historians of economic thought who, like the late Blaug, favor extensive approaches ('historical reconstructions' in Blaug's words) over retrospective approaches ('rational reconstructions' in Blaug's words), criticized the post-Sraffian interpretation of classical economists:[3] Blaug's (1999; 2002; 2009) criticism consists,

[1] See, for example, Garegnani (1984; 1987), Petri (1989), Kurz and Mongiovi (2002), Kurz (2003; 2006), Kurz and Salvadori (2010), Petri (2015), Mongiovi (2017), Petri (2018), Garegnani (2018) as well as Gehrke and Kurz (2018).

[2] Based upon their respective conceptions of the relation between 'old' and 'contemporary' statements, Lapidus' (1996) typology of approaches to the history of economic thought distinguishes the three different approaches as follows: the extensive approach "consiste à interpréter un ensemble d'énoncés anciens en fonction de problématiques en vigueur à l'époque où ils ont été établis" (878); in the retrospective approach, "les énoncés anciens (...) sont abordés en tant que préfiguration de développements contemporains" (880); the intensive approach transforms "l'état présent du savoir économique (...) au moyen de la réactivation d'un savoir ancien" (881). At least with regard to the interpretation of the labor theory of value in Ricardo and Marx, the post-Sraffian reading clearly exemplifies the retrospective approach.

[3] Cf. Blaug (1999), 81–82: "The Sraffian interpretation is just another 'Whig interpretation of history'. We assume that perfect truth is found in *Production of Commodities*, and then we read backward, finding Sraffa in much of Ricardo and Marx (...), and forget about almost everything else in classical economics because it will not fit the Procrustean bed of the interpretation. (...) [Sraffians commit the] sin of literally manufacturing a historical pedigree for neo-Ricardian linear production theory." Cf. also Blaug (2002), 237: "[Post-Sraffians] claim, not just to have reconstructed the ideas of some great economists of the past in the economics concepts and language of today, but also, miraculously, to have captured the very essence of those ideas better than even their inventors themselves understood them. (...) Since Sraffa has discarded the troublesome labor theory of value, they give us Ricardo and Marx without it because it is not 'an indispensable element of classical analysis.'" This description is fairly accurate: "The [Sraffian] proof that starting from those same data [namely

quite simply, in emphasizing precisely those aspects of Smithian, Ricardian and Marxian economic thought which lie beyond the scope of Sraffa (1960)[4] and, especially, in merely declaring that the post-Sraffian interpretation "leaves one wondering why both Ricardo and Marx were so obsessed with the labour theory of value" (Blaug 1999, 82–83); that "the qualified validity of the labour theory of value was never conceived as a solution to a static equilibrium problem along Sraffian lines" (87); and that "the 'core' of classical economics always involved some version of the labour theory of value" (93). Such a criticism, however, turned out to be not very fruitful, since it ultimately boils down to a sterile confrontation of two different methodological approaches to the history of economic thought (extensive versus retrospective), the choice of which is *eo ipso* a matter of arbitrary decision: thus, Blaug himself states that "the Sraffian interpretation of the surplus approach of classical economics is a perfectly valid rational reconstruction but a deficient and misleading historical reconstruction" (Blaug 2009, 232). Accordingly, Blaug's criticism makes sense only if one *presupposes*, as the late Blaug does,[5] that the proper task of the history of economic thought is to offer 'historical' rather than 'rational' reconstructions. Since post-Sraffian authors simply do not share this presupposition, Blaug's criticism missed its object, thus provoking a non-debate which Hegel's (1802) early essay on the method of criticism characterized as follows: "since reciprocal recognition is in this way suspended, what appears is only two subjectivities in opposition; things that have nothing in common with one another come on stage with equal right for that very reason; (...) criticism transposes itself into a subjective situation and its verdict contradicts its essence; its judgement is an appeal to the Idea of philosophy [here: to the idea of 'historical' reconstructions] but since this Idea is not recognized by the adverse party, it is only a foreign court of judgement for him" (Hegel [1802] 2000, 276).

Instead of accepting, as Blaug does, the aforementioned four premises and their conclusion as a valid 'rational reconstruction', while simultaneously rejecting the very same premises and conclusion as a valid 'historical reconstruction', it might be more appropriate to simply engage in a direct critical discussion of these premises itself. The discussion of the first, second and fourth premise can be cut short here, since they are accepted in what follows. The next section argues, however, that the second premise, albeit correct, is incomplete and that, due to the incompleteness of the second premise, the third premise is questionable.

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production techniques and the real wage] a correct determination of relative prices and of the rate of profit can indeed be achieved, although with other tools, *confirms* the solidity of the surplus approach" (Petri 2015, 79) – such that any reading which interprets the role of the labor theory of value in Ricardo and Marx other than that of a tool for solving Sraffa's problem suffers "from lack of competences in economic theory" (Petri 2015, 79).

[4] Consider statements like the following: "the classical economists, including Ricardo, never confined their ideas to the theoretical problem of price-determination" (Blaug 2009, 225); "[the (post-)Sraffian interpretation is] a rational reconstruction of a very small and possibly the least interesting part of Ricardo and Marx" (Blaug 2002, 239); "[Ricardo and Marx] were both far more concerned with questions of the dynamics of economic change than with the statics of price determination" (Blaug 2002, 239).

[5] Cf. Blaug (2001), 152: "Although I have been guilty myself of the very sin I have just deplored [namely to engage in 'rational' reconstructions which, according to Blaug, 'ultimately make the history of economic thought dispensable'], *I have come to the conclusion that the only approach to the history of economic thought that respects the unique nature of the subject material, rather than just turning it into grist for the use of modern analytical techniques, is to labor at historical reconstruction*" (emphasis added).

2. The role of the labor theory of value in Ricardo and Marx: an alternative interpretation

2.1. The incompleteness of the second premise

The second premise states that there is, within the generic classical surplus approach, a specific difference between pre-Smithian and (post-)Smithian exponents of that approach: although both the latter and the former theorize a 'classical price system' (in the sense of Cartelier 2015), characterized by a technique of production and a rule of imputation of the value of surplus, (post-)Smithian classical economists deal with a particular 'classical price system': a system of production prices whose specific difference consists in a particular rule of imputation of the value of surplus, namely the rule of the uniformity of the rate of profit. This, however, is not the only specific difference between pre-Smithian and (post-)Smithian exponents of the classical surplus approach. It might appear as such only if early classical economists are read exclusively through the lenses of what is present in Sraffa (1960). If, in contrast, the texts of early classical economists are studied from a point of view which is absent from Sraffa (1960), another specific difference becomes visible. What, then, is absent from Sraffa's *Production of Commodities by Means of Commodities*? Above all, "there is no history (in the sense of an ongoing process) in Sraffa's propositions" (Harcourt 1975, 370).[6] Reading the early exponents of the surplus approach, accordingly, in asking for the specific way in which economic theory and conceptions of the historical process are articulated, another specific difference is laid bare, namely the absence of a notion of historical progress in pre-Smithian classical political economy and its presence in (post-)Smithian classical political economy.[7]

In this respect, the study of the sequence Cantillon – Quesnay – Smith is particularly illuminating, not only because these authors are commonly acknowledged by post-Sraffian authors as leading pioneers of the surplus approach, but also because, fundamental commonalities notwithstanding,[8] Quesnay's theory is a direct critical response to Cantillon just like Smith's *Wealth of Nations* is a direct critical response to Quesnay. As I have argued

[6] Cf. also Garegnani (1990), 139: "the fact that, as Harcourt puts it, 'there is no history in Sraffa' (...) has to do with *Production of Commodities* being exclusively concerned with the relations in what I have here called the 'core' of classical theory, and is *not due to the theoretical approach he is reviving* here" (emphasis added). On the absence of history and historical time in Sraffa, see also Robinson (1978; 1980a).

[7] This proposition is akin to, but by no means identical with, Brewer's (1995; 2010) research on the emergence of the idea of ongoing *growth* (not: progress) as the 'normal' state of affairs. Brewer's (1995) article *The Concept of Growth in Eighteenth-Century Economics* and, in much more detail, his (2010) monograph *The Making of the Classical Theory of Economic Growth* ask when and how the idea of continuing growth as the normal state of affairs emerged, with the aim "to show how new that view was in the late eighteenth century" (Brewer 1995, 634). Surveying economic thinkers before 1750 as well as Quesnay, Hume, Steuart, Turgot and Smith, Brewer argues that "Adam Smith's view of continuing growth as the normal state of affairs was anticipated only by Turgot and (with very substantial qualifications) by David Hume" (609); "Turgot and Smith developed a theory that allowed them to conceptualize and to account for continuing growth, whereas their predecessors could not" (634); "no-one before Turgot and Smith had advanced a notion of continuing growth of the sort described above. (...) [P]revious writers (...) simply did not consider growth over decades and centuries at all (...). [T]he notion of growth presented by Turgot and Smith really was new" (Brewer 2010, 112–113). Since the notion of growth is by no means identical with the notion of progress (see, e.g., Pasinetti 1981, 50–79 and, particularly, 118–123), the histories of their origins are somewhat different: while the idea of ongoing growth as the normal state of affairs can be traced back to Turgot *and* Smith, the idea of ongoing progress as the normal state of affairs is a specific feature of Smith's economic theory, it is absent from Turgot's *economic* theory (cf. Meek 1973, 32–33; Gaul 2020, 143–149).

[8] For a comprehensive study of the sequence Cantillon – Quesnay – Smith which rather brings to the fore the continuities and commonalities (in a post-Sraffian perspective), see Aspromourgos' (1996) monograph *On the Origins of Classical Economics. Distribution and Value from William Petty to Adam Smith*.

elsewhere in detail,[9] this cumulative criticism is best understood as a successive change in the respective articulation between economic theory and conception of the historical process, which culminates in the emergence of a notion of historical progress in Smith's *Wealth of Nations*: Cantillon's economic thought rationalizes a cyclical conception of the historical process ("les États qui haussent par le commerce ne manquent pas de baisser ensuite"; Cantillon [1755] 2015, 117) and it is precisely this cyclical conception, 'pre-modern' and 'mercantilist'[10], which constitutes the target of Quesnay's criticism; however, Quesnay rejects this cyclical conception in favour not of an alternative conception of history, but of a total repression of the historical process as such through the actualization of an 'immutable' and 'perfect' *ordre naturel* (described, in terms of economic theory, by the *Tableau économique*); it is this a-historical idea of actualized a-temporal perfection, in turn, which constitutes the object of Smith's criticism of physiocracy – a criticism which relies upon the notion of a natural progress.

It is important to notice that this change, from Cantillon to Quesnay and from Quesnay to Smith, in the respective articulation between economic theory and conception of the historical process can be traced back to whether and, if so, how technical change is present in their respective economic theories. Cantillon's cyclical conception of history stems from the complete absence of technical change from his economic theory. Technical change being completely absent, the wealth of a nation, in the sense of Cantillon, can be increased solely in the sphere of international trade through an 'unequal exchange' of 'land values', i.e., as part of a zero-sum game. Contrariwise, Quesnay's purely negative criticism of Cantillon's cyclical conception of history is rendered possible by the consideration of technical change – his very first economic publication is essentially an ideal-type comparison of two different agricultural production techniques (*petite culture* versus *grande culture*). For Quesnay, international trade remains important for the increase of the wealth of a nation, but, as an immediate consequence of the allowance for technical change, it is approached in an entirely different manner: its function is to provide a solution to the old problem of securing a *bon prix*, a problem which is rendered even more acute by the envisaged transition to the technically superior *grande culture*. In short, the technical transition to *grande culture* is supposed to guarantee wealth in its physical dimenstion (*abondance*) and the transition to free international trade is supposed to guarantee wealth in its value dimension (*cherté*).[11] The lack of a positive alternative conception of history in physiocratic thought is due to the fact that technical change, although present, is not yet theorized in the proper sense of the word: first, technical change is present merely as a once-for-all transition (towards 'l'état de prospérité' whose *re*production, on a given technological basis, is the object of the *Tableau économique*), not as an ongoing, permanent process; second, technical change is addressed only partially, that is to say in the agricultural ('productive') sector, not generally; third, technical change is dealt with solely in concrete terms (as a comparison between small-scale, oxen-driven cultivation operating with a wooden plow-share versus large-scale, horse-driven cultivation operating with an iron plow-share), an abstract nomenclature and corresponding concepts for phenomena relating to technical change as such are still missing; fourth, and finally, technical

[9] See the first three chapters in Gaul (2020), 94–214. The following paragraphs are a mere résumé of these chapters and might, therefore, appear somewhat apodictic.

[10] Cf. Gaul (2021).

[11] Cf. Vaggi (1987), 43: "The idea that a country could grow rich mainly by improving the techniques of production of its products, without even trying to 'beggar its neighbours' by distorting commercial relations in its favour, was a new one in 1760. The idea that trade cannot originate wealth had never been proposed before Quesnay." Cf. Vaggi (2002), 76: "Quesnay singles out a new principle of the causes of wealth: productivity and technical progress, as opposed to the mercantilist emphasis on the ability to trade (...). This new principle sees the source of wealth in production and technology and not in that zero-sum game that is foreign trade."

change is exogenous (in the sense of a politico-economic project of modernization),[12] not endogenous.

Smith's criticism of physiocracy by appealing to the notion of a "natural progress of a nation towards wealth" (WN IV.ix.28) is based upon the recognition of technical change as an ongoing, general and endogenous process. The "modernity of this view is really extraordinary. Adam Smith was the first economist to perceive clearly the great possibilities that had come to light with the application of technological advance to the process of production" (Pasinetti 1974, 87).[13] The rigor, as simple as unprecedented, with which the *Wealth of Nations* shifted technical change – under the heading 'division of labor' – to the center of economic theory, is again coupled with a radically different approach to international trade: now international trade itself is explained by the existence of differences in production techniques across countries and considered as the result of a particular form of technical change, technical change 'across space' as it were (international specialization). Such a co-ordination of technical change proper and international trade as two forms of the same thing is particularly characteristic for Smith's thought and not to be found either in Cantillon or the physiocrats.

Now, it goes without saying that Smith's notion of natural progress relies not simply on technical change *per se*, but, more specifically, on technical change of a particular kind, namely *technical progress*. In this sense, Aspromourgos (2010) rightly emphasizes that the Smithian "account of division of labour entails a vision of liberal or competitive commercial society as exhibiting ongoing technical progress" (1169) and that Smith is "the first writer in the tradition of political economy to make technical progress a central fact of modern economic life" (1169). Also Blaug (2009) stresses that "many commentators believe the opening three chapters of *The Wealth of Nations* on the division of labour to contain the foundation stone of a theory of technical progress" (231), not without adding, however, that the latter is "totally ignored" (231) by the post-Sraffian interpretation: "Sraffian economics has nothing whatever to say about it" (226). Before this claim of Blaug is discussed (see section 3 further below), it is necessary to discuss Smith's *definition of technical progress* (see subsection 2.2) and Smith's *theory of technical progress* (see subsection 2.3), in order to understand why, due to the incompleteness of the second premise in the post-Sraffian argument, the third premise on the role of the labor theory of value in Ricardo and Marx is questionable. As we shall see, the labor theory of value in Ricardo and Marx is an answer to a problem permeating Smith's theory of technical progress.

[12] The most extensive discussion of 'technical change' in the writings of physiocrats, i.e., Quesnay's article *Fermiers*, envisages the private and public benefits from a prospective (not yet realized) replacement of oxen-driven by horse-driven cultivation, with the explicit aim of drawing the attention of both government and farmers to the fact that such a technical change would be in their own respective interests: Quesnay's statement that "*on croit vulgairement* qu'il y a beaucoup plus profit, par rapport à la dépense, à labourer avec des bœufs qu'avec des chevaux : *c'est ce qu'il faut examiner en détail*" (Quesnay [1756] 1846, 223; emphasis added) and his subsequent refutation of this 'vulgar opinion' by detailed calculations of the profitability of both techniques show that, for Quesnay, the concrete decisions about concrete production techniques are still a problem of economic theory (instead of being a practical problem supposed to be solved spontaneously by the self-interest of capitalists).

[13] Cf. also McNulty (1968): "[Smith], writing in the environment of the English industrial revolution, was eminently aware of the importance of dynamic changes in production techniques and industrial organization, which he somewhat loosely termed 'the division of labour.' It was precisely the productive and organizational relationships within the business enterprise and not, as with the physiocrats, the natural fertility of the soil, or, as with the mercantilists, exchange in the market per se, which was for Adam Smith the ultimate source of economic surplus."

2.2. The definition of technical progress

The following discussion of Smith's definition of technical progress proceeds from a discussion of its *genus proximum*, that is to say, of technical change. In the neoclassical tradition, technical change is conceptualized, usually under the heading 'factor substitution' and by recurring to the notion of a smooth production function, as a movement along the production function (a conceptualization which implies the definition of technical progress as an outward shift of the production function). In the contemporary classical (above all: post-Sraffian) tradition, however, technical change is conceptualized instead by recurring to the notion of wage-curves: when it comes to technical change, "it seems better to work with the apparatus of the wage curves and their envelope, and not with the problematic idealization, the production function" (Schefold 2013a, 67) – "wage curves have become the main tool for the analysis of technical choice" (46).[14]

For the sake of conceptual clarity, it is convenient to introduce the notion of wage-curves with reference to the simple framework of the corn model which describes an economic system with only one basic commodity, corn. Neglecting non-basic commodities, the production system consists of the production of corn by means of corn and labor. It is assumed that a unit of corn is produced by means of a units of corn and ℓ units of labor ($a > 0$, $\ell > 0$):

Table 1 A technique of production in the corn model

inputs				output
corn		labor		corn
a	$\oplus$	ℓ	$\rightarrow$	1

The economic system is *strictly viable* if its net product, or technical surplus, is positive ($1 - a > 0$, i.e., $a < 1$). Its *technique of production* is given by a particular combination of the technical coefficient a and the direct labor coefficient ℓ, i.e. by the couple (ℓ, a).

With wages paid *post factum*, the price equation is written

$$(1 + r)pa + w\ell = p \tag{2.1}$$

The relationship between the wage rate w and the rate of profits r, the w-r-relationship or wage curve, is given by

$$w(r) = p\frac{1 - a}{\ell} - p\frac{a}{\ell}r \tag{2.2}$$

Or, with corn as *numéraire*:

$$w(r) = \frac{1 - a}{\ell} - \frac{a}{\ell}r \tag{2.3}$$

The maximum wage rate, W, corresponding to $r = 0$, is given by the net-output-labor ratio:

$$W = \frac{1 - a}{\ell} \tag{2.4}$$

The maximum rate of profit, R, corresponding to $w = 0$, is given by the net-output-capital ratio:

[14] Cf. also Schefold (2013b), 1181–1182: "The theory of normal prices, with the wage curve as its main tool, emerges as the *fundamental* concept, and the aggregate production function is a *derived* concept of *limited applicability*. (...) [T]he system of wage curves is the essential analytical tool" (emphasis added). Also in the empirical literature exploring patterns of technical change from a classical perspective (e.g., Michl 1991; Foley and Marquetti 1999a; Foley and Marquetti 1999b; Ferretti 2008; Felipe, Laviña and Fan 2008; Vaona 2011; Marquetti and Soares Porsse 2014; Jeong 2017), "the basic tool of analysis (...) is the efficiency schedule, a version of Piero Sraffa's wage-profit rate relation" (Foley and Marquetti 1999b, 2). On the historical origins of the analysis of technical change by means of the concept of wage-curves in Smith, Ricardo and Marx, see Kurz (1998), Kurz (2010) as well as Haas et al. (2016).

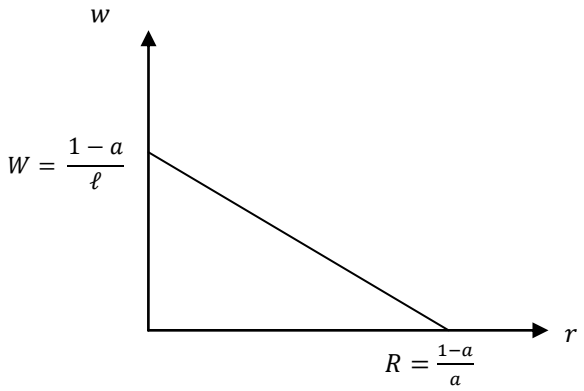
$$R = \frac{1-a}{a} \tag{2.5}$$

The absolute value of the slope of the wage curve represents the capital-labor ratio:

$$w'(r) = -\frac{a}{\ell} \tag{2.6}$$

The wage curve is useful for graphically representing a technique of production (see Figure 1).

Figure 1 Representation of a technique by means of a wage-curve



As a *technique of production* is described by the couple (ℓ, a), *potential technical change* (i.e., a technical *invention*) occurs whenever an alternative technique of production (ℓ^*, a^*) is added to the set of already known techniques (the 'book of blueprints' in the hands of engineers):

$$(\ell, a) \rightarrow (\ell^*, a^*) \text{ with } (\ell^*, a^*) \neq (\ell, a) \tag{2.7}$$

Technical change as such, whether potential or actual, is thus represented by a technical-change-vector[15]

$$\boldsymbol{\delta} = (\ell^* - \ell \quad a^* - a) = (\Delta\ell \quad \Delta a), \text{ with } \boldsymbol{\delta} \neq (0 \quad 0) \tag{2.8}$$

If a newly invented alternative technique of production (ℓ^*, a^*) is actually adopted, this *actual technical change* (i.e., technical *innovation and diffusion*) is reflected by a change in the position of the *w*-*r*-relationship or wage curve (a change either of W or of R or of both W and R). Therefore, the wage-curve is a most useful tool for the analysis of technical change, as Kurz (2010) emphasizes – it "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" (1186).

However, one might add a sixth point: the wage-curve also allows us to address the problem of distinguishing between *technical change* and *technical progress*, i.e., of defining the notion of technical progress – a problem which, as a rule, is absent from the post-Sraffian literature.[16]

[15] Cf. Leontief (1986b), 393: "A concise description of the technology governing the operations of a given industry and in particular its relations to other sectors of the economy can be visualized as a 'cooking recipe,' specifying the amounts of all current inputs – such as raw and intermediate materials, labor of various types, and so on – as well as the stocks of buildings, machinery, and inventories of different kinds required for production of its output. As in a kitchen cooking recipe, both the input flows and the stocks of implements needed to handle them are measured per unit of output. A change in technology can thus be described as a change in the cooking recipe." Cf. also Leontief (1986a), 34 and Leontief (1986c), 365.

[16] The notion of technical progress is not only absent from Sraffa's *Production of Commodities by Means of Commodities* ("Sraffa was not concerned with technical progress" [Pasinetti 1999, 12], it is "absent in Sraffa" [Pasinetti 2007, 281]), but also from standard references in the post-Sraffian literature such as Pasinetti (1977),

The notion of technical change being "a very general one (...), we may now ask more specifically: when is it that technical 'change' actually means technical 'progress'" (Pasinetti 1981, 206)[17]? Since the very term 'progress' refers to a continuous change in historical time which is directed, and directed towards increasing efficiency (at least tendentially), there are, viewed in the abstract, three possible candidates in order to define technical progress by means of wage-curves: the *differentia specifica* distinguishing progressive technical changes from non-progressive technical changes could be either a continuous (strict or tendential) increase in the maximum wage, W, or a continuous (strict or tendential) increase in the maximum rate of profit, R, or a continuous (strict or tendential) increase both in the maximum wage, W, and in the maximum rate of profit, R. Now, the second of these possible candidates can be ruled out: the *differentia specifica* has to be based upon an index which reflects techniques of production, i.e. particular combinations of technical coefficients a and labor coefficients ℓ, whereas the maximum rate of profit does not reflect techniques of production, since it depends only on technical coefficients and not on labor coefficients.

Therefore, there remain two possible definitions of technical progress: either technical progress is defined as an upward shift of the vertical intercept of wage-curves (definition I) or technical progress is defined as an outward shift of the entire wage-curve (definition II). The set of potential technical changes $(\ell_0, a_0) \rightarrow (\ell^*, a^*)$ shifting the vertical intercept of wage-curves upward is given by all techniques of production below the straight line $a^* = 1 - W\ell^*$ (see Figure 2a); the set of potential technical changes $(\ell_0, a_0) \rightarrow (\ell^*, a^*)$ shifting the entire wage-curve outward is given by the intersection of all techniques of production below the straight line $a^* = 1 - W\ell^*$ and of all techniques of production below the straight line $a^* = \frac{1}{1+R}$ (see Figure 2b).

Kurz and Salvadori (1995), Bidard (2004) as well as Bidard and Klimovsky (2006). A notion of technical progress is also absent – even if the term is present – from Kurz (2010) and Schefold (1976). There is, however, a noteworthy exception, namely Schefold's (1979) article *Capital, Growth, and Definitions of Technical Progress* to which we will refer further below.

[17] It should be noted here that Pasinetti's (1981) *Structural Change and Economic Growth* which not only addresses the problem of *defining* technical progress but proposes also a full-fledged *theory* of technical progress, can by no means be characterized as a post-Sraffian contribution: the reason is, quite simply, that Pasinetti (1981) abandons the hypothesis of a uniform rate of profit and, hence, the (Smithian, Ricardian, Marxian and Sraffian) system of production prices (see Gaul 2020, 357–358) in favor of a peculiar variant of a "pure labour theory of value" (Pasinetti 1981, 132). Thus, Pasinetti's work on structural dynamics can "be interpreted as a retreat from the difficulties of capital theory [i.e., from Sraffa] which not only allow us to criticize neoclassical models but often also stand in the way of a reconstruction of the classical approach. Here [in Pasinetti's work on structural dynamics] we have an honest attempt to say something definite, using an age-old variant of the labor theory of value" (Schefold 1994, 1937). Therefore, Blaug's (2009) claim that Pasinetti, "for all his central role in the capital theory debates has veered away from the Sraffian camp with his own approach to growth theory" (234), seems not as unfounded as Pasinetti himself (see Kurz and Salvadori 2011, 612, note 5) asserts it to be.

Figure 2 The set of progressive technical changes in ℓ-a plane

Figure 2a Definition I

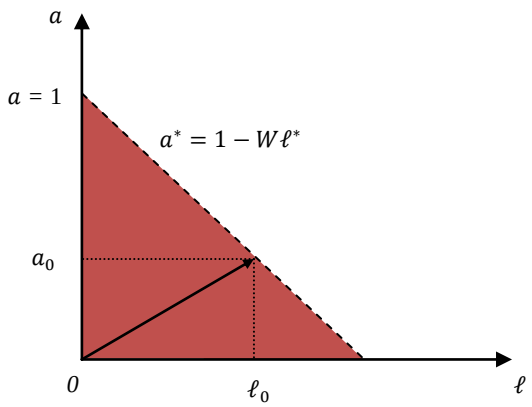
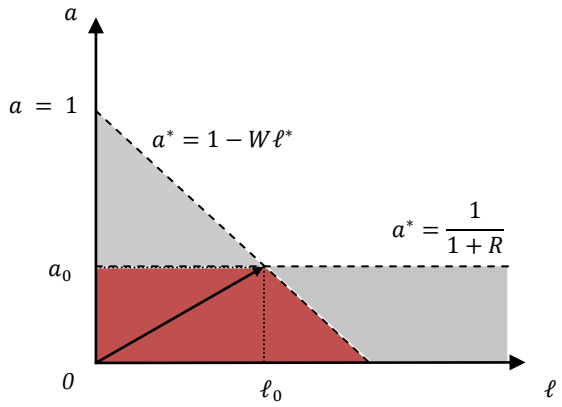


Figure 2b Definition II



In order to better grasp the difference between both definitions, it is convenient to resort to an alternative way of representing a technique of production. Hitherto, a technique of production was represented by means of a direct labor coefficient (ℓ: the quantity of labor necessary for the production of a unit of corn) and a direct technical coefficient (a: the quantity of corn necessary for the production of a unit of corn), i.e. by means of the couple (ℓ, a). However, a technique of production can be alternatively represented – using Sraffa's notion of a "subsystem" (Sraffa 1960, 89) or, what is the same thing, Pasinetti's notion of a "vertically integrated sector" (Pasinetti 1973; 1981, 109–117) – by means of a vertically integrated labor coefficient (v: the quantity of labor necessary for the production of a unit of corn as net output or 'labor value' of corn) and a vertically integrated technical coefficient (v_c: the quantity of corn necessary for the production of a unit of corn as net output, or 'corn value' of corn), that is to say, by means of the couple $(v \equiv \frac{\ell}{1-a}, v_c \equiv \frac{a}{1-a})$:

Table 2 A technique in terms of vertically integrated sectors

Inputs			Gross-output	Net-output
corn		labor	corn	corn
$v_c \equiv \frac{a}{1-a}$	$\oplus$ $v \equiv \frac{\ell}{1-a}$	$\rightarrow$	$\frac{1}{1-a}$	1

Figure 3 illustrates the set of progressive technical changes in v-v_c plane, first (Figure 3a) in accordance with 'definition I' and, second (Figure 3b), in accordance with 'definition II':

Figure 3 The set of progressive technical changes in v-v_c plane

Figure 3a Definition I

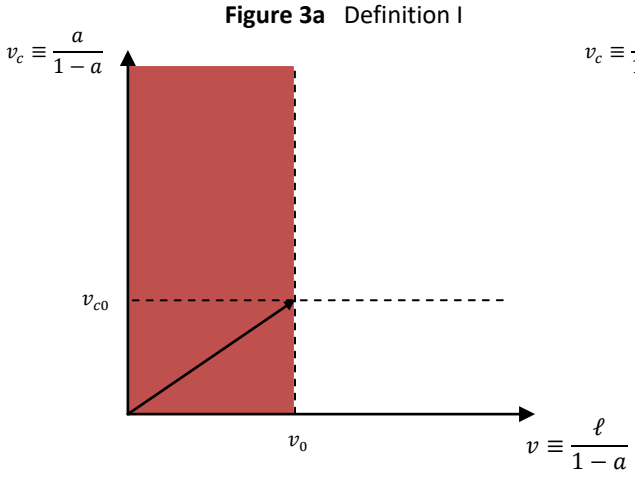
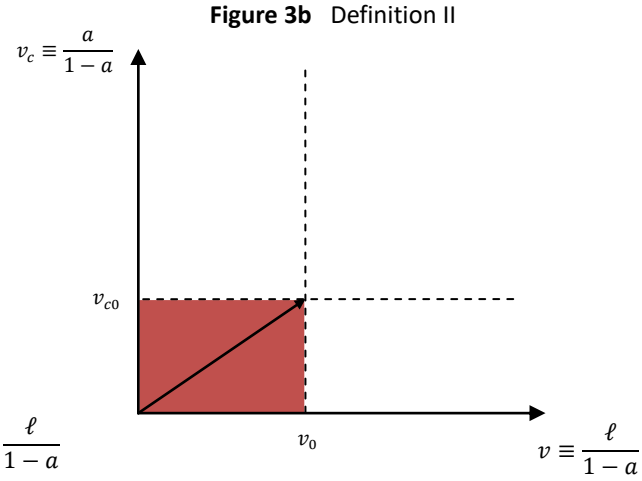


Figure 3b Definition II



The two definitions coincide to the extent that technical changes which decrease both labor values and commodity i values[18] (here: the 'corn value' of corn) are considered as progressive. They differ to the extent that 'definition II' treats labor values and commodity i values in a perfectly symmetrical manner, while 'definition I' treats them in an asymmetrical manner: according to the latter, and in contrast to the former, *all* technical changes which decrease labor values are progressive, even if they increase commodity i values. To put it somewhat differently: 'definition I' includes capital-using and labor-saving technical changes (i.e., technical changes $\boldsymbol{\delta} = (\ell^* - \ell \quad a^* - a)$ with $\Delta\ell < 0$ and $\Delta a > 0$) – provided that they increase total labor productivity[19] –, while 'definition II' excludes them. 'Definition II' thus conceives technical progress uniquely as a process of dematerialization; according to 'definition I', in contrast, technical progress may, but need not be, a process of dematerialization (it may often, but need not, come at a 'physical real cost', for example in the form of an increase in material and energy throughputs as measured by increasing commodity values of commodities). Therefore, 'definition II' expresses a strong concept of technical progress, while 'definition I' expresses a weak concept of technical progress.

It seems that 'definition II' and the corresponding strong concept of technical progress have been advocated, for instance, by Joan Robinson: "In real life a change in technology will often bring into being superior techniques which are preferred to existing ones at the same real wage rate and would be preferred at any real wage rate" (Robinson 1980b, 126–127).[20] Such a strong concept of technical progress, however, cannot be ascribed to the *Wealth of Nations*:

[18] For discussions of the concept of commodity i values of commodities from various points of view, see Gintis and Bowles (1981), Roemer (1982), Cockshott and Cottrell (1997), Manresa, Sancho and Vegara (1998), Soklis (2009; 2014) as well as Parys (2018).

[19] 'Total labor productivity' designates the inverse of labor values ($\frac{1}{v} \equiv \frac{1-a}{\ell}$), as opposed to 'direct labor productivity' ($\frac{1}{\ell}$); in contrast to 'direct labor productivity' and other measures of labor productivity, 'total labor productivity' reflects the *entire* technological structure and *nothing but* the technological structure (see Gupta and Steedman 1971, Ochoa 1986, Panethimitakis 1993, De Juan and Febrero 2000 as well as Flaschel, Franke and Veneziani 2013).

[20] Cf. also Robinson (1980b), 138: "Normally, a new technique is superior to the one in use and does not have to wait for a change in the rate of profit to be installed." Cf. also Kersting and Schefold (2020), 5: "I [i.e., B. Schefold] asked Joan Robinson in her class in Cambridge, whether she expected 'many' wage curves on the envelope. (...) She replied that she thought there would be only one wage curve dominating the others, that of the 'best' technique; it would be superior independently of the level of distribution. (...) When I asked her about visible changes of technique, she replied that that was technical progress."

Smith certainly explained the 'natural progress of a nation towards wealth' by the fact that observable technical changes in a commercial society exhibit a progressive pattern; yet, he specified this progressive pattern exclusively as 'improvements in the productive powers of labor', without saying anything definite about the direction of the evolution of the maximum rate of profit.[21] Ricardo[22] and Marx[23] fully adhered to Smith's weak concept of technical progress as the only concept of progress general enough to be compatible with the stylized facts of technical change. This is due to their recognition of capital-using and labor-saving technical change as an important, even the predominant, form of technical change.[24]

Some commentators explained the particular importance which both Ricardo and Marx accorded to labor values by the fact that labor values allowed Ricardo and Marx to derive the general proposition that the rate of profit is positive if and only if surplus labor is positive.[25] Against the idea that this latter proposition justifies to accord a special role to labor as opposed to non-labor inputs, it has been objected that "it is well known that one can define corn values or energy values of commodities instead of labor values, and show that corn is exploited or energy is exploited if there are positive profits. Indeed, profits are positive if and only if any input into production is exploited, if we choose to define value embodied in terms of it" (Roemer 1981, 204).[26] Therefore, it seems more plausible to explain the particular importance which both Ricardo and Marx accorded to labor values (as opposed to commodity *i* values) by their adherence to Smith's weak conception of technical progress.[27] Looked at it

[21] In the secondary literature, this is reflected in the fact that some interpreters (e.g., Kurz 2010, 1190–1192) ascribe to Smith the view that there is a tendency for the maximum rate of profit to increase, some interpreters (e.g., Verdera 1992; Tsoulfidis and Paitaridis 2012) ascribe to Smith the view that there is a tendency for the maximum rate of profit to decrease, while some commentators (e.g., Eltis 1984, 95) argue that both an increase and a decrease of the maximum rate of profit are consistent with Smith's view (as two possible cases of his growth theory).

[22] Cf. Ricardo (1951–73, vol. I), 80: "it is the essential quality of an improvement to diminish the quantity of labour before required to produce a commodity." Cf. Ricardo (1951–73, vol. I), 36: "Every improvement in machinery, in tools, in buildings, in raising the raw material, saves labour, and enables us to produce the commodity to which the improvement is applied with more facility." Ricardo's basic notion of 'difficulty of production' is nothing else than the inverse of the maximum wage.

[23] Cf. Marx ([1894] 1998), 83: "the productivity of labour, *i.e., the level of technical development*" (emphasis added); cf. Marx ([1847] 1976), 206: "Wherein consists, in general, any improvement, whether in agriculture or in manufacture? In producing more with the same labour; in producing as much, or even more, with less labour."

[24] Cf. Haas et al. (2016), 540: "in the newly added chapter 31, 'On Machinery', in the third edition of the Principles (1821), Ricardo discussed a particular form of technical progress (...). It is characterized by an increase in labour productivity and in the capital-output ratio, and thus a decrease in the maximum rate of profits: it is both labour saving and (fixed) capital using." For detailed reconstructions of Ricardo's analysis in terms of wage-curves, cf. Kurz (1998) and Kurz (2010); for general discussions of capital-using and labor-saving technical change in terms of wage-curves, cf. Schefold (1976) and Salanti (1985). Marx's emphasis upon capital-using and labor-saving technical change (rising 'organic composition of capital') is well-known – to the point that this form of technical change has been called 'Marx-biased' technical change (cf., e.g., Foley and Marquetti 1999a; 1999b; Marquetti 2003; Ferretti 2008; Marquetti and Soares Porsse 2014). While it is correct that Marx "takes the saving of labour at the expense of using more materials and machines as *the main form* of technical progress" (Schefold 2019, 291; emphasis added), it is not correct to claim, as Groll and Orzech (1990) do, that "according to Marx, technological change is *always* labour-saving or capital-using" (91; emphasis added): on Marx's analysis of capital-saving forms of technical change, see, e.g., Rosenberg (1982).

[25] For an explanation of Ricardo's emphasis upon labor values along these lines, see Bidard and Klimovsky (2006), 39–54; for an explanation of Marx's emphasis upon labor values along these lines, see, e.g., Morishima (1973).

[26] On this argument – the so-called 'Generalized Commodity Exploitation Theorem' –, see also Gintis and Bowles (1981), Roemer (1982) and Parys (2018); for a thoughtful and formal criticism of this argument, see Matsuo (2008).

[27] Cf. also Schefold (1989) who argues for "the conceptual pre-eminence of labour values as opposed to commodity values" (355) like this: "there is a specific reason for 'opening up' for labour. The distinctive role of labour values as compared with commodity values derives exclusively from the fact that growth in productivity means growth in the productivity of labour, which is directed at an increase in the surplus per unit of labour"

from the angle of Koselleck's 'conceptual history' of the term 'progress' – "a concept specifically calibrated to cope with modern experiences" (Koselleck 2002, 219–220) whose "content of experience (...) was not available" (219) before the period between 1750 and 1850 –, this weak definition of technical progress represents the way in which the classical economists casted the experience of the industrial revolution (imminent in the case of Smith; contemporary in the case of Ricardo) into a single concept. In light of the fact that 'productive powers of labor' and 'difficulty of production' are anything else than ephemeral categories in Smith's and Ricardo's thought, the view that "their writing is free from any discussion of such revolutionary change [as the first industrial revolution] and of any sign that they had an inklining of its imminence" (Wrigley 1994, 27) seems therefore difficult to sustain.

2.3. Smith's 'invisible hand' and the labor theory of value in Ricardo and Marx

Even if such readings have been repeatedly criticized,[28] 'economistic' interpretations of Smith's 'invisible hand', just as repeatedly, understood this metaphor as a reference to a process of competition which explains a *social* outcome as an *unintended* ('natural' in Smith's wording) consequence of *individually self-interested actions*. Now, "competition features within *The Wealth of Nations* in two distinct contexts; first, in the account given of the balancing of supply and demand in particular markets, and, secondly, in the explanation of structural and technological development. Smith offers us in effect both a theory of economic equilibrium and a theory of economic evolution; and in each of these competition has a key role to play" (Richardson 1975, 350–351). Accordingly, two different (not mutually exclusive) 'economistic' interpretations of the 'invisible hand' are possible: in the first, more common, interpretation, 'competition' refers to the process of gravitation of market prices towards natural prices, and the corresponding unintended, or 'natural', social outcome is *equilibrium*; in the second, less common, interpretation, 'competition' refers to the realization of "extraordinary profits" (WN I.x.b.43) through technical change, and the unintended, or 'natural', social outcome is *progress*. This latter interpretation has been proposed, for example, by Ignatieff (1984):

> the 'invisible hand' makes its appearance for the first time in Smith's work at a crucial moment: at the point where he shows [here Ignatieff is referring to the 'invisible hand' passage in the *Theory of Moral Sentiments*] how human progress can reconcile social inequality with adequate provision for the poorest. This argument continued to be the crux of Smith's defence of modernity in the *Wealth of Nations*. (...) Rising productivity per man hour prevented the distributional conflict between rich and poor from becoming a zero-sum game: growth did not give the labourer a rising relative share of national income, but his absolute share in distribution did increase, so that, however simple his standard of comfort might be in comparison to the rich in his own society, it exceeded the standard of 'many an African king' (...). To this day, Smith's argument has provided modern capitalism with its most basic defence: only a system of private property offers the incentives necessary for technical innovation and economic progress. While a regime of private property is inevitably unequal, the growth that private property makes possible enables even the poorest to live decently. (...) Only a society of strangers, of mediated and indirect social relations, has the dynamism to achieve progress. (Ignatieff 1984, 112–119)

The principal merit of this interpretation – an interpretation which is also advocated by historians of the idea of progress such as Nisbet (1980)[29] as well as Rapp (1992),[30] and

(353–354).

[28] See, to quote just one example for the dismissal of 'economistic' interpretations of the 'invisible hand' on the basis of textual evidence, Dellemotte's (2009) article *La ‹ main invisible › d'Adam Smith : pour en finir avec les idées reçues*.

[29] Cf. Nisbet (1980), 189–192: "It is inevitable that we classify the *Wealth of Nations* as economic in theme, indeed as the principal source of what would come in time to be called economics or political economy. But it is

economists such as Chandra (2004)[31] – is not mentioned by its proponents: it is the only reading of Smith which offers a convincing explanation for the role of the labor theory of value in Ricardo and Marx.

The labor theory of value in Ricardo and Marx is not an answer to Sraffa's problem (for the trivial reason that Sraffa was not known to Ricardo and Marx), but, first and foremost, an answer to a problem permeating Smith's economic theory of technical progress.[32] This problem stems from the prima facie paradoxical fact that economic theory can at the same time say very little and very much about technical change. Economic theory can say very little about technical change insofar as *potential* technical changes (technical *inventions*) are exogenous from the point of view of economic theory (at least in a fourfold sense: they depend, firstly, on natural laws; secondly, on knowledge of natural laws, i.e., on natural sciences and their historical development; thirdly, on knowledge of the application of natural sciences to the production process, i.e., on applied natural sciences – technology – and their historical development; fourthly, on the historically specific social determination of applied natural science, or technology, itself). Economic theory can say very much about technical change insofar as *actual* technical changes (technical *innovation and diffusion*) are endogenous from the point of view of economic theory: in a commercial society, the rationale for the adoption of a technical invention is the realization of "extraordinary profits" (WN I.x.b.43) and the question whether the adoption of a technical invention yields extraordinary profits depends on market prices. More precisely, since Smith's method of normal positions implicitly assumes that the time horizon relevant for the analysis of technical change is larger than the time horizon relevant for the analysis of market prices, the question whether the adoption of a technical invention yields extraordinary profits depends on average market prices, or, what is the same thing for Smith (Aspromourgos 2007), on equilibrium prices (natural prices or production prices).[33] Therefore, Smith's theory of economic progress depends implicitly on Smith's theory of economic equilibrium.

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also a text in the history of the idea of progress. I would argue indeed that *the major purpose of the book* is that of *not only describing human progress, especially economic progress*, but also of seeking to *demonstrate* the pattern of this progress, and *above all the root causes of economic progress*. (...) [Smith's] reference to 'an invisible hand' (...) must be seen in the context of Smith's larger philosophy of human progress" (emphasis added).

[30] Cf. Rapp (1992), 196: "[Smith's] Metapher der 'unsichtbaren Hand', die er in der klassisch gewordenen volkswirtschaftlichen Abhandlung über den Wohlstand der Nationen (1776) entwickelt, beruht auf derselben Denkfigur, die bei Kant als 'ungesellige Geselligkeit' und bei Hegel als 'List der Vernunft' erscheint. Gewiß steht der allgemeine Grundgedanke vom Fortschritt durch persönlichen Egoismus bei jedem Denker in einem anderen theoretischen Kontext. (...) Doch die Art, wie die spezielle Frage nach dem Zustandekommen des Fortschritts beantwortet wird, weist in allen drei Fällen dieselbe Tiefenstruktur auf."

[31] Cf. Chandra (2004), 57–80: "In the *Wealth of Nations*, Smith's main concern was economic progress. (...) [E]quilibrium economics was neither Smith's main contribution nor his chief concern. (...) The invisible hand should be seen from a dynamic rather than from an equilibrium perspective. It is more a device to propel an economy into a continual forward motion in an evolutionary framework. (...) [The very forces] which tend to take it towards its centre of gravity propel the centre of gravity forward (in the form of economic progress). (...) [T]he system of natural liberty is the best system for promoting economic progress."

[32] Cf. Blaug (2001), 156: "No idea or theory in economics (...) is ever thoroughly understood except as the end-product of a slice of history, the result of some previous intellectual development."

[33] In this sense, Cesaratto's (1995) article *Long-period method and analysis of technological change: is there any inconsistency?* argues that the "theoretical complementarity between the LPM [long-period method] and the analysis of [technical] change can be traced back to Adam Smith" (258): "Smith regarded the tendency towards an equilibrium composition of the social output (...) *as a premise for the division of labour and technical change*" (259; emphasis added). Of course, if natural prices are not centers of gravitation for market prices and if, accordingly, "prices of production are not close to market prices, their role for analyzing technical change may be very limited" (Flaschel 2010, x). In this case, production prices "may be irrelevant for the actual choice of technique under capitalism" (viii).

Even if in "the *Wealth of Nations* no obvious tension exists between the two theories, partly no doubt because they are sketched out in a manner loose enough to make it difficult to establish inconsistency" (Richardson 1975, 351), "the question of compatibility between Smith's two lines of thought" (351) nevertheless poses itself. Now, the problem permeating Smith's theory of progress is that the latter question cannot be answered by a mere interpretation of the text of the *Wealth of Nations*, because it "does not provide a fully adequate theory" (Roncaglia 2001, 139) of production prices, in the sense that their determination remains "an open issue in Smith's analysis" (138): production prices are said to be determined as the sum of wages and profits (leaving rents aside), "according to their natural rates" (WN I.vii.4), yet Smith offers no answer to the question as to how the level of the natural rate of profit is determined.[34] Ricardo, therefore, had to face two unresolved issues: first, to refine Smith's theory of economic equilibrium in answering the open question as to the determination of production prices; second, to answer the question of compatibility between Smith's theory of economic equilibrium and Smith's theory of economic progress.

Ricardo refined Smith's theory of economic equilibrium in abandoning the 'adding-up' approach as a misleading dead-end: albeit lacking the tool of simultaneous equations, Ricardo had a clear conceptual grasp of the fact that, once production techniques and real wages are given, production prices and the rate of profit are fully determined, as well as of the fact that, once techniques of production are given and real wages rise, production prices change and the rate of profit falls. Ricardo's insight into the constraint binding wages and profits is tantamount to the insight that an independent determination of the level of the natural rate of profit, as suggested by the logic of the 'adding-up' approach, is neither possible nor required.

This deeper understanding of a classical system of production prices allowed Ricardo also to deal with the second question as to the compatibility between Smith's theory of economic equilibrium and Smith's theory of economic progress. In contrast to Smith – according to whom relative production prices are equal to relative labor values exclusively in the 'early and rude state of society', i.e., in the absence of a positive rate of profit –, Ricardo perceived a contradiction between Smith's theory of economic equilibrium and Smith's theory of economic progress: if relative production prices are not equal to relative labor values in the presence of a positive rate of profit, then it is not strictly true that profit-maximizing technical changes (whether in time or across space) are progressive.

Therefore, Ricardo developed, in contrast to Smith, a *positive* analysis of the implications of a positive rate of profit for the relation between relative production prices and relative labor values. Two results emerge from that analysis: first, Ricardo argues that the existence of a positive and uniform rate of profit as such is not the cause of deviations of relative production prices from relative labor values: even in the presence of a positive and uniform rate of profit, relative production prices are equal to relative labor values if capital-labor ratios are uniform across sectors. Ricardo thus identifies the special case of uniform capital-labor ratios across sectors (i.e., the special case of strictly linear wage-curves) as an ideal condition for the identity between profitability and progressiveness of technical changes and, hence, as an ideal condition of possibility for natural progress in the Smithian sense. Second, Ricardo argues that, even if in the general case relative production prices deviate systematically from relative labor values (due to the presence of a positive uniform rate of profit in conjunction with non-uniform capital-labor ratios across sectors), deviations of relative production prices from relative labor values are strictly limited in magnitude to the point of being "insignificant" (Ricardo 1951–73, vol. VIII, 279) in their effects. In this sense, Ricardo considers the special case of uniform capital-labor ratios across sectors (i.e., the special case of strictly linear wage-curves), albeit "not rigidly true" (ibid.), as "the nearest approximation to truth" (ibid.): Ricardo thus argues that wage-curves are, in general, quasi-linear.

[34] See, e.g., Cartelier (1976), 126–143; Garegnani (1984), 301–302; O'Donnell (1990), 215–218.

With regard to Smith's notion of natural progress, Ricardo's first argument (the identification of uniform capital-labor ratios as the condition for the validity of the labor theory of value in the presence of a positive rate of profit) performs literally the same function as Samuelson's (1962) 'surrogate production function' does with regard to the notion of a neoclassical production function. Both Ricardo's reconstruction of the notion of natural progress and Samuelson's reconstruction of the notion of a neoclassical production function rely on the special case of uniform capital-labor ratios. However, while Samuelson (1962) merely assumed uniform capital-labor ratios, Ricardo's second argument (the claim that production price-labor value deviations are so slight as to be negligible) amounts to an explicit justification of this assumption: "in estimating, then, the causes of the variations in the value [production price] of commodities, although it would be wrong wholly to omit the consideration of the effect produced by a rise or fall of labour, it would be equally incorrect to attach much importance to it; and consequently, in the subsequent part" (Ricardo 1951–73, vol. I, 36) of the *Principles*, Ricardo reasons as if the pure labor theory of value was valid in general.

If Ricardo's chapter *On Value* is thus read as a reflection on the possibility of Smith's economic theory of technical progress (of which Ricardo's celebrated theory of international trade is but a particular case), it is neither convincing nor meaningful to characterize the role of the labor theory of value in Ricardo as that of an imperfect 'tool' for the determination of production prices and the profit rate, due to the lack of simultaneous equations. Rather, there is a real difference between the Ricardian and the post-Sraffian *interpretations* of the idealized outcome of the gravitation mechanism, i.e., of a classical system of production prices. Referring to Wittgenstein's 'duck-rabbit' (Wittgenstein 1958, 194), this difference may be best illustrated as follows: whereas post-Sraffian authors interpret a classical system of production prices as the foundation for their dismissal of the labor theory as a redundant tool (a 'duck'), Ricardo interprets a classical system of production prices as the very foundation for his insistence on the qualified validity of the labor theory of value (a 'rabbit'): production prices are "with some deviations in proportion to labour employed. My commodity and your commodity are both worth £1000 – they will therefore probably have the same quantity of labour realized in each" (Ricardo 1951–73, vol. VIII, 279). Thus, for Ricardo, average relative market prices are close to relative labor values precisely because and only because relative production prices are attractors for market prices (since production prices are 'with some deviations in proportion to labour employed'). While the difference between the Ricardian and the post-Sraffian interpretation of a classical system of production prices is irrelevant if a single 'normal' position in 'logical time' is considered, it becomes relevant if a sequence of 'normal' positions in 'historical time' is considered. The next section discusses therefore the implications of these divergent interpretations for a 'materialist understanding of the history of capitalist economies'.

3. The implications for a materialist understanding of the history of capitalist economies

The implication of the post-Sraffian interpretation of a classical system of production prices for a materialist understanding of the history of capitalist economies is as follows:

> [A]ccording to Ricardo and Marx we should expect that, based on the criterion of profit-maximization, entrepreneurs-investors *ex ante* select those production methods from a given set of methods which minimize the total labour coefficients for different commodities. (...) [Ricardo's and Marx's solution to the problem of technical choice] must be regarded as a failure. (Kurz 1979, 36–49)

> [In contrast to what is claimed by Smith's 'invisible hand'], capitalists cannot be trusted to

> adopt and reject new technologies to raise labor productivity when the rate of profit is positive. In short, unlike Marxian theory, Sraffian theory demonstrates that perhaps the strongest argument in defense of capitalism – that whatever other flaws it may have, capitalism can be relied on to promote dynamic efficiency [i.e., in the present terminology, to promote progressive technical changes] – turns out to be untrue. (Hahnel 2017a, 100)

> Marxist economists have been largely uninterested in the effects of technical change on productivity – apparently willing to accept that Adam Smith's (...) invisible hand does work. Consequently it has fallen to Sraffians to emphasize that capitalists can *not* be trusted to always serve the social interest with regard to adopting and rejecting new technologies [in the sense of adopting progressive technical changes and rejecting regressive technical changes]. (Hahnel 2017a, 46)

The question whether, in which sense, and in what circumstances, progressive technical changes serve 'the social interest' is a normative question and, therefore, not of the least interest in the present context;[35] the only question of interest is whether profit-maximizing and, hence, actually observable technical changes are progressive. From the point of view of the post-Sraffian interpretation, the answer is as follows: since relative production prices depend not only on production techniques but also on distribution, hence deviate from relative labor values for positive and uniform rates of profit in the general case of non-uniform sectoral capital-labor ratios, there is the logical possibility of profit-maximizing and regressive technical changes. Hence, the proposition that cost-minimizing, or profit-maximizing, technical changes are progressive is not true.

In order to illustrate the post-Sraffian answer, suppose a two-sector production system in which a single technique of production (ℓ_i, a_{1i}, a_{2i}) is known and in use in the i-th sector, until a technical invention $(\ell_i^*, a_{1i}^*, a_{2i}^*)$ in the first sector appears (as specified in the Table 3):

Table 3 Numerical example of a profitable and regressive technical change

		Inputs						Output
		Commodity 1		Commodity 2		Labor		
Sectors	Sector 1	$a_{11} = \frac{1}{10}$	$\oplus$	$a_{21} = \frac{5}{12}$	$\oplus$	$\ell_1 = 47\frac{1}{2}$	$\rightarrow$	1
		$a_{11}^* = \frac{1}{50}$	$\oplus$	$a_{21}^* = \frac{1}{2}$	$\oplus$	$\ell_1^* = 47\frac{1}{2}$	$\rightarrow$	1
	Sector 2	$a_{12} = \frac{1}{4}$	$\oplus$	$a_{22} = \frac{1}{6}$	$\oplus$	$\ell_2 = 60$	$\rightarrow$	1

In the initial situation, the vector of labor values is:

$$\mathbf{v} = \boldsymbol{\ell}[\mathbf{I} - \mathbf{A}]^{-1} = (v_1 \quad v_2) = (100 \quad 102) \tag{3.1}$$

The classical system of production prices (with wages paid *post factum*) is given by:

$$\mathbf{p} = w\boldsymbol{\ell} + (1 + r)\mathbf{pA} \tag{3.2}$$

In order to render visible the deviations of production prices from labor values, it is convenient to reformulate the price system in vertically integrated terms and to impose the linear w-r relation ($w = 1 - r/R$) on the price system (which is equivalent to expressing the wage rate and prices in terms of a specific numeraire, namely the Standard net product; cf. Sraffa 1960, §43; Pasinetti 1977, 117):

$$\mathbf{p} = w\mathbf{v} + r\mathbf{pH} \tag{3.3}$$

$$\mathbf{p} = w\mathbf{v} + r\mathbf{vH} + r(\mathbf{p} - \mathbf{v})\mathbf{H} \tag{3.4}$$

[35] In two, closely related, contributions, Hahnel himself argues that progressive technical change – *if* it is achieved *exclusively* by capital-using and labor-saving technical change and *if* it is translated *exclusively* into increasing output rather than increasing leisure – violates the conditions for environmental sustainability (Hahnel 2017b; Hahnel 2017c). In this case, it is questionable whether (and if so, in which sense) progressive technical change serves 'the social interest'.

$$\mathbf{p} = \mathbf{v} + r\mathbf{v}\left[\mathbf{H} - \frac{1}{R}\mathbf{I}\right] + r(\mathbf{p} - \mathbf{v})\mathbf{H} \tag{3.5}$$

This latter expression shows Standard production prices as the sum of three components (Shaikh 2012), the first term representing labor values and the sum of the second and third terms representing the deviations of production prices from labor values (due to a uniform rate of profit in conjunction with non-uniform sectoral capital-labor ratios). The second term indicates price-value deviations to the extent that they are determined by the difference between a sector's vertically integrated organic composition and the 'average' or Standard composition. The third term indicates price-value deviations to the extent that they are determined by the difference between the production prices of the elements of capital and the labor values of the elements of capital.

Assuming an exogenously given real wage $\mathbf{d} = \begin{pmatrix} d_1 \\ d_2 \end{pmatrix} = \begin{pmatrix} 1/500 \\ 1/500 \end{pmatrix}$, then in the initial situation the vector of production prices, thus decomposed, is:

$$\mathbf{p} = (100 \quad 102) + (7.3 \quad -5.1) + (-0.7 \quad 0.5) = (106.6 \quad 97.4) \tag{3.6}$$

The potential technical change $\boldsymbol{\delta} = (\ell_1^* - \ell_1 \quad a_{11}^* - a_{11} \quad a_{21}^* - a_{21})$ is actualized, if it is cost-reducing at the prevailing production prices, thus allowing 'extraordinary profits' for those who innovate the first. Let $\bar{\mathbf{p}}$ denote the vector of production prices augmented by the wage, $\bar{\mathbf{p}} \equiv (w \quad \mathbf{p})$; then, the potential technical change is actualized if the following condition ('profitability condition') is satisfied:

$$\bar{\mathbf{p}} * \boldsymbol{\delta} < 0 \tag{3.7}$$

In the numerical example, $\bar{\mathbf{p}} * \boldsymbol{\delta} \cong -0.4$: the potential technical change is cost-reducing and, therefore, actually adopted. To verify whether this technical change is progressive, let $\bar{\mathbf{v}} \equiv (1 \quad \mathbf{v})$ be the vector of initial labor values augmented by 1; then, a technical change is progressive (i.e., by definition, $\mathbf{v}^* < \mathbf{v}$), if the following condition is satisfied (see Roemer 1981, 100–101):

$$\bar{\mathbf{v}} * \boldsymbol{\delta} < 0 \tag{3.8}$$

In the numerical example, $\bar{\mathbf{v}} * \boldsymbol{\delta} = 0.5$: the technical change is regressive. Once the process of diffusion is completed and the new technique of production is adopted by all firms in the first sector, the new vector of labor values is:

$$\mathbf{v}^* = \boldsymbol{\ell}^*[\mathbf{I} - \mathbf{A}^*]^{-1} = (v_1^* \quad v_2^*) = (100.6 \quad 102.2) \tag{3.9}$$

The deviation of relative production prices from relative labor values leads to technical regress, that is to say – if this technical change is represented graphically by means of wage-curves – to a downward shift of the vertical intercept of wage-curves (see Figure 4; note that the switch-point between the two techniques lies to the left of the actual rate of profit):

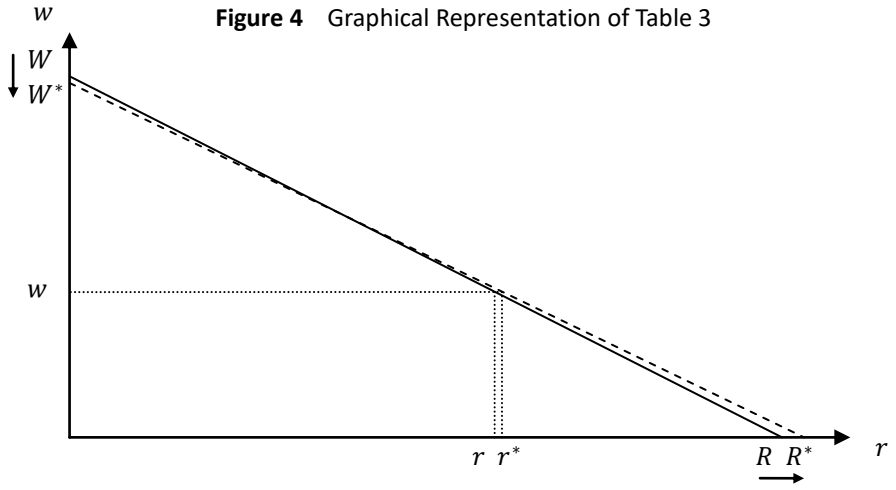
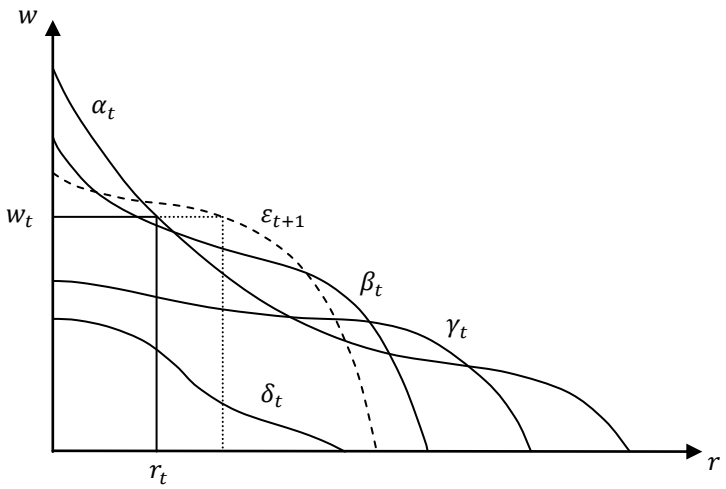


Figure 4 Graphical Representation of Table 3

It might be tempting to conclude from the preceding illustration of the post-Sraffian criticism of the classical theory of technical progress that this only demonstrates the shortcoming, and indeed untenability, of the weak concept of technical progress encountered in Smith, Ricardo and Marx: in this sense, one might argue, as Joan Robinson does, that only those technical changes should be defined as 'progressive' which lead both to a higher maximum wage and to a higher maximum rate of profit and that only those technical changes should be defined as 'regressive' which lead both to a lower maximum wage and to a lower maximum rate of profit – with a grey zone of 'neutral' technical changes which either lead to a higher W and a lower R or to a lower W and a higher R. On the basis of these latter definitions, one might then further argue that – once the special case of 'neutral' technical changes, with respect to which anything is possible, is set aside – the criterion of profit-maximization leads to the adoption of 'progressive' technical changes and to the rejection of 'regressive' technical changes.
However, even if 'neutral' technical changes are set aside, the proposition that cost-minimizing, or profit-maximizing, (non-neutral) technical changes are 'progressive' (in the sense of Robinson's definition) is not true. Since in the general case of non-uniform capital-labor ratios across sectors the shape of a wage-curve in multi-sector production systems will "be far more complex than that of a straight line" (Pasinetti 1977, 88), to the point that "nothing whatever can be said in general about their shape" (89), it is still perfectly possible that the criterion of profit-maximization leads to the adoption of a 'regressive' technical invention. This case is illustrated in Figure 5: it is assumed that in period t four production techniques are known (α_t, β_t, γ_t and δ_t). At the ruling wage rate, w_t, technique α_t is cost-minimizing and, hence, in use. In period $t+1$, a new technique, ε_{t+1}, is invented: since this technique is cost-minimizing, it will be adopted, even if it is 'regressive' (both according to the classical definition and according to the 'Joan-Robinson'-definition). Whereas in period t the wage-curve corresponding to α_t is observable, in period $t+1$ the wage-curve corresponding to ε_{t+1} is observable: the new wage-curve has both a lower maximum wage and a lower maximum rate of profit.

Figure 5 The choice of technique according to Pasinetti (1977), 161



Therefore, as Schefold (1979) put it, the post-Sraffian interpretation of a classical system of production prices "in its full abstract generality, is incompatible with *any* reasonable theory of (...) progress (...). [In] its abstract generalization, [it] seems to have lost all contact with reality" (236–249; emphasis in original) – at least if it is assumed that actually observable technical changes in historical time indeed follow a 'progressive' pattern. In contrast to Steedman's affirmation that "the development of a *materialist understanding of the history of*

capitalist economies is now [i.e., 'after Sraffa's' formal restatement of a classical system of production prices] seriously hampered by the continued attention paid" (Steedman 1977, 67; emphasis added) to the labor theory of value, the implication of the post-Sraffian interpretation of a system of production prices for a materialist understanding of the history of capitalist economies is the exact opposite: "The modern [i.e. Sraffian] rigour in the theory of capital and value has been achieved at the cost of making the integration of theory and of accounts of real historical processes more difficult" (Schefold 1980, 140)[36] – again, at least if it is assumed that actually observable technical changes in historical time indeed follow a 'progressive' pattern. This, of course, might not be the case, the notion of progress might simply be a 'grand metanarrative' (as post-modern authors claimed ever since Nietzsche): since relative production prices are what they are – the solution to Sraffa's equations –, since they are neither equal to relative labor values nor to relative corn values, to relative steel values or any other commodity *i* value of commodities (Parys 2018), economic theory cannot say anything concerning the historical evolution of production techniques (of the matrix of technical coefficients and of the vector of labor coefficients), i.e., regarding the problem of whether, and if so, why, technical change "in a capitalistic society does exhibit some regularities and/or recurrencies in the long run" (Salanti 1985, 115). In particular, a law of rising labor productivity is as a 'mystical' conception as a law of rising corn productivity or a law of rising steel productivity – anything goes. From the point of view of the post-Sraffian interpretation, nothing can accordingly be said concerning historical tendencies generated immanently by the economic system itself – except for one proposition: profit-maximizing capitalists adopt technical inventions (or, actualize potential technical changes) which, effectively, increase the actual uniform rate of profit; and even this proposition, known as the theorem of Okishio, is valid (and, hence, empirically falsifiable) only under the strong assumption that the process of diffusion of a newly adopted technique (which is simply taken for granted in the present paper, however it might be theorized) has no impact whatsoever on real wages.[37] As a result, Blaug's claim that "Sraffian economics has nothing whatever to say" (2009, 226) about Smith's theory of progress is – if 'Sraffian economics' is understood as referring to the predominant *interpretation* of Sraffa (1960) – a perfectly accurate description, indeed, a mere paraphrase of the central tenets of the post-Sraffian analysis of technical change itself.

The implication of the Ricardian interpretation of a classical system of production prices for a materialist understanding of the history of capitalist economies is quite different. The difference, however, does not concern the *logical possibility* of profit-maximizing and regressive technical changes, since Ricardo fully acknowledged deviations of relative production prices from relative labor values (even if, due to the lack of simultaneous

[36] In this sense, Blaug's (2009) claim that 'Sraffian economics' is a case in point illustrating the trade-off between (logical) rigor and (empirical) relevance in economics, seems to be well-founded. Cf. also Salanti (2014), 150–161: "[Blaug's] discussion of a perceived trade-off between rigor and relevance cannot be simply dismissed (...). [T]he much celebrated rigor of Sraffian analysis has been obtained at the cost of a very limited scope when we try to employ it to say something useful about real economic systems."

[37] See Okishio (1961). For a critical comment on the Okishio theorem, see Okishio (2000): "Many people have criticised the Okishio theorem (...). These criticisms have not persuaded me, because, given the assumptions, the theorem is valid. However, I now think my assumptions were inappropriate. The Okishio theorem asserts that if the real wage rate in terms of consumption goods is constant, and a new technique, which lowers unit costs in terms of the present price–wage (production price) configuration, is introduced in a basic sector, then the equal rates of profit must be higher when the new equilibrium is established. Although the original theorem is logically valid, it rests on two questionable assumptions" (493). One of these 'questionable assumptions' is that "of a constant real wage" (493). This assumption "implies either a non-monetary economy or the instantaneous adaptation of the money-wage to the prices of consumption goods. Both are unrealistic. A capitalistic economy is a monetary production economy. Labourers receive a money-wage. The money-wage rate and the prices of consumption goods change owing to competition in the consumption goods market and in the labour market. The assumption of a constant real wage rate cannot be maintained" (493).

equations, he explained them only by the second term in equation [3.5] above, without having grasped the existence of the third term[38]). Rather, the difference concerns the *empirical relevance* of profit-maximizing and regressive technical changes: Ricardo's dictum that it is 'incorrect to attach much importance' to production price-labor value deviations, on the grounds that they are strictly limited in magnitude to the point of being 'insignificant' in their effects implies the proposition that profit-maximizing and regressive technical changes are empirically irrelevant (in the sense that the probability that profitable technical changes are progressive approaches certainty as the number of technical changes increases).[39]

The appeal of Ricardo's interpretation, *avant la lettre*, of Sraffa's price equations consists in its capacity to generate, in sharp contrast to the post-Sraffian interpretation, substantial and determinate empirical propositions concerning the historical evolution of wage-curves, which, as such, are capable of being falsified by reference to empirical data. More precisely, it predicts, firstly, that actual wage-curves are nearly linear, secondly, that switch-points between two actually adopted techniques are situated to the right of the actual rate of profit, and thirdly, that actual technical changes exhibit, accordingly, a progressive pattern in the sense of an upward-shift of the vertical intercept of wage-curves (which may be accompanied by a rise in the maximum rate of profit, but is at least frequently accompanied by a fall in the maximum rate of profit – otherwise the weak definition of technical progress would be meaningless). Once Ricardo's interpretation of a classical system of production prices as an 'empirical labor theory of value' is adopted, Blaug's (2009) criticism of Sraffa (1960) as being logically rigorous, yet empirically irrelevant – Blaug approvingly quotes Salanti according to whom it "is hard to find in all their [i.e. Sraffian] analysis even the slightest attempt to bridge the gap between theory and empirical evidence" (Salanti 2001, 816) – is hard to sustain: since actual wage-curves can be estimated using both Sraffa's price equations and input-output data, Sraffa's 'logical rigor' is fully in line with Blaug's demand that "the fecundity of a theory [should be assessed] by its ability to explain stylized facts, meaning easily observed and well-attested empirical regularities about an economy or an economic system" (Blaug 2009, 239). The next section, therefore, confronts Ricardo's propositions concerning the historical evolution of wage-curves with the historical evolution of actual wage-curves.

[38] Albeit lacking simultaneous equations as well, Marx, in contrast to Ricardo, did grasp the existence of the third term, without however being able to take it into account in his transformation procedure: "Since the price of production may differ from the value of a commodity, it follows that the cost price of a commodity containing this price of production of another commodity may also stand above or below that portion of its total value derived from the value of the means of production consumed by it. It is necessary to remember this modified significance of the cost price, and to bear in mind that there is always the possibility of an error if the cost price of a commodity in any particular sphere is identified with the value of the means of production consumed by it. Our present analysis does not necessitate a closer examination of this point" (Marx [1894] 1998, 164).

[39] Cf. Farjoun and Machover (1983), 145–149: "[The] question [whether profitable technical changes are progressive] is not the right one to ask. Rather, the question to ask is how probable is it that repeated [technical changes] (...) would result in lowering the labour content of a unit of output. (...) [What] mainly interests us is not what may happen in an individual case, but what tends to happen as a cumulative result of a sequence of changes of inputs. (...) [The law of decreasing labour-content] is a probabilistic law, not a deterministic one. Technical change under capitalism does not always increase the productivity of labour; but its long-term cumulative effect does tend to do so, with probability increasing towards certainty." Farjoun and Machover derive this probabilistc law from the proposition that market prices equal labor values on average, without recurring to the theory of production prices. For Ricardo, in contrast, production prices are equal to labor values on average. This latter proposition and the conditions for its validity are the object of Schefold's recent contributions on the theory of production prices in random economic systems (see Schefold 2013a; 2016a; 2016b; 2019).

4. Empirical evidence on the historical evolution of wage-curves

In the present context, the existing empirical literature on wage-curves can be subdivided into three groups: the first group (e.g., Michl 1991; Foley and Marquetti 1999a; Foley and Marquetti 1999b; Ferretti 2008; Felipe, Laviña and Fan 2008; Vaona 2011; Marquetti and Soares Porsse 2014; Jeong 2017) estimates the evolution of wage-curves over time with the explicit purpose of identifying different patterns of technical change from a 'classical-Marxian' perspective and shows the frequency of technical change in its capital-using and labor-saving form (denominated as 'Marx-biased' technical change in the aforementioned contributions). However, in assuming a simplified, one-commodity production system and using aggregate data, this group estimates what may be called 'surrogate' wage-curves, that is to say wage-curves that are linear *by construction*. The second group (e.g., Leontief 1986b; Petrović 1991; Da Silva 1991; Tsoulfidis and Maniatis 2002; Tsoulfidis and Rieu 2006) estimates wage-curves using Sraffian price equations and input-output data; however, since this strand focuses mostly on the question of the shape of actual wage-curves, the latter are estimated only for a single year. The third group (Marzi and Varri 1977; Özol 1984; Da Silva 1987; Cekota 1988a; Cekota 1988b; Ochoa 1989; Marzi 1994; Degasperi and Fredholm 2010) computes wage-curves for several years, using Sraffa's price equations and input-output data. While these contributions, with the exception of Degasperi and Fredholm (2010), focus on the historical evolution of wage-curves in a single country, in what follows, wage-curves are estimated, based upon Sraffa's price equations and input-output data, for twelve countries (Canada, the USA, the UK, Germany, Austria, Poland, the Netherlands, France, Italy, Spain, Portugal and Greece) from 2001 to 2007 with two-year intervals.

More precisely, wage-curves are derived from the classical-Sraffian system of production prices for a pure circulating capital model:

$$\mathbf{p} = w\boldsymbol{\ell} + (1+r)\mathbf{pA} \tag{4.1}$$

The solution for production prices is given by the following expression:

$$\mathbf{p} = w\boldsymbol{\ell}[\mathbf{I} - (1+r)\mathbf{A}]^{-1} \tag{4.2}$$

The unit vector **e** is chosen as the numeraire of the price system:

$$\mathbf{pe} = 1 \tag{4.3}$$

From equations (4.2) and (4.3) it follows that:

$$w\boldsymbol{\ell}[\mathbf{I} - (1+r)\mathbf{A}]^{-1}\mathbf{e} = 1 \tag{4.4}$$

Hence, the wage-profit relationship is:

$$w = \frac{1}{\boldsymbol{\ell}[\mathbf{I} - (1+r)\mathbf{A}]^{-1}\mathbf{e}} \tag{4.5}$$

For each country and year, the respective matrix of technical coefficients **A** is estimated from the 2015 edition (ISIC Revision 3) of OECD input-output tables (with a 33-sector level of aggregation; see Appendix), in dividing element-by-element the inputs of each sector j, q_{ij}, by its gross output, Q_j:

$$\mathbf{A} \equiv [a_{ij}], \text{ with } a_{ij} = \frac{q_{ij}}{Q_j} \tag{4.6}$$

For each country and year, the respective vector of labor coefficients $\boldsymbol{\ell}$ is estimated from the same source, together with data on sectoral employment from the OECD STAN database, by applying the standard procedure in the literature (see, e.g., Ochoa 1989, 427; Tsoulfidis and Rieu 2006, 291), i.e., in dividing employment in the j-th sector, L_j, by its gross output, Q_j, and in homogenizing heterogeneous labor by means of the ratio of the j-th sector's wage rate, w_j, to the minimum sectoral wage rate, w_{min}:

$$\boldsymbol{\ell} \equiv [\ell_j], \text{ with } \ell_j = \left(\frac{L_j}{Q_j}\right)\left(\frac{w_j}{w_{min}}\right) \tag{4.7}$$

Figures 6–17 show the wage-curves for the twelve countries in the period from 2001 to 2007.

Fig. 6 Actual Wage Curves, Canada (2001-2007)

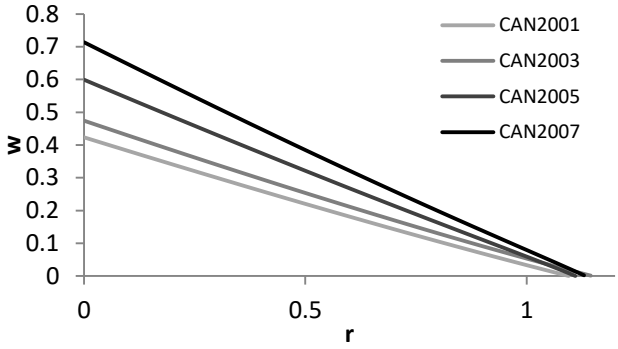


Fig. 7 Actual Wage Curves, United States (2001-2007)

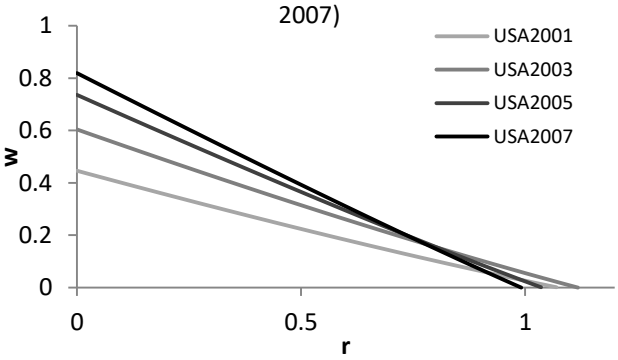


Fig. 8 Actual Wage Curves, United Kingdom (2001-2007)

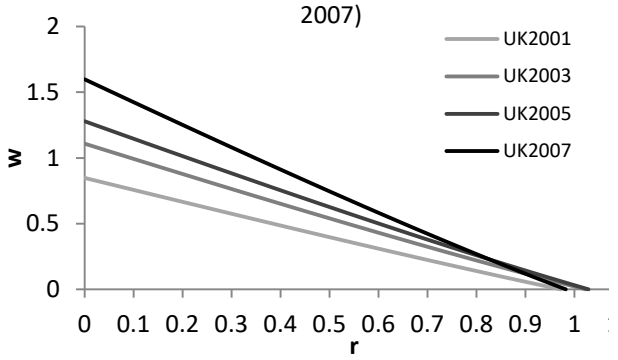


Fig. 9 Actual Wage Curves, Germany (2001-2007)

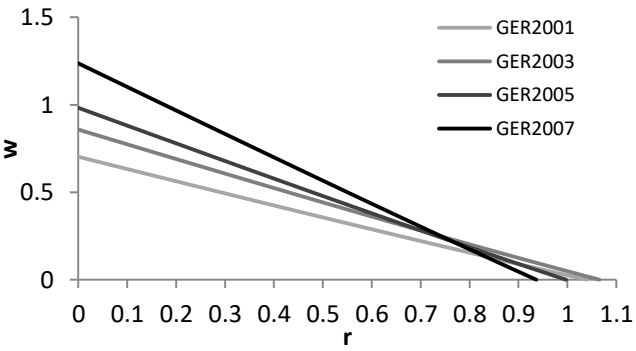


Fig. 10 Actual Wage Curves, Austria (2001-2007)

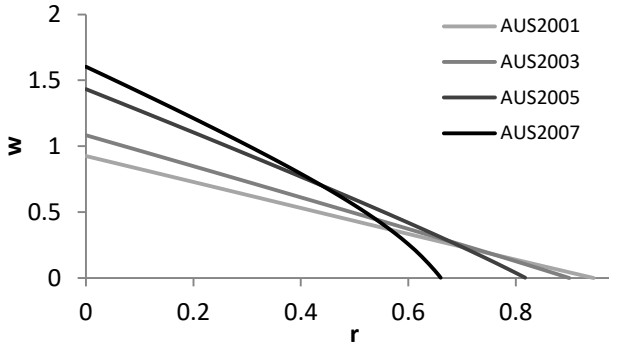


Fig. 11 Actual Wage Curves, Poland (2001-2007)

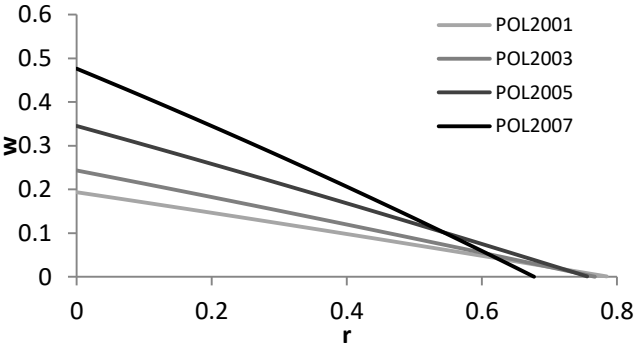


Fig. 12 Actual Wage Curves, Netherlands (2001-2007)

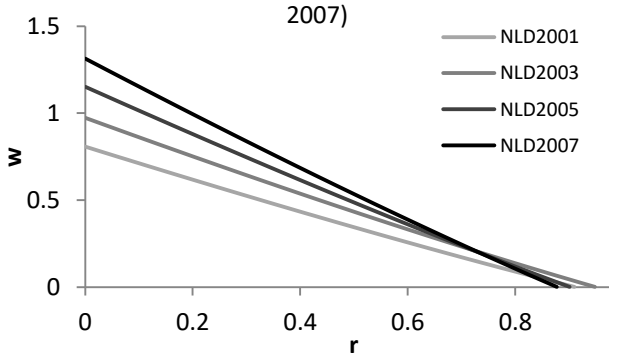


Fig. 13 Actual Wage Curves, France (2001-2007)

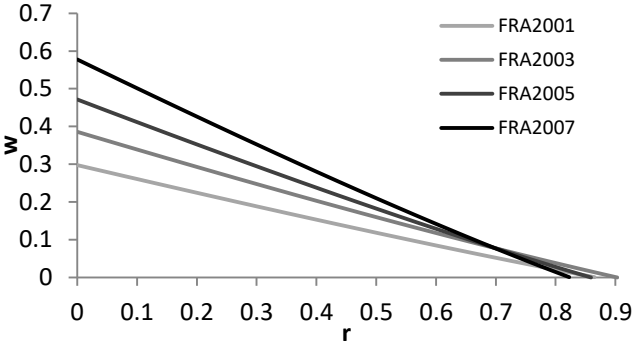


Fig. 14 Actual Wage Curves, Italy (2001-2007)

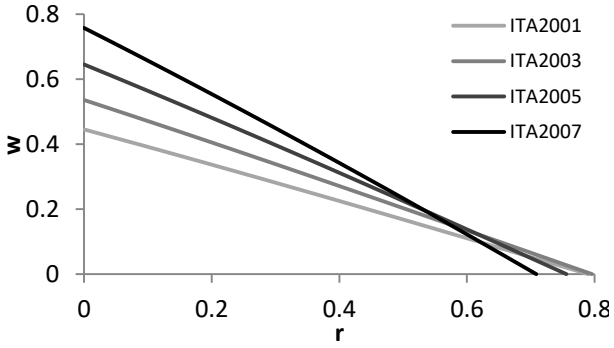


Fig. 15 Actual Wage Curves, Spain (2001-2007)

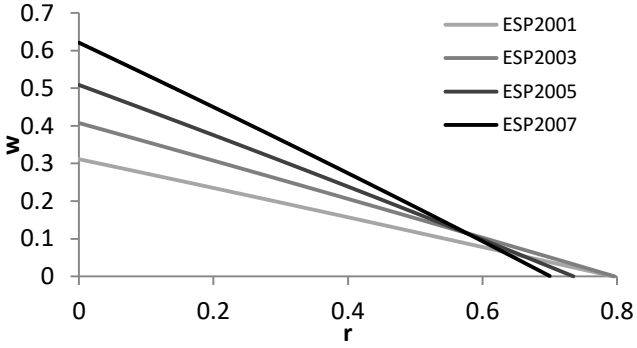


Fig. 16 Actual Wage Curves, Portugal (2001-2007)

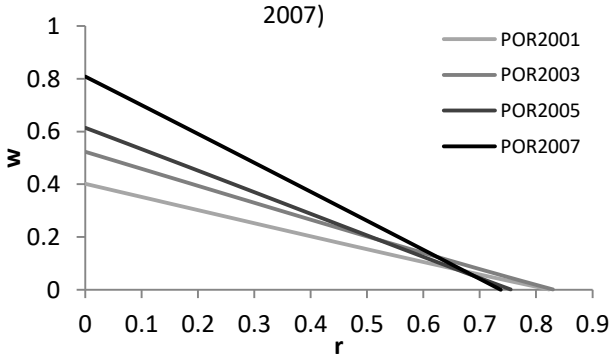
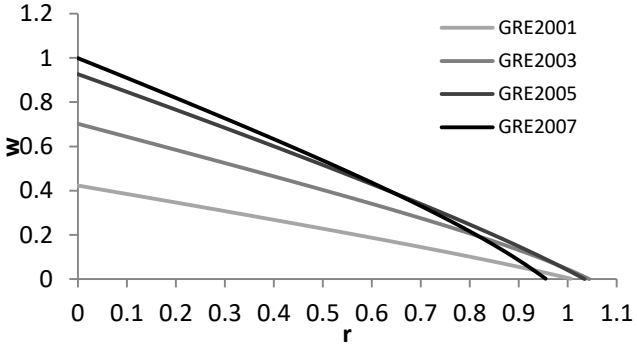


Fig. 17 Actual Wage Curves, Greece (2001-2007)



If we make, for the sake of argument, the counterfactual assumption that the estimated production techniques (the estimated matrices of technical coefficients and the estimated vectors of labor coefficients) represent perfectly and exclusively the 'true' production techniques (i.e., assuming that the estimation itself is perfect, that the underlying data is not distorted by cyclical factors and that returns to scale are constant), four observations seem appropriate: first, actual wage curves are nearly linear in the relevant range of the rate of profit. Second, switch-points between two actually adopted techniques are situated to the right of the actual rate of profit. Third, actual technical changes clearly exhibit a progressive pattern in the sense of an upward-shift of the vertical intercept of wage-curves and *only* in this sense. This does not exclude, of course, that capital-saving technical changes which increase not only the maximum wage (labor productivity) but also the maximum rate of profit ('capital productivity') do occur: such a form of technical progress is observed, over two-year intervals, in Canada (2001-2003 and 2005-2007), in the US (2001-2003), in the UK (2001-2003 and 2003-2005), in Germany (2001-2003), in the Netherlands (2001-2003), in France (2001-2003), in Italy (2001-2003), in Portugal (2001-2003) as well as in Greece (2001-2003), and, over the entire period considered, in Canada and in the UK. The first three observations suggest that Smith's 'invisible hand' works indeed – the classical theory of progress, as rationalized by Ricardo, is perfectly consistent with, and not falsified by, the preceding 'stylized facts.'[40] What is not consistent with, and falsified by, the preceding 'stylized facts' is, fourth, a strong conception of technical progress as the outward-shift of the entire wage-curve, and theories, if they exist, which predict such an outcome. The reason is, of course, the existence of capital-using technical changes which increase the maximum wage and decrease

[40] The patterns observed in Figures 6–17 are treated here as 'stylized facts' since the same patterns are observed both by studies belonging to the first group mentioned above (Michl 1991; Foley and Marquetti 1999a; Foley and Marquetti 1999b; Ferretti 2008; Felipe, Laviña and Fan 2008; Vaona 2011; Marquetti and Soares Porsse 2014; Jeong 2017) and by studies belonging to the third group mentioned above (Marzi and Varri 1977; Özol 1984; Da Silva 1987; Cekota 1988a; Cekota 1988b; Ochoa 1989; Marzi 1994; Degasperi and Fredholm 2010).

the maximum rate of profit: such a form of technical progress is observed, over two-year intervals, in Canada (2003-2005), in the US (2003-2005 and 2005-2007), in the UK (2005-2007), in Germany (2003-2005 and 2005-2007), in Austria (2001-2003, 2003-2005 and 2005-2007), in Poland (2001-2003, 2003-2005 and 2005-2007), in the Netherlands (2003-2005 and 2005-2007), in France (2003-2005 and 2005-2007), in Italy (2003-2005 and 2005-2007), in Spain (2003-2005 and 2005-2007), in Portugal (2003-2005 and 2005-2007) as well as in Greece (2003-2005 and 2005-2007), and, over the entire period considered, in the US, Germany, Austria, Poland, the Netherlands, France, Italy, Spain, Portugal and Greece.

Conclusion

The historical evolution of wage-curves seems to suggest the same conclusion that Anne Carter (1970; 1974) reached through her input-output study of technical change in the US economy, namely that progressive technical change

> dominated technical change during the post-war period. The great bulk of industrial innovations – automation, computerization, material and design changes – represented direct or indirect economies of labor. (Carter 1974, 579)

> [T]he economy behaves as if labor saving were the goal of technical progress, and most [technical or structural] changes can be justified by reduced direct and, to a lesser extent, indirect labor requirements (...). *The dominance of laborsaving changes in structure may not be mere historical accident but also a systematic consequence of the basic orientation of the economic system*. (Carter 1970, 152–153; emphasis added)

What distinguishes the approach of classical economists from Carter's purely empirical approach is Ricardo's claim that the dominance of progressive technical changes in structure *is* a systematic consequence of the basic orientation of the economic system, viz. of the property of relative equilibrium prices to be approximately equal to relative labor values.

The weak notion of progress, as theorized by Smith, Ricardo and Marx, is relevant for two reasons. First, it implies, as against post-modern dismissals of progress, that progress is not simply a 'grand metanarrative' or an 'ideological discourse': private decisions about production techniques by independent producers and according to the criterion of profitability generate a sequence of wage-curves exhibiting an orderly, and in this sense rational, pattern of change. It is not meaningful to characterize the upward-shift of the vertical intercept of wage-curves as a 'metanarrative' or a 'discourse'. Nor is it meaningful to qualify Marx's statement that this "development of the productive forces of labour is the historical task and justification of capital" (Marx [1894] 1998, 258) as an expression of "objectivist *assumptions* of progress" (Lohmann 2018, 436) or of Marx's adherence to "historicism as one important form that the *ideology of progress* or 'development' took from the nineteenth century on" (Chakrabarty 2000, 7) – rather, it is an expression of Marx's adherence to the Ricardian interpretation of a classical system of production prices, i.e., to Ricardo's rationalization of Smith's theory of progress.[41]

Second, the weak notion of progress implies, as against stronger notions, that progress in a commercial society of independent producers is nothing more than the upward-shift of the vertical intercept of wage-curves. The rationality in the historical evolution of wage-curves as a result of private decisions about production techniques by independent producers and according to the criterion of profitability is of a very limited kind: from the point of view of a

[41] Cf. Foley (2006), 122: "Marx sees the technical progressiveness of capitalism as its deepest inner nature. His analysis of technical change grows out of Adam Smith's discussion of the widening division of labor. Marx is at pains to show that the process is not a general ahistorical feature of human society, but rather specific to the competitive mechanisms and social relations of capitalism. (...) [His] vision of the actual dynamics guiding capitalist production is Smithian."

different standard of rationality, for instance of what Marx called a "rational regulation of the human metabolism with nature" (Marx [1894] 1998, 807), technical progress may be neutral, beneficial (most probably in its capital-saving, dematerializing forms) or harmful (most probably in its capital-using, materializing forms). Therefore, it is not meaningful to ascribe to Marx the view, as Fischer-Kowalski and Haberl (2015) do, that the evolution of applied technology "*only* depend[s] on (principally unlimited) human ingenuity" (103; emphasis added) in order to object to this, allegedly Marxian, conception that "civilizational 'progress' is (...) associated so far with an ever higher human energy demand. What is usually enveloped in the term 'technological progress' *does not only rely upon human learning and ingenuity, but also on a rising energy supply from nature*" (108; emphasis added). The fact that technical progress comes often at a 'physical real cost', for example in the form of an increase in material and energy throughputs as measured by increasing commodity values of commodities, is precisely the rationale behind the weak notion of progress encountered in Smith, Ricardo and Marx.

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Appendix

Table A.1 Input Output Nomenclature

01	Agriculture, hunting, forestry and fishing
02	Mining and quarrying
03	Food products, beverages and tobacco
04	Textiles, textile products, leather and footwear
05	Wood and products of wood and cork
06	Pulp, paper, paper products, printing and publishing
07	Coke, refined petroleum products and nuclear fuel
08	Chemicals and chemical products
09	Rubber and plastics products
10	Other non-metallic mineral products
11	Basic metals
12	Fabricated metal products
13	Machinery and equipment, nec
14	Computer, electronic and optical equipment
15	Electrical machinery and apparatus, nec
16	Motor vehicles, trailers and semi-trailers
17	Other transport equipment
18	Manufacturing nec; recycling
19	Electricity, gas and water supply
20	Construction
21	Wholesale and retail trade; repairs
22	Hotels and restaurants
23	Transport and storage
24	Post and telecommunications
25	Financial intermediation
26	Real estate activities
27	Renting of machinery and equipment
28	Computer and related activities
29	R&D and other business activities
30	Public administration and defence; compulsory social security
31	Education
32	Health and social work
33	Other community, social and personal services