

THE CAMBRIDGE CAPITAL CONTROVERSY IN HISTORICAL PERSPECTIVE AND SOME UNSETTLED ANALYTICAL ISSUES

Andrés Lazzarini (Universidad de Alicante)*

1. INTRODUCTION

Capital theory is a central part of any economic approach to value and distribution. Since the dawn of systematic economic analysis, however, the issue of capital has been simmering in the work of some notable economists of the past like David Ricardo, Karl Marx, Thorstein Veblen, Eugen von Böhm-Bawerk, John Bates Clark, Knut Wicksell, Friedrich von Hayek, John R. Hicks (Cohen and Harcourt 2005, pp.xxvii-xxviii; Cohen 2010, p.6). In the specific case of the neoclassical theory¹, the issue of capital sparked off open controversies which have characterised most of its development². The latest of these theoretical conflicts³ is the Cambridge capital controversy (henceforth CCC), which took place between 1953 and the mid-1970s involving outstanding scholars from both of the sides of the ocean⁴, and whose importance in the development of the discipline, which even a neoclassical author like Robert M Solow had early on to recognise (Solow 1963, p.9), could not be concealed –

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¹ We use the terms marginalist or neoclassical interchangeably to refer to the school of thought established in the late 19th century.

² In this respect, Bliss (1975, p. vii) pointed out: "When economists reach agreement on the theory of capital they will shortly reach agreement on everything else."

³ See Kurz (1987) for a brief review of previous controversies.

⁴ The CCC label was coined by Harcourt (1969). Since then it has been acknowledged that the Cambridge, Massachusetts US side must be regarded as the neoclassical side, while the Cambridge, UK the critical side, because the latter in the 1950s, 1960s and even 1970s hosted some critics of orthodoxy, chiefly A. Bhaduri, Krishna Bharadwaj, P. Garegnani, G.C. Harcourt, Nicholas Kaldor, Luigi L. Pasinetti, Joan Robinson, Piero Sraffa. On the other hand, key neoclassical participants, like Paul A. Samuelson and Robert M. Solow (this one still is) were affiliated to the MIT (US). Both Christopher J. Bliss and Frank H. Hahn, who became the most active neoclassical participants during the 1970s, were affiliated to Cambridge, UK (in Bliss's case at least part of the time). *The Economic Journal*, *The Journal of Economic Literature*, *The Quarterly Journal of Economics*, and *The Review of Economic Studies* were the economics journals where the protagonists mainly chose to debate.

the CCC, chiefly the results known as *reswitching* and *capital-reversing*, showed that the basic premises of marginalist theory are generally not robust.

Yet, it is noticeable that although it is broadly acknowledged that the critical side of the controversies won the debate (Birner 2002; Cohen and Harcourt 2003, 2005; Garegnani, 1990)⁵, an authority in the history of economics like Mark Blaug has recently cast doubt about the “precise significance of these negative results” (Blaug 2009, p. 237). While Blaug (*ibid.*) also recognises that the critical side “scored a great victory in the Cambridge controversies”, he adamantly repeats the same reasons he had put forth in Blaug (1975) in order to play down the significance of the controversy, namely that “one of the striking features of the victorious side was their categorical refusal to throw light on the debate by empirical research” (Blaug 2009, p. 238)⁶. On the other hand, it must be also acknowledged that there are some disagreements with respect to the implications of this theoretical conflict even within the circle of the critical scholars that have been making praiseworthy efforts to disseminate the important lessons from the CCC among practitioners and disentangle many of the issues discussed (Petri 2007, 2008; Cohen and Harcourt, 2008)⁷. Both disagreements and doubts seem to reveal a concern of paramount importance underlying the CCC: if the Cambridge, UK side won the debates, how is it that the marginalist theory was not replaced by an alternative? According to Harcourt (1995), the answer must be sought in the fact that some of the most important Cambridge, UK combatants have died (Joan V. Robinson, Piero Sraffa, Nicholas Kaldor), which would have helped to spread the current attitude of neoclassical economists which regards the CCC *as if* it had never existed. Harcourt (1995, p. 45), however, has also insisted in pointing out that although marginalist theory is dominant, there is an “uneasy state of rest, under the foundations of which a time bomb is ticking away”; still the aforementioned question remains open (Cohen and Harcourt 2003, p.207).

⁵ Also see Garegnani (2009).

⁶ Since the aim of Blaug’s (2009) paper goes beyond the controversies we will not go into detail. Moreover the central aim of his paper is to criticise the relevance of the whole “Sraffian economics”, so the reader is referred to Kurz and Salvadori (2010) who have written an in-depth and much researched reply to Blaug from the opposite side of the coin.

⁷ Avi Cohen has tried to bridge the gap within the critical side by saying that Petri’s “long/short period distinction will make for a richer, but not fundamentally different, story” (Cohen 2010, p.11, fn. 12; see Petri 2007, pp. 602-603). In the present paper we introduce this distinction as a fundamental cornerstone in the development of the controversy.

Contrariwise, Christopher J. Bliss, a staunch neoclassical participant in the controversy since 1970, has recently put forth another answer to that question – the marginalist theory was not replaced by an alternative because “in the world at large the impact [of the CCC] is negligible” (Bliss 2009, p. 3; for a similar position *cf.* also Bliss 2005, pp. xii, xxiv). Since a negligible episode can hardly have an effect on the development of the discipline, then the unsettled situation surrounding the controversy would be revealing that marginalist theory is the dominant approach to value, distribution and output, because the critical side will have been wrong and unable to offer an alternative theory. Yet Petri (2007, p. 599) has argued that Bliss’s view “confirms the unwillingness to make the effort to understand (or even only to read) the opponents’ [i.e., the critics’] arguments, which has characterized the neoclassical contributions to the capital debates since the mid-1970s”. Independently of whether Bliss’s answer is too extreme to accept, I shall try to elaborate another interpretation.

The present situation of the CCC should rather call for the attention of scholars to deepen the examination of the issues involved in the debates: Was the critical side a homogenous group of theorists? Which was the notion of capital underlying these debates? To which period is referred the victory of the critical side in the literature? Did the neoclassical participants really accept defeat in the controversy? The aim of the paper is *not* to provide a detailed chronological review of the contributions to the CCC (see Harcourt 1969; 1972; 1976; 2001). Nor am I claiming that other works have not addressed these issues; rather, my aim is to address them by exploring the historical evolution of the CCC from 1953 until 1976 chiefly by dividing it into two different phases so as to provide a historical-analytical perspective that could enable us to better understand the historical elements characterising the present situation. Our perspective is chiefly drawn as a result of distinguishing the two different concepts of capital used by neoclassical participants in the two different phases.

The main feature which distinguishes the first phase (1953-1970) is that the concept of capital at issue is the traditional notion – the single magnitude in value terms susceptible to adopting any physical form *endogenously*; more importantly, the traditional, long-period marginalist theory was founded on such a concept. In the second phase (1971-1976)⁸, on the other hand, the defence of neoclassical theory was

⁸ Our methodology to divide the controversy into two phases can also be found in Miroski (1989, especially pp. 341-343). Although this author does not divide it according to which notion of capital was

conducted in terms of the Walrasian notion – the physically heterogeneous capital goods, which are *exogenous* variables. This concept of capital, originally formulated by Walras (1926 [1954]) but with little influence among the most renowned neoclassical authors at the time of the first editions of his *Elements* (*cf.* Wicksell 1901 [1934], p. 171), is the current notion of capital used by contemporary economics in the intertemporal and temporary general equilibrium models (henceforth IGE and TGE, respectively). We shall argue that this change of the basic terms of the problem of capital in the *transition* from one phase to the other was not sufficiently clear at the time of the CCC both for the neoclassical participants and for some critical authors – a neglect with negative implications, for this change entails much more than a simple manipulation of the formal structure of the theory. In fact, in such a transition some participants on the neoclassical side defiantly replied to the critics that general equilibrium models with capital do not require aggregation⁹, something that bewildered many and helped *not* come to terms with the decisive results shown in the first phase. To support our hypothesis, it will be necessary to show:

I) that reswitching and capital-reversing not only impinge on the versions of the theory built around an aggregate production function (henceforth APF) but on those relying on the concept of capital in value terms used in the foundations of the theory;

II) that the negative results were unanimously accepted by all the participants – though reluctantly by the neoclassical side – only in the first phase;

at issue, he points out that the first phase was characterised by a “disoriented and disorganized” reply from the neoclassical side, while in the second phase it was “subtle and sophisticated” Miroski (1989, p. 343). He locates the second phase *after* the 1966 Symposium, in particular around 1975 with the work of Bliss (1975). As we shall argue, Miroski’s characterisation could well apply to our division in that in the first phase the neoclassical stance was “disorganized” to withstand the negative results (see section 3) while in the second their stance was rather “subtle” in that they tried to dispute the relevance of the controversy by discussing them *within* the neo-Walrasian framework of intertemporal and temporary general equilibrium models. As to our first phase, we have chosen 1953 to refer to Robinson (1953-54), the paper which started the CCC, while the year 1970 refers to both Garegnani (1970a) and Bliss (1970), because the former definitely destroyed Samuelson (1962) (*cf.* fn.37 below), while Bliss’s contribution to the CCC already put at the centre the Walrasian notion of capital, the notion of capital at issue in the second phase. As to the second phase, the year 1971 is due to Robinson (1971), where the Cambridge economist speaks of the “end of the controversy”, while 1976 is partly due to Garegnani (1976), which brings the implications of the CCC to the methodology of economics once the latter had adopted the Walrasian capital, and partly to Harcourt (1976), the updated survey which incorporated the versions relying on the Walrasian capital. Of course there are works overlapping both our phases (*e.g.* both Blaug 1974 and Galloway and Shukla, 1974 belong to the first phase essentially). Our division therefore represents a time approximation which hopefully may shed light on the evolution of the controversy. In section 4, below, we extend further on the reasons for choosing these key contributions as important time references.

⁹ Bliss (1975).

III) that the critical side has not always been unified in their rebuttals of the neoclassical side during the second phase; and

IV) that in the second phase some neoclassical participants, by putting forth purposely bewildering arguments, have misrepresented the scope of the critical arguments raised in the first phase and hence disregarded them.

The remainder of the paper consists of section 2 which prepares the necessary historical and analytical background to grasp the implications of the CCC. Section 3 deals with points referred to as I) and II) above. We present an appendix in order to further discuss point I) in terms of a generalisation of Wicksell's (1901 [1934]) model. In section 4, we analyse the way in which some participants of the neoclassical side faced the CCC in the second phase and the schism within the critical side when rebutting the former (*i.e.* points referred to as III) and IV) above), trying to clear up some misunderstandings created during some exchanges among participants in that phase. Finally, we conclude in section 5. Our main claim is that present observers might not have perceived that in the second phase the combination of points referred to as III) and IV) above gave rise to what I believe is a *halfway intermission* of the critical development of this theoretical conflict rather than a definitive and conclusive standstill; further, not surprisingly, this combinatory phenomenon might have contributed to blur the deep implications for the dominant theory.

2. A NECESSARY BACKGROUND

2.1 THE ROLE OF CAPITAL IN VALUE TERMS

To understand the main implications of the CCC, it is worth considering the foundation on which the marginalist theory rests – the principle of factor substitution, and its theoretical structure. It can be useful to remember that marginal theory takes the following three groups of circumstances as data.

- (i) Consumers' tastes and preferences.
- (ii) Alternative techniques of production.
- (iii) The endowment of the factors of production available in the economy¹⁰.

¹⁰ This includes the property rights' endowments and the distribution of fixed capital.

It is well known that, since the marginalist theory uses these data to determine relative prices, output, and distribution simultaneously, then these variables will depend crucially on the former; therefore, from a methodological standpoint, the data must not change while the endogenous variables are being determined (Schlicht 1985).

In a simple, corn-output corn-capital economy (the other factor being homogenous labour), a problem of measurement of capital does not emerge, because the units in which capital is expressed are the same in both of its roles – *i.e.* the role of describing the alternative methods of production (datum [ii]), and the role of defining the factor endowment ([iii]). Assuming constant returns to scale and free competition, in such an economy the principle of factor substitution ensures the derivation of a downward-sloping marginal productivity curve for both of the factors, via the *direct mechanism* of substitution. If, say, the wage rate (w) falls (rises), cost-minimising firms will tend to adopt those *methods* that use a higher (lower) proportion of labour relative to corn-capital because datum [ii] will enable firms to choose a more (less) ‘labour-intensive’ technique. On these grounds the marginalist theory derives downward-sloping demand functions for the factors, ensuring uniqueness and stability of the equilibrium positions (Garegnani 1990)¹¹.

Outside the one-commodity model it is not straightforward to derive downward-sloping productivity curves. The founders of the marginalist theory did analyse the more realistic economies in which capital is heterogeneous both in the alternative production processes and in the production of different consumption goods. To grasp the role of capital in marginalist theory, it is worth providing the basic characteristics of the capital goods:

- (a) Unlike land or labour, they are reproducible.
- (b) They are utilised for further production.
- (c) They wear out within a sufficiently short-period of time.

As a matter of logic, a contradiction may arise if the measurement of capital in the role of the endowment, which must be independent of prices and distribution, differs from the one in the role of describing the methods of production, which must ensure that an *increase* of the factor in physical units lead to an *increase* of output in such terms (Wicksell 1901 [1934], p. 149). This concern was at the root of the most

¹¹ We are assuming that factors’ supply functions are *well-behaved* so as not to jeopardize the uniqueness and stability of equilibrium. The indirect mechanisms of substitution through datum [i] can easily be introduced by assuming two (or more) consumption goods, produced in fixed factors’ proportions.

influential marginalist authors as well as underlying previous controversies in capital theory¹². Which was, then, the notion used by the fathers of the marginalist theory? In the history of this school, one can well find that authoritative authors such as Stanley Jevons (1879), E. Böhm-Bawerk (1891), K. Wicksell (1934), J.B. Clark (1899 [1925]), Alfred Marshall (1920), J. R. Hicks (1932), among others, all conceived of capital as a single valued magnitude. As Wicksell (1901 [1934], pp. 144-5) has clearly defined:

Capital includes the raw materials (...) and other commodities which must be saved-up. This, of course, is the commonly accepted sense of the term. (...) all these [different capital goods] have only one quality in common, namely that they represent certain quantities of exchangeable value so that they may be regarded as a single sum of value, a certain amount of the medium of exchange, money.

In the formation period of marginalism, the capital endowment has been taken in *value terms*, which is in contradiction with the necessity to express the capital goods in technical units defining the methods of production. But, before going any further, it is important to inquire into the reasons why the fathers of the marginalist theory, with the notable exception of Léon Walras, so conceived of capital. Were the traditional marginalist authors not aware of the peril of circular reasoning involved by a value magnitude? Why did they stick at such a concept for the foundation of the theory?

The reasons have to do with two basic concerns at the root of traditional theory. The first is to determine the supply prices of the capital goods yielding a uniform rate of return (henceforth URRSP), as long as free competition prevails throughout. The rationale is that for wealth holders capital is a homogeneous fluid of value independently of the physical form it might adopt, and for them there is a perfect substitutability of capital goods in such terms. Since, for them, the different capital goods in which to invest will depend on the (expected) most profitable industries, then competition will make the rates of return tend towards uniformity, while the physical composition of the endowment is being endogenously determined in the investment

¹² See, *e.g.*, Kaldor's (1937) *Econometrica* survey on the capital theory controversy between Knight, Hayek, and Kaldor himself.

process¹³. But, since capital goods are reproducible commodities, their production will imply that, in equilibrium, their supply prices must cover their costs (*cf.* feature [a] above). Following Petri (2004, pp. 31-2), we can say that this is the supply aspect of capital, because it allows the theory to endogenously determine its physical composition by the condition of the URRSP, while keeping its quantity in value roughly constant (*Cf. fn. 16*).

The second concern is to determine equilibrium positions on the basis of the factor substitution principle. Since in heterogeneous capital goods economies substitution generally entails changes in the kinds of capital goods, rather than in the proportion of capital to labour¹⁴, the theory can derive, by conceiving of capital as a single magnitude which can change form but not its quantity in value, an *inverse relationship* between capital and the interest rate (and, simultaneously, between labour and the wage rate) conforming to the basic neoclassical premise that the adoption of ‘more capital-intensive’ techniques would lead to more product reflecting a ‘lower productivity’ of this factor, hence a lower interest rate. So one can say there is a demand side of the traditional concept of capital, which justifies a treatment of the demand for capital analogously to the original factors of production (Petri *id.* p. 32). This concept of capital of variable form in turn makes it possible to assume the existence of a sufficient substitutability between capital and labour¹⁵. Hence, income distribution imposes a certain capital-labour ratio whose physical form is variable, to be endogenously determined by equilibrium. As one renowned, neoclassical economist from Cambridge (UK) has clarified it in the beginning of the 1930s: “if ten men are to be set to dig a hole instead of nine, they will be furnished with *ten cheaper* spades instead of *nine more expensive ones*” (Robertson 1931, p. 47, emphasis added).

Thus it is this concept of capital that allows the theory to endogenously determine the physically heterogeneous capital goods and at the same time to treat the endowment

¹³ “[T]he operation of the laws of capital depends upon the assumption of a constant adjustment of concrete capital goods in an endless repetition of the same *process of investment and production*. [T]his is only of practical importance in capital investments of *relatively short duration*” (Wicksell 1901 [1934], p. 186, emphasis added).

¹⁴ As Bliss (1975, p.102) has put it: “Labour intensive production methods will normally call for different capital inputs and not merely less of the same capital inputs relative to labour.”

¹⁵ See Hicks (1932, pp. 20-1).

as an amount of value in a fixed quantity¹⁶. Then, since capital goods wear out in short periods of time (*cf.* feature [c] above) they cannot be taken as data in the role of the endowments¹⁷ for determining a long-period equilibrium, which is the key feature of traditional analysis aimed at determining a URRSP¹⁸. Although a value measurement of capital gives rise to serious problems for the theory (capital in value terms as datum *depends on* distribution, which is what the theory should determine from that datum), still the marginalist approach found a very important justification for such a choice –the substitution mechanisms should ensure an inverse relationship between ‘factor-intensities’ and factor rentals. Such demand functions, moreover, would ensure the stability of the equilibrium. It is not so difficult to envisage that only by means of a downward-sloping demand can any out-of-equilibrium position (a realistic starting point for economic analysis) be settled, in the long-period around the equilibrium position determined by theory¹⁹. It was the *belief* in this principle of substitution of scarce factors on which the plausibility to derive downward-sloping demand functions for them ultimately rests, and therefore to regard both commodities’ and factors’ prices as scarcity indexes.

2.2 NEOCLASSICAL CAPITAL THEORY JUST BEFORE THE CCC

When Joan Robinson kicked off the post-war CCC in 1953, the issues in neoclassical capital theory were far from settled. Although critical drawbacks were implied by a value concept of capital it was not until the 1930s that serious misgivings about its theoretical tenability started being raised. Since then, a group of neoclassical economists, though initially hardly influential, had started casting strong concerns on

¹⁶ In the adjustment equilibration processes the quantity of capital undergoes changes (due to prices changes), but those changes can be assumed to take place slowly enough, in comparison to the speed of adjustment of the physical capital goods, so as to take that quantity as roughly constant.

¹⁷ The identification of factors’ endowments can easily be satisfied for labour and land. Labour actually consists of different kinds but it can plausibly be assumed that, for long periods, the hierarchy of wages of the different kinds does not undergo relevant changes, so one can take the different kinds as different powers of a standard labour. But even if these wages cannot be taken as constant, the kinds of labour can always be dealt with by treating each kind as a factor to which there will correspond separate supply and demand functions. A similar reasoning can be applied to the case of land. But this cannot be extended to the case of capital goods, which are liable to very rapid changes in the short-period; hence a measurement in value terms.

¹⁸ An analysis of the method of long-period positions is developed in Garegnani (1990).

¹⁹ The importance of the gravitation process for the foundation of traditional theory is clearly spelt out in Marshall (1920, p. 291).

the value notion of capital. Hayek (1928), Hicks (1939 [1946]) and Lindahl (1929 [1939]) avoided falling in a value measurement of capital as data by taking the (Walrasian) physically heterogeneous capital goods vector instead, thus becoming the forerunners of IGE and TGE models (see Gherke, 2003). (In the case of Hicks, it must be noticed that it was after Shove's 1933 harsh critique of Hicks' 1932 *Theory of Wages* that Hicks relinquished the value notion of capital²⁰). Yet, despite the rejection of the traditional concept of capital, these authors (and others too²¹) did not raise doubts on the demand side role of capital in value of variable form, and thus no doubts on the substitution mechanisms (Petri 2004, pp. 137, 153-6). This may hint at the problem of why capital in neoclassical theory over the 1940s, 1950s and arguably the 1960s, was still conceived of as a single valued magnitude by the influential centres of economic theorising, in spite of the fact that the forerunners' influence was to increase in the years and decades to come, an influence that was to be exerted mainly on economists with strong mathematical orientation (e.g. some of the bulk of economists working at the Cowles Commission in the 1940s and 1950s).

These historical speculations have found a setback to be fully proved in the history of economic thought, because there are very few surveys on capital theory of the time which could give us an accurate assessment of the weight of the Walrasian capital vis-à-vis the traditional notion²². Yet one of those few surveys, (Dewey, 1965)²³, scarcely quoted in the history of economics but which incorporated the most, if not all the authoritative treatises in (neoclassical) capital theory²⁴, puts at the centre the traditional concept of capital – “[since] the capital stock is constantly changing. So also is the

²⁰ Shove (1933, p. 470, emphasis added) summarises his strong critique of Hicks (1932) in this way: “It must suffice to indicate what seem to be the main sources of obscurity. The central thesis is this: that if wage-rates generally are forced above ‘the competitive level’ (whatever exactly that may be), unemployment will be caused in two ways: (i) by ‘the tendency for capital to shift from the less capitalistic to the more capitalistic trades’ (and methods) (pp. 187-8), *i.e.*, to ‘those which use a relatively large proportion of capital to labour in making a unit of product’ (p. 187), from those which use a relatively small proportion[;] (ii) because ‘the total supply of capital’ will be diminished (p. 193), since capital will be ‘lost’ (p. 193), ‘eaten into’ (p. 193), ‘consumed’ (p. 199), ‘destroyed’ (p. 199), ‘cut into’ (p. 200), ‘dissipated’ (p. 206) or ‘decumulated,’ and ‘savings’ therefore checked (p. 193). Unfortunately ‘capital’ is not defined and we are not told how quantities of it are to be measured, and similarly of ‘saving’. Presumably, these are ‘matters which properly belong to the theory of capital’ (p. 200).”

²¹ e.g. Lange (1944).

²² Harcourt's (1969) survey does not incorporate the Walrasian notion of capital.

²³ Dewey's book was reviewed by Harcourt (1967).

²⁴ Dewey (1965) discusses the main works of: Jevons, Böhm-Bawerk, T. N. Carver, J.B. Clark, A. Marshall, I. Fisher, F. Knight, F. Hayek, J.R. Hicks. He also incorporated P.A. Samuelson, R. Solow, and J. Robinson but the controversy is not surveyed. Interestingly enough, before joining Duke University and later on Columbia in the 1960s, Donald Dewey spent part of his research years after the Second World War at the University of Cambridge, the London School of Economics and Chicago.

composition. ... When fully depreciated, it is scrap metal available for use in the construction of a virtually unlimited range of capital assets” (Dewey 1965, p. 3). Note that this statement can only make sense by envisaging the capital endowment “as a certain *quantity of exchange value*” (Dewey 1965, p. 128, emphasis added) while its composition is being endogenously determined, as the first excerpt shows. But the aim of our paper is not to review the neoclassical capital theory situation in the fifties. Rather, we want just to contextualise it, stressing the fact that although two notions of capital, the traditional and the Walrasian, somehow coexisted unquestionably since the 1930s, the importance of the former still towered over the latter²⁵. The CCC demonstrates our suspicion.

3 THE FIRST PHASE OF THE CCC (1953-1970)

3.1 RESWITCHING AND CAPITAL-REVERSING

As discussed in the previous section, to ensure a univocal relationship between ‘capital intensity’ and changes in distribution the theory relies on the factors’ substitution mechanisms. So at *low* interest rates (r) and from a spectrum of alternative techniques (*e.g.* A and B both using heterogeneous capital goods to produce a homogenous final consumption good), producers will be led to adopt a ‘more capital-intensive’ technique (say A) so that this technique will minimise the production costs of the consumption good. A *rise* in r , according to the neoclassical premises, must lead producers to change (switch) to a ‘less capital-intensive’ technique (B), insofar as this technique minimises costs and thus leads the economy to a *lower* quantity of capital per worker. Any further *rise* in r would lead producers to choose another technique (say, C , but never A) which in advance would have been classified, in some physical unit, as ‘less capital-intensive’²⁶.

²⁵ Also, it is worth drawing attention to Knight’s entry in the *Encyclopaedia Britannica* “Capital and Interest”, which considers capital as a single factor expressed in value, and, not surprisingly, it was reprinted in 1946 by the American Economic Association (*cf.* Knight 1946, p. 389). For a critique of Knight’s theory of capital, see Kaldor (1937).

²⁶ This, in the language of Cohen and Harcourt (2003), refers to the “parable” of the inverse, monotonic relationship between quantity of capital and the rate of interest. This of course involves an inverse, monotonic relationship between the capital/output ratio and the rate of interest.

The CCC has destroyed the belief in factor substitution. The possibility that a same technique, whichever the physical measurement of its relative ‘factor-intensity’ be adopted, could be chosen both for low and high interest rates, while another technique is chosen in between, has been known in the CCC as *reswitching*, which implies *capital-reversing* – a positive relationship between capital demand and r . Why do these phenomena occur? They occur because production techniques involve heterogeneous capital goods and hence the cost-minimising techniques chosen will depend on distribution and prices (Harcourt, 1969; Garegnani, 1990; see also the Appendix). Samuelson (1966, p. 571), in his admission of these results, chose a very straightforward example to illustrate these phenomena²⁷. By using the Austrian concept of capital as *time*, Samuelson assumed there are two techniques (A and B) to produce champagne both of them using different proportions of labour and time (i.e. capital is past labour, hence time). One unit of champagne, which emerges in $t=0$, in technique A is the result of the fermentation of 1 unit of brandy over one period ($t=-1$), which in turn was the result of having applied 7 units of labour in $t=-2$. On the other hand, to produce 1 unit of champagne with technique B , 6 units of labour must be applied to wine over $t=-1$, which was the result of the ripening of grape juice over $t=-2$, in turn the result of having applied 2 units of labour over $t=-3$. Under these conditions, if $1 < r$ technique A is preferred; if $0.5 < r < 1$ B is preferred, and, finally, if $0 < r < 0.5$ A is preferred *again* – technique A *reswitches*²⁸. This result implies that there is no monotonic relationship between changes in distribution and ‘capital’-intensities; moreover the demand for capital may be either negative or positive with respect to r , with probable multiple equilibria or extreme equilibrium distributive values like zero wages or zero interest (Garegnani, 1970). This result no doubt constituted a sharp blow to the neoclassical theory of production *and* distribution.

Reswitching and capital-reversing started being acknowledged in the CCC especially since Sraffa (1960)²⁹ and a series of contributions thereafter. Above all it is worth recalling the 1966 Symposium organised by the Harvard-based *Quarterly Journal of Economics*, which clearly showed that reswitching is of general character. This symposium was the result of a collective response to the attempts carried out by

²⁷ This example is, in fact, the same one we find in Sraffa (1960, p. 37).

²⁸ The cost-minimising equations are: For A , $p=7w(1+r)^2$; and for B , $p=2w(1+r)^3+6w(1+r)$, where p is the price of champagne. The technique which is preferred is the one yielding the highest w for any given r over all its plausible values. Switches occur when the costs are equal in both techniques.

²⁹ See, especially, Sraffa (1960, pp. 38, 81-4).

Samuelson and Levhari (Levhari, 1965)³⁰ to try to show that reswitching can only arise for single industries but not for the whole economy³¹. In fact the issue concerned itself with the principle of substitution, because the idea of an *ordering* of techniques according to factor ‘intensity’ disappears because that ordering depends on distribution. Garegnani (1966, p. 564) briefly summarises the consequences of these striking results:

the ‘return’ of a technique shows that any measure of capital intensity, even if it could be found, would lead to contradicting the principle of an inverse relationship between rate of interest and capital intensity.

The symposium was the key episode in the controversy which unveiled that those results undermine capital not only in its supply side role, but also in its demand side role (*cf.* 2.1 above), and hence showed that the whole approach relies on non robust premises, *i.e.*, the principle of substitution of scarce factors cannot robustly be extended to encompass produced means of production.

The CCC owes much of its appreciation within the profession to Harcourt (1969), the survey which greatly influenced some participants on both sides of the Atlantic, specially the younger generations³², and which was especially inspired by Joan Robinson. Although in her kicking-off 1953-54 paper Robinson’s critiques were vividly addressed, they mainly focused on the critique of the APF, intended actually to criticise the use of the method of long-period positions to analyse processes of changes (more on this below, 4.3). The APF assumes that national output is produced *as if* it were a single good, both a consumption and capital good, produced by means of labour and itself. It is this unrealistic assumption that is scathingly criticised by Robinson, and echoed by Harcourt’s surveys (Harcourt 1969, 1972). Important as it may be the APF is not substantially essential for the foundation of the theory, despite of the fact that later on, chiefly in the mid-1950s through the 1960s, its use has generalised both for didactical

³⁰ Luigi L. Pasinetti was actually the *first* critic to provide a counterexample to Levhari (1965) in a paper submitted to the Rome Congress of the Econometric Society in 1965. Pasinetti (1966) is an improved and shorter version of that paper.

³¹ A decade prior to the Symposium, however, in MIT there was little doubt as to the theoretical tenability of heterogeneous models. Moreover, Samuelson and Solow recognise that the notion of capital in value is central for long-period equilibrium, see Samuelson and Solow (1956, pp. 537-38).

³² I owe this information to personal conversations with Prof. Geoff C. Harcourt. He also kindly allowed me to take a look at his archives containing many papers and letters related to the controversy, which also helped me to improve this paper.

and practical purposes. But actually, the birth of suchlike functions was intended to empirically test the marginalist theory, not to be its foundations (Cobb and Douglas, 1928)³³. On the other hand, the concept of capital in value was intended for an analysis which encompasses heterogeneous goods. For example, this is chiefly the case in Wicksell (1901 [1934]) who deals with heterogeneous capital goods, but needs to take capital in value (see the Appendix).

Notwithstanding their emphasis on the APF, Robinson and Harcourt converged, in this phase, towards the criticism centred on reswitching affecting “all the versions of neoclassical theory”³⁴, highlighting the flaws in its logic. Despite that Robinson did not extend on these phenomena which she had herself encountered earlier than Sraffa (1960) and the Symposium³⁵, she backed up reswitching over the first phase (see Naqvi and Robinson, 1967)³⁶. Indeed, the deep implications of reswitching and capital-reversing prompted renowned neoclassical scholars to dispute the CCC.

3.2 REACTIONS OF THE NEOCLASSICAL SIDE (I)

In the aftermaths of the Symposium a full agreement on the relevance of reswitching was still far from being unanimously reached, though in the appearance it seemed the other way round.

³³ Though Harcourt (1972, p. 7) says that the APF is “by far” the most common version of marginal theory. The reasons of why the first blows in the controversy came to be associated with the APF must be sought in the fact that both Solow (1956, 1957) and Swan (1956) had generalised its use in neoclassical growth models. Interestingly enough, Joan Robinson’s attack on the APF did take place *before* the literature on APF had grown. Cohen points out that it was Kaldor’s (1937) paper which introduced the APF (Cohen 2010, p.10). I was however unable to find it in Kaldor (1937).

³⁴ Harcourt (1972, p. 8). A similar position is in Harcourt (2001, p. 189).

³⁵ In her famous article Robinson (1953-54, p. 106) regarded capital-reversing as “a Ruth Cohen’s *curiosum*”, while in Robinson (1956, p. 109, fn. 1) “a somewhat intricate piece of analysis which is not of great importance”. It is important to recognise that Robinson (1953-54) did not specify the production conditions of the capital goods, which did not help readers to come to grips with the implications of reswitching. In fact one should give Champernowne (1953-54) credit for having specified the productive conditions of capital goods as well as for having noticed reswitching in his examples, though, he excluded it because “intuition suggests that the excluded case [i.e., reswitching] is unrealistic” (Champernowne, 1953-54, p. 119). Maybe future generations will accept that it is only *after* Sraffa (1960) and Samuelson (1962) that the CCC really started (*cf.* fn. 37 below).

³⁶ As suggested by the 1936 Piero Sraffa’s letter to Joan Robinson, it is likely that Robinson got reswitching from Sraffa, though its significance took a while to make itself felt (see Sraffa 1936).

Nobel laureate Paul Samuelson was the most important neoclassical author who opted to dispute critics since almost the beginning (Samuelson, 1962)³⁷. In the wake of the 1966 Symposium, Samuelson in fact admitted that reswitching is a phenomenon of general character because he rejects considering this result as “perverse”. In fact, he points out, “[reswitching] can be called ‘perverse’ only in the sense that the conventional parables did not prepare us for it” (Samuelson 1966, p. 578). Still, Samuelson complemented his recognition of the critical course of the controversy, a few pages later, with a *different* assessment of the issues, characterising reswitching as a “[p]athology [that] illuminates healthy physiology” (Samuelson *id.*, p. 582). Like his staunch allies, he did not take reswitching as a really damaging weapon of his healthy theory; rather, it is just an anomaly which the marginal theory could well tackle:

[due to capital-reversing] after sacrificing present consumption and accumulating capital goods, the *new steady-state equilibrium* can represent a rise in interest rate! (Samuelson 1966, p. 579, emphasis added).

Many commentators at the time of the first phase of the controversy were content with this verdict, however. But it must be recognised that Samuelson narrowed the implications of capital-reversing by considering its consequent theoretical position as a “steady-state equilibrium”; *i.e.*, his admission did not mean really questioning the supply and demand theory – let alone abandoning it – which determines “equilibrium”. His reluctant acceptance of reswitching eclipsed over the message which he conveyed to the practitioners:

³⁷ Samuelson tried to derive from a supposedly “quasi realistic complete system of heterogeneous capital goods” a “surrogate production function”, or namely an “as if” APF (Samuelson 1962, p. 201). According to Robinson, for a long time the discipline “remained cooped up in this position” (Robinson 1970, p. 311), and “for several years, everyone (except Piero Garegnani) was somewhat baffled by the surrogate production function” (Robinson 1975, p. 37). Not surprisingly, Garegnani in a long-gestated paper (Garegnani (1970a) is the product of Garegnani’s oral debates with Samuelson in 1961/1962 when the former visited MIT with a Rockefeller fellowship) neatly replied to Samuelson, showing that the “‘surrogate production function’ is nothing more than the [aggregate] production function, whose existence in such an economy *no critic has ever doubted*” (Garegnani 1970a, p. 416, emphasis added). Surely, under Samuelson’s representation of the productive system reswitching cannot arise.

If all this causes headaches for those nostalgic for the old time parables of neoclassical writing, we must remind ourselves that scholars are not born to live in an easy existence. We must respect, and appraise, the facts of life (Samuelson 1966, p. 583).

where Samuelson made it clear that reswitching is a temporary “headache”, not being seriously dangerous for his “healthy” theory.

Many if not most of the neoclassical side chose to minimise the implications of reswitching. For example, the attitude of many scholars was to discredit the Cambridge, UK, on the grounds of an *empirical irrelevancy* of reswitching. That was the case of Ferguson (1969) and Blaug (1974). As Ferguson (1969, p. xvii) claimed:

[Although the validity of] the Cambridge Criticism is unquestionable, its importance is an empirical matter that depends upon the amount of substitutability there is in the system. Until the econometricians have the answer for us, placing reliance upon neo-classical economic theory is a matter of faith³⁸.

On these terms there could not realistically be a fair communication between both of the sides, because the critical side directed their criticisms at the foundations of the theory, that is, at the substitution principle itself. Downward-sloping demand functions were not as much a result of ascertaining their probabilities of occurrence in real life as a result derived from their *vision* of how economies with produced means of production work – from the data taken as given, the theory can determine the dependent variables via supply and demand functions relying on the principle of substitution. To point to the empirical irrelevancy was misleading.

By around 1970/1971 the neoclassical side had shown reluctance to *frankly* accept reswitching, which would have led to a full reconsideration of dominant theory. From a history of economics standpoint it would have been natural that the successive discussions had encompassed the debates over such implications. Did the way chosen by some participants in the CCC over such big issues help pave the way for a fully clear

³⁸ Carter (forthcoming) nicely explores the exchange between C.E. Ferguson and J. Robinson in the controversy, trying to throw further light on why neoclassical theorists, in the wake of the Cambridge debates, took refuge in the empirical verifiability of neoclassical theory.

consideration of the main results? To answer this question we must now turn to the second phase of this theoretical conflict.

4. THE SECOND PHASE OF THE CCC (1971-1976)

4.1 WALRASIAN CAPITAL AS A WAY-OUT OF THE PROBLEM OF CAPITAL

In this phase the neoclassical side, by and large, started to argue against critics by relying on the Walrasian notion of capital³⁹ in the hope of sidestepping reswitching.

A representative defence of the marginalist tenets in such terms is found in the eager engagement of Christopher Bliss (1970) in the CCC, which constitutes the *hinge* joining the implications of reswitching, which rose to prominence in the first phase, and the change in the terms of the problem emerging in the second phase. In his reply to Garegnani (1970a), Bliss (1970) disputes the former results on drastically different grounds, taking Garegnani's argument as if they would have referred to short-period or neo-Walrasian equilibrium⁴⁰. Bliss argues that one of the most striking Garegnani's conclusions (*i.e.*, the non-existence of a plausible equilibrium in the savings-investment market due to capital-reversing) is in contradiction with Debreu's results, which include the same conditions used by Garegnani to show the existence of equilibrium⁴¹. Since in Debreu's economy capital is conceived as physically heterogeneous capital goods, Bliss (1970, p. 438) argues that "[w]ith more than one capital good current demand for investment goods will depend not only upon present prices but also upon future expected prices". Evidently Bliss is taking Garegnani's argument as if the latter were a short-period problem of expectations⁴². This charge is finally completed by Bliss (*id.* p. 438) – "the major fault in [Garegnani's] argument is the illicit importation of long-period equilibrium theory into the analysis of a short-run situation".

But, was actually this one the background of the controversies? The notion of capital at issue in the CCC was the concept in value – the notion that allows the theory

³⁹ See Walras (1926 [1954], pp. 278-312, Lessons 23-28).

⁴⁰ Bliss (1970) refers to a "momentary equilibrium". We call *neo-Walrasian* equilibrium the modern notion of equilibrium sustained by IGE or TGE because, like Walras (1926 [1954]), they take as data the heterogeneous capital goods.

⁴¹ Debreu (1959). The conditions are demand functions' continuity and technology convexity.

⁴² Bliss (1970, p.438) says: "Garegnani's error" arises from overlooking "expected changes [of prices] over time."

to determine a long-period equilibrium bearing a persistent nature and liable to theoretically guide the actual variables. This was the background accepted by *all the participants* in the first phase. Garegnani (1970b, p. 439) replied to Bliss, arguing that the discussion of short-period equilibrium was *not* part of his argument and since

there is a long-run analysis undermined by the inconsistencies of the notion of capital it must use[,] the temptation might be strong to use the short-period approach[, leaving] room for the doubts about the fruitfulness of the whole approach.

Unfortunately Garegnani's arguments were not replied to by Bliss, or by any other marginalist participant, *at that moment*. Surely the neoclassical camp, as represented by Bliss, started believing that the critical results could be sidestepped via the Walrasian capital.

4.2 REACTIONS OF THE NEOCLASSICAL SIDE (II).

Bliss's stance in the controversy has not been isolated. Some neoclassical participants also included Frank H. Hahn (1972, 1974, 1975, 1982), Carl C. von Weizsäcker (1971), Joseph Stiglitz (1974), who all suggested that contemporary theory relying on a Walrasian notion of capital is not in jeopardy from the theoretical problems. Hahn (1975, p. 364), for instance, harshly protested against critics by raising the question that "Why do people balk only at aggregation of machines and not of people?"⁴³ The underlying meaning of his claim is that Hahn takes the problem of capital as essentially not being a different problem from the technical aggregation of different kinds of labour. But the issue of aggregation of heterogeneous items of capital goods cannot be seen as a problem of aggregation of original factors, because capital goods are liable to rapid changes in short period – hence the endowments are not taken as data in the traditional neoclassical theory (*cf.* fn. 17). Yet Hahn seems to have misunderstood the meaning of the traditional concept of capital in neoclassical theory,

⁴³ Hahn's stance goes hand in hand with the message of Bliss (1975, p. 147) who writes accusingly that "the widespread belief that there is a notable, particular and distinct problem posed by capital aggregation is at best an ill-formulated idea, and at worst is based simply on ignorance [because the] conditions for general capital aggregation are identical to the conditions for the aggregation of labour."

which allows it to endogenously determine its physical composition while taking it in value as data (*cf.* the Wicksell's model in the appendix, especially equations [11-12]). Otherwise, why, some years later, would Hahn have pointed out the following?

In general, there does not exist a function from the vector of endowments to the scalars such that knowledge of the scalar is sufficient to determine a neoclassical equilibrium. If you put it the other way round, it is even more obvious. [T]he neoclassical equilibrium can be found given the vector of endowment which may have, say, 10^8 components. It would be surprising if there were a single number which gives the same information as the 10^8 dimensional vector (Hahn 1982, p. 369).

Both Bliss and Hahn have regarded the problem of capital as a technical matter of aggregation, a problem encompassing no more than a convenient *simplifying* device. Indeed, far from regarding the problem of capital as essential to the theory, these participants have referred to it in the way in which Robinson and other critics have chosen – attacking the APF; still, as already discussed, the APF has not been the instrument upon which the theory was built. Moreover, the traditional long-period theory, which needs to take capital in value, was regarded by the neoclassical side as a *stationary state* theory; these participants took the URRSP condition as if it were the result of stationary prices (more on this below). This was, in a nutshell, the neoclassical stance in the wake of the controversy's results.

That which is at least apparent is that in this phase the discussion of the implications of the controversy veered off the natural track it should have followed; indeed the neoclassical participants might have *accommodated* the critical results of the CCC in their favour. Craftily, the neoclassical side attempted to remove the background on which the theoretical row had developed thus far, and hence the discussion of the implications of the problem of capital as unveiled by the controversy was at least clouded. How did the critical side rebut the neoclassical position?

4.3 CRITICAL REBUTTALS AND A SCHISM WITHIN THE CRITICAL SIDE

Since the CCC started disseminating in the 1970s onwards, the critical positions have been essentially two. One group is associated with the name of Garegnani and the other with the names of Robinson and Harcourt.

As above discussed, the position of some representative neoclassical participants stressing the reliance on the Walrasian capital ignored a well-known and documented problem at the time of the CCC – a URRSP cannot be determined in a Walrasian framework. This problem was shown and emphasised by Garegnani⁴⁴. For the scope of the present article, suffice it to briefly see that in terms of the model appended to this paper, both equations [11] and [12] cannot be satisfied if the physical capital goods are taken as data. That is why some of these goods' demand prices will fall *below* their supply prices (costs of production)⁴⁵. Hence no URRSP can be obtained. If analysis is kept within the traditional, long-period method, these capital goods would *not* be produced thereafter, as Walras himself was compelled to recognise in the fourth and definitive edition of his *Elements* (Walras, 1926 [1954] p. 308). The consequences, however, are far reaching⁴⁶.

Capital goods' prices falling below their costs will in principle entail a change in the *composition* of the capital stock, hence changes in prices and quantities. In the process of groping towards equilibrium, the changes in the quantities of capital goods will be generally in contradiction with the assumed endowments of the capital stock which the theory takes as given⁴⁷. Thus the equilibrium reached will not bear the necessary persistence that it is however required to, so that the theoretical equilibrium positions may be regarded as gravitational centres. We obtain a short-period equilibrium. Ironically enough, this is what Garegnani (1970b, p. 439) conjectured in

⁴⁴ Garegnani (1960; 1976; 1990); *cf.* also Eatwell and Milgate (1999). Interestingly, this problem was also spread out in the controversy by Joan Robinson: "When the neo-neoclassicals reconstituted orthodoxy after the Keynesian revolution they went to Walras, who does not have a theory of profits at all" Robinson (1970, p. 315). Joan Robinson was a member of the examining committee of Garegnani's PhD Cambridge dissertation in 1958.

⁴⁵ In terms of the model appended to the present paper, for some capital goods the LHS of [8] will fall below the RHS (see appendix).

⁴⁶ For the reconstruction of the whole argument, see the recently published paper on Walras's theory of capital originally written by Garegnani in 1962 while visiting MIT (Garegnani, 2008).

⁴⁷ For example, the long-period theory, which endogenously determines the physical composition of capital, encompasses those capital goods which will not be reproduced (*e.g.* outdated computers). How could this issue be allowed to occur with a Walrasian notion of capital?

his reply to Bliss – the temptation of orthodox theory was, in fact, “to use the short-period approach.”

Garegnani (1976) extended the implications of the CCC to the methodological arena by viewing the *change* to modern neoclassical theory (i.e. IGE and TGE) as a historical process of the formation and dissemination of this school with particular emphasis on capital, and hence with reswitching. According to Garegnani (1976, 2009), the problem of capital has been boiling since almost the birth of the marginalist school. Since the CCC has made it clear that a value notion of capital is indefensible to derive plausible supply-and-demand equilibrium, the marginal approach was compelled to *give up* its traditional formulation grounded on a value notion of capital. Such abandonment was accomplished by the reformulation of the theory carried out by Hicks (1939 [1946]). Probably cornered by the 1933 Shove scathing critique of Hicks (1932) (see fn. 20), Hicks thus removed the most apparent dependence of equilibrium on valued capital, but, by adopting the Walrasian capital, had to give up *also* the method of long-period positions, based on the persistence of equilibrium which allows conducting economic analysis when changes in the permanent conditions take place. Then, once reswitching had been admitted by *all the participants* in the first phase, the dominant theory adopted the short-period general equilibrium reformulation which provided a last-ditch refuge from the results of the CCC. That is why Garegnani speaks of a *Hicksian divide* (Garegnani, 2009).

The new equilibrium is short-period; it turns out to be path-dependent: changes in prices and physical goods will change the very data from which the former must be derived. That is why the modern versions of the theory have to abandon the traditional concern of determining a URRSP. Dropping the equilibrium condition of a URRSP implies radically changing the object and the method of economic science (*e.g.* lack of persistency). But the participants replying to Garegnani such as Hahn and Bliss rather confused the terms of the issues. They saw the satisfaction of the URRSP condition as a result of *stationary* prices in an IGE. However, in an IGE prices will not be constant due to the endogenous change in capital goods, hence the own-commodity rates of return will differ from one another, hence the confusion of the terms (Garegnani 1990)⁴⁸. In the long-period versions prices are taken as *roughly constant* when adjustments take

⁴⁸ Hahn pointed out (1975, p. 361): “The crudest empirical observations will convince one that there is no unique rate of profit to be observed in the economy. Do we conclude from *that* that competition is functioning badly? Answer: No. Consult any general equilibrium text.”

place, *i.e.* in the adjustment processes leading to a URSSP, so that the stationary assumption was legitimated on the grounds of the persistence of the equilibrium. Thus, in the wake of reswitching the theory sacrificed its method in order to salvage supply-and-demand theory.

How did the other group of critics react to the neoclassical stance?

At that time of the CCC Robinson and Harcourt, the most frequently quoted critics, disputed the neoclassical counteractions on quite different grounds. In his second most important survey Harcourt (1976, p. 58) thus concluded:

while general equilibrium *may* emerge logically intact as ‘the theory of inter-temporarily efficient paths and their price duals’ [Hahn, 1972, 3] it is *not* the theory which is relevant for the issues raised in the Cambridge controversies. The attempts to use the other versions of neoclassical theory flounder both on the results of the reswitching and capital-reversing debates, with which is allied the problem of measurement of ‘capital’, and the (more fundamental) criticisms that stem from the distinction between comparisons and changes⁴⁹.

Although Harcourt (1976, p. 29) somewhat echoed the problem of Walrasian capital as well – “If there are fixed specific inputs, the analysis is short-run and no uniform rate of profits emerges” – he shows reluctance to criticise the lacking of persistence of short-period positions, and instead puts forth a rather weak critique that IGE “is not an explanatory hypothesis, principally because it cannot handle historical time” (Harcourt 1976, p. 33). But this is due mainly to Robinson’s renouncing of any other long-period approach, alternative to marginal theory, in spite of her looking “somewhere else to determine the laws which determine the distribution [of income] among the classes of the community” (Robinson 1971, p. 602)⁵⁰.

Underlying the difference vis-à-vis Garegnani is the fact that Harcourt has given more importance to the “criticisms that stem from the distinction between comparisons and changes”. This methodological concern was actually the most important of

⁴⁹ Later on, however, Harcourt (2001) recognised that the marginal theory is affected in all its versions by the controversy’s results. In effect he says that one of the results was the “retreat by modern defenders of [neoclassical] theory, a retreat marked by the change in the definition of equilibrium” Harcourt (2001, p.193).

⁵⁰ As Harcourt has argued, Joan Robinson was surely thinking of Kalecki’s macroeconomic theory of distribution, see Harcourt (2006, especially pp. 6-28).

Robinson's criticisms since her 1953-54 paper. Although in the first phase of the CCC Robinson and Harcourt backed up reswitching, later on she would reject all the literature grown around it. For Robinson reswitching affects measurement, but as Harcourt (1976, p. 29, emphasis in original) points out "the problem is not the *measurement* of capital but its meaning, its institutional framework, 'rules of the game', and social relationships."

I really suspect that the other group of critics (*e.g.*, Garegnani and Eatwell) would have agreed with Robinson on the *last sentence just quoted*, if and only if:

i) Robinson had not seen the issue of measurement as a problem exclusively concerning the APF⁵¹; and had not *played down* the importance of reswitching:

Samuelson took a false step when he tried to identify the quantity of capital-stuff of the parable with the value of capital on a pseudo-production function. To postulate a well-behaved pseudo-production function did not really make the argument any better, nor did the discovery of 'reswitching' make it any worse. (...) The 'reswitching' argument that made Samuelson lose his faith in his parable was just *as irrelevant as the parable itself* (Robinson 1971, pp. 599-600, emphasis added).

ii) Robinson had not denied an alternative long-period theory to the marginalist approach. In fact, her critique concerned itself with the methodological procedure of using long-period equilibrium comparisons in order to throw light on actual processes as they evolve through *historical time*. She, however, did not distinguish between the different long-period theories, and hence also criticised the classical theory, as revived by Sraffa (1960):

The specification of Sraffa self-reproducing or self-expanding system exists in logical time, not in history. (...) If we construct the equations for a single self-reproducing system and then confront it with an unforeseen change we cannot say anything at all before we have introduced a whole fresh system specifying how the economy behaves in short-period disequilibrium (Robinson 1974, p. 50).

⁵¹ As echoed by Harcourt: "[The] aggregate versions link most satisfactorily on to the preoccupation of the great classical political economists with the distribution of income as capital goods accumulate over time. Robinson clearly had it in mind when she wrote her famous article" (Harcourt 1976, p. 27).

iii) Robinson, as well as Harcourt, had properly spelt out what they meant by *general equilibrium*. General equilibrium not only is the modern IGE, as Harcourt thinks in 1976, but also the long-period theory, like Wicksell's system, which takes capital in value as datum, and simultaneously determines prices, output and distribution (*cf.* Appendix). Harcourt's view that the IGE "may emerge logically intact" is a verbal expression at that time of a not fully grasped change in the structure of the theory when the latter adopted the Walrasian capital, with short-period equilibrium prices (though see fn. 49).

It is interesting to notice that while one subgroup of critics rebutted the neoclassical stance in the second phase on the grounds that the shift to neo-Walrasian theory represented a *refuge* from the logical inconsistencies discovered in the controversy, the other subgroup chose to rebut the neoclassical side by pointing out that these are not the versions relevant for the issues raised in the controversies. Thus, the critical side was not able to offer a unified stance to withstand the visible misdirection of the neoclassical counter-arguments in the second phase. It is our contention that this schism in the critical side helped pave the way for the accommodation of the critical course by the neoclassical participants in the second phase, although injecting misunderstandings into the communication.

5. *WHITHER THE CAPITAL CONTROVERSY?*

We have revisited the CCC with especial attention focussed on its evolution during the later phase, where two heterogeneous positions within the critical side were traced back. As discussed above, although both subgroups agreed that reswitching undermines the marginal theory, one fought for a revival of classical political economy relying on the long-period method, while the other one emphasised the "meaning" of capital and advocated an analysis in historical time denying *any* long-period approach. Arguably these differing opinions on the critical side helped the neoclassical side to retake the initiative in the second phase. With this historical perspective one could, possibly, better appreciate Bliss's (2005, pp. xxiv-xxv) judgement on the relevance of the controversy today:

[M]ainstream theorizing has taken different directions. Interest has shifted from general equilibrium style (high-dimension) models to simple, mainly one-good models. (...) Could the old concerns about capital be taken out, dusted down and addressed to contemporary models? If that could be done, one would hope that its contribution could be more constructive than the mutually assured destruction approach that marred some of the 1960s debates.

The return to one-commodity, APF models which imply a value notion of capital is not questioned by Bliss even though, as we have seen, the controversy showed that such models are not robust. More importantly, Bliss himself dismissed all the theoretical conflict by defending “high brow” neo-Walrasian theory which, as argued by some participants in the controversy, is of little avail to study real economies if at all. However, what this and other neoclassical authors do not admit is that the implications of reswitching would have naturally led to a full reconsideration of the marginal approach (as *all* the critics have emphasised in the first phase) and hence to replace it with another alternative theory. Indeed the upshots of the controversy were marred due to the unfortunate combination of circumstances characterised by the unclear and blurred ways chosen to argue by the neoclassical side in the second phase and the later schism within critics. Therefore it is all these circumstances that provide support for the idea that the Cambridge controversy actually underwent an *intermission* in its development. Hopefully, this perspective of the conflict would be helpful for future debates.

APPENDIX: WICKSELL (1901 [1934]) LONG-PERIOD GENERAL EQUILIBRIUM MODEL

The aim of this appendix is to show the properties of Wicksell (1901 [1934]) system in order to make it clear that the theory does not rely on an APF but on individual production functions, but, still, has to introduce a value magnitude of capital.

Assumptions of the model⁵²:

⁵² The present model is a generalisation of the one presented by Petri (1978).

- Production of a consumption good (c) in yearly cycles.
- Linearly homogenous production functions (f, g_i).
- Consumption good is the *numéraire*.
- Supplies of labour (L) and land (B) are independent of prices.
- Production is of the point-input, point-output type.
- The n capital goods (K_i) only require land and labour to be produced.
- Capital goods last one period. *i.e.* circulating capital.

General equilibrium economic relationships:

$$c = f(L_c, B_c, K_1, \dots, K_n) \quad [1] \text{ Production function of } c.$$

$$\frac{\partial f}{\partial L_c} = w \quad [2] \text{ Marginal product of } L_c.$$

$$\frac{\partial f}{\partial B_c} = r \quad [3] \text{ Marginal product of } B_c.$$

$$\frac{\partial f}{\partial K_1} = v_{K1}$$

.....

$$\frac{\partial f}{\partial K_n} = v_{Kn} \quad [4] \text{ Marginal products (rentals) of each } K_i.$$

$$K_i = g_i(L_{ki}, B_{ki}) \quad i=1, 2, \dots, n \quad [5] \text{ Production functions of each } K_i.$$

$$\frac{\partial g_i}{\partial L_{ki}} = \frac{w}{P_{ki}} \quad [6] \text{ Marginal product of } L_{ki}.$$

$$\frac{\partial g_i}{\partial B_{ki}} = \frac{r}{P_{ki}} \quad [7] \text{ Marginal product of } B_{ki}.$$

$$P_{ki} K_i = wL_{ki} + rB_{ki} \quad [8] \text{ Capital goods' costs (supply prices).}$$

$$L = L_c + \sum_1^n L_{ki} \quad [9] \text{ Equilibrium of Supply and demand of } L.$$

$$B = B_c + \sum_1^n B_{ki} \quad [10] \text{ Equilibrium of Supply and demand of } B.$$

$$\frac{v_{kj} - P_{kj}}{P_{kj}} = \frac{v_{km} - P_{km}}{P_{km}} \quad \forall j \neq m \quad [11] \text{ Uniformity rate of return over capital goods'}$$

supply prices (URRSP).

$$\pi = \frac{v_{km} - P_{km}}{P_{km}} \quad [12] \text{ Uniformity rate of return over capital goods'}$$

supply prices (hence the interest rate π).

The total unknowns are $5n+6$, that is: $c, L_c, B_c, w, r, \pi, (n)K_i, (n)L_{ki}, (n)B_{ki}, (n)v_{ki}, (n)P_{ki}$. However the number of independent equations is $5n+5$, that is [1], [2], [3], [9], [10], [12], $(n)[4], (n)[5], (n)[6], (n)[7], (n-1)[11]$. (Note that the n equations in [8] are not independent)⁵³.

Wicksell, in order to logically close his system had to introduce, though reluctantly, capital expressed in value terms (cf. Wicksell 1901 [1934], pp. 204-5).

Hence we have one more additional equation into the system:

$$\bar{K} = P_{k1} K_1 + P_{k2} K_2 + \dots + P_{kn} K_n \quad [13]$$

And with [13] the balance of number of equations and unknowns is re-established. Yet the LHS of [13] is an expression in value terms (supply side role of capital) which depend on prices and distribution. Moreover, if the change in \bar{K} is due only to changes in prices and distribution, we have a “Price Wicksell Effect”, whereas if it is due to change in the production techniques – changing the composition of the capital stock and therefore also prices and distribution – then we have a “Real Wicksell Effect”. So, whatever its cause, a rise in the rate of interest may lead to either a fall or a rise in \bar{K} , *i.e.* the RHS of [13] can fall (as expected by theory) or rise (as shown in the CCC). Thus the demand side role of capital is undermined.

⁵³ Since [6] is linearly homogeneous by assumption, then $K_i = \frac{\partial g_i}{\partial L_{ki}} L_{ki} + \frac{\partial g_i}{\partial B_{ki}} B_{ki}$. If both sides of this equation are multiplied by P_{ki} , then one can substitute w for $P_{ki} \frac{\partial g_i}{\partial L_{ki}}$ and r for $P_{ki} \frac{\partial g_i}{\partial B_{ki}}$ from [6] and [7], and equation [8] is thus obtained.

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