AGAIN ON THE RELEVANCE OF REVERSE CAPITAL DEEPENING AND RESWITCHING

Ariel Dvoskin and Fabio Petri*
University of Buenos Aires-CONICET and DEPS, Università di Siena
(June 2015; revised May 2016)

ABSTRACT

Among the recent interventions in the capital controversy, the debate between Paola Potestio and Kurz & Salvadori has raised important issues. We agree with Potestio’s rejection of the legitimacy of a value endowment of capital but we disagree with her dismissal of the relevance of reswitching and reverse capital deepening: these phenomena are very important because they undermine the demand-side role of the conception of capital as a single factor. For the marginal approach to be plausible, this demand-side role had to imply the stability of the savings-investment market even in shorter time frames than those required by a complete adaptation of the ‘form’ of capital; this was taken by Marshall to authorize doing without a given endowment of value capital, which opened the door to the shift to the modern neo-Walrasian versions of the marginal approach. With proof from Hayek, Hicks, Malinvaud, and Lucas we argue that a continuing belief in traditional time-consuming marginalist disequilibrium adjustments based on capital-labour substitution is the hidden reason why the claim often made by contemporary marginalist economists, that the economy can be assumed to be all the time on the equilibrium-growth path, is not found patently unacceptable. The true microfoundation of DSGE macromodels is not intertemporal equilibrium theory, but the time-consuming adjustment mechanisms on whose basis the marginal approach was born and accepted, and on whose basis monetarism was then able to re-assert a pre-Keynesian view of the working of the economy.

1. INTRODUCTION

In recent years a series of papers have come out discussing the relevance of reswitching and reverse capital deepening, and raising a number of issues that deserve further discussion and clarification. An opportunity to discuss some central aspects of the question (although by no means all the relevant ones) is supplied by the contributions of professor Paola Potestio, that are

* We thank Franklin Serrano and two anonymous referees for very useful comments. The usual disclaimer applies.

© 2016 John Wiley & Sons Ltd
particularly stimulating because she rejects neoclassical capital theory but argues that ‘reswitching and capital reversal are unimportant for the critique of neoclassical distribution theory’ (1999, p. 391). This stark claim is advanced as part of a criticism of how Kurz and Salvadori (1995, chapter 15) describe the relevance of reswitching and reverse capital deepening. These phenomena, the two authors argue, destroy the certainty of a decreasing demand curve for value capital in the face of a given supply (a vertical supply curve, cf. 1995, p. 448), thus destroying the presumption of a stable equilibrium in the market for value capital. Potestio counters that the argument is based on supply and demand curves for value capital that in fact have no theoretical legitimacy; the proof of their illegitimacy (we understand her to argue) means that the neoclassical reasoning determining the equilibrium rate of interest is anyway untenable, and therefore the neoclassical theory of distribution is indefensible for reasons independent of reverse capital deepening and in fact undermining the argument supposed to show its relevance. The attempts by Kurz and Salvadori to clarify their position (1998, 2001) have not convinced her (Potestio, 2001, 2010, 2011), inducing her to reiterate that ‘reswitching and capital reversal have no particular role in the critique of [the] neoclassical theory of distribution’ (2010, p. 138). Her central criticisms concern (1) the illegitimacy of a given value endowment of capital because the value of capital goods changes with prices, and (2) the arbitrariness of the capital demand curve, whose shape depends on the arbitrary choice of numéraire.

Potestio’s arguments contain significant elements of truth: we fully agree with her that the inconsistency addressed in (1) suffices to undermine neoclassical theory in its formulations in terms of a long-period disaggregated general equilibrium, that is, with a uniform rate of return on supply price and accordingly an endogenous ‘form’ of capital. On this point we think it is enough to remember that Wicksell, with admirable honesty, writes in (1934, p. 202) that ‘it would clearly be meaningless—if not altogether inconceivable—to maintain that the amount of capital is already fixed. One of us has also indicated the implication of this fact for the determination of the neoclassical demand curve for labour: ‘a long-period labour demand curve needs a given endowment of “capital”, conceived as a single factor and therefore as a quantity of value, and we know that this given endowment is theoretically undefinable independently of distribution. Thus one cannot even start to discuss the shape of the long-period labour demand curve because one does not possess sufficient data for its determination’. Petri (2004, p. 297). Therefore on the legitimacy of a value endowment of capital we fully agree with Fratini’s support of Potestio (Fratini, 2012, p. 32; 2013, p. 357). The other interesting arguments by Fratini on the relevance of reswitching and reverse capital deepening we hope to discuss in a future paper.

© 2016 John Wiley & Sons Ltd
before equilibrium between production and consumption has been achieved’ because ‘Whether expressed in terms of one or the other, a change in the relative exchange value of two commodities would give rise to a change in the value of capital’, with the implication, as Wicksell admits a few lines later, of an ‘indeterminateness’ of the capital endowment. However, we shall argue that this criticism does not imply that reswitching and reverse capital deepening are ‘unimportant’ or ‘have no particular role’. The latter phenomena remain extremely important because they undermine the demand-side implications of the traditional neoclassical conception of capital-labour substitution, implications fundamental for the belief in the stability of the savings-investment market and of labour markets, and that in the course of the one and a half century since the birth of the marginal approach have gradually acquired a sort of autonomy, i.e. have come to be considered defensible independently of the legitimacy of a given value endowment of capital, and capable of permitting reformulations of the supply-and-demand approach that do without that specification of the capital endowment. These reformulations share fundamentally the same

---

2 It may be worth noting in this connection that Kurz and Salvadori are not very explicit on the issue in their 1995 book or in their replies to Potestio. In their 2001 article (p. 481) they write: ‘Even if there were no conceptual problems of conceiving of the two curves as demand and supply curves, the neoclassical economist would be confronted with a serious problem: the instability of the resulting equilibrium’. This sentence suggests that, although the two authors prefer to stress a further problem, there are ‘conceptual problems’ with a given supply of value capital; and indeed one can derive from other writings of theirs a clear admission of the illegitimacy of a given endowment of value capital, e.g. Salvadori (1977, p. 19), Kurz (2000, p. 766). But in this article they proceed to state that if one assumes (1) that consumption goods are consumed in fixed proportions, (2) that the growth rate is uniform and given (possibly zero), and (3) that the numéraire consists of the consumption bundle, then ‘the supply of capital in terms of the numéraire can be fixed independently of the equilibrium values of the rate of profit and relative prices (and thus independently of the demand function for capital)’ (p. 482). At the end of the article they add that the assumption of only one consumption good (or rigid basket) ‘is employed only for the sake of argument, as a concession to the neoclassical construction’ but insist that under that assumption ‘both the “supply” of, and the “demand” for, “capital” could be defined in an economically meaningful way, and consequently, they could be used to determine a long-period equilibrium’. We find these statements perplexing, and suspect the authors to have expressed themselves in a way that does not do full justice to their views. Their intention seems to be to dispose of a possible criticism of indefiniteness of the meaning of a given exchange value, due to arbitrariness of the numéraire and to a possible variability of the numéraire’s physical composition as relative prices change: thus they argue that the neoclassical tradition did indicate a definite good in terms of which the value of capital is measured, the consumption basket, and that for critical purposes one may well concede to the neoclassicals a rigid consumption basket. But they do not discuss the problem that, even in this case, to take as given the exchange value of the capital goods of an economy is illegitimate, as admitted by Wicksell.
‘vision’ of the forces determining distribution, employment and growth as the traditional versions, but still differ enough to invite different types of criticism.\(^3\) We have in mind here above all the intertemporal equilibria nowadays considered the sole ‘rigorous’ foundation of the neoclassical approach, but also temporary equilibria without perfect foresight (although the latter appear to be now out of fashion). These neo-Walrasian versions must be discussed too, if one wants to criticize, in Potestio’s own words, ‘neoclassical distribution theory’, because nowadays it is in terms of these versions that that theory of distribution is presented.

In these versions the general equilibrium (GE) does not rest upon a given endowment of value capital. So the criticisms raised by Potestio will be brushed aside by a neoclassical economist who believes in the right to formulate his approach in terms of neo-Walrasian equilibria. However, we will contend that a continuing faith in the demand-side implications of the traditional treatment of capital as a single value factor remains fundamental in neoclassical economics; in particular, as discussed in section 3, it is the main reason why some necessary consequences of the neo-Walrasian treatment of capital, such as the need to eliminate the actual implementation of disequilibrium activities and hence to envisage the economy as being always on the equilibrium path, are not laughed at as ridiculous. We develop here a point already advanced in Petri (1999, 2004), but that seems not to have been paid so far the attention it deserves: the actual path followed by a market economy cannot perfectly coincide with an intertemporal equilibrium path; unless some argument is given why the actual path does not drift away from the intertemporal equilibrium path, the latter does not have explicative/predictive content; an argument to such an effect is indeed implicit in the mainstream literature that attributes explicative content to continuous-equilibrium paths; this argument is nowadays almost never made explicit but nonetheless it is present and fundamental, and it consists of a continuing faith in traditional capital-labour substitution, a faith that supports a continuing belief in traditional time-consuming marginalist disequilibrium adjustments pushing the economy toward the full employment of resources and toward an income distribution reflecting marginal products. The true microfoundation of modern mainstream (DSGE) macromodels, we therefore claim, is not intertemporal equilibrium theory, it is the

\(^3\) In this connection, Potestio’s exclusion of any focus ‘on the historical points of the development of neoclassical theory or the specific characteristics of the positions of earlier neoclassical writers’ (1999, p. 384) appears to us dangerous, because many ways of thinking of earlier neoclassical economists survive in more recent positions with less clarity, and it is therefore often necessary to look at the historical development of the theory in order really to grasp contemporary neoclassical ways of thinking.
time-consuming adjustment mechanisms (relying on substitution between labour, and capital the single factor) on whose basis the marginal approach was born and accepted, and on whose basis monetarism was then able to re-assert a pre-Keynesian view of the working of the economy.

This contention, in order to be convincing, requires proof that the demand-side implications of the marginalist traditional conception of capital were able to survive the abandonment of long-period equilibrium analysis and of the connected need for a given endowment of value capital. To such an end we argue, first, that this was precisely Marshall’s accomplishment, and that a seldom perceived reason for the success of his approach is that such a survival was indispensable to the plausibility of the marginal approach, because this approach needed to argue the stability of the savings-investment market over shorter time horizons than required for a complete adaptation of the ‘form’ of capital. Section 2, after presenting these considerations, finds proof of the generalized acceptance of Marshall’s approach in its complete dominance over macroeconomic theory (up to the recent turn to continuous-equilibrium growth models); in the same section we note that the absence in Marshall of the need for a given endowment of value capital of variable ‘form’ does not in the least mean the absence of the conception of capital as a single factor in a crucial role—the demand-side role of ensuring a negatively interest-elastic demand-for-savings function (i.e. investment function). We reconstruct this role and finally argue that Potestio’s worry, that stability may depend on the choice of numéraire, has no foundation for the Marshallian savings-investment market. But the absence of reverse capital deepening is necessary for the stability of this market.

In section 3 we complete the proof, first, by demonstrating the presence in Hicks and Hayek of a continuing belief in capital-labour substitution as the basic mechanism ensuring the adjustment of the flow demand for savings (i.e. investment) to the flow supply of savings. The proof continues with Malinvaud and finally, with Lucas. This latter author is particularly important, as the one who started the fashion of continuous-equilibrium macromodels and claimed intertemporal GE as their microfoundation. Finally, we advance our thesis that the continuous-equilibrium path of Ramsey or DSGE macro models can only have an explanatory role similar to that of traditional long-period equilibria: as rough indicator of the qualitative trend the actual economy (which is never perfectly in equilibrium) follows; and can have such a role only because of a continuing faith in traditional capital-labour substitution operating in time-consuming disequilibrium. The importance of reverse capital deepening, that undermines the regular operation of this substitution, is then clear.
Section 4 adds some clarifications on the critical import of reswitching, which is partly different from the one of reverse capital deepening: it destroys the neoclassical belief in the principle of substitution even more radically than reverse capital deepening, because it destroys it even if the attempt is made to view capital not as a quantity of exchange value but as ‘real capital’, a productive force embodied in the physical capital goods that increases the quantity of output per unit of labour. Section 5 presents the main conclusions of the article.

In the course of her discussion of the illegitimacy of the given value capital endowment, Potestio (1999) makes some statements that we find questionable, but we discuss them in an Appendix because they are not indispensable to her central thesis. We have preferred to locate in the same Appendix also our comments on Potestio’s criticism of the demand-for-capital curve because, upon attentive examination, this criticism comes out to be another criticism of the inconsistency of a given value endowment of capital, viewed from a different angle; therefore it does not add to her conclusions.

2. THE RELEVANCE OF THE DEMAND-SIDE CRITICISM

2.1 The connection between capital demand and investment

Potestio’s valid criticism of the given value endowment of capital raises the question: why should one worry about the shape of the capital demand curve, if anyway the long-period equilibrium cannot be determined owing to the impossibility to determine the supply of capital? Whatever the shape of the demand-for-capital curve—one might continue, the non-existence of a supply curve precludes the possibility meaningfully to speak of stability or instability of a non-existent equilibrium; the stability question becomes irrelevant.

The answer we are about to give to this question requires understanding first the implicit connection in the marginal approach between the demand for capital as a stock, and its demand as a flow, i.e. investment.

In traditional marginal theory (with the partial exception of Walras4) capital is a factor of variable ‘form’; as one changes the rate of interest and moves along the long-period demand curve for value capital, to each point of the curve there corresponds a different vector of capital goods, that is,

---

4 Partial because, as noted by Garegnani (1990, p. 56), Walras when discussing accumulation treats capital as a single factor.
not only a different ‘quantity’ but also a different ‘form’ of the capital stock. The ‘quantity’ of capital of which the economy is endowed need not be in the ‘form’ needed in the given conditions; for example if there has been labour immigration, the rate of interest ensuring a demand for capital equal to its endowment will require a ‘form’ of capital different from the one adapted to the previous rate of interest. But the approach admits of course that at each given moment the capital stock is not a malleable substance free to change its ‘form’ ‘instantaneously’, so to speak; the quantity of ‘capital’ it represents is embodied or crystallized in concrete capital goods, and the change in ‘form’ can only happen as these capital goods are used up or scrapped and the resources that might reproduce them are used to produce other capital goods. This can only be a gradual process, since after the change in the rate of interest most of the existing (and no longer optimal) plants will generally keep being used for at least some time because still capable of generating positive quasi-rents, and accordingly most of the labour force will keep being employed in these plants, only gradually becoming ‘free’ to be employed with the new optimal plants and methods as the oldest plants become due for scrapping and replacement. We come here to the important point. If for example many fixed plants last twenty years and when the rate of interest changes they are of uniformly distributed age, then in all likelihood it would take close to 20 years for all of them to be replaced by plants of the new optimal type. The thesis that the equilibrium gives a good indication of trends would be hardly plausible if based on adjustments of such slowness: the trial-and-error process of adjustment would take several generations, if for each level of the rate of interest close to 20 years had to pass in order to make it visible whether equilibrium between supply and demand for capital has been achieved.

But the approach implicitly argues—and, because of the concluding observation of the previous paragraph, needs to argue—that income distribution is determined by a process that operates on a much shorter time scale: precisely because the change of ‘form’ can only be gradual, the demand for capital as a stock concretely manifests itself as a succession of flow demands for capital goods of the ‘form’ appropriate to the existing income distribution, that is, demands for the capital goods required to re-employ, in new plants embodying the new optimal production methods, the flow of labour gradually ‘freed’ by the closing-down of the plants that reach the end of their economic life. Adjustment of the ‘form’ of new capital to a changed income distribution takes only the time required for the tendency of normal relative prices toward the new levels to assert itself: this tendency does not require that all capital has adapted to the new optimal ‘form’ but only that the competition of the first new, better adapted plants

© 2016 John Wiley & Sons Ltd
be able to impose the new lower prices, obliging older plants to earn residual quasi-rents. Reaching an equilibrium rate of interest on the savings-investment market requires therefore much less time than for all plants to take the new optimal ‘form’. Already existing plants are passive, they are obliged to accept the prices imposed by the new, better adapted plants: so it is in the decision on production methods for new plants—the only place (apart from rare exceptions) where a choice among alternative production methods can be conceived to exist—that marginal products are determined; income distribution is actually determined by the factor proportions ‘at the margin of new investment’, to use Knight’s expression, proportions that anyway were seen as generally not too different from economy-wide factor proportions because changes in factor supplies were slow and gradual.

In conclusion, the demand for the stock of capital was important in so far as it helped determine the stability and the comparative statics of the equilibrium of the savings-investment market, where the flow supply of savings (‘free capital’) and the flow demand for savings (i.e. investment) met. It is well known that the argument to such an effect was often put in terms of a credit market where a flow supply of ‘loanable funds’, corresponding to the part of gross income saved, had to come into equilibrium with a flow demand for these funds to be then used to purchase newly produced capital goods (and therefore absorbing, in equilibrium, the productive resources not utilized for the production of consumption goods—resources generating products of a value equal to gross savings). These two flows were flows of exchange value and the rate of interest was the price considered capable of bringing them into equilibrium, above all (given the variety of possible forms of the savings function) because the demand function, i.e. investment demand, would increase if the rate of interest decreased in response to an excess supply of loanable funds.

On this basis one can better understand the success of analyses such as those of Marshall and the Marshallian school, where reference to long-period general equilibria and to a given endowment of value capital is seldom used, the analysis remains mostly confined to short-period situations where the durable elements of the capital stock are given, and the reasoning gains in apparent realism from this characteristic.

5 ‘Under conditions of perfect competition, or in an economic system in the position of the theoretical equilibrium (stationary or moving), all sources would yield a uniform rate of return on their cost of production, which would be equal both to their cost of reproduction and their market value … Under real conditions, this rate “tends” to be approximated at the margin of new investment (or disinvestment), with allowance for the uncertainties and errors of prediction’ (Knight, 1946, p. 396).
2.2 Capital-labour substitution and investment in Marshall’s short-period equilibrium

The previous discussion reveals, we believe, a requirement of the traditional marginal approach. We have seen that the logic of traditional marginal theory de facto obliged one to presume that the rate of interest was determined on the savings-investment market, by a tendency toward an equilibrium of flows (supply of, and demand for, savings or loanable funds) that required for its approximate achievement much less time than a complete adaptation of capital to long-period equilibrium. It was therefore necessary for the traditional neoclassical economist to presume that, even in a situation in which the ‘form’ of capital was largely given, a sufficiently definite supply function and a sufficiently definite demand function for savings or loanable funds could be assumed to exist.

We would like to suggest now that the popularity of the approach of Marshall, an approach which was universally accepted as shown by the fact that ‘it underlies both the controversy between Pigou and Keynes and the subsequent related literature’ (Garegnani, 1964(1978), p. 347), was largely due precisely to his making this implicit presumption much more explicit, by insisting that ‘the income derived from capital already invested in particular things, such as factories or ships, is properly a quasi-rent... the phrase ‘the general rate of interest’ applies in strictness only to the anticipated net earnings from new investments of free capital’ (Principles, VI, II, 4; 1920 (1972), p. 443), and by determining the rate of interest as the return obtainable from the marginal units of ‘free capital’.

As Garegnani (1978, pp. 347–8) immediately adds, without reference to a ‘well-behaved’ substitution between capital and labour there would have been no basis in this approach for the assumed negative interest elasticity of investment.6 And indeed the conception of capital as a single factor analogous, in the substitution mechanisms, to labour or land is clear in Marshall. It emerges when investment choices are discussed, and is very similar to J. B. Clark’s in that technical choice is treated (e.g. in Principles, VI, I, 8: 1920 (1973), pp. 430–31) as if production functions with value capital as one of the factors were legitimate. But the admission that, once built, durable capital goods are rather analogous to lands does not preclude viewing the ensemble of these goods as representing an amount of a single factor capital: the reference to the total stock of capital of an economy as a

---

6 Nowadays there are several attempts to derive this negative elasticity without relying on traditional capital-labour substitution, but they are all vitiated by grave deficiencies (Petri, 2004, ch. 7, 2015).
single quantity is clear when Marshall, at last ‘considering the whole world, or even the whole of a large country as one market for capital’, speaks of ‘the general fund of capital’, and of ‘a rise in the rate of interest which will cause capital to withdraw itself partially from those uses in which its marginal utility is lowest. It is only slowly and gradually that the rise in the rate of interest will increase the total stock of capital’ (Principles, VI, II, 4; 1920 (1972), pp. 443–4). Thus Marshall is the author who brings out most explicitly what is implicit anyway in the traditional marginal approach, namely the fact that the demand for capital can only concretely manifest itself through a succession of demands for savings, and capital-labour substitution can only operate in ‘new investments of free capital’.

For our purposes what is important is that in such a short-period approach, although the notions of capital the single value factor, and of a ‘well-behaved’ capital-labour substitution, are present and fundamental, still the rate of interest is determined without explicitly including a given scalar total endowment of capital among its determinants. What is given is the existing ‘equipment’ (durable capital goods); this, plus the fully employed labour supply, determines the level of production and income, and hence (assuming a propensity to save dependent on the interest rate) a well-defined savings schedule (or supply function of ‘free capital’).

The general acceptance of this view is confirmed by Keynes, who adopts the Marshallian short period as his framework of analysis, and presents on p. 180 of The General Theory a diagram where a different savings schedule is drawn as a function of the interest rate for each level of aggregate income, and one of these income levels is ‘the level corresponding to full employment’ (pp. 181–2). The fact that Keynes does not consider the full-employment income level the only one worthy of attention confirms the general belief at the time that the short-period framework posed no obstacle to the notion of a savings schedule: with Keynes, the legitimacy of such a schedule is simply extended to the whole range of possible income levels.

Thus already before the birth and spread of neo-Walrasian general equilibria, we find a widely accepted Marshallian approach that suggests that the marginal/neoclassical approach can be formulated without including among the data of equilibrium a well-defined value capital endowment. The next section will argue in detail the presence of capital-labour substitution in the determination of new investments in neo-Walrasian economists, and its fundamental role in the survival of an idea of time-consuming gravitation which strictly speaking the neo-Walrasian notions of equilibrium exclude, but which is the real justification of the view of continuous-equilibrium paths as acceptable representations of actual paths. The Marshallian approach paved the way to the adoption of such a theoretical position by presenting the
operation of capital-labour substitution ‘at the margin of new investment’ as capable of surviving the abandonment of the treatment of the economy’s capital endowment as a given quantity of a single value factor. This continued acceptance of the demand-side implications of capital the value factor was fundamental in the debates on Keynes, permitting the ‘neoclassical synthesis’ criticism of Keynes, and then the success of monetarism, which by re-asserting a pre-Keynesian view of the working of the economy opened the door to contemporary neoclassical macroeconomics.

It is here that reswitching and reverse capital deepening show their relevance. They destroy the survival of the conception of capital as a factor the demand for which is, concretely, a negatively interest-elastic flow, by destroying the legitimacy of the negatively interest-elastic demand for the stock from which the flow is derived. The destructive implications of reswitching go for certain aspects beyond those of reverse capital deepening and will be pointed out in section 4; here we remember the implications of reverse capital deepening.

These are simply explained. In so far as the investment function reflects the demand for value capital for new plants, its interest elasticity rests on the elasticity of the long-period demand for value capital per unit of labour; owing to reverse capital deepening this elasticity cannot be presumed to be always negative, and even less can it be presumed to be negative and significant (Petri, 2011; cf. below, section 3). On this basis, the criticism that reverse capital deepening makes possible is: ‘you neoclassicals depict your theory as based on a negatively interest-elastic investment function; well, such a function cannot be presumed; hence your theory is revealed not to have the foundation that you admit it needs’. The criticism of the demand-side implications of the traditional marginalist conception of capital is relevant.7

---

7 We suggest that the possibility of a neoclassical retreat into short-period versions, and the capacity of reswitching and reverse capital deepening to question the credibility of those versions too, are the reasons why, for many years after 1960, Garegnani in his critique of marginalist capital theory (e.g. 1964, 1970) left the criticism of the given value endowment of capital nearly totally unmentioned, an otherwise perplexing attitude since in his 1960 book he had presented that criticism as a sufficient reason to reject the marginal approach. In ‘Note su consumi …’ (1964; English translation 1978) the criticism is exclusively of the demand curve for capital (and hence of the investment function). In ‘Heterogeneous Capital …’ (1970) the assumption that one can meaningfully define net savings independently of distribution (assumption d, p. 425), or equivalently that ‘in the face of changes in systems of production and relative outputs, we can speak of a constancy of capital’ (p. 426), is judged ‘highly questionable’ (p. 425, footnote 2), but it is not stated that the problems with this assumption suffice to reject the theory. One must wait for ‘Quantity of Capital’ (1990) for again a characterization of the given value capital endowment as an insurmountable difficulty, a major reason for the neoclassical shift away from long-period equilibria.
2.3 On the possible dependence of the short-period capital-demand curve on the numéraire

We refer the reader to the Appendix for a discussion of Potestio’s criticism of the demand-for-value-capital curve; here we discuss the possibility that the dependence of the shape of the demand-for-capital curve on the choice of numéraire may affect the stability of the savings-investment market in a Marshallian short-period framework; we will argue that the choice of numéraire cannot affect the stability of this market.

For each level of the interest rate and associated normal prices, the physical vector of capital goods determining the value demand for savings (that is, gross investment) can be determined according to the analysis sketched in section 2.1 above; it is the vector of new capital goods optimally required for the full reabsorption in new plants of the labour ‘freed’ by the closure of old plants. It is the physical component of what in Petri (2004, p. 127) has been named the long-period investment function, which the Marshallian economist will consider largely to determine investment in the short period equilibrium too,8 owing to the lesser time, required for prices to gravitate toward their long-period levels, relative to the time required for changing the ‘form’ of capital completely.9 As the rate of interest changes, the changes of this vector, combined with the changes of normal prices, trace the investment function in value terms. This must be confronted with the full-employment savings function, which traces the value of full-employment income not spent on purchase of consumption goods. This function too must result, for each level of the interest rate, from the associated normal prices, and from a vector of capital goods potentially produced, to whose value the savings correspond. However, the physical composition of full-employment savings is only potential, since except in equilibrium it cannot correspond to quantities of capital goods actually produced: the latter will be determined by the quantities demanded, which

---

8 This is a full-employment equilibrium, the short-period element consisting only of the given ‘form’ of the ‘equipment’. That is, we are leaving aside the other main element characterizing the short period for the economy as a whole: the fluctuations in employment due to the business cycle.

9 As argued by Garegnani (1964(1978)) cited in section 2.2 above, there is no reason even for a neoclassical economist to believe in a negative interest elasticity of investment in the short period, unless she/he assumes the short period to be sufficiently long for the long-period factor substitution forces to dominate the composition and amount of the capital required to re-employ the labour gradually ‘freed’ by the closure of the oldest plants. But this implies that relative prices are close to being long-period prices. Then the analysis applies of Petri (2013, pp. 47–51; 2015, pp. 325–30).
outside equilibrium will be different from the full-employment equilibrium ones. But although only potential, the physical composition of the full-employment savings supply must be determined in order to determine full-employment income (factor prices depend on the composition of demand). It seems reasonable to take this composition as equal, for each level of the interest rate, to the physical composition of investment (on the basis of the argument that it is unclear why a general excess or deficiency of savings over investment should be concentrated more in some industries than in other ones). Then for each level of the interest rate the physical composition both of investment and of savings is determined, and they must be evaluated at the same prices, so which one is greater in value terms is independent of the choice of numéraire, which is the conclusion we needed.

3. CAPITAL-LABOUR SUBSTITUTION IN SOME NEO-WALRASIAN VERSIONS OF THE MARGINAL APPROACH: FROM HAYEK TO DSGE THEORY

3.1 The real justification of a descriptive validity of intertemporal general equilibrium

Let us now come to recent neoclassical theory that declares to rely, not on Marshallian short periods, but rather on neo-Walrasian equilibria. The latter include among the givens of equilibrium a given initial endowment for each capital good, even the most short-lived ones. As a result, no room at all is left for the actual implementation and correction of disequilibrium productions during the adjustment towards equilibrium: these cannot be allowed, because any disequilibrium production would alter the endowments of capital goods, possibly significantly, and then the equilibrium itself would be modified, and it would become impossible to establish where disequilibrium processes are taking the economy. This impermanence problem is reinforced by the substitutability problem: different production methods generally require different capital goods, not the same capital.

---

10 Actually, outside equilibrium, income cannot be assumed equal to the equilibrium income, because some resources will not be fully utilized; a discussion of the stability of the savings-investment market based on a full-employment savings schedule can be criticized for this fact already, but here we are only interested in reconstructing the logic of traditional reasonings.

11 Note that this conclusion does not depend on the assumption that the physical composition of savings is the same as that of investment, it holds whatever the way that physical composition is determined, as long as it is univocally determined for each level of the interest rate.
goods in different proportions, and therefore even small changes in the endowments of capital goods can drastically alter their relative scarcities and hence their equilibrium rentals, as well as the full-employment marginal product of labour and hence real wages. If the neo-Walrasian equilibrium is a temporary equilibrium without perfect foresight, dependent therefore on the given expectations entertained by the agents, an additional problem is that expectations are not only subjective, hence hardly ascertainable (especially when one studies past periods), but also susceptible to change during disequilibrium, and in ways that cannot be determined on the basis of the equilibrium’s data; so an *indefiniteness problem* arises, which is compounded the moment one attempts to establish the sequence of temporary equilibria that is necessary to determine the evolution of the economy, because expectations can change from one period to the next, and therefore even to assume that they do not change during the disequilibrium adjustments inside each period does not avoid an indefiniteness of their evolution from one period to the next.12 (And this has no doubt helped the tendency of research since the end of the 1980s to abandon the study of temporary equilibria without perfect foresight, although the main reason seems to have been the great difficulties with formalization and with proving existence.)

We will argue that in these analyses the faith in the traditional marginalist adjustments based on capital-labour substitution is hidden but is still there, and *necessarily so* the moment an explanatory and predictive role is assigned to modern GE theory (or to the macroeconomics that claims it as its microfoundation).

The point is, that no one with a minimum of good sense would assert that actual and equilibrium paths coincide: in actual economies there is no auctioneer, no complete futures markets, no perfect foresight, no ultra-fast adjustments, but rather disequilibrium activities, imperfect foresight, trial-and-error adjustments, discovery of novelties, mistakes, regrets, in one word: time-consuming disequilibria. Therefore those economists, who accept neo-Walrasian intertemporal GE as a fundamentally correct theory of the basic forces shaping production, distribution and growth, must believe that there are adjustment mechanisms working in real time that cause deviations from the intertemporal equilibrium path to be sufficiently corrected or compensated so that the trend the economy actually follows is not too far from the path described by the intertemporal equilibrium models. Therefore the latter models cannot aim to describe the actual path

---

12 On the impermanence, substitutability and indefiniteness problem see Garegnani (1990, 2005).
precisely, they can only aim to indicate the important qualitative aspects of this path. And which are these? Clearly, that income distribution tends to reflect factor scarcity (marginal products in a broad sense), therefore if for example labour supply increases, the real wage tends to decrease; that if competition is allowed to operate without impediments, the economy tends to realize the full utilization of resources; that growth is fundamentally supply-determined: in other words, the marginalist/neoclassical theses traditionally derived from long-period analysis or its short-period Marshallian variant. And the forces behind these tendencies can only be the adjustment mechanisms resting on traditional capital-labour substitution, on whose basis the marginal approach was born and accepted: fundamentally, the tendency toward equilibrium between supply and demand for labour because the demand for labour is a decreasing function of the real wage, and the tendency toward equilibrium between savings and investment because investment is a decreasing function of the rate of interest. The continuing implicit faith in these mechanisms reveals a continuing acceptance (in spite of the Cambridge controversies) of capital-labour substitution as traditionally conceived in the marginalist/neoclassical tradition.

As the authors we discuss below make clear, this acceptance reveals itself in two aspects. First, the comparative statics of disaggregated intertemporal equilibrium paths, or the changes the path itself undergoes (e.g. because at a certain point there is a rise of real wages), are believed to be describable in terms of traditional changes in capital-labour ratio. Second, when it is explicitly admitted that the actual economy is not continuously on the intertemporal equilibrium path, the impermanence problem is not perceived, the economy is described as gravitating toward an equilibrium unaffected by disequilibrium decisions: that is, the fact that the composition of capital is changing is neglected, as if one could treat the capital endowment as that of a single factor of variable ‘form’.

On this basis, we claim that the reference, in recent decades, to disaggregated intertemporal equilibrium with perfect foresight (or rational expectations) as the ‘rigorous’ microfoundation of mainstream macro models is only a smokescreen; the real microfoundation is the continuing belief in the existence of the traditional adjustment mechanisms based on capital-labour substitution, that are assumed to cause the economy to gravitate around a path which is, essentially, the one described by traditional long-period marginalist theory, in more recent times represented in simplified form by the path of the Solow-Ramsey growth model.13

13 It is important to realize that the quantity of the single capital good of Solow’s model is persistent enough to allow for time-consuming disequilibrium adjustments; so the so-called
Without some such belief the evaluation of intertemporal equilibria as descriptively valid—an evaluation implicit in the claim that macro models should adopt them as their microfoundation\textsuperscript{14}—would be devoid of any justification, because of the impossibility to argue that the actual path remains reasonably close to the intertemporal equilibrium path. So we contend that the claim, that mainstream macro models derive their legitimacy from their intertemporal general equilibrium microfoundation, must be reversed. The logically prior thing is the belief in the working of those traditional adjustment mechanisms; this belief concludes to a belief in the traditional marginalist/neoclassical conclusions; this allows one to view one-good models like Solow’s as indicating (albeit in greatly simplified and approximate form) the qualitative trend of actual market economies. This conclusion once reached (\textit{without, it will be noticed, any appeal to intertemporal GE theory}), one can then take a further step. Disaggregated intertemporal equilibrium paths are qualitatively similar to Solow-Ramsey paths: they too trace a full-employment path, with income distribution determined by marginal products; it becomes then possible to argue that intertemporal equilibria too indicate sufficiently correctly the qualitative trend of the economy.

Thus, it is the never abandoned view of the economy as gravitating toward the path traced by traditional long-period equilibria (or sequences of short-period Marshallian equilibria) owing to adjustment mechanisms based on capital-labour substitution, that allows attributing to intertemporal GE theory some validity as a descriptive theory in spite of the absurd

\textsuperscript{14}'Momentary equilibrium' of Solow's model has no need for the auctioneer or any other kind of instantaneous adjustment in order for the economy to gravitate towards it; the time scale over which the tendency towards it can be assumed to operate might well be years; so it is in fact a traditional long-period equilibrium, centre of gravitation of time-consuming trial-and-error adjustments, where the single factor capital homogeneous with output is simply the traditional marginalist conception of capital as a single value factor of variable 'form', made less evident by the assumption of a single output, but in fact intended, as shown by the applications of the model, to describe the economic role of heterogeneous capital goods. Solow’s model is the way the traditional notion of long-period general equilibrium currently survives in neoclassical theory. Then one can modify the model by making the propensity to save depend on expectations as to future income and income distribution, expectations that have plenty of time to be corrected; in this way one passes, without too much loss of credibility, to Ramsey-type descriptive models, whose 'momentary equilibria' can again be seen as centres of gravitation of time-consuming adjustments. The fact that these models can be considered to describe the path of economies without auctioneer has no doubt contributed to their popularity.

\textsuperscript{14} 'It is now widely agreed that macroeconomic analysis should employ models with coherent intertemporal general-equilibrium foundations' (Woodford, 2009, p. 269); see also Wickens (2008).
assumptions it needs (complete futures markets or perfect foresight; instantaneous adjustments to equilibrium).

Our persuasion is not only that we can see no other way to defend a descriptive validity of intertemporal general equilibria; it is also that in fact this is how neo-Walrasian theorists do reason. We proceed to supply some evidence in support of this interpretation.

3.2 Hayek and Hicks

We mentioned two aspects in which the continuing faith in traditional neo-classical conclusions reveals itself in neo-Walrasian authors: the acceptance of traditional capital-labour substitution; and the neglect of the possibility that the actual path may drift away more and more from the equilibrium path. These aspects are clear in the first promoters of the shift to neo-Walrasian equilibria: Lindahl, Hayek, Hicks. In all three, although over a succession of short periods, the economy is believed to behave as if capital could be treated in the traditional marginalist way, in spite of the lack of analytical support for such a view (apart from special examples) after the abandonment (or at least, the declaration of abandonment) of the conception of capital as a single factor. The thing has been shown in some detail elsewhere (Petri, 2004, chapter 5; Dvoskin and Lazzarini, 2013). Here some shorter, partly new observations may suffice; for space reasons, we leave Lindahl aside.

In Hayek’s Pure Theory of Capital (1941), the first aspect is crystal-clear. In chapter XX, Hayek considers an economy that is initially stationary and examines the consequences of a fall in the rate of interest on cost-minimizing techniques. He admits that, in general, the capital goods employed in production are specific to each technique and, when distribution changes, the new cost-minimizing methods can be initially introduced only in new plants. While it may take ‘a considerable period of time’ (p. 279) for the effects of a decrease in the rate of interest to assert themselves fully, this influence will however start making itself felt immediately, by regulating the proportion of capital to labour in new plants; while the old plants, where this proportion cannot be promptly altered because capital ‘is irrevocably sunk’ (p. 283), yield residual quasi rents. And the effect of that decrease is argued to be the same as in traditional theory: to induce entrepreneurs to adopt more roundabout methods of production, namely to increase the ratio of capital per unit of labour:

... in so far as labour succeeds in securing for itself a larger share of the output and in raising real wages it will tend to bring about a substitution of capital for
labour or a transition to more capitalistic methods of production. (Hayek, 1941, p. 290)\textsuperscript{15}

As to the second aspect, Hayek repeats again and again that the intertemporal continuous-equilibrium paths he studies do not pretend to describe the actual behaviour of the economy, and presents the role of his equilibrium method as ‘to serve as a guide to the analysis of concrete situations, showing what their relations would be under ‘ideal’ conditions, and so helping us to discover causes of impending changes’ (p. 28); but if that were all, the method would only tell us that the economy will not behave as equilibrium would indicate, leaving actual behaviour mysterious; so Hayek cannot stop at that, and in fact he also writes that the justification of his equilibrium method ‘is not that it allows us to explain why real conditions should ever in any degree approximate towards a state of equilibrium, but that observation shows that they do to some extent so approximate’ (pp. 27–8); in other words, one does not obtain, from the determination of intertemporal equilibrium paths, reasons for believing that the actual path remains close to the equilibrium path, but in fact it does! Elsewhere he speaks of ‘the self-correcting forces of the price mechanism’ (p. 408), which suggests an equilibrium toward which markets gravitate (and therefore, a persistent equilibrium, a notion reconcilable with Hayek’s neo-Walrasian turn only if the heterogeneous capital goods are still somehow ultimately

\textsuperscript{15} Hayek’s faith that things work \textit{as if} capital could be actually treated as a single homogeneous factor survives even after the results of the Cambridge controversies. During his exchange with Hicks on the so-called ‘Ricardo effect’ in the late 1960s, Hayek (1969) admits that the representation of the factor substitution mechanisms in terms of isoquants with labour and ‘capital’ (the single factor) on the axes is, rigorously, illegitimate, but he judges that this does not affect the conclusions: ‘Since the magnitudes represented along the two coordinates both consist of variable combinations of heterogeneous goods and services, these can of course be represented only in value terms. This would be strictly legitimate only if we could assume that the prices of the various goods and services involved remain constant. In fact, however, the changes which we will consider necessarily involve some changes in the relation between these prices. Hence the slightly unsatisfactory nature of this technique, to which I have referred before, derives. It seems to me, however, that this defect is of comparatively minor significance and does not seriously detract from the validity of the conclusions which can be derived in a comparatively simple manner by this method’ (Hayek, 1969, p. 275). By the ‘validity of the conclusions’ thus reached, Hayek means here that an increase in the price of output in terms of money wages (i.e. an increase in the rate of profits) ‘will correspond to a combination of a smaller stock of capital, C’, and a larger amount of current input [labour], E’, than were used before’ (p. 276). Notice the fideistic nature of these statements: Hayek attempts no defence of the claim that the defect ‘is of comparatively minor significance’, in spite of the fact that by then the Cambridge, UK, critics had been arguing precisely the opposite for several years, and on the basis of unassailable analytical results.
viewed as a single quantity of capital). 16 And indeed as the book proceeds to issues nowadays classified as macroeconomic, discussing (for the purpose of countering Keynes) savings and investment, and monetary influences on the rate of interest, it becomes clearer and clearer that Hayek believes he is studying actual market outcomes, not hypothetical equilibrium paths. He admits disequilibria,17 but he views them as temporary deviations from a long-run trend which is a traditional succession of transitions toward long-period equilibria that gradually change because of accumulation, technical progress, etcetera, with prices tending to long-period prices,18 and income distribution determined, as shown above, by the proportion of labour to a capital still ultimately viewed as somehow a single quantity.

Let us now turn to Hicks’ highly influential *Value and Capital* (1939). Let us examine first some manifestation of the second abovementioned aspect. It is well known that when Hicks presents the temporary-equilibrium method, he affirms that ‘our method seems to imply that we conceive of the economic system as being always in equilibrium’ (p. 131), temporary equilibrium being the outcome of an ‘essentially instantaneous adjustment’ (p. 337). What is however perhaps less known is that Hicks is unable fully to conform to this ‘method’: in ch. XXI he declares that the assumption of fully flexible prices in the very short period is ‘highly unrealistic’, and ‘must be dropped’ (p. 265).

The motivation for this admission is the discovery (ch. XX) that the equilibrium is only ‘imperfectly stable’ (p. 248), because if the elasticity of expectations is greater than one, when the current price of a commodity or input decreases the tendency to posticipate its purchases to a subsequent period in which the good will cost even less (intertemporal substitution) can overpower the intra-temporal substitution (that Hicks assumes always works as required for stability); and Hicks’ opinion is that in this case the

---

16 See also Hayek’s intervention in the Socialist Calculation Debate, where he explains that the cost minimizing method is not known in advance, but ‘has to be discovered and to be discovered anew sometimes almost from day to day, by the entrepreneur’ (Hayek, 1940, p. 139), evidently through a trial-and-error process of experimentation; this again suggests that the equilibrium position determined by the theory is a centre of gravitation of actual variables influenced by trial-and-error decisions.

17 See e.g. his footnote on industrial fluctuations on p. 389, and the following passage: ‘a situation, in which abundant unused reserves of all kinds of resources, including all intermediate products, exists, may occasionally prevail in the depths of a depression’ (p. 373).

18 Indeed Hayek’s equilibrium paths have relative prices evolving in the direction of long-period prices, so they describe transitional dynamics toward steady-state equilibria, and Hayek uses the comparison of these tendential final outcomes to conclude on the effects of changes in policy or in some data.
overpowering will generally happen. Nor is this surprising, because Hicks is acutely aware of the substitutability problem, which is rendered particularly relevant by the very-short-period framework of temporary equilibria, in which ‘the initial equipment ... will generally contain, in a nearly finished form, most of the output which can be produced in the present’ (p. 206), and therefore both substitutability between current inputs, and variability of the composition of current output, are extremely limited; so much so that, for the case of inelastic price expectations, it is Hicks’ opinion that ‘stability is chiefly maintained by substitution over time’ (p. 251).19

But, Hicks states, reality does not seem to exhibit such instability, so ‘we should expect to find possible stabilizers’ (p. 258) that would allow interpreting the potential instabilities as ‘fluctuations’ around the path traced by the sequence of temporary equilibria (p. 258). One of these consists precisely of eliminating the assumption of price flexibility in the very short-period, in particular in the labour market.20 The rigidity of wages, that may ‘even extend for quite a long time’ (p. 270) (which implies the possibility of long lasting unemployment), is envisaged as a suitable anchor for price expectations, that helps dampening the elasticity of price expectations. ‘The existence of unemployment’, so Hicks concludes, ‘almost necessarily makes for stability... Unemployment is the best stabilizer we have yet found’ (p. 269). (In fact, given his admission of the substitutability problem and hence of an extremely rigid very-short-period demand for labour, the absence of a rapid wage flexibility is indispensable to Hicks also to avoid totally unrealistic conclusions, such as temporary equilibria with a zero wage in case of an excess supply of labour.)

Hicks is thus forced to renounce the idea of continuous equilibrium in the labour market and to resume the traditional neoclassical idea of equilibrium as an outcome that can plausibly emerge only over a sufficient interval of time (possibly ‘quite a long time’, in fact). But that there is a tendency to such a ‘full equilibrium’ is never doubted: although over a succession of ‘weeks’, the wage decrease caused by unemployment will be able to induce the change in the composition of capital required for the

19 Hicks’ conclusions have been confirmed by McKenzie (2002, pp. 64–9).
20 ‘... so far we have been assuming that prices are perfectly flexible, so that it is possible for all prices to move together, under the free play of supply and demand, in the course of a single week’s trading. This assumption too must be now dropped, for it is of course highly unrealistic. In most communities there are a large number of prices which for one reason or another, are fairly insensitive to economic forces, at least over short periods. This rigidity may be due to legislations, or to monopolistic action ... It may be due to no lingering notions of a “just price”. The most important class of prices subject to such rigidities are wage-rates. They are affected by rigidity from all three causes.’ (p. 265)
operation of the mechanisms of substitution, and full employment will eventually assert itself.

Of course (and here we come to the first aspect), this means that the change in the vector of capital goods is conceived as having the same effect on the demand for labour as if the different capital goods could be treated as in fact elements of the traditional single factor ‘capital’ of variable ‘form’. Hicks is less explicit than Hayek, but traditional capital-labour substitution emerges also in his attempt (ch. XVII) to derive a sort of average period of production that contra-varies with the interest rate.\textsuperscript{21} Hicks’ conclusion is very traditional: ‘A fall in the rate of interest lengthens the average period’ (p. 220). It is on this basis that, in the following chapter XVIII, he derives the further conclusion that ‘a change in the rate of interest will affect the volume of current expenditure [both in consumption and in investment demand] in the opposite direction’ (p. 236). While he admits that this effect may not be strong, in any case ‘the direction of the effect seems to be quite clear’ (p. 236).

The absence of doubts on traditional capital-labour substitution (confirmed, years later, by the Commentary Hicks adds to the second edition, 1963, of The Theory of Wages\textsuperscript{22}) implies a continuing belief in those persistent tendencies regarding income distribution, employment and relative prices that marginalist theory had traditionally derived from the treatment of capital as a single factor of production; Hicks admits that the traditional factor substitution mechanisms that justify those tendencies cannot operate in the very short period, but allows those mechanisms to operate over a succession of ‘weeks’. Little wonder, then, that the new method is believed capable of describing with tolerable approximation the position that the economy tends to realize over a succession of ‘weeks’.

\textsuperscript{21} For reasons of space we cannot present here a detailed analysis of Hicks’ average period. See Fratini (2013).

\textsuperscript{22} In this Commentary Hicks esteems it legitimate to talk of ‘the Factor of Production Capital’ (p. 343), which, although also conceivable as ‘Physical Things’, must anyway be measured ‘by taking a money value of the Capital stock and deflating it by an appropriate index-number’ (p. 344); and he clearly accepts traditional capital-labour substitution: ‘so long as we stick to the comparative problem, comparing one state of steady growth equilibrium with another … as soon as there is any choice of techniques, higher real wages make for “substitution” of capital for labour. The economy with the higher real wage will use techniques with a higher proportion of (physical) capital to labour; and will increase its production of goods with a relatively high capital content relatively to its production of others’. (pp. 365–6). Where one cannot help noticing Hicks’s surprising faith in the possibility of talking of the proportion of physical capital to labour, as if capital were physically homogeneous.
3.3 Malinvaud

The belief, that things work as if capital could be considered a single (value) factor, survives even in those modern general equilibrium specialists who, like Edmond Malinvaud and Kenneth Arrow, are responsible for having developed and perfected the neo-Walrasian method of analysis in the second half of the XXth century. For reasons of space, here we only discuss Malinvaud.23

We mentioned that one of the most striking features of the neo-Walrasian method is the assumption, which this method is obliged to make, that the economy is always on the equilibrium path. Interestingly, in Mass Unemployment (1984) Malinvaud rejects this assumption. To be sure, Malinvaud does accept the marginal approach to prices and distribution; but he stresses, in particular, that the ‘labour market does not operate in this way [...] [wages] adjust much less than would be required for permanent market clearing. [...] its influence [of the law of supply-and-demand in the labour market] is slow and, therefore, quite limited in the short term’ (pp. 19–20).

Malinvaud like Hicks is aware of the little room for substitutability in the short period; he notes, as a reason why full employment equilibrium does not obtain in the short run even neglecting the obstacles posed by ‘legislations’, ‘regulations’ or trade unions, that ‘the degree of capital-labour substitutability is ... quite small in the short term, for work on given equipments with a given organization of production, but quite significant in the long term, when equipments are built or replaced, and when methods of production are reorganized’. (p. 64). The expression ‘capital-labour substitutability’ is already revealing enough; and indeed, like Hicks, Malinvaud has no doubt on the ‘long term’ effect of a change in real wages on choice of techniques: when real wages decrease, eventually ‘a lower relative cost of labour with respect to capital induces firms to choose a less capital-intensive technique of production and, therefore, to have larger labour demand for any given amount of the aggregate demand for their product’ (p. 64); having admitted a negative short-period influence of reduced real wages on aggregate demand, he draws the conclusion that ‘the responses of employment to lower wages will be negative in the short term but positive in the long term’ (p. 65).

A very similar conclusion is reached in Diagnosing unemployment (1994): we find now Malinvaud denouncing the illegitimacy of the attempt to measure the ‘wage gap’ as the difference between the actual real wage and

23 For Arrow, the reader is referred to Dvoskin, 2016, appendix.
an *equilibrium* real wage determined by the intersection of a labour-supply curve with a labour-demand curve derived from a capital stock ‘fixed at its current state’ (p. 127). ‘Clearly, the contemplated equilibrium is not meant to be implemented in the short run, but after several years at least, so that productive capacities are themselves consistent with it’. Hence, this way to measure the wage gap ‘removes from the representation of the demand for labour what I consider to be its main proximate medium-term determinant . . . namely the adaptation of the capital stock’. (p. 127–8).

We have here a rather clear example of a neo-Walrasian theorist who seems unable to perceive the contradiction between his theoretical general equilibrium model, that takes the composition of the capital endowment as given and arbitrary, and his description of the forces making for equilibrium, that implies that the equilibrium capital endowment must be of endogenously determined composition. For Malinvaud is far from rejecting neo-Walrasian general equilibrium theory,24 but we have seen that he says that the only plausible determination of an equilibrium real wage is the one based on a demand-for-labour curve that includes ‘the adaptation of the capital stock’; that is, such that to each point of the labour demand curve there corresponds a different vector of capital goods, adapted to the changed amount of labour and changed real wage; accordingly, when the wage changes the capital goods that cooperate with labour must be given time to change ‘form’ and adapt to the real wage. In this way Malinvaud shows full awareness that the principle of substitution on which neoclassical theory is erected requires the treatment of the endowments of the several capital goods as variables *endogenously determined* by the conditions of equilibrium. But then, since factor endowments are required by the logic of the approach to be among the givens of the theory, the approach *requires* the treatment of capital as a single factor of production, capable of changing ‘form’ without changing in quantity. Malinvaud does not say explicitly that this conception of capital is legitimate, but he does have recourse to a model where capital is treated as a single factor in the production function (1994, chapter 6), and we have seen that he has no hesitation in affirming that, if enough time is allowed for capital to change form, the adjustment caused by wage decreases will work in the *standard neoclassical direction*.

This may explain why in his *Macroeconomic Theory* textbook (1998a, 1998b) Malinvaud admits that ‘the equations which would hold under the hypothesis that supplies and demands would be continually in equilibrium in all markets’ are ‘repeatedly contradicted in short-run adjustments’, and nonetheless he decides to accept the view that ‘they are . . . valid for long-

---

24 See for example Malinvaud (1993).
term trends’ (1998b, p. 642); and hence he relies on standard neoclassical growth models of the Ramsey-Solow type (where capital is treated as a single factor of production) to explain these trends in distribution, employment and growth. All this seems to us a very strong confirmation of our argument in section 3.1.

3.4 Lucas, and DSGE macro-models

That the same belief in traditional capital-labour substitution is present in those contemporary neoclassical macroeconomists who claim the theory of intertemporal equilibrium as the microfoundation of their models may appear less evident, since differently from Malinvaud they seem to assume that the economy is continuously on the intertemporal equilibrium path, and the theory of intertemporal equilibrium apparently has no room for the conception of capital as a single factor. But in fact, we will now argue, the belief is there and it is what allows them to believe, as they evidently do, that intertemporal equilibrium paths are good indicators of actual paths.

For Robert Lucas, the leading scholar of this group, and famously known for claiming that the economy is always in intertemporal equilibrium (cf. Lucas, 1980), we can indicate a revealing passage. In the well-known article on endogenous growth—the text of a lecture delivered at the University of Cambridge—Lucas states that reflection on human capital

… has very much altered the way I think about physical capital. We can, after all, no more directly measure a society’s holding of physical capital than we can its human capital. The fiction of ‘counting machines’ is helpful in certain abstract contexts but not at all operational or useful in actual economies—even primitive ones. If this was the issue in the famous ‘two Cambridges’ controversy, then it has long since been resolved in favour of this side of the Atlantic [That is, the English side]. Physical capital, too, is best viewed as a force, not directly observable, that we postulate in order to account in a unified way for certain things we can observe: that goods are produced that yield no immediate benefit to consumers, that the production of these goods enhances labor productivity in future periods, and so on. (Lucas, 1988, pp. 35–6)

Thus according to Lucas physical capital cannot be measured, but this is not a problem, because it is a force that we postulate in order to explain certain observable facts as due to its effects. Let us then have a look at how this postulated force permits to explain empirical observations according to
Lucas. In order to explain the actual trends in income distribution and employment, Lucas (cf. Lucas, 1975, 1988) has recourse to one-sector models where the unique consumption good is produced by itself and labour, under a well-behaved production function with capital and labour as inputs, and with their marginal products determining income distribution along the growth path (cf., e.g. Lucas, 1975, p. 1115). So the ‘force’ works exactly like traditional neoclassical capital the single value factor. But then, why the reference to disaggregated intertemporal equilibrium as the microfoundation of the analysis? The answer, clearly, is composed of two beliefs that subsequent real-business-cycle and DSGE scholars seem to share with Lucas: (1) one-good neoclassical growth models produce essentially the same paths as to growth, output per unit of labour, and income distribution as disaggregated intertemporal general equilibrium models, and (2) the latter models, the only ones that can be considered ‘rigorous’ in that they do not simplify through aggregations of unclear micro legitimacy, produce paths that reflect well the behaviour of actual economies.

Of these two beliefs, the fundamental one is the second, since it is the theory of intertemporal equilibrium that is claimed to be the rigorous microfoundation of the macro analyses. But what justifies it?

We have argued in section 3.1 that the only possible justification is a continuing belief in the traditional, time-consuming marginalist/neoclassical adjustment mechanisms based on capital-labour substitution, evidently considered capable of correcting or compensating disequilibria, so that the trend the economy actually follows is not too far from the path described by the intertemporal equilibrium models (which therefore cannot aim to describe more than some approximation to the trend that the actual economy follows).

Few people seem to realize that this is admitted by Lucas himself, since he concedes that the hypothesis of rational expectations makes sense only for situations sufficiently persistent for agents to have had the time to learn how correctly to form their expectations:

... the economic interpretation of this assumption of rational expectations is that agents have operated for some time in a situation like the current one and have therefore built up experience about the probability distribution which affects them. For this to have meaning, these distributions must remain stable through time (1974, p. 190).

Clearly then, after any unexpected change, during the learning process mistakes necessarily occur and the economy does not behave as the rational
expectations equilibrium would indicate; and given that learning is going on all the time because technical progress, new ideas and fashions, etc. are constantly producing unexpected novelties, the implication is that the economy can never perfectly reach the shifting rational-expectations equilibrium path, a fact that one can neglect only if one sees the theoretical path as only an approximate centre of gravitation of the actual path.

That the learning of rational expectations takes time is admitted by many other scholars, for example Sargent (1993, p. 23), or Evans and Honkapohja (2001). One might argue that this does not by itself make it impossible to assume continuous equilibrium: a temporary equilibrium might be reached instantaneously at the beginning of each 'week' although generally on the basis of non-rational (that is, mistaken) expectations. But the resulting path might diverge more and more from the rational expectations path, and certainly, owing to mistaken expectations, it will involve productions of capital goods different from those of the rational expectations path: so in order to neglect the possibility of an increasing divergence, one must again conceive the rational expectations path as in fact an approximation to the trend of an actual path which is kept sufficiently close to the rational expectations path by adjustments that determine a trend that can be studied by treating capital as a single factor: which is precisely what Lucas or Sargent do in their models.

These examples confirm that a survival of a faith in traditional long-period marginalist/neoclassical analyses, a faith independent of neo-Walrasian GE theory and based rather on traditional capital-labour substitution, and emerging nowadays in the use of neoclassical macro models where capital is a single factor, is the real microfoundation of the claimed validity of intertemporal equilibrium theory as a positive theory, not the reverse. Without a faith in the adjustments behind those analyses, the implausible assumptions needed by neo-Walrasian equilibria would make it impossible to attribute descriptive relevance to these equilibria; and the path traced by the macro models would offer no guarantee that the actual path of the economy does not diverge more and more from it.

This explains why we discussed the Marshallian short-period approach first: in it the adjustment mechanisms supporting that faith can be made explicit, and discussed—and found wanting.

4. RESWITCHING

What does reswitching by itself, that is, independently of its generally being a cause of reverse capital deepening, add as a criticism? Its possibility was
initially met with disbelief: evidently something in the marginalist/neoclassical ways of thinking was deeply incompatible with it. We try now to point out what this ‘something’ is.

As we remember in the Appendix, there is a logical necessity behind the measurement of the single factor ‘capital’ as a quantity of exchange value in the marginal approach. But clearly a marginalist economist cannot stop at this: it cannot be the value of capital goods, by itself, to make capital goods productive. Capital goods contribute to production in the same technological sense in which land or labour do, so if one wants to see them as embodiments of a common factor ‘capital’, the latter must deliver the productive contribution of the capital goods in which it is embodied, a productive contribution the greater, the greater the (net) product one obtains for given quantities of other factors. Therefore the marginalist economist necessarily views the value of a vector of capital goods as measuring the quantity of ‘real’ capital embodied in them, in the sense of potential productive contribution of those capital goods; this is the conception emerging, for example, in Hicks’s description of capital as Physical Things in 1963 (cf. section 3.2 above). This conception of ‘real’ capital, since it aims at grasping the capacity of more capital services to increase the net output obtainable from given amounts of other factors, and since these productive services can only come from concrete capital goods, necessarily implies that if two techniques employ the same physical vector of capital goods, then the productive services contributed by capital, or the amount of ‘real’ capital, are the same in the two techniques.

This conclusion brings one to a potential separation of value capital from ‘real’ capital: a change of value of an unchanged vector of capital goods, due for example to a change of income distribution (a price Wicksell effect), cannot be viewed as a change of the quantity of ‘real’ capital. Thus, for example, Champernowne’s ‘chain index’ (1953) considers the quantity of capital not to change as long as the technique in use and the net outputs do not change. The role of capital as a factor of production naturally tends to make the conception of ‘real’ capital the truly important one, relegating its measurement as a quantity of exchange value to an unfortunate necessity faute de mieux, a measurement that perhaps one can admit to be unsatisfactory without feeling obliged to give up the idea that the services contributed by capital goods can be viewed as representing services supplied by a single factor ‘real’ capital.

But the theory, that gives birth to this conception, bases its explanation of income distribution on factor substitution; therefore this conception goes together with the certainty that ‘real’ capital will be combined with labour in a proportion that depends negatively on the relative price of
capital’s and labour’s productive contributions; in other words, this conception takes it for granted that as income distribution varies in favour of capital (the rate of interest rises), the choice of techniques will be in favour of techniques employing more and more labour per unit of net product, whatever the product under discussion. If one believes that there must be a way to conceive heterogeneous capital goods as representing or embodying amounts of a single factor ‘real’ capital, then (neglecting scarce natural resources for simplicity) one must believe that any net output is produced by labour and ‘real’ capital, hence if a rise of the real wage (and associated decrease of the interest rate) causes less labour per unit of that net output to be used, necessarily the employment of ‘real’ capital must be greater.

Reswitching destroys the legitimacy of this conception of substitution between ‘real’ capital and labour for economies with heterogeneous capital goods. The same amount of ‘real’ capital and of labour per unit of net output can come back at a lower real wage, after having been abandoned in favour of another technique as the real wage started decreasing from a higher level. The attempt to go beyond the value measurement of capital to a ‘real’ conception indicative of capital goods’ aggregate productive contribution in technical, physical terms does not salvage the ‘principle of substitution’.

Without reswitching, economists would have gone on believing that a higher real wage (and therefore a lower reward of capital) necessarily induces the adoption, in the long period, of techniques that use less labour in order to produce a given net product; and the idea would have survived that, if a smaller productive contribution of labour is used to produce an unchanged output, a greater productive contribution of other factors must be making up for it, and then the right would have been thought to exist to call the increased productive contribution coming from capital goods ‘use of more capital’, and the idea would have survived that a lower rate of interest causes the ‘use of more capital’, a technological (albeit vague) idea of ‘use of more capital’ independent in principle of value measurements.

That the criticism of the ‘principle of substitution’ made possible by reswitching is independent of value measurements makes reswitching important even apart from its being often associated with reverse capital deepening. In fact reswitching undermines the validity of the ‘principle of substitution’ without any need to interpret the latter expression as referring to substitution between labour and ‘capital’ (not only value capital but even ‘real’ capital). For labour the principle of substitution can be defined in purely physical terms and without specifying substitution with what. The general notion of ‘principle of substitution’ applied to labour is that when
the real wage rises (in terms of the net product labour helps to produce\textsuperscript{25}), if this causes a change of technique then the change will be such that labour will be used less in the production of a given net output: clearly this will require that some other input be used more, but no previous specification of these other inputs or more generally of the alternatives is needed for this definition of the principle of substitution. And reswitching contradicts it.

5. CONCLUDING REMARKS

One might ask at this point: but then, what is important for the criticism of the demand-side role of capital the single factor in the marginal/neoclassical approach, substitution between labour and value capital, falsified by reverse capital deepening, or substitution in ‘real’ terms, falsified by the possibility that a higher real wage go together with the use of more labour per unit of net output? The answer is: both. As must be expected from a theory suffering from internal inconsistencies, its adherents have found more than one way to obscure, or to come to terms with, its inconsistencies. Criticisms directed at different aspects or versions are therefore possible and useful. Reverse capital deepening undermines the stability of the savings-investment market. Reswitching, besides being generally a cause of reverse capital deepening, undermines the idea that behind the admittedly unsatisfactory measurement of capital as a quantity of exchange value there is ‘real’ capital, and that substitution between labour and ‘real’ capital works in the way neoclassical theory postulates. So one can concur with Garegnani (1990, p. 71) on reswitching and reverse capital deepening as revealing ‘the absence of a factual basis for the theory’.\textsuperscript{26}

\textsuperscript{25} We leave aside joint production; then the wage rises in terms of all goods, so it is impossible that some capital good rises in price even more than labour.

\textsuperscript{26} It is our impression that Potestio underplays these important implications of reswitching and reverse capital deepening because she has been persuaded by D’Ippolito’s claim (1987, 1989) that reswitching is highly improbable: this comes out in particular in Potestio (2010, pp. 150–4). It is then worth remembering that D’Ippolito’s reasoning and results have been found unacceptable by Ciccone (1996) and by Petri (2011), both of whom, on the basis of different reasonings, conclude that the ‘a priori’ probability of reswitching (conceding for the sake of argument the relevance of such a notion) is much higher than D’Ippolito’s calculation. Furthermore, there is reason to think that the shapes of wage curves that render reswitching less likely—the ones associated with relative prices changing little with income distribution—are also the ones that make it more likely that there is very little change of the capital-labour ratio all along the envelope of wage curves (Petri, 2011, p. 408), depriving of any theoretical foundation the negative interest elasticity of investment so important for the thesis that investment tends to adjust to savings.
This being the situation, *a priori* reasonings appear unable to conclude to anything capable of supporting a neoclassical demand curve for savings, or for labour. On the other hand, appeals to empirical evidence will go, if anything, against neoclassical theory: to make just one example, it is well known that according to empirical evidence the influence of the rate of interest upon investment is at best very weak. We feel therefore that we can confirm the opinion, expressed by one of us, ‘that reswitching and reverse capital deepening undermine the entire supply-and-demand approach to value, distribution and growth’ (Petri, 2011, p. 380). Which does not mean that this is the only line of criticism capable of such an outcome.

**APPENDIX**

*On capital as a ‘pure value entity’*

Potestio states that there are two possible conceptions of the given value endowment of capital, the first one being a value fixed in terms of some numéraire, the second one being ‘that the value is fixed whatever good is used to express it . . . [which] means to conceive of the given capital in the long run as a sort of pure value entity’ independent of the choice of numéraire (1999, p. 386); of this second conception she notes that ‘a concept of a pure value entity does not have any economic meaning’ (2010, p. 143). We suggest that this second conception *can* be given an economic meaning: it suffices to interpret it as expressing a belief that relative prices can be treated as given. The foundation of the traditional conception of capital as a value factor was precisely an underestimation of the dependence of relative prices on distribution, which meant that the exchange value of the aggregate of capital goods was taken as essentially given independently of income distribution (and hence also independently of the choice of numéraire). The underestimation is shown by the fact that, when some serious reflection was dedicated to the issue, what emerged was unease with the value measurement,27 as shown e.g. by Wicksell, Lindahl, Hayek, Hicks. If this is accepted, then what capital was for those traditional neoclassical authors who conceived of capital as ‘a pure value entity’ does not seem to be, *contra* Potestio (2010, p. 143), ‘a sort of metaphysical question’: the ‘quantity of capital’ of which the economy was endowed was viewed as one element of the set of possible vectors of...

---

27 Or outright dissatisfaction: Veblen (1908, pp. 160–67) criticized J. B. Clark precisely on the fact that prices cannot be assumed known before equilibrium is determined.
capital goods (all of the same exchange value\textsuperscript{28}) producible with the employment in the past of the productive resources that abstinence made available; the element of that set present in the economy was viewed as transformable into another element of that set if technical or consumer choice changed. An indefensible answer, but not a metaphysical one.

In this perspective, the adoption of some representative basket of consumption goods as numéraire appears to have been, not a way to \textit{surmount} the arbitrariness of a value endowment of capital given in terms of one good rather than of another, but rather the natural way to represent that given endowment as cumulated past abstinence from consumption.

\textit{On Potestio’s criticism of the demand-for-capital curve}

Potestio has questioned the meaningfulness of the demand-for-value-capital curve arguing that ‘The demand side of Fig. 1 is as economically inconsistent as its supply side’ (1999, p. 388), because of dependence of its shape on the numéraire:

Changing the numéraire not only changes the value of capital employed at each rate of profit, but could also change the direction in which this value moves. As

\textsuperscript{28} Potestio seems not to be sure as to why capital conceived as a single factor was measured, and therefore its endowment was given, as an amount of value. She writes: ‘The step: capital cannot be given in kind, thus it must be given in value, is actually neither logically necessary nor automatic’ (1999, p. 286, footnote 3; also 2010, p. 142). But consider two fields A and B of land of the same quality, and assume it is known that in a situation of normal prices field A earns a total amount of rent twice the amount earned by field B. We can conclude that field A’s area is twice the area of field B, because once arbitrage has been given time to operate, all units of a factor earn the same rental rate, and therefore field A must contain twice as many units of factor ‘land’ as field B. Now suppose A and B are two different capital goods, with capital good A earning a net rental rate twice the one of capital good B. If one wants to see their net earnings as the reward for the amount of services they supply of a common factor ‘capital’, \textit{then} one is obliged to see A as embodying twice as much ‘capital’ as B. But the value of A will also be twice the value of B, because the common net reward per unit of ‘capital’ is interest, which accrues at a common rate per unit of value capital. Thus, it is a logical implication of the approach that the amount of the common factor ‘capital’ crystallized in different capital goods and determining their net rental rates must be \textit{proportional} to their normal values. Since nothing else is proportional to the normal value of capital goods, measuring ‘capital’ as an amount of value is logically necessary. And contrary to the suggestion in Potestio (2011, p. 215), this was accepted as legitimate by Böhm-Bawerk: ‘I, too [like J. B. Clark], believe that capital is a “fund” or “quantum” of matter. I think it clear that anyone who wishes to make an estimate of the size of this fund must measure it, not by counting the pieces or calculating their volume or weight, but by measuring it in terms of value—nowadays in terms of money’. (Böhm-Bawerk, 1906, p. 5)
r rises, increasing values of capital with one numéraire could become decreasing values of capital with another numéraire. (ibid. p. 387)

The argument becomes clearer if reformulated as follows. Potestio agrees with Kurz & Salvadori on the fact that a change of numéraire does not affect the intersections between supply and demand for value capital nor their stable or unstable nature if the good in terms of which the endowment of value capital is fixed (and which need not coincide with the numéraire) does not change; her argument is that stability may depend on the choice of this good (implicitly chosen as numéraire in the above quotation).

To prove it, Potestio assumes an economy with two goods (that are circulating capital goods when used as inputs), given technique, and given gross quantities produced $x_1$ and $x_2$; good 2 is the numéraire, $p_2=1$; the value of the capital endowment $K^*$ is fixed in terms of good 1, i.e. the supply of value capital corresponds to the value of a given quantity $x_1^*$ of good 1, $K^* = p_1 x_1^*$. The given quantities produced and given coefficients imply that the demand for value capital varies with $r$ owing exclusively to a price Wicksell effect, the change in $K^d = a_{11} x_1 p_1 + a_{12} x_2 p_1 + a_{21} x_1 + a_{22} x_2$ where $a_{ij}$ is the quantity of input $i$ in the production of good $j$; the value of the supply of capital changes with $r$ (because good 1 is not the numéraire) so as to correspond always to the value of the same amount $x_1^*$ of good 1, that is, in equilibrium $a_{11} x_1 p_1 + a_{12} x_2 p_1 + a_{21} x_1 + a_{22} x_2 = p_1 x_1^*$; assuming $dp_1/dr > 0$, a small rise of $r$ from an equilibrium level causes $K^*$ to rise more than $K^d$ because the latter includes an amount of good 2 whose value remains unaltered: hence, one may argue, (local) stability. But if the supply of value capital is fixed in terms of good 2, then as $r$ rises $K^*$ does not change, while $K^d$ rises because it includes an amount of good 1 and we have assumed $dp_1/dr > 0$: hence instability.

What the example renders particularly clear is the absurdity of a supply of value capital given in terms of a specified good—which is the root cause of the dependence of stability on the choice of that good. In this economy, if the rate of interest changes and the result is a revaluation of the unchanged stocks of capital good 1, their owners will find that the value of the capital they own has changed, so it is absurd to assume that the endowment of value capital has not changed; and this will necessarily affect the savings-investment market: for example assuming the consumers’ desire to consume has not changed in physical terms, and that savings are full-employment income minus the value of that consumption, the supply of savings or loanable funds changes and, under Potestio’s assumptions, in exactly the same way as the demand for capital, so equilibrium is not disturbed (or, if there was disequilibrium to start with, it is not corrected, in full accord with the
neoclassical idea that it is technological substitution or substitution in consumer choice that corrects disequilibria in factor markets).

Therefore this example only confirms in a particularly clear way the illegitimacy of a given value endowment of capital: any change of relative prices will alter the value of any vector of capital goods, and this can only mean that the value *endowment* of capital, which cannot mean something different from the value of the existing capital goods, depends on income distribution.

But arbitrariness, and in fact nonsense, of the choice of the good in terms of which the value endowment of capital is fixed, call it choice (A), is not the same thing as arbitrariness of the choice of numéraire, call it choice (B). It is the arbitrariness of choice (A), not of (B), that produces the indeterminateness of stability in Potestio’s example. This can be rendered even more evident by fixing the numéraire: then the demand-for-capital curve is given; now take as the given value capital endowment the observed value of the capital goods in the economy under study; how the value capital supply changes with changes in income distribution will depend on the good in terms of which this given initial value endowment is assumed not to change: it is the shape of the supply curve, not of the demand curve, that changes if choice (A) is changed while the numéraire is kept fixed, rendering stability dependent on the arbitrary choice (A).

So we are only looking at the illegitimacy of the given value capital endowment from a different angle, concentrating on the indeterminateness of stability depending on the good in terms of which the value of the capital endowment is fixed; but this criticism is superfluous once the illegitimacy of a given value capital endowment is accepted, and anyway the problem is again the supply-side problem with capital in long-period equilibria.

REFERENCES

Böhm-Bawerk, E. (1906): ‘Capital and interest once more: I. Capital vs. capital goods’, *The Quarterly Journal of Economics*, 21 (1), pp. 1–21.

Ciccone, R. (1996): ‘Possibilità e probabilità di comportamento “perverso” del capitale’, *Studi Economici*, 58 (1), pp. 41–73.

Champernowne, D. G. (1953): ‘The production function and the theory of capital: a comment’. *Review of Economic Studies*, 21, pp. 112–35.

D’Ippolito, G. (1987): ‘Probabilità di perverso comportamento del capitale al variare del saggio di profitto: il modello embrionale a due settori’, *Note Economiche*, 2, pp. 5–37.

D’Ippolito, G. (1989): ‘Delimitazione dell’area dei casi di comportamento perverso del capitale in un punto di mutamento della tecnica’, in Luigi Pasinetti (ed): *Aspetti Controversi Della Teoria Del Valore*, Il Mulino, Bologna, pp. 191–8.
Dvoskin, A. (2016): ‘An unpleasant dilemma for contemporary general equilibrium theory’, The European Journal of the History of Economic Thought, 23 (2), pp. 198–225.

Dvoskin, A., Lazzarini, A. (2013): ‘On Oskar Lange’s theoretical position on equilibrium and capital’, History of Economics Review, 58 (Summer), pp. 1–26.

Evans, G., Honkapohja, S. (2001): Learning and Expectations in Macroeconomics, Princeton University Press, Princeton.

Fratini, S. M. (2012): Capitale e Rendita. Due Saggi di Teoria Economica, Aracne Editrice, Rome.

Fratini, S. M. (2013): ‘Real Wicksell effect, demand for capital and stability’, Metronome, 64 (2), pp. 346–60.

Garegnani, P. (1960): Il capitale nelle teorie della distribuzione, Giuffrè, Milan.

Garegnani, P. (1964[1978]): ‘Note su consumi, investimenti e domanda effettiva, Parte I’, Economia Internazionale; as translated as “Notes on Consumption, Investment and Effective Demand: I”, Cambridge Journal of Economics, 2, pp. 335–53.

Garegnani, P. (1970): ‘Heterogeneous capital, the production function and the theory of distribution’, Review of Economic Studies, 37 (3), pp. 407–36.

Garegnani, P. (1990): ‘Quantity of capital’, in Eatwell, J., Milgate, M., Newman, P. (eds): The New Palgrave: Capital Theory, Macmillan, London, pp. 1–73.

Garegnani, P. (2005): ‘Capital and indeterminacy of equilibria. A reply to Mandler’, Metroeconomica, 56 (4), pp. 411–37.

Hayek, F. (1940): ‘Socialist calculation: the competitive solution’, Economica, 7 (26), pp. 125–49.

Hayek, F. (1941[1950]): The Pure Theory of Capital, Routledge, London.

Hayek, F. (1969): ‘Three elucidations of the ricardo effect’, The Journal of Political Economy, 77 (2), pp. 274–85.

Hicks, J. R. (1932 [1963]): The Theory of Wages, 2nd edn, Macmillan, London.

Hicks, J. R. (1939 [1946]): Value and Capital, 2nd edn. Clarendon Press, Oxford.

Keynes, J. M (1936 [1973]): The General Theory of Employment Interest and Money, Macmillan, London.

Knight, F. H. (1946): ‘Capital and interest’, Encyclopaedia Britannica, IV, pp. 779–801 (reprinted in Readings in the Theory of Income Distribution, ed. by the American Economic Association, Toronto, 1946).

Kurz, H. D. (2000): ‘Wicksell and the problem of the ‘missing’ equation’, History of political economy, 32 (4), 766–88.

Kurz, H. D., Salvadori, N. (1995): Theory of Production. A Long Period Analysis. Cambridge university press, Cambridge.

Kurz, H. D., Salvadori, N. (1998): ‘Reverse capital deepening and the numéraire: a note’, Review of political economy, 10, pp. 415–26.

Kurz, H. D., Salvadori, N. (2001): ‘The aggregate neoclassical theory of distribution and the concept of a given value of capital: a reply’, Structural Change and Economic Dynamics, 12, pp. 479–85.

Lucas, R. (1974): ‘Equilibrium search and unemployment’, Journal of economic theory, 7, pp. 188–209.

Lucas, R. (1975): ‘An equilibrium model of the busyness cycle’, Journal of political economy, 83 (3), 1113–44.

Lucas, R. (1980): ‘Methods and problems in business cycle’, Journal of Money, Credit and Banking, 12 (4), pp. 696–715.

Lucas, R. (1988): ‘On the mechanics of economic development’, Journal of Monetary Economics, 22, pp. 3–42.

Malinvaud, E. (1984): Mass Unemployment, Blackwell, Oxford.

Malinvaud, E. (1993): Équilibre Général dans les Économies de Marché, Economica, Paris.

Malinvaud, E. (1994): Diagnosing Unemployment, Cambridge University Press, Cambridge.

Malinvaud, E. (1998a): Macroeconomic Theory. Volume A, North-Holland, Amsterdam.
Reverse Capital Deepening and Reswitching

Malinvaud, E. (1998b): *Macroeconomic Theory. Volume B*, North-Holland, Amsterdam.

Marshall, A. (1920 [1972]), *Principles of Economics*, 8th edn. MacMillan, London and Basingstoke.

McKenzie, L. (2002): *Classical General Equilibrium Theory*, MIT Press, Cambridge, MA.

Petri, F. (1999): ‘Prof. Hahn on the “neo-Ricardian” criticism of neoclassical economics’, in Mongiovi, G., Petri, F. (eds): *Value, Distribution and Capital. Essays in Honour to P. Garegnani*, Routledge, London, pp. 19–68.

Petri, F. (2004): *General Equilibrium, Capital and macroeconomics: A key to recent controversies in equilibrium Theory*, Elgar, Cheltenham.

Petri, F. (2011): ‘On the likelihood and relevance of reswitching and reverse capital deepening’, in Gehrke, C., Salvadori, N. (eds): *Keynes, Sraffa and the Criticism of Neoclassical Theory*, Routledge, London, pp. 380–418.

Petri, F. (2013): ‘The inevitable dependence of investment on expected demand: implications for neoclassical macroeconomics’, in Leverero, E. S., Palummo, A., Stirati, A. (eds): *Sraffa and the Reconstruction of Economic Theory*, Vol. II, Palgrave Macmillan, Houndmills, Basingstoke, pp. 44–67.

Petri, F. (2015): ‘Neglected implications of neoclassical capital-labour substitution for investment theory: another criticism of say’s law’, *Review of Political Economy*, 27 (3), 308–40, doi: 10.1080/09538259.2015.1067367.

Potestio, P. (1999): ‘The aggregate neoclassical theory of distribution and the concept of a given value capital: towards a more general critique’, *Structural Change and Economic Dynamics*, 10, pp. 381–94.

Potestio, P. (2001): ‘The aggregate neoclassical theory of distribution and the concept of a given value capital: a counter-reply’, *Structural Change and Economic Dynamics*, 12, pp. 487–90.

Potestio, P. (2010): ‘“Perverse cases” and the debate on neo-classical theory of distribution: recent contributions on an open issue’, in Vint, J., Metcalfe, J. S., Kurz, H. D., Salvadori, N., Samuelson, P. A. (eds): *Economic Theory and Economic Thought. Essays in honour of Ian Steedman*, Routledge, Abingdon, UK, pp. 138–160.

Potestio, P. (2011): ‘The aggregate neoclassical theory of distribution and the concept of a given value capital: towards a more general critique’, in Ciccone, R., Gehrke, C., Mongiovi, G. (eds): *Sraffa and Economic Theory*, Vol. I, Routledge, London.

Salvadori, N. (1977): ‘Introduzione’, in Blaug, M. (ed): *La controversia di Cambridge*, Liguori, Napoli.

Sargent, T. (1993): *Bounded Rationality in Macroeconomics*, Clarendon Press, Oxford.

Veblen, T. (1908): ‘Professor Clark’s Economics’, *Quarterly Journal of Economics*, 22 (2), pp. 147–95.

Wickens, M. (2008): *Macroeconomic Theory. A General Equilibrium Approach*, Princeton University Press, Princeton, NJ.

Wicksell, K. (1934 [1901]): *Lectures on Political Economy*, Vol. II, Routledge, London.

Woodford, M. (2009): ‘Convergence in macroeconomics: elements of the new synthesis’, *American Economic Journal: Macroeconomics*, 1 (1), pp. 267–279.

Ariel Dvoskin
University of Buenos Aires-CONICET
E-mail: advoskin@gmail.com

Fabio Petri
DEPS, Università di Siena
Piazza S. Francesco 7
53100 Siena
Italy
E-mail: fabio.petri@unisi.it