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Yet another look at Léon Walras's theory of *tâtonnement*

Pascal Bridel and Elisabeth Huck

My sole aim is to show that the 'present-mindedness' of our contemporaries tends to blind them to the original purport of past texts.

(Jaffé 1981: 244)

Since William Jaffé's ultimate article in 1981, and thanks to the impetus given by this patron saint of all Walras scholars, Walrasian studies have undergone a remarkable development. At the centre of this revival stand of course the scholarly 14-volume *Œuvres économiques complètes*¹ (the Lyon edition) and Donald Walker's important contribution epitomized by his 1996 *Walras's Market Models*. Building on this solid basis, a new generation of Walras students has recently emerged on the Continent. Mainly based in French, Dutch and Swiss universities,² some of these researchers have tackled head-on some difficult and little-known theoretical, methodological and epistemological issues underlying not only Walras's pure economics but also his general approach to economics as a whole. There is now a substantial body of evidence indicating that Walras's general equilibrium model should not be viewed in isolation but as part of his much more ambitious project including his applied and social economics. As summarized by Dockès, 'in order to understand the *Elements*, or at least how Walras conceived them, an intelligence of the rest of his work is necessary' (1996: 8–9). One might also add that the *Elements* are also crucial in the understanding of Walras's *Études d'économie sociale* and *Études d'économie politique appliquée*.

Hence, some of the modern debates around Walras's general equilibrium model or the relationships between pure, applied and social economics are put in new and interesting perspectives. Moreover, these discussions are not restricted to historians of thought; they also provide a

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useful analytical background to the serious problems raised by various contemporary practitioners of general equilibrium models. In particular, is modern general competitive equilibrium (of the post-Arrow–Debreu type) a good approximation of the functioning of decentralized competitive economies? Or is it only a fixed point, a benchmark or even a mere base camp from which economists are setting up their theoretical expeditions? Is this theory a genuine reference point, the value of which would be more normative than positive? Finally, over this entire debate looms large the central question of the validity of a theory of exchange totally unable to explain the process through which an abstract and decentralized market economy reaches the equilibrium positions it has successfully managed to define. Paraphrasing Edgeworth, what should one eventually think today of the theory of exchange set up by Walras ‘where, though the mode of motion towards equilibrium is indeterminate, the position of equilibrium is mathematically determined’? (1881: 4).

Hence, the theory of *tâtonnement* is undoubtedly at the centre of one of the most debated and controversial topic in Walras’s as well as in modern general equilibrium theory. Already fiercely criticized by Bertrand and Edgeworth in the 1880s, this key component of Walras’s model lived a highly controversial life in the hands of many prestigious theorists down to Sonnenschein (1972), Mantel (1974) and Debreu’s (1974) seminal (but negative) results. Similarly, in the usually more sedate world of historians of thought, the status of the successive versions of Walras’s own *tâtonnement* mechanism has been the subject of sometimes heated but mostly inconclusive discussions.³ Faced with the recent decline of interest in General Equilibrium among modern theorists as well as the intense discussion around Walras’s original contribution, time seems ripe for yet another look at Walras’s theory of *tâtonnement*. After all, no economist should be indifferent to the exact scientific status of the original matrix of the adjustment mechanism through which markets are supposed to converge (or not) towards a set of equilibrium prices. By recalling the exact intentions behind Walras’s original formulation, and despite the fascination it still exerts on modern theorists, one might also understand better its ultimate failure under the guise of modern stability analysis.

The theory of *tâtonnement* also appears to be a well chosen theme to test the exact ambitions of Walras’s *Éléments*, and in particular, its alleged ‘realism’. According to a first interpretation,⁴ ‘the ultimate aim of the book was to construct a model, by the use of which we can examine how the capitalist system works’ (Morishima 1977: 4). Walras is thus supposed to have constructed a *descriptive* model of the functioning of a decentralized competitive and capitalistic economy.⁵ According to another interpretation,⁶ Walras was essentially attempting to build the model of an *ideal*

economy – in his own words, the theory of the determination of prices ‘under a hypothetical régime of perfectly free competition’ (1954: 40).⁷ As an idealized competitive mechanism, the theory of *tâtonnement* would largely be constrained by the necessity to prove the convergence of this mechanism towards a unique general equilibrium position. Such an objective is also closely linked with the absolute necessity faced by Walras to include in his theory of exchange a ‘mode of motion’ towards equilibrium, but also the unequivocal requirement faced by this theory of *tâtonnement* to prohibit any *hysteresis* effect.⁸ In particular, distributional (or income) effects endogenous to the *tâtonnement* mechanism are excluded.

In order to strengthen this second interpretation, the central aim of this article is to show that: i) from the very first 1874 edition of the *Eléments*, Walras could not ignore the impact of endogenous distribution effects on the *tâtonnement*; ii) that, in opposition to Edgeworth’s theory of exchange (based on an *utilitarian pleasure machine*), the convergence of *tâtonnement* towards equilibrium prices is an integral part of Walras’s *market machine*; and iii) that the successive alterations and refinements brought by Walras to his *tâtonnement* mechanism throughout the various editions of his *magnum opus* are determined by the necessity to eradicate any source of path dependency. The internal coherence of Walras’s model is eventually shown to win clearly over any pretence of ‘realism’⁹ linked to its external coherence.

Even if this aspect is not dealt with in detail, the part played by *tâtonnement* in Walras’s theory of exchange and the necessary absence of distributional effects in his theories of exchange and production are central characteristics of the ‘justice in exchange’ which, in Walras’s ‘Theory of Property’, is nothing but one of the leading arguments behind his solution to the *question sociale*. Hence, ‘distributional neutrality’ appears to be one of the characteristic and crucial elements linking Walrasian pure and social economics.¹⁰

The article is in four parts. Starting with a detailed discussion of the *theorem of equivalent redistributions*, Part 1 examines the central role played by the distributional neutrality of *tâtonnement* in Walras’s pure theory of exchange. Part 2 extends this discussion to Walras’s attempts at reaching a similar result when dealing with the successive versions of his theory of production before 1900. Part 3 contrasts Walras’s and Edgeworth’s respective technologies of exchange in order to demonstrate that a distributionally neutral *tâtonnement* is an intrinsic part of Walras’s theory of exchange. Finally, and besides briefly summarizing the results, the conclusion develops somewhat the crucial connection between the necessity of a converging and distributionally neutral *tâtonnement* in pure economics with Walras’s theories of property and justice.

1. The distributional neutrality of *tâtonnement* in the pure theory of exchange

In the first 1874 version of his pure theory of exchange, Walras was already well aware of *hysteresis* phenomenon.

On the one hand, the so-called *theorem of equivalent redistributions* (1874, § 141; 1954: 182–91) shows that Walras could not ignore that endogenous changes in the distribution of wealth are an obstacle to the convergence of the *tâtonnement* mechanism towards the general equilibrium position.

On the other, and as soon as 1883,¹¹ Bertrand draws Walras’s attention to the fact that, within the *tâtonnement* in pure exchange, disequilibrium transactions are bound to cause shifts of the demand curves. In the second edition, Walras reacts to this critique by explicitly introducing the no-trade-out-of-equilibrium hypothesis (the so-called no-actual-trading or suspension of exchange rule) (1885, *OEC*, IX: 312, n.1; 1889, §42; 1954: 84–6).

1. *The theorem of equivalent redistributions (1874): the distribution of wealth as a parameter of general equilibrium*

A comparative static theorem The *theorem of equivalent redistributions* was initially formulated in 1874 and remained unchanged throughout the *Elements*’s five editions:

Given several commodities in a market in a state of general equilibrium, [their] current prices [...] will remain unchanged no matter in what way the ownership of the respective quantities of these commodities are redistributed among the parties to the exchange, provided, however, that the value of the sum of the quantities possessed by each of these parties remains the same.
(1954: 185)

Using vector notations, the two situations compared by Walras can be defined in the following manner. The first corresponds to a system *S* of initial endowments between agents; in the case of *N* agents ($i = 1, 2, \dots, N$) and *m* commodities ($j = a, b, \dots, m$), agent (*i*) is endowed with a basket of commodities $q_i = (q_{a,i}, q_{b,i}, \dots, q_{m,i})$. The general equilibrium is thus defined as *P*, the vector of prices in *numéraire* (p_i). The second corresponds to a situation in which initial endowments have been redistributed between agents in a series *S'* of baskets (q'_i) under the two conditions of ‘constancy of the total existing quantities’ and ‘equivalence¹² of quantities possessed’ (1954: 185). These two conditions can thus be expressed with the following two-equation system:

Hence, the *theorem of equivalent redistributions* states that, with the series S' , the equilibrium set of prices reached is the same than that reached with the initial series S . In other words, a redistribution of the agents' initial endowments allowing each agent to remain on his budget line (at prices P) is a solution in which the original equilibrium is reached again. Consequently, and all in all, this theorem does not seem to be simply a 'truism' (Walker 1996: 336–7).

A first illustration of the distributional neutrality In his classic 1967 article, Jaffé refers to this theorem lamenting that Walras had not used it to clarify his theory of *tâtonnement*. As a matter of fact, Jaffé argues, Walras could have deduced from this theorem that, during the *tâtonnement*, a change in the value of the various baskets of commodities owned by agents would affect the vector equilibrium prices (1967: 223–4). Hence, at the end of the *tâtonnement*, agents would be faced with a multiplicity of equilibria and not a unique solution identical with the 'mathematical solution'. In his 1981 article, Jaffé changed his mind and made an about turn on his 1967 argument. Since Walras compares two different initial endowments leading to the same set of equilibrium prices, the case of a change in equilibrium prices cannot be envisaged on the basis of the theorem of equivalent redistributions (1981: 246–7).

For his part, Walker (1996: 336–7) also casts doubts on Jaffé's 1967 analysis. According to Walker, a change in the quantity of resources held by an agent would also bring about a change in his supply function for the *services* yielded by these resources, excluding thus the maintenance of the same set of equilibrium prices. This critique does not seem however to be pertinent. On the one hand, the validity of the theorem of equivalent redistributions is demonstrated in a pure exchange framework in which the services of resources are, by definition, absent. On the other, the equilibrium reached is, after all, the same (see Walras 1954, §§139–42). As a matter of fact, at the equilibrium prices P corresponding to the initial endowments S , the net demands (x_1, y_1, \dots) of *e.g.* agent (1) are such that the quantities $(q_{a,1} + x_1, q_{b,1} + y_1, \dots)$ maximize his utility. At these same prices P , but for the other endowment system S' , the agent's net demands (x'_1, y'_1, \dots) are different; but they also allow him to get an optimal basket $(q_{a,1}' + x'_1, q_{b,1}' + y'_1, \dots)$. Preferences being given, these net demands corroborate the double equality $q_{a,1} + x_1 = q_{a,1}' + x'_1$, $q_{b,1} + y_1 = q_{b,1}' + y'_1, \dots$. Leaning on his double condition, Walras shows that the aggregate net excess demands for all commodities are equal to zero, *i.e.* that $x'_1 + x_2' + \dots = 0$, and $y'_1 + y_2' + \dots = 0$. Hence, P is also an equilibrium price for the initial endowment system S' .

The *theorem of equivalent redistributions* considers thus the distribution of

wealth as a parametric determinant of the ‘mathematical solution’. It is, of course, a comparative static result, which should not be confused with the issue of *tâtonnement*. However, and as Jaffé rightly wrote in 1967, links can be drawn between these two arguments: if the *tâtonnement* mechanism alters wealth distribution, then this change of parameter will preclude the convergence towards general equilibrium prices. And Walras could not ignore this conclusion! As a matter of fact, and as early as the first edition of the *Eléments*, Walras had restated the theorem of equivalent redistributions by asserting that:

the only way we can affirm that there will be *absolutely no change in prices* is by assuming both conditions to be satisfied: that of constant value of the quantities possessed by each holder and that of constancy of the total existing quantities in the market.
(1954: 185; emphasis added)

Is this assertion not a first implicit statement of the *necessary* ‘neutrality’ of *tâtonnement* with regard to the distribution of wealth?

Another argument in favour of this interpretation is the link set up by Walras in 1874 between the part played by his measure of value and the theorem of equivalent redistributions.

The theorem of equivalent redistributions and the measure of value In the first edition of the *Eléments*, Walras draws a close link between the theorem of equivalent redistributions and his search for a measure of wealth. As a matter of fact, while in editions 2 to 5, the *numéraire* is introduced simultaneously with the first formulation of general equilibrium, in the first edition it only appears in the pure theory of exchange in lesson 25 (1874, §143) following that devoted to the theorem of equivalent redistributions.¹³ Accordingly, Walras has to define an instrument in order to measure wealth. In that respect, the *numéraire* plays a ‘essential part’ since its unit is the ‘instrument of measure of wealth’ (1954: 189). In particular, the *numéraire* allows a proper measure of individual wealth which is, for agent (1), ‘ $Q_{a,1} = q_{a,1} + q_{b,1} p_b + q_{c,1} p_c + \dots$ ’ (1954: 188).

What is essential in the present discussion is the next step in Walras’s argument:

In accordance with the theorem¹⁴ of equivalent distributions of commodity holdings we could allow $q_{a,1}, q_{b,1}, q_{c,1}, q_{d,1}, \dots$ to vary as we please. Provided that the new quantities possessed by our individual continue to satisfy the above equation [$Q_{a,1} = q_{a,1} + q_{b,1} p_b + q_{c,1} p_c + \dots$] (and provided that the total quantities of the various commodities remain constant), party (1) will always be able to obtain on the market, at the prices $1, p_b, p_c, p_d, \dots$ the same quantities of (A), (B), (C), (D), \dots which will afford him maximum satisfaction at these prices. Our $Q_{a,1}$, which represents not only all the above-mentioned quantities of the different commodities but also the

quantities of maximum satisfaction is, therefore, a quantitative expression of the wealth which party (1) possesses.

(1954: 188–9)

When discussing the problem of the measure of value, this particular mention of the theorem of equivalent redistributions – together with the twin conditions of equivalence in value and equality of total quantities – is clearly not innocuous. Hence, and even if Walras does not put it specifically in writing, this theorem could be reformulated in the following manner: *Given the total quantities of commodities, a change in their physical distribution between agents, 'neutral' with respect to the distribution of wealth (at the set of prices corresponding to the initial endowments), does not affect the vector of equilibrium prices. General equilibrium is unchanged.* Of course, such a statement still belongs to the field of comparative static. However, the insistence with which Walras draws his reader's attention to the link between the theorem of equivalent redistributions and the measure of wealth is an unequivocal sign that, as soon as 1874, Walras could not ignore the *hysteresis* issues linked with the redistribution of wealth intrinsic to a dynamic disequilibrium process.

1.2 Bertrand's critique and the no-trade-out-of-equilibrium rule in the pure exchange tâtonnement

Bertrand's critique: the problem of trade out of equilibrium Bertrand (1833) is probably the first of Walras's commentators to notice that, on actual markets, transactions do occur out of equilibrium. His logical conclusion is, of course, that the Walrasian process of price variation would not converge to the general equilibrium unique 'theoretical' solution.

Bertrand's critique is doubtless the first salvo in a theoretical debate which, despite Sonnenschein and Mantel's seminal contributions, is still raging today. As a matter of fact, Bertrand suggests that, on actual markets, transactions do take place at prices different from equilibrium prices. Under such 'realistic' conditions, the vector of equilibrium prices resulting from *tâtonnement* is undetermined. The agents' endowments change constantly during the adjustment process, so would their net demand functions as well as the vector of equilibrium prices.¹⁵

Walras's answer: no trade out of equilibrium In 1885, Walras readily reckons formally the problem raised by Bertrand: 'on the theoretical market, in case of an excess of demand over supply or of supply over demand, [. . .] exchange stays suspended until [. . .] supply and demand are equal again'

(1885, *OEC*, IX: 312, n. 1).¹⁶ In the *Eléments*, this *no trade out of equilibrium* rule, which ensures the constancy of demand functions, is explicit from the second edition onwards. In Walras's famous wordings concerning the 'problem of exchange of two commodities for each other': 'Theoretically, trading should come to a halt' (1889, §42 as in 1954: 85).

In the same second edition, in the pure exchange model, Walras adds the following crucial passage:

The theorist has *the right to assume that the underlying price determinants are invariant* over the period he has chosen to use in his formulation of the law of equilibrium prices. But, once this formulation has been completed, it is his duty to remember that the forces that underlie prices are by their nature variable, and consequently he must formulate the law of the variation of equilibrium prices. [. . .] For the *forces underlying the establishment of prices are the very forces that underlie the variation of prices.*

(1889, §101 as in 1954, §102: 146; emphasis added)

Changes in the parameters of general equilibrium can only be envisaged within a comparative static framework such as the *law of variation of equilibrium prices*; such parametrical changes cannot be examined within the discussion of the *establishment of equilibrium*.¹⁷

Hence, as early as the second 1889 edition, in his pure exchange theory, Walras excludes from *tâtonnement* any variation of the parametric determinants of general equilibrium. In fact, this procedure amounts to suppressing any possible move away from equilibrium while precisely discussing the question of its establishment. In the theory of production, the elimination of any source of *hysteresis* will have to wait for the *tâtonnement sur bons*; but this generalization of the *no-trade-out-of-equilibrium* rule would only be completed in the fourth 1900 edition of the *Eléments*.¹⁸ What does happen then to *tâtonnement* in the theory of production in earlier editions of the *Eléments*?

2. The neutrality of the *tâtonnement* without *bons* in the theory of production (1874–96)

In his theory of production, Walras offers three successive and different versions of the *tâtonnement* model in edition 1, editions 2–3 and edition 4 of the *Eléments*. Like for the theory of exchange, in the theory of production, the convergence of *tâtonnement* towards general equilibrium prices has to assume the absence of hysteresis effects. However, in the first three editions of the *Eléments*, Walras undertakes the hopeless task of demonstrating the convergence towards general equilibrium of a *tâtonnement without bons* including out of equilibrium transactions.¹⁹

In order to examine Walras's answer to Bertrand's critique within the

tâtonnement sans bons framework, one has to distinguish carefully two components of this *tâtonnement* model. On the one hand, the assumptions that characterize the 'ideal type' competitive mechanism; on the other, a demonstration of the convergence towards general equilibrium conducted within a mathematical iterative mechanism involving changes in prices and quantities. In parts 2.1 and 2.2, it is shown: i) that this demonstration takes the distributional neutrality of *tâtonnement* for granted; ii) that the assumptions on which the competitive mechanism relies are precisely built on the absence of distributional effects linked to disequilibrium transactions; and iii) that, as long as out of equilibrium transactions are tolerated, Walras's attempts at suppressing distributional effects are simply hopeless.

2.1 *Distributional neutrality: a sheer assumption*

In all editions, the *tâtonnement* model includes two phases relative to the markets for goods and the markets for services. In each phase of *tâtonnement*, an iterative variation of quantities and/or of prices constitutes the framework within which Walras intends to demonstrate the convergence towards general equilibrium.²⁰

In its first phase (§§253–4 in *EEP1*, §§206–9 in *EEP2–3*, §§210–13 in *EEP4–5*; 1954: 244–8) – the prices of productive services being given and invariable – the *tâtonnement* model deals with the quantities of goods and their selling prices. If the selling price of one good exceeds its production cost, entrepreneurs enter the sector in which profit can be made; this, in turn raises the quantity 'cried' on the market. In the opposite case, this quantity diminishes. Since the prices of services are given, *tâtonnement* has no influence whatsoever on the production costs. In return, quantity variations induce an inversely related variation of selling prices. Walras considers that the gap between selling prices and costs of production progressively decreases. Finally, the iterative process allows the system to reach a set of quantities of goods for which selling prices are equal to costs of production (equilibrium in the goods markets).

In its second phase (§§256–61 in *EEP1*, §§211–15 in *EEP2–3*, §§215–19 in *EEP4–5*; 1954: 249–53), the *tâtonnement* takes place on the prices of services in order to equalize aggregate demand and supply of all and every services (equilibrium in the markets for services).

During the iterative process, it is crucial to underline, in phase 1, the constancy of the aggregate demand functions for goods, F_b , F_c , F_d , . . . , and, in phase 2, the constancy of the aggregate supply functions for services, O_s , O_k , O_p , . . . Hence, it appears clearly that the invariability of these functions simply assumes away any distributional effect that amounts to eliminating *ex definitio* any cause of hysteresis.²¹ Finally, is this distributional neutrality

of the *tâtonnement* model really justified when put in the perspective of the assumptions behind the *tâtonnement sans bons*?

2.2 *Distributional neutrality: an operating requirement*

The chief differences between the three successive versions of *tâtonnement* in the theory of production are directly linked to the assumptions which characterize, for Walras, the working of the ‘ideal type’ mechanism of competition. The indispensable distributional neutrality is already clearly present behind the *working* of the *tâtonnement sans bons* of the *Eléments*’s first three editions. However, the scenario used by Walras to answer Bertrand’s objection is hardly convincing.

The functioning of the tâtonnement sans bons: the quest for distributional neutrality This discussion is devoted to the model offered by Walras in his editions 2 and 3 in which two paragraphs are explicitly devoted to the working of the *tâtonnement*:

Il s’agit d’arriver à l’équilibre de la production [. . .] en supposant les données du problème invariables pendant tout le temps que dureront nos tâtonnements. [. . .] Nous devons supposer que, pour chaque reprise du tâtonnement, nos entrepreneurs trouveront, dans le pays, des propriétaires fonciers, travailleurs et capitalistes possédant les mêmes quantités de services et ayant les mêmes besoins des services et des produits. [. . .] A des prix criés d’abord au hasard, et ensuite en hausse ou en baisse suivant les circonstances, les entrepreneurs emprunteront [. . .] les quantités de ces services nécessaires pour fabriquer certaines quantités de produits déterminées d’abord au hasard, et ensuite en hausse ou en baisse suivant les circonstances. Puis ils viendront vendre ces quantités [. . .] à ces propriétaires fonciers, travailleurs et capitalistes possédant toujours les mêmes quantités de services et ayant toujours les mêmes besoins de services et de produits. Le tâtonnement sera fini lorsque, en échange des produits qu’ils auront fabriqués, les entrepreneurs obtiendront [. . .] précisément les quantités de rentes, travaux et profits qu’ils leur devront et qu’ils auront fait entrer dans la confection des produits.

Afin de mieux faire saisir les opérations qui vont suivre, nous les partagerons en deux phases [. . .]. Nous supposerons d’abord que les entrepreneurs [. . .] achètent leurs services producteurs [. . .] en s’engageant à restituer plus tard des quantités de ces services non pas égales mais simplement équivalentes, et nous déterminerons ainsi les quantités [de produits . . .] de fa on à ce que les entrepreneurs ne fassent ni perte ni bénéfice. Nous supposerons ensuite que les entrepreneurs s’engagent à restituer plus tard des quantités de services non plus seulement équivalents mais égales, et nous déterminerons ainsi les quantités [. . .]²² de fa on à ce que l’offre et la demande effectives des services soient égales. On voit assez comment cette manière de procéder fait abstraction sinon du numéraire au moins de la monnaie.²³

(*EEP2*–3, §§203–4; 1988: 308 and 312)

It is important to recall here that, in his first edition, Walras did connect phase I of *tâtonnement* to an imaginary foreign market²⁴ (*EEP1*, §250). This

assumption (which disappeared in edition 2) was seemingly introduced in order to eliminate the repercussion of out of equilibrium production on home markets. However, since Walras does not elaborate much on this bizarre mechanism, it is difficult to draw a definite judgement on the working of such a rudimentary model.

In editions 2 and 3, the assumptions behind the functioning of the *tâtonnement* are very clearly based on the distributional neutrality requirement. First, Walras assumes that, for each round (*reprise*) of the *tâtonnement* mechanism, the initial conditions of the problem are met again – a hypothesis absent from edition 1.²⁵ But is Walras in a position to make this assumption which amounts to eliminate by definition all hysteresis effects? Since there are neither exchange nor production of capital goods, the quantities of capital goods owned by any agent cannot of course vary. The individual's *wealth* is thus always the same at each round of the *tâtonnement*; this in turn ensures the constancy of aggregate demand and supply functions. Despite the apparent rigour of this argument, a further problem is raised by out-of-equilibrium transactions.

The arbitrary removal of hysteresis effects . . . an inconsistency in the model
 During the two phases of *tâtonnement*, this inconsistency is revealed by the impact of disequilibrium transactions on aggregate supply and demand functions.

Walras notices that, during the first phase, the prices of services being constant, 'each trader has [. . .] always the same income valued in *numéraire* $r = q_t p_t' + q_p p_p' + q_k p_k' + \dots$ and he has to allocate this income between the consumption of services and that of goods' (*EEP2-3*, §208). However, 'the selling prices being usually different from the costs of production, entrepreneurs [. . .] will incur losses or make a profit' (*EEP2-3*, §206). Do these losses or profit alter the distribution of wealth between agents? To answer this question, the assumptions behind the working of *tâtonnement* have to be considered again.

The absence of money leads Walras to suppose that entrepreneurs first borrow services²⁶ in order to produce and then exchange these goods against services provided by consumers in order to pay back the original lenders. The value of the services provided by consumers being equal to that of the goods acquired, the consumers' individual wealth cannot be altered by disequilibrium transactions. But what about the entrepreneurs even if they are absent from Walras's model? Disequilibrium production is synonymous with a gap between the value of the borrowed services and that of the services provided by the consumers. This profit or loss cannot be considered in money terms since Walras is explicitly abstracting from money (*EEP2-3*, §204). Moreover, and for the same reason, the agents'

initial endowments cannot include a stock of *numéraire*. Thus, entrepreneurs can neither stock these profits in *numéraire* nor hand them back to the initial lenders in case of losses. And even if they could, the *tâtonnement* mechanism would no longer be distribution neutral: the wealth of both the entrepreneurs and the initial lenders would clearly be affected. The endogenous shift of their supply and demand functions would prevent the convergence towards general equilibrium. Hence, the fact that Walras does not introduce the possibility of hoarding *numéraire* is hardly surprising. Moreover, goods, like services, have to be consumed during each round of the *tâtonnement*. A profit-making entrepreneur has thus to consume his surplus in services unless he can turn it into goods he also has anyway to consume during the same round. Clearly, Walras's supply and demand functions for services can no longer remain unchanged and lead thus to hysteresis effects. According to Walker (1996: 152), this would not be a source of a 'path-dependency' of the model in so far as these 'transitory profits' would tend towards zero. This last-minute ditch in favour of Walras is hardly acceptable. The fact that profits tend towards zero does not imply that the *tâtonnement* mechanism follows a dynamic convergent path. In fact, in phase I of the *tâtonnement*, Walras simply arbitrarily eliminates the distributional effects of profit and losses.

In the second phase of this mechanism, since the prices of services are allowed to change, the agents' *numéraire* incomes and their budget constraints are altered. The aggregate supply functions of services are thus bound to change; but Walras studiously avoid mentioning this issue. Besides the argument about the initial conditions found intact at each new round of the *tâtonnement*, Walras might also implicitly use here the no-trade-out-of-equilibrium rule introduced in his theory of pure exchange in the aftermath of Bertrand's review. In fact, this second phase of the *tâtonnement* can be identified with a pure exchange of services.

Eventually, Walras's attempt to eliminate arbitrarily hysteresis effects linked to out-of-equilibrium transactions is hopeless. In the first three editions of the *Eléments*, the assumptions behind the *tâtonnement* mechanism are not compatible with the distributional neutrality hypothesis. In the demonstration of the convergence of the system towards the general equilibrium theoretical solution, this hypothesis implies nothing else but the constancy of the aggregate supply and demand functions. This *internal incoherence* is probably what ultimately led Walras to introduce in his fourth 1900 edition his famous *tâtonnement sur bons*.

All in all, in the first three editions of the *Eléments*, Walras fails to answer in a rigorous manner Bertrand's objections in the field of his theory of production. This puzzle is also, in substance, one of the aspects of the intense debate which erupted a few years later between Edgeworth and Walras.

3. The Walras–Edgeworth debate on *tâtonnement*: ‘competitive markets’ vs ‘fields of competition’

The importance of this debate²⁷ is central both as a pointer to a better understanding of Walras's own position in his search for the distributional neutrality of his *tâtonnement* mechanism as well as to the decisive turning point taken by the technology of exchange in economic theory at that time. These two elements are in fact closely linked. The ‘market-machine’ vs ‘pleasure-machine’ opposition between Walras and Edgeworth is clearly reflected in their respective adjustment mechanisms towards equilibrium. The necessity for Walras to offer a coherent version of *tâtonnement* is of paramount importance in his strategy to demonstrate that Edgeworth's recontracting procedure is only a particular case of his more general ‘competitive market’ approach: a theory of exchange deprived of a so-called ‘mode of motion’ towards equilibrium is tantamount, for him, to only half a theory of exchange. Similarly, it appears that, for Edgeworth as well, the absence of distributional effect in the *tâtonnement* mechanism is intimately linked with the notion of perfectly free competition – a special case of what he considers as his more general theory of exchange.

Hence, the present section concentrates mainly on a particular aspect of this much larger debate²⁸ about the relevance and the range of validity of ‘perfectly free competition’. Leaving aside the wider aspect of Edgeworth's questioning of Walras's ‘market’, we consider below the problems linked to their respective ‘mode of motion’ towards equilibrium, and in particular of the distribution effects connected to the nature of this mechanism. Edgeworth's reading of Walras's *tâtonnement* as *a* (static) way, and not *the* way, towards equilibrium in the particular framework of perfect competition is first examined (3.1). Then, Edgeworth's more fundamental attack on *tâtonnement* is discussed in connection with his assertion about the impossibility of building a proper dynamic stability theory. This argument is then connected with Walras's fundamental assertion that *tâtonnement* is not only indispensable to but also the ‘crowning’ of his general equilibrium model (3.2).

3.1 Edgeworth's reading of Walras's *tâtonnement*

Edgeworth starts his critical discussion of Walras's position with a straightforward Bertrand-like critique on the necessity of the no-trade-out-of-equilibrium hypothesis to avoid, in particular, distributional effects.²⁹

Si nous essayons maintenant de mettre en formule la concurrence [. . .], il convient de considérer les utilités [. . .] comme variant continuellement avec l'accroissement ou le décroissement des variables dont elles représentent une fonction constante³⁰ mais aussi comme variant d'une fa on discontinue par suite de changements dans la fonction.
(Edgeworth 1891: 372–3)

One can safely infer that *if* ‘the forces present in the system are given’, and, *if*, during the *tâtonnement* ‘the equilibrium position is determined’, hence Walras’s *tâtonnement* mechanism is understood by Edgeworth as implying the no-trade-out-of-equilibrium hypothesis and the concomitant absence of distributional effects. Moreover, thanks to the recontracting rule introduced in his own theory, Edgeworth is fully aware of the path-dependency effects introduced by out-of-equilibrium exchanges. Though he does not dispute either the existence of *an* equilibrium position or that the *tâtonnement* allows this equilibrium position to be reached, Edgeworth disputes the ability of the *tâtonnement* mechanism to describe *the* path leading to equilibrium. In other words, and at the risk of being repetitive, Edgeworth denies *tâtonnement* the ability to determine the path leading to the equilibrium position *even if the tâtonnement is a virtual timeless mechanism, a distribution-neutral iterative mechanism excluding exchanges at disequilibrium prices*. Even in such a well-defined framework, the ‘path’ leading to equilibrium depends on the order in which the *n* markets are visited.

Walras’s formal answer, by the intermediary of Bortkiewicz’s pen (1890) compounds the difficulties by blaming Edgeworth for attributing to Walras a confusion between statics and dynamics. The invocation by both Walras and Edgeworth of two *different* notions of dynamics allegedly attributed to Jevons will add confusion to perplexity.

In his *Theory of Political Economy*, on two consecutive pages (pp. 101 and 102 of the second 1879 edition), Jevons examines two different concepts of ‘dynamics’. An apparent confusion between these two different definitions due to Bortkiewicz, and subsequently challenged by Edgeworth, allowed a welcome clarification in connection with *tâtonnement*. In fact, and despite Bortkiewicz’s confusion, this episode confirms that Edgeworth’s understanding of *tâtonnement* corresponds to Walras’s (even if, of course, Edgeworth persists to consider this piece of analytical work as ‘not a very good idea’).

Jevons’s ‘page 101’ concept of ‘dynamics’ corresponds to a genuine dynamic process taking place in historical time in which all variables are constantly changing (in particular, the agents’ endowments and preferences are *not* given; hence distribution effects).

Edgeworth considers rightly ‘page 101’ dynamics as ‘un changement dans les forces économiques du marché et de la position d’équilibre correspondante’ which can be linked to the case where ‘les instructions données par les propriétaires à leurs agents pour les prix des marchandises changeraient de jour en jour’ (Edgeworth 1891: 366, n. 1). It is to this ‘page 101’ dynamics that Bortkiewicz erroneously referred to as Edgeworth’s interpretation of Walras’s idea of ‘dynamics’ in connection with *tâtonnement*:

. . . le mode de résolution des équations d'équilibre, étudié par M. Walras est absolument conforme à l'idée que Jevons s'est faite de la nature [statique] de ces équations. *Quant au problème de l'échange, M. Walras l'envisage aussi du point de vue purement statique, en ce sens qu'il suppose les quantités possédées de produits comme étant des quantités constantes, et les courbes de rareté comme ne variant pas . . .* Donc le critique anglais a eu tort en reprochant à M. Walras d'avoir passé du point de vue statique au point de vue dynamique, du moins si on emploie ces termes dans l'acception de Jevons. (Bortkiewicz 1890: 359; italics added)

This notion of 'dynamics' rightly attributed to Walras by Bortkiewicz corresponds to Jevons's 'page 102' dynamics:

It is only as a purely statical problem that I can venture to treat the action exchanges. Holders of commodities will be regarded not as continuously passing on these commodities in streams of trade, but as possessing certain fixed amounts which they exchange until they come to equilibrium.

(Jevons 1879: 102)

This second notion also attributed to Walras by Edgeworth is defined by the latter as 'la descente à la position d'équilibre en partant de cette supposition que les forces sont pour le moment constantes [which can be compared] au marchandage par lequel à un jour donné les agents arriveraient à la position d'équilibre' (Edgeworth 1891: 366, n. 1). For Edgeworth, one of the sources of the misunderstanding between Walras, Bortkiewicz and himself can be precisely located in this confusion between 'p. 101 dynamics' and 'p. 102 dynamics' (1891: 366, n. 1).

In fact, mirroring probably Walras's own hesitation in his second edition, Bortkiewicz oscillates between an interpretation of the *tâtonnement* with and without exchanges at disequilibrium prices, between a so-called 'realist' and a straightforward analytical version of the *tâtonnement* (1890: 86 and *Correspondence*, II: 431). Moreover, besides introducing the no-trade-out-of-equilibrium hypothesis in the theory of exchange of his second edition, Walras had also introduced the assumptions of constant utility functions and constant endowments in the successive rounds of *tâtonnement* in his theories of production and capitalization.³¹

In the last analysis, and despite the confusion introduced by Bortkiewicz (though in an article written under Walras's close supervision), one can safely conclude that both Walras and Edgeworth adopt Jevons's 'p. 102 dynamics', and, hence, the same 'static' reading of *tâtonnement*.

However, Edgeworth's critique of Walras's mechanism was in fact much more fundamental than this relatively 'narrow' technical point. This Edgeworth–Walras debate implies in the end no less than the opposition of two widely different technologies of exchange reflecting two very different conceptions of the core of the theory of exchange: Walras's 'competitive market' vs Edgeworth's 'fields of competition'.

3.2 ‘. . . the direction followed by the [economic] system to reach the position of equilibrium does not belong to the sphere of science’ (Edgeworth 1891: 364)

The Edgeworthian approach assumes economic agents (organized within ‘fields of competition’ and free to communicate) who, in the absence of any market price, are free to enter into contracts and recontracts manifesting thus their conflicting interests. In such an environment, and through a sequence of non-binding contracts and recontracts to avoid distributional effects, an equilibrium is defined as an allocation which cannot be improved on by further recontracting between agents, i.e. an allocation which cannot be modified in a mutually advantageous way by any agent or coalition of agents. As is well known, for Edgeworth, this ‘simple case brings clearly into view the characteristic evil of indeterminate contract [. . . because] we see that in general for any number [of agents] short of the *practically infinite* [. . .] there is a finite length of the contract-curve’ (1881: 29 and 39). In a nutshell, except for the particular ‘competitive’ case, the system is indeterminate. Hence, while admitting that the position of equilibrium can be mathematically determined, Edgeworth makes amply clear that the ‘mode of motion’ towards equilibrium is indeterminate. While the existence of an equilibrium is accepted, from the very inception of his system, Edgeworth denies the possibility of any rigorous stability theorem.

The Walrasian approach offers of course an entirely different technology of exchange. Prices are quoted on the markets – one price per good – and agents, considering them as given, express their respective supply and demand. The equilibrium price ‘partakes of the character of a *natural* phenomenon [. . .] and does not result either from the will of the buyer or from the will of the seller or from any agreement between the two’ (1954: 69). The market-machine grinds then through a *tâtonnement* mechanism³² a vector of equilibrium prices, which allows market clearing on all and every markets. A ‘hypothetical régime of perfectly free competition’ (1954: 40), Jevons’s law of one price and some sort of centralized pricing system (even if the auctioneer is absent from the *Eléments*³³) rule supreme. The law of one price is clearly one of the elements necessary to Walras in connection with the neutrality of exchange on the initial distribution of income. In modern terminology, for Walras, the existence theorem is mathematically determined and the *tâtonnement* mechanism is *the* ‘mode of motion’, the so-called ‘practical’ solution (formalizing the law of supply and demand³⁴ towards the equilibrium position).

During the course of the debate, and in perfect accordance with the model outlined ten years earlier in *Mathematical Psychics*,³⁵ Edgeworth goes well beyond the technical argument discussed in 3.1. He formulates in fact

the most radical critique ever addressed at Walras's *tâtonnement* mechanism by simply putting into question the whole traditional market-machine cum supply-and-demand apparatus. In other words, Edgeworth is simply (!?) attacking Walras's cherished idea that, to be complete, a price theory should provide both a static definition of a vector of equilibrium prices *and* a 'dynamic' iterative theory of price formation describing the path leading to this equilibrium. Given the mode of co-ordination between agents based on his recontracting principle, and short of an infinity of agents, Edgeworth considers as 'not a very good idea' (1889: 380) any attempt at formalising the old gravitation process, *even if out-of-equilibrium exchanges are excluded*.

In 1891,³⁶ borrowing Walras's example, in which two goods are exchanged between agents represented on the market by brokers fully aware of the agents' willingness to exchange, Edgeworth remarks:

... les forces en jeu dans le système étant données, la position d'équilibre vers laquelle tend le système se trouve par là même déterminée. Mais je maintiens que le jeu de tout ce marchandage [i.e. the *tâtonnement*] par lequel le prix du marché se trouve déterminé, la direction que suit le système pour arriver à la position, *ne rentre pas dans la sphère de la science*.

(1891: 364; italics added)

And a few pages later, he adds his famous metaphor:

Si nous comparons le jeu de l'offre et de la demande sur le marché [the so-called higgling of the market] à la descente d'une masse liquide sur les flancs d'une vallée [...], il y a bien une position d'équilibre déterminée et elle est très bien indiquée par l'auteur. Mais parfois il se représente d'une manière tout à fait arbitraire le liquide comme coulant dans un lit déterminé, tandis que la seule chose que nous puissions dire c'est que, d'une façon ou d'une autre, la masse fluide arrivera à la position d'équilibre.

(1891: 369)

Likewise, in his little-known entry *Higgling* in the original Palgrave *Dictionary of Political Economy*, Edgeworth writes in 1896 that '*even if the dispositions of all the parties were known beforehand*, there could be predicted only the position of equilibrium, not the particular course by which it is reached' (1896, II: 305; italics added).

Finally, in Edgeworth's own words added to the 1925 reprint of his 1889c article, 'we have no general *dynamical* theory determining the path of the economic system from any point assigned at random to a position of equilibrium. We know only the statical properties of the position [of equilibrium]' (1925, II: 311). Hence, the opposition between Edgeworth and Walras exists at the level of the possibility as well as of the nature of the path leading to 'the position of equilibrium'.

Given the crucial issue at stake, Walras's answer is characterized both by

incredulity and irritation. Walras simply does not understand the critique because, in fact, he has no idea of Edgeworth's recontracting procedure. The misinterpretation is total. In a letter to his faithful Bortkiewicz, Walras displays particularly well the fact that each author speaks a wholly different theoretical language:

Edgeworth estime que je fais des efforts absolument oiseux pour démontrer que les opérations de hausse et de baisse des prix, d'augmentation et de diminution des quantités de produits fabriqués, *etc.*, sur les marchés ne sont autre chose que la résolution par tâtonnement des équations de l'échange, de la production et de la capitalisation. Et en cela, il montre qu'il n'a aucune idée de l'objet et du but de l'économie politique pure lesquels consistent surtout et avant tout dans la démonstration dont il s'agit.

(*Correspondence*, II: 363)

And in a subsequent letter to Gide, Walras adds:

. . . la théorie du tâtonnement [. . .] est l'essence même de la théorie de la détermination des prix.

(*ibid.*: 370)

Beyond the fact that he admits here explicitly that his *tâtonnement* mechanism is an ideal type, Walras displays his ignorance of Edgeworth's intentions. Walras cannot conceive, or does not want to envision, a different analytical framework than his. Too much is at stake: jettisoning *tâtonnement* would deprive his theory of exchange of the very part on which is based his 'market-machine' supposed to formalise his *libre concurrence absolue*³⁷ hypothesis, and, hence, his entire general equilibrium model.

In formulating his second objection to the *tâtonnement* mechanism – a way and not *the* way towards equilibrium – Edgeworth refers in fact to his own recontracting process as a general case of Walras's special competitive market approach. However, since Edgeworth does not refer explicitly to the relevant passages of *Mathematical Psychics*, since Walras has only but a scant knowledge of this book and Bortkiewicz none whatsoever, it is not really surprising that the discussion showed some signs of confusion. The best illustration of this opposition between a theory of exchange based on the formulation of supplies and demands at given prices and a theory of exchange based on higgling and recontracting is given by Bortkiewicz's reaction to Edgeworth's objection:

Y aurait-il pour M. Edgeworth un autre phénomène économique [than *tâtonnement*] se produisant sur le marché? Non, M. Edgeworth croit bonnement qu'il est tout simplement oiseux de chercher à démontrer la voie suivant laquelle le système économique est amené à l'équilibre.

(1890: 359)

For Edgeworth, the issue at stake is that his recontracting hypothesis is precisely an alternative mechanism – and more general at that – than

Walras's *tâtonnement* the validity of which is narrowly restricted to competitive markets. In a short concluding note added in 1925 to his 1889 Opening Address, Edgeworth reformulates his 1891 critique in a brilliant and terse passage:

[Walras] describes *a* way rather than *the* way by which economic equilibrium is reached. For we have no *dynamical* theory determining the path of the economic system from any point assigned at random to a position of equilibrium. We only know the statical properties of the position [. . .]. Walras's laboured description of prices set up or 'cried' in the market is calculated to divert attention from a sort of higgling which may be regarded as more fundamental than his conception [of *tâtonnement*], the process of *recontract* [. . .]. It is believed to be a more elementary manifestation of the propensity to truck than even the effort to buy in the cheapest and sell in the dearest. The proposition that there is only one price in a perfect market may be regarded as *deducible* from the more axiomatic principle of *recontract*.

(1925, II: 311–12)

Hence, for Edgeworth, it is not only illusory to try to determine the path towards equilibrium (it is 'outside the sphere of science' to dynamize static equilibrium equations) but also that, even if possible, such a procedure would only be valid for the narrow case of 'static', timeless 'perfect markets' excluding by definition out-of-equilibrium exchanges and production and, hence, any distributional effects. Well beyond the static or dynamic nature of the *tâtonnement*, the opposition between the recontracting principle and the notion of supply-and-demand at given prices, between 'fields of competition' and 'competitive markets' is at the heart of the controversy between Edgeworth and Walras.

In a letter to Bortkiewicz written after the publication of Edgeworth's 1891 article,³⁸ Walras links with great clarity the greater generality of his 'competitive model' (as opposed to Edgeworth's recontracting approach) with the imperative of providing a theoretically coherent formulation of the 'law of supply and demand' in the Classical tradition as the 'mode of descent towards equilibrium':

... le secret de la science est de mettre au premier plan le cas général et de reléguer au second plan les cas particuliers et les exceptions; car là, en définitive, est le fond de ma querelle avec Edgeworth. Dans la question du tâtonnement par exemple, je prends le mode presque universel de libre concurrence en matière d'échange, celui qu'a décrit John Stuart Mill, et qui consiste à faire la hausse en cas d'excédent de la demande sur l'offre et la baisse en cas d'excédent de l'offre sur la demande, et je démontre que ce procédé amène l'équilibre de l'offre et de la demande. Sur quoi, on me jette à la tête le marché des fonds publics anglais, le systèmes des enchères hollandais, etc, etc [. . .]. Et bien ces messieurs feraient bien de traiter ces cas [. . .] plutôt que d'en arguer pour soutenir que le cas général ne rentre pas dans la 'sphère de la science'.

(*Correspondence*, II: 434–35)

Clearly, in this debate, Edgeworth fully understood (even if he disagreed

on the generality of Walras's approach) the necessity for Walras to provide a rigorous theory of *tâtonnement* to prove the convergence of this mechanism towards a unique general equilibrium position. In this perspective, distributional effects endogenous to the *tâtonnement* mechanism would naturally be excluded. In this last respect, Edgeworth was simply drawing parallels with his own recontracting procedure with non-binding contracts.

For his part, Walras understood equally well the necessity to provide such an internally coherent 'practical solution' in order to prove the greater generality of his 'competitive market mechanism', in order to prove to Edgeworth that his general equilibrium approach could mathematically define the equilibrium position *and* a 'mode of motion towards equilibrium'. In other words, Walras wanted to be seen as the first formalizer of the ubiquitous but fleeting 'law of supply and demand' inherited from the Classical School.

4. A logical road down to the *tâtonnement sur bons*

At the end of this discussion, some recapitulating remarks are of the order to illustrate the vital necessity for Walras to salvage (at any costs) the necessity of a *tâtonnement* mechanism – whatever its exact nature. In other words, beyond the 'mere technicalities' linked to the exact working of *tâtonnement*, the presence of an adjustment mechanism 'of some sort' is necessary for the sake of completeness of his theory of competitive exchange as *the* scientific object *par excellence* of his pure economics. In that respect, the debate with Edgeworth probably played an important role on Walras: the imperative requirement to formulate an internally coherent *tâtonnement* mechanism was made more urgent by Edgeworth's critique and, together with Bertrand's earlier remarks, must have set him on the road towards the *tâtonnement sur bons*.

As early as 1874, Walras demonstrates that the distribution of wealth is one of the parameters of his general equilibrium model. He is also fully aware of the hysteresis effects brought about by the distributional consequences endogenous to the *tâtonnement* mechanism. Hence, in his second edition, Walras is led to alter this *tâtonnement* model: on the one hand, the no-trade-out-of-equilibrium rule is introduced in his pure theory of exchange; on the other, the assumptions behind the working of the *tâtonnement* mechanism are re-stated in order to include *ex definitio* the necessary distributional neutrality of the *tâtonnement* in the theory of production. Moreover, Edgeworth's frontal assault against the very feasibility of any 'mode of convergence' towards general equilibrium strengthens Walras's

determination to complete his construction of a *tâtonnement* mechanism in his theory of production. The convergence of *tâtonnement* and its distributional neutrality are fundamental parts of pure economics as well as, more generally, of the grand 'Walrasian design'.

On the one hand, and most importantly, the internal coherence of the *Eléments* is here at stake. The various attempts at suppressing the distributional effects of disequilibrium transactions in the first three editions end up as failures. Introduced in the fourth edition, the *tâtonnement sur bons* eventually succeeded in formalizing a *tâtonnement* mechanism truly neutral. Since all sources of price variations are rejected *ex definitio* in the discussion of the law of establishment of prices, such a theoretical illustration of the competitive mechanism is, *per se*, highly contentious. But the *tâtonnement sur bons* alone can ensure the internal coherence of the Walrasian argument. As a matter of fact, the assumptions behind the working of the *tâtonnement* mechanism are at last compatible with a convergence demonstration in which the supply functions of services and demand functions for goods are constant. This interpretation runs counter to Walker's (1996). According to this author's opinion about Walras's 'phases of theoretical activity', 'the decline of Walras abilities is evidenced by his introduction of a written pledges [*tâtonnement sur bons*] model that is [. . .] incomplete and sketchy' (1996: 12). The model of editions 2 and 3 is supposed to fulfil realistic aims endowing it with theoretical features far superior to the *tâtonnement sur bons*. However, in the *Eléments*, Walras's epistemology is not 'realist'. In essence, Walras does not endeavour to describe the workings of a capitalist economy akin to the contingent reality beyond his windows.³⁹ It is of course possible to argue that Walras is a 'realist' but only in the sense of a philosophical realism characterized by an attempt to understand the essence of reality.⁴⁰ At the very beginning of the *Eléments*, Walras insists for example on the difference between the stock market – a 'real type' – and the *tâtonnement model* which is an 'ideal type' (1954, §44 and §48: 86–8 and 90–1). In 1898, he re-affirms this argument with vigour: 'I have explained [. . .] that, in order to build the theory of the determination of current prices [. . .], I took for granted an equilibrium established *ab ovo* [. . .] and an *hypothetical market* on which *tâtonnements* could be conducted until the establishment of equilibrium' (1898: 307; emphasis added). Hence, even if Walras keeps repeating that the 'theoretical solution' is reached in an 'empirical' manner,⁴¹ the theoretical argument he provides is only valid for an economy 'under a hypothetical régime of perfectly free competition' (editions 2–5 as in 1954: 40).

On the other hand, the convergence of the *tâtonnement* mechanism towards a unique general equilibrium constitutes one of the most central arguments of pure economics. As early as 1877,⁴² Walras considers that this

problem is a 'key point' (1883: 307) and the 'heart of the question' (1883: 308) in his theory of prices.

In essence, the object matter *par excellence* of the *Eléments* is an economy working 'under a hypothetical régime of perfectly free competition'. And the *tâtonnement* is after all the 'ideal type' theoretical representation of the competitive mechanism. As far as *a theory of exchange deprived of a mode of motion towards equilibrium is tantamount to only half a theory of exchange*, it is most crucial for Walras to demonstrate rigorously the convergence of the *tâtonnement* towards general equilibrium. Moreover, such an achievement would also allow Walras to characterize competition with the same conditions as general equilibrium: maximum satisfaction of wants under the budget constraint with free utilization of resources; unicity of price determined by the equality between aggregate supply and demand; equality between supply price and cost of production for each and every good. Thus, in the pure theories of exchange and production, and after having defined the general equilibrium conditions and established the convergence of the *tâtonnement* mechanism towards this set of equilibrium prices, Walras is eventually in a position to provide his general and *analytical definition of free competition*. The first version established in the simple case of two goods exchanged between an indefinite number of holders 'simply' 'embraces [for him] the whole of pure and applied economics' (1954: 143). In the more general production case, his definition includes explicitly the conditions of *libre concurrence absolue* so crucial to Walras's social economics:

Production in a market ruled by free competition is an operation by which services can be combined and converted into products of such a nature and in such quantities as will give the greatest possible satisfaction of wants within the limits of the double condition, that each service and each product have only one price in the market, namely the price at which the quantity supplied equals the quantity demanded, and that the selling price of the products be equal to the cost of the services employed in making them.

(1954: 255)

In his 'theory of property', Walras assesses these conditions of 'perfectly free competition' stated in this *analytical definition of free competition* and concludes to the 'justice in the competitive exchange'. This demonstration constitutes for him 'the heart of the scientific theory of property' (1896 as in *OEC*, IX: 179). The 'justice in exchange' is precisely characterised by the fact that, like the Jevonsian barter, the competitive exchange 'leaves unchanged the *inequality* of wealth' (1896 as in *OEC*, IX: 179–80). The distributional neutrality of competition (and, in particular, of *tâtonnement*) plays thus a central part in the Walrasian theories of property and of justice: as a matter of fact, the very notion of 'justice in exchange' finds its analytical content in the *Eléments*. Eventually, the distributional neutrality

of free competition forms one of the bridges linking pure economics with social economics.

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Notes

- 1 Henceforth OEC. EEP (followed by a number) stands for the various French editions of Walras's *Éléments d'économie politique pure*.
- 2 Berta (2000), Costa (1998a, 1998b), Huck (1999, 2001), Lendjel (1997, 1998), Lhuillier (2000), Rebeyrol (1999); Jolink (1991); Baranzini (1993, 2001), Tatti (2000).
- 3 Even Jaffé altered radically his views on *tâtonnement* between his 1967 and 1981 articles. Together with Walker's 1972 and 1987 contributions, they form the bulk of the output published on Walras's theory of *tâtonnement*.
- 4 Initiated by Morishima (1977, 1980) and developed by Walker (1996) for the second and third editions of Walras's *Éléments*.
- 5 Among Walker's numerous quotations, the following describes accurately (in connection with the theory of *tâtonnement*) the author's intentions: 'Through analytical reasoning, Walras attained his idea of how the market works and was consequently able to develop his model of economic tatonnement. It was, he believed, the *image* of the equilibrating process in real markets' (1996: 263).
- 6 Jaffé (1977, 1980, 1981), Baranzini (1993, 2001), Bridel (1996, 1997), De Caro (1988), Huck (1999), Lendjel (1997) and de Vroey (1999).
- 7 This exact wording (*libre concurrence absolue*) already appears in 1877 in a letter addressed by Walras to Renouvier (*Correspondence*, I: 542).
- 8 'A term used [. . .] to describe the circumstance in which the equilibrium of a system depends on the history of that system' (Pearce 1996: 190).
- 9 'Realism' is understood here as an attempt at describing some sort of contingent 'real' world.
- 10 See Jaffé (1980) and Huck (1999).
- 11 Bertrand (1883) reviews here Walras's *Théorie mathématique de la richesse sociale* (1883). On this episode see Walras's letter 396 (Jaffé, *Correspondence*, I: 552–3), Jaffé (1977: 87–8), Bridel (1996: 195–202) and Walker (1996: 95–100).
- 12 For Walras, the word 'equivalence' usually refers to equality in value; a value expressed at general equilibrium prices. On page 185, Walras speaks of 'constant value of the quantities possessed by each holder'.
- 13 The absence of prices expressed in *numéraire* in the lessons preceding lesson 25 makes difficult the formulation of any relationship related to value: indeed, what direct prices should be used? Walras bypasses the difficulty by using *exchange values* to formulate the budget equation, Walras law or, in lesson 24, the equivalence between quantities, i.e. the equivalence in value between two different baskets (two different initial endowments). He suggests the following explanation: though they are 'arbitrary terms', this relationship 'corresponds exactly to the proportions [. . .] which all commodities bear to one another and which are common to all parties'; and if there are m exchange values, 'these terms, taken two at a time, yield $m(m-1)$ prices of the m commodities in terms of one another. This makes it possible, under

- certain circumstances, to insert the arbitrary terms themselves, instead of their ratios, in our calculations' (1954: 178).
- 14 In his own copy of the *Eléments*'s first edition, Walras pencils in TB (for *très bien*) next to this reference to the theorem of equivalent redistributions.
 - 15 See Bridel (1996: 163–9) for a full discussion of Bertrand's remarkable book review. Bertrand had already mentioned the issue to Walras during a brief encounter as early as 1877 (see letter from Walras to Haton de La Goupillière, *Correspondence*, I: 552–3).
 - 16 In original French: 'Sur le marché théorique, en cas d'excédent de la demande sur l'offre ou de l'offre sur la demande, [. . .] l'échange demeure suspendu jusqu'à [. . .] l'égalité de l'offre et de la demande' (1885, *OEC*, IX: 312, n. 1).
 - 17 All his life, Walras tried desperately to keep together these two indispensable halves of his theory of exchange. This problem is discussed in more detail below in 3.1 devoted to the controversy between Walras, Edgeworth and Bortkiewicz on the static/dynamic nature of Walras's *tâtonnement*.
 - 18 Walras develops for the first time his famous *tâtonnement sur bons* in his 1899 'Equations de la circulation' in connection with his frantic attempt at introducing money into general equilibrium (Bridel 1997: 123–39).
 - 19 According to the Negishi-Hahn tradition, one should perhaps use here the term *non-tâtonnement*. However, given the present authors' intentions, and even in the presence of disequilibrium transactions, the expression *tâtonnement* is used throughout the rest of this paper.
 - 20 Similar in all editions, this demonstration is not rigorous from a modern point of view; but the objective here is only to put in evidence the necessary neutrality of *tâtonnement*.
 - 21 Technology and tastes are in fact given and invariable.
 - 22 The prices of services are listed here: 'prices' should be read here, not 'quantities'.
 - 23 This last sentence was already present in §250 in *EEP1* and survives in §208 in *EEP4–5* (1954: 243).
 - 24 In connection with this foreign market hypothesis, surprisingly, Rebeyrol (1999: 135) holds a different opinion on the presence of disequilibrium transactions.
 - 25 The comments made by Bertrand are probably behind the introduction of these restrictions linked to this 'reprise du *tâtonnement*' (Bridel 1996: 258).
 - 26 In what follows, the problems raised by this bizarre hypothesis are ignored. As a matter of fact, how can one 'borrow' services?
 - 27 On this debate, see Jaffé (1967: 257–8), Walker (1996: 302–15), Bridel (1996: 251–9) and Berta (2000: 135–53).
 - 28 Hostilities began with Edgeworth's review of Walras's second edition (1889a; see also 1889b) and, with the help of Bortkiewicz's article (1890) written under Walras's supervision, the indirect debate between the two men dragged on until Edgeworth's 1891 reply in the *Revue d'économie politique*. This sometimes heated debate between Edgeworth and Walras takes place without any of them having completely understood the gap between their widely different technologies of exchange. Furthermore, most modern discussions of this debate are not careful enough to outline in detail their respective frameworks. Creedy (1986: 79) is often unfair to Walras and Walker (1996: 304–5) has little time for what he seems to consider as Edgeworth's idiosyncratic approach.
 - 29 In the second edition (reviewed by Edgeworth), Walras formally introduced the no-trade-out-of-equilibrium hypothesis in the theory of exchange only but had not yet come round to introducing the *tâtonnement sur bons* in the theory of production.
 - 30 Edgeworth refers here to the constancy of functions during *tâtonnement*.

- 31 See respectively §203 and 247 of the second 1889 edition of the *Eléments* and above 2.2.
- 32 Based on the law of supply and demand, i.e. the net excess demand rule.
- 33 As shown by Walker (1996: 55–6, 86–9 and 266–67).
- 34 Moreover, and as shown by Benetti (2002), the ‘law of supply and demand’ is only a particular rule of price adjustment purely *exogenous* to the determination of general equilibrium in Walras's model.
- 35 Walras read Edgeworth's small volume in 1886 (*Correspondence*, II: 359).
- 36 In a rejoinder published in French in the *Revue d'économie politique* and never translated into English.
- 37 We use the French expression to avoid any confusion with the modern concept of ‘perfectly free market’.
- 38 This article was left unanswered by Walras and marks the end of his relation with Edgeworth.
- 39 On this point, Morishima (1977, 1980) advocates an interpretation close to Walker's. In contrast, see Jaffé's well known interpretation of general equilibrium as a ‘realistic utopia’ (1981: 345).
- 40 Ideal types are true in the sense of an ontological truth’ (Dockès 1996: 53).
- 41 For example, in the theory of production, *tâtonnement* has to show that ‘this problem to which we have given a theoretical solution is the same problem which is solved in practice in the market by the mechanism of free competition’ (§249 in *EEP1*, §202 in *EEP2–3*, §206 in *EEP4*; 1954: 241–2).
- 42 About the probable year of writing of this text, see the editor's comments in Walras's *OEC*, vol. XI: 301.

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Abstract

Starting with a detailed discussion of the *theorem of equivalent redistributions*, Part 1 examines the central role played by the distributional neutrality of *tâtonnement* in Walras's pure theory of exchange. Part 2 extends this discussion to Walras's attempts at reaching a similar result when dealing with the successive versions of his theory of production before 1900. Part 3 contrasts Walras's and Edgeworth's respective technologies of exchange in order to demonstrate that a distributionally neutral *tâtonnement* is an intrinsic part of Walras's theory of exchange. Finally, and besides briefly summarizing the results, the conclusion develops the crucial connection between the necessity of a converging and distributionally neutral *tâtonnement* in pure economics with Walras's theories of property and justice.

Keywords

Edgeworth, Walras, *tâtonnement*, competition, hysteresis