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Again on the relevance of reverse capital  
deepening and reswitching

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# **Again on the relevance of reverse capital deepening and reswitching**

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## **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 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.

**KEYWORDS:** CAPITAL- MARSHALLIAN EQUILIBRIUM- NEOWALRASIAN EQUILIBRIUM  
- REVERSE CAPITAL DEEPENING- RESWITCHING – SAVINGS-INVESTMENT MARKET

**JEL CLASSIFICATION:** B21- D24 - D46- D51

## Introduction<sup>(1)</sup>

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 (and, occasionally, revealing misunderstandings) that deserve further discussion and clarification. Particularly stimulating are the contributions of professor Paola Potestio, since 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 Kurz & Salvadori (1995, chapter 15), who describe the relevance of reswitching and reverse capital deepening as due to their destroying the certainty of a decreasing demand curve for value capital in the face of a given supply (a vertical supply curve, cf. 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 neoclassical theory of distribution” (2010 p. 138). Her central criticisms concern (i) the illegitimacy of a given value endowment of capital because the value of capital goods changes with prices, and (ii) the arbitrariness of the capital demand curve, whose shape depends on the arbitrary choice of numéraire.

We wish to contend that Potestio’s arguments contain elements of truth, that do not, however, imply an ‘unimportance’ or ‘no particular role’ of reswitching and reverse capital deepening. We partially separate the discussion of these two phenomena. On the role played by reverse capital deepening, we develop a point already advanced in Petri (1999, 2004), but that seems not to have been paid so far the attention it deserves: the fundamental, albeit hidden, role of a continuing faith in traditional capital-labour substitution in the more recent (neo-Walrasian) versions of the marginal, or neoclassical, approach. Without this faith, that supports a continuing belief in traditional time-consuming marginalist disequilibrium adjustments, the claim often made by contemporary marginalist economists, notably macroeconomists, that the economy can be assumed to be *all the time* on the equilibrium-

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<sup>1</sup> We thank Franklin Serrano for useful comments. The usual disclaimer applies.

growth path would be patently unacceptable. This point is pursued in sections II, III and IV, by arguing, first, that the shift to the currently dominant versions of the marginal approach was made easier by how the demand for the economy-wide *stock* of capital was necessarily conceived concretely to operate: as a *flow* demand for savings; and, second, by proving the presence in Hicks, Hayek, Malinvaud, Lucas of a continuing belief in capital-labour substitution as the basic mechanism ensuring the adjustment of this flow demand to the flow supply of savings. The role of reswitching is discussed in Section V: we there argue that 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.

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 conclusion. 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.

## **II. Implications of the illegitimacy of a value endowment of capital.**

The conclusion professor Potestio reaches on the basis of her criticism of the supply-of-capital curve is: “the critique of [the] neoclassical long-run theory of distribution can immediately stop with the economic inconsistency of a value of capital fixed in something” (1999 p. 387).

We agree that this inconsistency suffices to undermine that 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 [2] [3]. Indeed, it

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<sup>2</sup> 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).

<sup>3</sup> A long-period equilibrium must not be confused, as Hicks did in *Value and Capital*, with a

seems impossible to disagree with Wicksell when, with admirable honesty, he admits in (1934, p. 202) that “it would clearly be meaningless – if not altogether inconceivable – to maintain that the amount of capital is already fixed *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<sup>[4]</sup>.

However, Potestio commits a logical jump when she continues: “Reswitching, capital reversal and the instability of the equilibrium of Fig. 1 are unimportant for this critique in the same sense in which the lack of a pen is unimportant for an illiterate person” (*ibid.*). The fact, that long-period neoclassical equilibria cannot be determined because the capital endowment cannot be determined, does not imply that to point out other weaknesses of the neoclassical

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‘secular’ equilibrium, stationary or steady-state, where the total quantity of capital relative to labour is *endogenously* determined as the one inducing the needed growth rate.

<sup>4</sup> 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 seems intended to suggest 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 (i) that consumption goods are consumed in fixed proportions, (ii) that the growth rate is uniform and given (possibly zero), and (iii) that the numéraire consists of the consumption bundle, then “the *supply of capital* in terms of the numeraire 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 indeterminacy 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, because their value will change with any change of relative prices, as admitted by Wicksell.

approach or of some of its variants becomes unimportant. If in an approach there is more than one logical weakness, to point out all of them helps to clarify what is wrong with that theory; and it helps those, who have been brought up on that theory and find its abandonment difficult, to realize that the theory is really hopeless and the effort to explore other approaches is necessary. All the more so, since the mistaken belief that capital can be treated in the same way as labour or land has helped the development of ways of thinking on different problems, that tend to survive without a clear perception of their origin in that belief. 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 by looking at the historical development of the theory that one really grasps contemporary ways of thinking.

What we have particularly in mind is the importance of the demand-side implications of the traditional marginalist conception of capital, implications 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 'vision' of the forces determining distribution, employment and growth as the traditional versions, but still differ enough to invite different types of criticism. We have in mind here the intertemporal equilibria nowadays considered the sole 'rigorous' foundation of the neoclassical approach (temporary equilibria without perfect foresight 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 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 shall argue, the continuing faith in the demand-side implications of the traditional treatment of capital as a single value factor is the main reason why some necessary consequences of the neo-Walrasian treatment of capital, in particular 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. In the following section we show the importance of this faith by arguing that the shift to the currently

dominant versions of the marginal/neoclassical approach was made easier by how the demand for the economy-wide *stock* of capital was necessarily conceived concretely to operate: as a *flow* demand for savings. This conception was never abandoned and constitutes the implicit justification of current neoclassical macro theory. The thing is best grasped by considering the short-period Marshallian approach (then inherited by Keynes and universally adopted in subsequent macroeconomic theory up to the turn to continuous-equilibrium models). The relevance of reswitching and reverse capital deepening will then be clear.

### **III. The relevance of the demand-side criticism.**

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 Walras<sup>[5]</sup>) 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, 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

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<sup>5</sup> Partial because, as noted by Garegnani (1990, p. 56), Walras when discussing accumulation treats capital as a single factor.

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 twenty 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 generations, if for each level of the rate of interest twenty 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 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 be able to impose the new lower prices<sup>[6]</sup>, 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

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<sup>6</sup> E.g. even without any change in optimal technologies a reduction in the rate of interest cannot but push freely competing firms to try and undercut their competitors by lowering product prices relative to money wages since average costs have decreased; if they don't, it will be new firms – whose birth will be stimulated by the persistence of prices higher than average costs – that will do it to gain market share.



determined by the factor proportions “at the margin of new investment”, to use Knight's expression<sup>[7]</sup>, 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 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) by ensuring that the *demand* function, i.e. investment demand, would significantly<sup>[8]</sup> increase if the rate of interest decreased in response to an excess supply of loanable funds. The connection between this view of the influence of the interest rate upon investment, and demand for capital, has been described by the late Pierangelo Garegnani with a clarity that can hardly be surpassed. Here for space reasons we only cite his conclusion, referring the reader to Garegnani (1990, pp. 58-61; 1978, p. 352) for the full argument.

... the traditional analyses of the demand and supply for capital were in effect intended to be an analysis of the demand and supply for savings, abstracting from the complications likely to operate at each particular moment of time in the savings-investment market. (Garegnani 1990 pp. 59-60).

On this basis one can better understand the possibility of analyses such as those of

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<sup>7</sup> “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).

<sup>8</sup> Of course all tendency towards a supply-and-demand equilibrium on a market requires, in order to be plausible, that excess demand changes *significantly* when price changes: otherwise the force pushing the price toward the equilibrium level, being weak, would be unable to give equilibrium the role of correct indicator of the trend of the average of actual prices and quantities.

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. Let us remember the essential characteristics of the approach:

[it] appears to renounce the attempt to determine an equilibrium situation characterised by a uniform rate of return on the supply prices of the capital goods. It can thus avoid referring to the ‘quantity of capital’ available in the community as a given magnitude. Instead, it takes as given the productive equipment existing in the various industries, on which a ‘quasi rent’ is obtained, depending on the level of the wage and the demand for the products. The real wage, on the other hand, is determined by the relation between the supply of and the demand for labour, the latter depending on the available productive equipment. The rate of interest results, finally, from the equilibrium between the current demand for investible resources and the current supply of savings. (Garegnani. 1978 p. 347)

The analyses internal to this approach reveal, we believe, an aspect of the traditional marginal approach which it is best to have clear.

We have seen that the logic of traditional marginal theory *de facto* obliged one to presume that the rate of interest is determined on the savings-investment market, by a tendency toward an equilibrium of *flows* (supply of, and demand for, savings or loanable funds, and supply of, and demand for, labour ‘freed’ by the gradual closure of old plants) that cannot be the ones corresponding to *complete* long-period equilibrium (but can nonetheless be treated as sufficiently close to the ones corresponding to long-period prices). It was therefore necessary for the traditional neoclassical economist to presume that, even in a situation of incomplete adaptation of the ‘form’ of capital to the given income distribution, i.e. in a situation in which the ‘form’ of capital is largely given, a sufficiently definite supply function and a sufficiently definite demand function for savings or loanable funds, as well as sufficiently definite supply and demand functions for labour, can be assumed to exist and to determine income distribution.

We would like to suggest 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 1978 p. 347),

was largely due precisely to his making this implicit presumption explicit. As Garegnani (1978, pp. 347-8) immediately adds, without reference to a ‘well-behaved’ substitution between capital and labour as the main determinant of investment, there would be no basis for the assumed negative interest elasticity of investment<sup>[9]</sup>. 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. And although the rate of interest is determined on the savings-investment market in a situation of capital largely given in ‘form’, the reference to the total stock of capital of an economy as a 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). Here capital is definitely a single factor, of which one can compare the quantities in spite of the changes in composition entailed by the rise of the rate of interest, and of which one can say that it ‘withdraws’ from some uses and moves to other uses much like labour. In conclusion, Marshall’s preference for a short-period framework in no way abandons capital-labour substitution, it only brings out more clearly 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.

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 total endowment of capital expressed as a single quantity among its determinants. The given existing ‘equipment’ (durable capital) is believed sufficient to generate a decreasing labour-demand schedule<sup>[10]</sup> that, with its intersection with the labour

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<sup>9</sup> 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).

<sup>10</sup> It is unnecessary to repeat here the several reasons to question such a belief (see for example Garegnani, 1979, pp. 77-78, footnote ‡; Petri, 2004, pp. 298-303). Marshall’s approach is not exempt from supply-side difficulties; for example, the difficulty with drawing a line between capital goods whose endowments can be taken as given, and capital goods whose quantities are endogenously

supply schedule, determines the full-employment level of production and income, and hence a well-defined savings schedule.

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 only 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. Of course, Keynes does not determine the rate of interest at the intersection of a *given* savings-supply schedule with the savings-demand (or investment) schedule; but before the *General Theory*, and even afterwards for the economists who continue to believe in the tendency toward full employment, this is how the rate of interest is determined, and the stability of the savings-investment market is ensured by the marginalist conception of capital-labour substitution working “at the margin of new investment”. The rate of interest is still determined by the marginal product of capital, although the one ‘at the margin of new investment’.

Thus already before the acceptance of neo-Walrasian general equilibria, the Marshallian approach was suggesting that the marginal/neoclassical approach could be formulated without including among the data of equilibrium a well-defined value capital *endowment*, as long as one could determine a definite flow of savings and one continued to accept the demand-side implications of traditional capital-labour substitution.

Relative to such an approach, the temporary equilibrium of Hicks’s *Value and Capital* (1939) certainly represents a significant *methodological* break because of the need for the assumption of instantaneous equilibration and therefore of *continuous* equilibrium (albeit with periodic revisions due to belied expectations); but it does not constitute a *theoretical* break, because the conception remains central, of the rate of interest establishing equilibrium on the savings-investment market owing to the operation of capital-labour substitution in the determination of new investments. The next Section will argue in detail the presence of this conception in neo-Walrasian economists and its fundamental role in the survival of an idea of

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determined by the short-period equilibrium, can explain why the Marshallian half-way was found unacceptable when general equilibrium theory was reformulated without an endowments of capital as a single value factor (see section IV). But here we are interested in pointing out the importance of the faith in capital-labour substitution for the determination of the short-period equilibrium.

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 contorted 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 V; 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 2011a; cf. below, the next-to-last paragraph of Section V). 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.

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, 1966, 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<sup>[11]</sup>.

#### IV. The neo-Walrasian versions.

Let us now come to recent neoclassical theory that declares not to rely on Marshallian short periods but rather on neo-Walrasian intertemporal equilibria where an aggregate investment function does not appear. We will argue that in these analyses the faith in the traditional marginalist adjustments based on capital-labour substitution is hidden, but it is still there, and necessarily so the moment an explanatory and predictive role is assigned to modern general equilibrium theory (or to the macroeconomics that claims it as its microfoundation).

This faith is clear in the first promoters of the resumption of a Walrasian specification of the capital endowment and consequent shift to neo-Walrasian equilibria: Lindahl, Hayek, Hicks. In all three the traditional marginalist adjustment mechanisms are fully accepted; although over a *succession of short periods*, the economy is believed to work *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 some special examples) now that capital the single factor was declared to have been abandoned. The thing has been shown in some detail elsewhere (Petri, 1991; 2004, chapter 5; Dvoskin and Lazzarini, 2013; Dvoskin, 2014). Here some shorter, partly new observations may suffice.

The working of the factor substitution mechanisms over the sequence of periods of the neo-Walrasian path is for instance clear in Hayek's *The pure theory of capital* (1941).

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<sup>11</sup> In "Note su consumi ..." (1964; English translation 1978-9) the criticism is exclusively of the *demand* curve for capital (and hence of the investment function). In "Heterogeneous Capital ..." (1970) the endowment problem emerges only, and rather implicitly, when in Section VI it is noted that in order to determine the demand curve for labour one must be able to "speak of a constancy of capital", which requires what, earlier in the article, Garegnani has described as assumption (d): the possibility meaningfully to define net savings independently of distribution. Actually this possibility is denied in the footnote accompanying the statement of assumption (d), but the first line of that footnote characterizes the assumption as 'highly questionable' rather than totally illegitimate; in other words Garegnani does not state that by itself this problem would suffice to reject the theory, and in fact proceeds to grant assumption (d) so as to focus on the demand-side problems; thus on labour his argument is that, even conceding the treatment of the (value) capital endowment as given and constant as the real wage changes, still the demand for labour is not necessarily downward-sloping. One must wait for "Quantity of Capital" (1990) for again an explicit criticism of the value capital endowment as entailing an insurmountable difficulty, that explains the neoclassical shift away from long-period equilibria.

Consider the following passages of chapter XX of that book. Hayek assumes there that there are several techniques to produce a final good, and examines the consequences of a fall in the rate of interest on cost-minimizing techniques. Given that capital goods are technique-specific, he continues, the new cost-minimizing, more roundabout, methods of production that are adopted when the rate of interest decreases can be initially introduced only in new plants, and since

... the investments in the later stages of the new process can obviously be made only after the corresponding investments in the earlier stages have already been made, the whole process of lengthening the investment structure *will be diffused over a period of time*. When the new investment first begins to take place, only the input applied at the beginning of the various processes will be invested for longer periods; but people will do this with the intention of changing... *in succeeding periods* the investment periods of units of input in the later stages of the same process. The transition from one sort of investment structure to another will therefore make it necessary during a considerable period of time for input to be transferred from one 'stage' of the process to another. (Hayek, 1941 p. 279; emphasis added).

And a few pages later Hayek again stresses that, when techniques change,

...what can be re-invested in the new and different form will be only the current pure input [i.e. labour] and the more versatile non-permanent resources. Such capital, on the other hand, as was irrevocably sunk, before the new saving was foreseen, in very durable and highly specific equipment, cannot, of course, be promptly or wholly shifted to a different use ... and in some cases it will be found that even in the course of time only part of the capital originally invested can be recovered and re-invested in a different form (p. 283).

Notice then that it is only gradually – within the framework Hayek (1941) is developing, the sequence of periods of the neo-Walrasian equilibrium path – that the effects of a decrease in the rate of interest will assert themselves fully, although the effect will start exerting its effects immediately, by regulating the proportion of capital to labour in new plants. And, moreover, the effect of that decrease is argued to be the same as in traditional theory, namely to induce entrepreneurs to increase the ratio of capital per unit of labour. This is crystal-clear for example in the following passage:

...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)

Hayek's faith that things work *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..

The survival of the same faith, not only in the traditional mechanisms, but also in the traditional conception of capital itself, emerges clearly in Hicks's *Commentary* added to the second edition (1963) of his *Theory of Wages*, whose first edition (1932) he had let go out of print because dissatisfied with its treatment of capital as a single value factor. In 1963 little is



left of that dissatisfaction. Now Hicks esteems it legitimate to talk of “the Factor of Production Capital” (p. 343), which can be regarded as a Fund (of value) or as “Physical Things” (a rather vague notion, intended to reflect the principle that, for given amounts of the other factors, more ‘capital’ must mean more net output), but in *both* cases must be measured “by taking a money value of the Capital stock and deflating it by an appropriate index-number” (p. 344). He sees little to be criticized in the use of an aggregate production function (cf. especially p. 345); he esteems that heterogeneity of capital goods poses no fundamental difficulty<sup>[12]</sup>; he believes in 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)

Note Hicks’s faith in these lines in the possibility of talking of the proportion of *physical* capital to labour, as if capital were a physically homogeneous good.

These pieces of evidence are further strengthened by the observation that the belief, that things work *as if* capital could be specified as 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 XX<sup>th</sup> century. For reasons of space, here we only discuss Malinvaud<sup>[13]</sup>.

We mentioned above (cf. section III) 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. While of course Malinvaud accepts the marginal approach to prices and distribution, in *Mass Unemployment* (1984) he refuses to adopt the peculiar

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<sup>12</sup> The following passage indicates that Hicks thinks that recourse to the *Value and Capital* approach would make no difference to the conclusions of the theory: “Some difficulties can indeed be brushed aside. Heterogeneity of product and heterogeneity of capital stock can be dealt with by using our formal theory of many factors and many products; and it is to be noticed that this now makes it unnecessary to insist that the economy is to be taken to be in a state of full equilibrium, in the sense that there is perfect equalisation of yields on every sort of capital good.” (Hicks 1963 p. 346)

<sup>13</sup> For Arrow, the reader is referred to Dvoskin, 2014, appendix and Petri 2004, chapter 5, appendix 5A2.

vision of the working of the forces of supply and demand entailed by neo-Walrasian equilibrium<sup>[14]</sup>. He insists, 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” (p. 19-20).

At first Malinvaud identifies in the existence of “legislations”, “regulations” and the role played by labour unions (p. 20) the causes that may limit, at least over relatively short time spans, the possibility of equilibrium in the labour market. Later, however, he proceeds to give a reason why full employment equilibrium does not obtain in the short run even neglecting those obstacles: in order to grasp “why adjustments are not quicker or more satisfactorily oriented” (p. 50), he claims, “one must pay some attention to the mobility of labour and capital from contracting to expanding industries” (*ibid*), and he goes on to note 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); so in fully traditional (rather than neo-Walrasian) vein, that is, relying on time-consuming disequilibrium adjustments, he argues that when real wages decrease, it is only *eventually* that “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” (*ibid.*); and 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 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). The “basic flaw” (*ibid*) of this attempt, he explains, is that this construction “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. 127-128).

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<sup>14</sup> In his works, Malinvaud mainly discusses the temporary equilibrium versions of the neo-Walrasian method since he esteems that intertemporal equilibrium “is not adequate to treat most macroeconomic questions” due to the assumption of complete markets (Malinvaud, 1998a, p. 48).

In these passages Malinvaud comes very close to admitting the incompatibility between the neo-Walrasian treatment of capital as a given vector of capital goods and the marginalist explanation of distribution: for Malinvaud 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, the capital goods that cooperate with labour must be given time to *change ‘form’* and adapt to each level of the real wage. Malinvaud shows in other words 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*.

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<sup>[15]</sup>, 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: (i) 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* (ii) 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?

Clearly, no one with a minimum of good sense could deny that 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, in one word: time-consuming disequilibria. But then those economists who accept neo-Walrasian intertemporal equilibria as a fundamentally

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<sup>15</sup> Lucas carefully avoids being clearer on what he means by such a statement, evidently being unsure as to what the Cambridge controversy was really about.

correct theory of the basic forces shaping production and distribution must believe that there are adjustment mechanisms working in real time that cause disequilibria 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 (which therefore cannot aim to describe more than some approximation to the trend that the actual economy follows)[<sup>16</sup>].

But then the reference 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 belief in the existence of stable adjustment mechanisms that cause the economy to gravitate around a path like the one of Solow’s growth model[<sup>17</sup>], and these can only be the time-consuming adjustment mechanisms resting on traditional capital-labour substitution, on whose basis the marginal approach was born and accepted. These mechanisms are not mentioned, but they are still implicitly believed to be active and successful. Without some such belief the reliance on intertemporal equilibria would be devoid of any justification, given that by themselves neo-Walrasian equilibria and their sequences tell us *nothing at all* about the actual path a market economy not continuously in equilibrium will follow. Possibly one reason why the continuing faith in the traditional, time-consuming, adjustment mechanisms remains unmentioned is that there is some

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<sup>16</sup> 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 reach the shifting rational-expectations intertemporal equilibrium path, a fact that one can neglect only if one sees the theoretical path as only a centre of gravitation of the actual path..

<sup>17</sup> 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 ‘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 can well be years. So it is in fact a long-period equilibrium, centre of gravitation of time-consuming adjustments. Then one may 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, and in this way one passes, without much loss of credibility, to Ramsey-type descriptive models, whose ‘momentary equilibria’ can again be seen as centres of gravitation of time-consuming adjustments.

perception that their functioning cannot be supported by general equilibrium theory since the latter is incompatible with time-consuming disequilibrium processes; but in fact that faith is the basis of the claim that neo-Walrasian GE models are not totally useless, because it justifies (independently of disaggregated intertemporal equilibrium theory) the belief that one-good models like Solow's indicate the trends of actual market economies, and this makes it possible to argue that disaggregated intertemporal equilibria too indicate that trend, because they too trace a full-employment path, with income distribution determined by marginal products. So the neoclassical analyses based on the capacity of traditional capital-labour substitution to cause the economy to gravitate, through time-consuming adjustments, toward full employment are the real microfoundation of the claimed validity of intertemporal equilibrium theory as a positive theory, not the reverse. Without a faith in those analyses the implausible assumptions needed by neo-Walrasian equilibria would make it impossible to attribute descriptive relevance to these equilibria.

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.

## **V. 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 IV above). This conception of 'real' capital, since it aims

at grasping the capacity of capital technically to co-operate with other factors for the production of a net output, and since this productive contribution can only come from concrete capital goods, necessarily implies that if two techniques employ the same physical vector of capital goods, then the productive contribution of capital, or the amount of 'real' capital, is 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 capital goods can be viewed as representing quantities of 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<sup>[18]</sup>), *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<sup>[19]</sup>.

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

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<sup>18</sup> 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.

<sup>19</sup> Of course *if* one believes that there must be a way to conceive heterogeneous capital goods as representing or embodying amounts of a single factor capital, *then* (neglecting scarce natural resources for simplicity) one must believe that any net output is produced by labour and 'capital', hence if a rise of the real wage (and associated decrease of the interest rate) causes *more* labour per unit of that net output to be used, necessarily the employment of 'real' capital must be less; so another implication of reswitching is that one knows in advance that the principle of substitution will fail for 'real' capital whichever the way one tries more precisely to define it.



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”<sup>[20]</sup>.

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 2011a p. 380). Which does not mean that this is the only line of criticism capable of such an outcome.

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## ***APPENDIX***

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<sup>20</sup> It is our impression that Potestio underplays these important implications of reswitching and reverse capital deepening and prefers to stress the supply-side problem 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 (2011a), 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, i.e. that investment per unit of labour is *not* significantly affected by changes of the rate of interest – which would undermine the neoclassical approach anyway (Petri 2011a, p. 408; cf. footnote 7).

*A). 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); she spends considerable time on this second conception. We cannot think of anyone ever having conceived of capital in this second way, *unless* as a way to express a belief that relative prices can be treated as given: otherwise it would have meant to leave the production permitted by the given amount of capital totally indeterminate, as Potestio notes: “a concept of a pure value entity does not have any economic meaning” (2010, p. 143). The expressions suggesting a view of capital as a ‘pure value entity’ can be better explained by noting that 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 any aggregate of capital goods was taken as essentially given independently of income distribution: 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<sup>[21]</sup>, as shown by Wicksell, Lindahl, Hayek, Hicks and many others. But then the adoption of some representative basket of consumption goods as numéraire was not a way to *surmount* the arbitrariness of a value endowment of capital given in terms of one good rather than of another (an issue on which we return in part B of this Appendix), it was the natural way to interpret that given endowment (whose illegitimacy was not perceived) as cumulated past abstinence from consumption. Thus it does not seem correct to say that “what capital is ... is a sort of metaphysical question” (Potestio 2010, p. 143): Potestio must have meant, what capital *was* for those traditional neoclassical authors who conceived of capital as a single factor of variable ‘form’; but then the answer does not seem metaphysical: ‘capital’ was implicitly conceived as the *set* of possible vectors of capital goods (all of the same exchange value<sup>[22]</sup>) producible with the employment in the past of the

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<sup>21</sup> 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.

<sup>22</sup> Potestio seems not to be sure as to why capital conceived as a single factor was measured, and therefore 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). 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

productive resources that abstinence made available; of that set, one element (roughly appropriate to the given composition of output and to the given income distribution) would be present in the economy, transformable into another element of that set if technical or consumer choice changed. An indefensible answer, but a rather concrete one.

***B) 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 numeraire 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  $r$  rises, increasing values of capital with one numeraire could become decreasing values of capital with another numeraire.” (ibid. p. 387)

The argument, liable to misunderstanding if so expressed, becomes clearer with the example she supplies. The dependence of the demand for value capital on the choice of numéraire is relevant in so far as it may render the *excess* demand for value capital indeterminate: but actually Potestio agrees with Kurz & Salvadori 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

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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', *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 *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), Böhm-Bawerk did not criticize the conception of capital as a value magnitude: “I, too [like J. B. Clark], believe that capital is a “fund” or “quantum” of matter. I think it clear that any one 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)

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, given gross quantities produced  $x_1$  and  $x_2$  (she might also have taken as given the net products); 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 value of capital corresponds to the value of a *given* quantity  $x_1^*$  of good 1; hence  $K^*=p_1x_1^*$ . 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 the value of  $K^d = a_{11}x_1p_1+a_{12}x_2p_1+a_{21}x_1+a_{22}x_2$  where technical coefficient  $a_{ij}$  is the quantity of input  $i$  in the production of good  $j$  and the physical quantities are given; the value of the *supply* of capital changes with  $r$  (because good 1 is not the numéraire) so as to correspond always to the same amount  $x_1^*$  of good 1, that is, in equilibrium  $a_{11}x_1p_1+a_{12}x_2p_1+a_{21}x_1+a_{22}x_2 = p_1x_1^*$ ; assuming  $dp_1/dr > 0$ , a rise of  $r$  causes  $K^*$  to rise more than  $K^d$  because the latter includes an amount of good 2 whose value remains unaltered: there is excess supply of value capital, 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: there is excess demand for value capital, 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 must be technological substitution or substitution in consumer choice to correct 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 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. (The only numéraire in terms of which a given physical endowment of capital goods does not change value with changes in prices is that physical vector itself; but during any transition to a different technique that vector would be altered, and then the dependence of the value of the existing capital goods upon relative prices would reassert itself. It might be objected that the relevance of changes in the value of the initial physical vector of capital goods is unclear, because a change of the rate of interest changes the composition of capital; but the latter change will come about only after and because prices adapt to the new rate of interest, this is what makes it convenient to replace the used-up capital goods with different capital goods; so when the composition of capital starts to change the value of capital has already changed via revaluation of the existing capital goods.)

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). Once choice (A) is made, the change in the shape of the demand-for-capital curve due to a change of choice (B) is irrelevant for the stability or not of equilibrium, because the shape of the supply curve changes too and the stable or unstable nature of the intersection of the two curves does not change; on this there is agreement between Potestio, and Kurz & Salvadori. It is the arbitrariness of choice (A), not of (B), that produces the indeterminateness of stability in Potestio's example. This can be rendered 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<sup>[23]</sup>, concentrating on the indeterminacy of stability depending on the good in

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<sup>23</sup> These observations permit a further consideration on Kurz and Salvadori's stress on the need that the composition of the numéraire consumption basket be rigid. The need for such an assumption disappears if it is accepted that, as argued in part A of this Appendix, the fact that the capital endowment was given in terms of some representative consumption basket indicates a choice of *numéraire* (the one best expressing the conception of capital as created by abstinence) within an underestimation of the dependence of relative prices on distribution, and not the fixation of the value of capital in terms of a good esteemed capable of legitimizing the assumption that the value of capital

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.

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does not change as relative prices change. Therefore we see the preoccupation of Kurz and Salvadori with assuming that price changes do not alter the composition of consumption as superfluous: if the underestimation of price changes were legitimate, then any numéraire, whether of fixed composition or not, would be legitimate; since it isn't, the supply of value capital is indeterminable and the relevance of a variable composition of consumption disappears.

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