

Edgeworth versus Walras on the Theory of Tatonnement

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I. INTRODUCTION

The purpose of this essay is to evaluate Francis Y. Edgeworth's criticisms of Léon Walras's work on tatonnement.¹ Those criticisms were aimed at Walras's theory as it stood during the years from the early 1870s to 1899. In the latter year and in 1900 Walras developed a theory of tatonnement in production, as briefly described below, but this essay is concerned with it only insofar as it shares the characteristics of the theory that Walras advocated for most of his career, and only indirectly. The reason for undertaking the evaluation is that Edgeworth's criticisms deal with basic issues in the interpretation of Walras's theory: its importance within his general equilibrium model and to the economic theory of his time, its methodological soundness, the feasibility of its objectives, and the breadth of its applicability. An examination of Edgeworth's criticisms therefore contributes to an understanding of its characteristics, function, and value.

Walras had developed the major outlines and most of the details of his conception of tatonnement by 1889, when he published the second edition of the *Eléments d'économie politique pure*.² Edgeworth's criticisms were first presented in his review (1889a) of that edition. He had warned that Walras might not like the review (Edgeworth to Walras, August 20, 1889, L 910, pp. 338-39),³ but Walras feigned unconcern about the matter, commenting that since he expected some more or less lively criticisms, but he had been careful not to go to the library in Lausanne to read them (Walras to Charles Gide, September 20, 1889, L 923, p. 357; and see Walras to Luigi Perozzo, October 13, 1889, L 925, p. 359). Of course, he soon succumbed to temptation, and became involved in a vigorous and sometimes acrimonious controversy with Edgeworth. Very early in the debate, Walras's feeling for Edgeworth became close to dislike. Walras had hoped, he confided to Charles Gide, that the mathematical method in economics would eliminate the posturing and charlatanism Edgeworth displayed (Walras to Gide, November 3, 1889, L 933). Walras thought him a humbug and a puffist who was quite capable of discrediting the new method of mathematical economics (Walras to Gide, April 11, 1891, L 1000), "a man who seems competent enough as a mathematician, but who is mediocre as an economist, and who in addition has a superficial and inconsistent intellect" (Walras to Maffeo Pantaleoni, January 5, 1890, L 953, p. 385).

Ladislaus von Bortkiewicz joined the debate in response to Walras's request that he answer Edgeworth, in order, as Walras put it, to try to prevent mathematical economics from straying into sterile fantasies (Walras to Bortkiewicz, October 17, 1889, L 927, pp. 363-64; see also Walras to Bortkiewicz, November 3, 1889, L 932, pp. 369-70); and, as will be seen, Vilfredo Pareto delivered his judgment on an aspect of the controversy. Bortkiewicz felt, like Walras, that Edgeworth was "extremely superficial as an author and a critic" (Bortkiewicz to Walras, December 29, 1889, L 952), a sentiment that was reciprocated by Edgeworth. In the hope, Edgeworth wrote, of providing "a sufficient defense against the accusation of having unjustly

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attacked one of those whom I consider to be a master," he recalled that in his review he had described Walras as one of the small number of persons who had made an original contribution to economics (Edgeworth 1891, p. 11), although not by his theory of tatonnement.⁴ Any commentary that tries to be impartial without being insipid, Edgeworth continued, is liable to the sort of criticisms that Bortkiewicz had made (*ibid.*, pp. 11–12, n. 1). Edgeworth was incensed that the critique of his work by Bortkiewicz was presented "in a tone of continuous denigration," and maintained that his own remarks were not. Nevertheless, they were in fact interspersed with barbed comments calculated with unerring precision to irritate their target. Edgeworth charged, for example, that Bortkiewicz did not bring to the subject the degree of attentiveness that is indispensable in mathematical studies (*ibid.*, p. 18, n. 1). He was a true believer who, having become attached to a particular literal interpretation of Walras's work, became confused upon discovering contradictory passages in his holy books (*ibid.*, p. 17, n. 1). In the course of the debate Edgeworth elaborated upon and added to his criticisms, and during the rest of his life he intermittently reiterated them. Walras also commented on the issues for many years in his correspondence, which, with the exception of two or three relatively unimportant letters, has not been used before in the examination of his theory of tatonnement. We shall now see what inspired such strong and enduring passions in such eminent scholars.

II. EDGEWORTH'S CRITICISMS

Edgeworth freely acknowledged Walras's contribution to the formulation of the conditions of static equilibrium in exchange, referring to Walras as "the economist who first stated the theory of exchange in all its generality" and to the justice of claiming priority for him with respect to it (*ibid.*, p. 13; and see Edgeworth 1889b, 2, pp. 281, 296–97; Edgeworth 1915, 2, pp. 452, 453).⁵ Edgeworth distinguished Walras's statements of static equilibrium, however, from his theory of tatonnement, correctly interpreting the latter as an attempt to describe how the market system works its way to equilibrium (Edgeworth 1891, p. 13). That theory, Edgeworth thought, was "not a very good idea" (Edgeworth 1889a, p. 435), for several related reasons.

i. The content of the theory, Edgeworth maintained, is so limited that it can be stated briefly, so Walras should not have devoted so much of the *Eléments* to it (*ibid.*). His "prolonged and reiterated" analysis of the dynamic problem (Edgeworth 1891, p. 20) was "out of proportion to the importance of its results" (Edgeworth 1889a, p. 435) and risked appearing purely speculative to the economist and insignificant to the mathematician (Edgeworth 1891, p. 20).

Walras regarded that criticism as mistaken (Walras to Bortkiewicz, October 17, 1889, L 927; Walras to Edgeworth, March 8, 1890, L 964). "Some critics," he wrote, "are . . . amused at the number of pages that I take to demonstrate that the equilibrium price must be reached by raising the price in the case of the quantity demanded exceeding the quantity supplied and lowering the price in the case of the quantity supplied exceeding the quantity demanded." Walras reported that when he had asked one of his critics how he would demonstrate the stability of equilibrium, the person had replied in surprise that he thought it is self-evident. Walras had replied: "There is nothing self-evident but axioms, and this is not one of them" (Walras 1896, p. 470; Walras 1926, p. 472).⁶ In fact, Walras's theory of tatonnement does not deal at excessive length with a minor or purely speculative matter. It is an attempt to accomplish the important task of establishing the occurrence and characteristics of equilibrating processes in a competitive multi-market system. Walras realized that the solutions to his equations could not be identified as equilibrium values unless there is a dynamic process in the

system that causes its variables to tend to move toward those solutions. That question is of such complexity that it involved Walras in a lengthy consideration of market iterative processes and of the effects of changes in any particular price upon other prices. His investigation of those issues was a significant part of the beginnings of modern general equilibrium analysis, and their resolution, far from being a simple matter that could be briefly stated, eventually required extensive research by the finest general equilibrium theorists of the twentieth century. Moreover, Edgeworth was in error in believing that the theory of tatonnement involves nothing more than the raising and lowering of prices. Although that process and its impact upon excess demand quantities are essential parts of the equilibrating process, a number of other important related disequilibrium economic phenomena, such as the emergence of economic profits and their role in guiding the reallocation of resources, form the substance of Walras's theory of tatonnement (Walker 1987a and 1987b). He studied such matters not only in connection with stability analysis but in order to understand the dynamic behavior of the economy for its own sake.

ii. Edgeworth took the position that all purely competitive markets behave in the same general way, so there was no need for Walras to give a separate exposition of tatonnement in the markets for different types of commodities. There was, for example, no need for Walras to have discussed the equilibrating process in the capital-goods market because the forces of supply and demand operate in that market in just the same way as in other markets (Edgeworth to Walras, March 1889; Edgeworth 1889a, L 874, p. 435).

Edgeworth was mistaken in that criticism, for the reason, made clear by Walras, that the tatonnement process has different characteristics in the four differing situations of pure exchange, production of consumer commodities, production of capital goods, and a monetary economy (Walras 1889, pp. xiv–xviii; Walras 1926, pp. xi–xv).

Walras's theory of exchange deals with the general features of the dynamic path of prices in organized purely competitive markets on a number of assumptions that impart special characteristics to the tatonnement process. First, the amounts of the commodities available for exchange and the preferences of the traders are given (Walras 1877b, pp. 126–31; Walras 1926, §§ 125–33), the latter being a condition that is also assumed in the tatonnements in Walras's other models. That is, no production or consumption occurs during the tatonnement in a pure exchange economy. Second, transactions in any market are allowed only at the equilibrium price. Third, prices are cried by traders or a price-setter in each market until the equilibrium price is found, following the procedure of changing the price in the same direction as the sign of the market excess demand (Walras 1880a, p. 461; Walras 1880b, p. 78; Walras 1889, pp. 68–69; Walras 1926, § 42). The result of those conditions is that the set of equilibrium prices and the quantities of each commodity traded are those which are the solutions to the set of equations of general equilibrium in which the initial asset distribution is a parametric condition.

In contrast, for an economy in which the production of consumer commodities occurs, Walras considered tatonnement processes in relation to the determination of the prices of productive services and rates of production of commodities. As intimated earlier, in 1899 and 1900 Walras developed a pledges model of tatonnement in production in which the participants pledge that they will buy or sell specified amounts of commodities provided that the set of prices is an equilibrium one, and do not engage in actual production or consumption at any other set of prices. Prior to 1899, however, Walras espoused a disequilibrium-production model. That was the model with which Edgeworth was familiar when he wrote his review and to which he had reference in his subsequent criticisms of tatonnement in production, so it is the one that will be

considered here. It describes the efforts of entrepreneurs to make adjustments of rates of production of commodities when markets are in disequilibrium, efforts that are very different from the bidding activities of traders in the tatonnement in a pure exchange economy. In the process of production, entrepreneurs grope their way toward equilibrium by shifting resources among industries. Driven by the desire to make profits, they establish new firms in profitable industries and expand the output in existing firms in such industries. As the output expands in any industry, the price of the commodity falls in its exchange market. Simultaneously, the prices of productive services are bid up, thus raising the average cost of production. Eventually the output price and the average cost of each commodity become equal, and at the same time the supply and demand quantities become equal in all markets. The level of economic profit is then zero, the production tatonnement ceases, and the influx of resources ends. Driven by the desire to avoid losses, entrepreneurs reduce output and abandon firms in unprofitable industries. As the output in any industry decreases, the opposite of the changes just mentioned occur in prices and average costs until equilibrium is found. The level of economic profit is then zero, the production tatonnement ceases, and the exit of resources ends (Walras 1877b, p. 231–32, 258–65; Walras 1896, p. 477; Walker 1986).

The market for capital goods has some additional characteristics. Nevertheless, Walras complained, Edgeworth “honestly believes that I am amusing myself by inventing” the problem of determining which capital goods ought to be constructed, “for the pleasure of complicating matters” (Walras to Bortkiewicz, October 17, 1889, L 927). In reality, Walras contended, the capital-goods market requires special attention, which he gave it under the title of the theorem of the maximum utility of new capital goods (Walras to Edgeworth, April 4, 1889, L 876; Walras to Wicksteed, April 9, 1889, L 877; Walker 1984b). As in his treatment of consumer commodities, Walras developed both a disequilibrium-production model and a pledges model of tatonnement in the capital-goods market. For the same reasons as were given in connection with his models of the market for consumer commodities, only the disequilibrium-production model will be considered here. Walras’s contention regarding it was justified, because the capital-goods tatonnement is conditioned by the institutions, rules, and equilibrating processes in the markets for savings and credit, and by the circumstances of the production, purchase, and use of commodities that yield a flow of revenue. The resulting tatonnement is one of entrepreneurs interacting with capitalists, workers, landlords, and sellers of raw materials in an effort to select the particular kinds of new capital goods that should be produced and to adjust the output of them so as to maximize profits (Walras 1877b, pp. 297–98; Walras 1889, pp. 279–80; Walras 1926, §§ 251, 257–58). It eventuates in the equilibrium conditions that the ratio of the net price obtained from the sale of the services of a capital good to its price is equal for all such goods, that saving and investment are equal, and that the prices of new capital goods are equal to their costs of production (Walras 1877b, pp. 289, 300–301; Walras 1926, §§ 260, 262–64; Walras to Knut Wicksell, November 10, 1893, L 1170). The process determines the desired additions to the durable capital stock and the equilibrium net rate of return on capital goods, which is the pure rate of interest (Walker 1984b, pp. 535, 552). Thus the tatonnement in capital formation involves a variety of phenomena not present in pure exchange or in the production of consumer commodities.

In his theory of tatonnement in a monetary economy, finally, Walras had to deal with the special phenomena introduced by the circumstance that transactions are made with money. Cash balances are needed, he argued, because ordinarily income is not forthcoming in the necessary amounts when planned purchases must be made. The balances were regarded by

Walras as yielding a service of availability—a convenience of possession—just like physical circulating capital; they are valuable because they ensure that goods and services can be acquired when they are needed. The service provided by money is supplied by capitalists, that is, by people who have excess cash balances. It is demanded by consumers to make purchases of consumer goods and services and by entrepreneurs to make purchases of productive services, raw materials, and semi-finished goods. The monetary tatonnement, Walras explained, is one of groping for optimum cash balances and for an equilibrium rate of interest (Walras 1889, pp. 375–81; Walras 1896, pp. 375–81). If the net quantity of cash balances demanded exceeds the net quantity supplied at the quoted rate of interest, the rate is raised, and entrepreneurs and consumers reduce the net quantity demanded and capitalists increase the net quantity supplied. In the opposite case, the rate is lowered, and the quantity demanded decreases and the quantity supplied increases. The tatonnement continues until the equilibrium rate of interest on money capital is determined, namely the rate which equates the quantities of cash demanded and supplied (Walras 1889, p. 381; Walras 1896, p. 381). These matters were then related by Walras to the determination of the money prices of commodities and the price level (Walras 1889, pp. 383–86; Walras 1896, pp. 383–86; Walras 1926, § 282).

Thus exchange, production of consumer commodities, production of capital goods, and a monetary economy each have special structural and behavioral features. In attempting to deal with them in his various discussions of tatonnement, Walras was not repeating himself or manufacturing complexities where none existed.

iii. Edgeworth argued that Walras’s theory of tatonnement confuses the meaning of the static equations of exchange with the process of dynamic adjustment toward equilibrium. Walras tried, Edgeworth contended, to base his dynamic theory upon the static equations and to derive its properties from their characteristics, but “as Jevons points out, the equations of exchange are of a statical, not a dynamical, character. They define a position of equilibrium, but they afford no information as to the path by which that point is reached” (Edgeworth 1889a, p. 435). Walras should have realized that they do not deal with “the play of supply and demand by which that position is attained” (Edgeworth 1891, pp. 12, 14).⁷

That was not a legitimate criticism of Walras’s work. As Bortkiewicz rightly observed, Walras did not mix up statics and dynamics. His procedure conforms perfectly to the idea that Jevons expressed of the nature of the static equations, namely that they are accurate representations of equilibrium conditions provided that certain conditions are constant during the equilibrating process (Bortkiewicz 1890, p. 85). Walras confined himself to the static point of view, “in the sense that he assumes the quantities of products possessed as being constant, and the utility functions as invariant.” He maintained those assumptions without deviation when he dealt with the dynamic question of “the solution of the equations of exchange by the raising and lowering of the price” (*ibid.*, p. 86). Bortkiewicz manifested by those remarks his realization that, contrary to Edgeworth’s opinion, Walras had a sound conception of the difference between the static and dynamics. Walras made this evident by the careful and correct distinction that he preserved between statics and dynamics in his theorizing and by his analysis of the difference between them. The “static theory of exchange,” he explained, “may be defined as the exposition of the equilibrium formula of the maximum satisfaction that obtains when there is proportionality of the value of each commodity to the intensity of the last want it satisfies.” The static aspect of the theory is the statement of equilibrium conditions and the study of the existence of equilibrium. The “dynamic theory,” he continued, is a different matter. It may be defined as “the demonstration of the attainment of that equilibrium through

the play of the raising and the lowering of prices until the equality of the supply and demand quantities is established" (Walras 1895, p. 630). Thus dynamics is the study of the stability of equilibrium. He went on to refer again to statics and dynamics as two different problems, and claimed priority in examining the latter (*ibid.*).

Furthermore, Walras did not confuse *comparative* statics with dynamics. His view of the character of the former, formulated as early as 1875 and repeated many times subsequently, was a model of clarity, revealing the soundness of his grasp of the methodological characteristics of static analysis. It is the right of the theoretician, he explained, to assume that utility functions and endowments are constant when he formulates the law of the establishment of equilibrium prices. It is his duty, however, once that operation is finished, to remember that in real markets those parameters are subject to change, and accordingly to examine the results of their variations and to formulate the laws of the variation of equilibrium prices (Walras 1875, pp. 390–91; Walras 1877b, pp. 135–37; Walras 1889, p. 125; Walras 1926, §§ 102, 137–38), that is, to study comparative statics.

Finally, Walras did not try on any occasion to derive dynamic market processes from the conditions of static equilibrium. He repeatedly indicated the impossibility of such a derivation and the consequent necessity for a dynamic theory based upon considerations that are logically antecedent to the statement of the conditions of static equilibrium. He rightly emphasized that Edgeworth, in one of his treatments of equilibrium, had neglected part of the problem. As a result of examining only the static equations and of indicating nothing about the mode of their solution by tatonnement in the marketplace, Edgeworth's treatment of the general equilibrium of exchange (Edgeworth 1889b, 2, pp. 296–97) was incomplete. It is not enough, Walras argued, to consider only the mathematical solution of the equilibrium equations. It is also necessary to explain how the real market system works dynamically and eventuates in their empirical solution (Walras to Pantaleoni, January 5, 1890, L 953, p. 385; Walras to Perozzo, March 18, 1890, L 969, p. 404). That essential process was the subject of his theory of tatonnement.

iv. Edgeworth maintained that Walras's theory of tatonnement could not accomplish its purpose because the problem of modeling the dynamic behavior of markets is virtually insoluble. Edgeworth's thought on this matter in 1889 stressed the difficulty of studying economic dynamics. Even in regard to exchange in a competitive market for a single commodity, he contended, the dynamic problem is so difficult that, although we know that such a market tends to reach equilibrium, economic theory has not described how it does. The "economic problem of several trading bodies distributing and exchanging *inter se* under the influence of self-interest, and in a regime of competition, is much more hopelessly difficult than the as yet imperfectly solved dynamical problem of several material bodies acting on each other *in vacuo*" (Edgeworth 1889b, 2, p. 280). Furthermore, if there is mobility between different occupations, it is virtually impossible not only to formulate a model of the dynamic path of the system but even to find its equilibrium:

When we advance from the simplest type of market to the complexities introduced by division of labour, it is seen to be no longer a straightforward problem in algebra or geometry, given the natures of all the parties, to find the terms to which they will come. Here, even if we imagine ourselves in possession of numerical data for the motives acting on each individual, we could hardly conceive it possible to deduce *a priori* the position of equilibrium towards which a system so complicated tends (*ibid.*, p. 281).

By 1891 Edgeworth had come to believe that a knowledge of dynamics is impossible in

principle. According to him, the unsatisfactory character of Walras's theory of how prices are adjusted in such a way as to lead markets to equilibrium may be shown by drawing an analogy between market behavior and the flow of a liquid down the sides of a valley. Walras sometimes arbitrarily represented the liquid as flowing in a specific and determinate course, whereas the only thing that can be stated is that in one manner or another it arrives at equilibrium (Edgeworth 1891, p. 19). The same is true regarding the progress of the economy from disequilibrium to equilibrium, so "the better position is that only the position of equilibrium is *knowable*, not the path by which equilibrium is reached" (Edgeworth 1904, 1, p. 39; emphasis added). Although economic theory has succeeded in achieving a description of the conditions that prevail in static equilibrium, "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" (Edgeworth 1925, 2, p. 311). Edgeworth took the extreme position that "the give and take of bargaining by which the price is determined, the direction that the system follows to arrive at the equilibrium position, *is not part of the domain of the science*" (Edgeworth 1891, p. 12, emphasis added). Consequently, he concluded, the dynamic behavior of markets can be discussed only in an abstract manner (*ibid.*), which he presumably considered as the nature of his discussion of recontracting (Edgeworth 1881).

Walras rejected Edgeworth's imposition of a ban upon the investigation of dynamic paths, disagreeing with his opinion that

I am engaged in absolutely useless exercises in my efforts to demonstrate that the operations of the raising and lowering of prices, of the increases and decreases of the quantities of products produced, etc. on the markets are nothing other than the solution by tatonnement of the equations of exchange, of production, and of capital formation (Walras to Bortkiewicz, October 17, 1889, L 927, p. 364).

Walras regarded Edgeworth's argument that it is useless to try to demonstrate the way that the economic system moves to equilibrium as a council of despair and as the product of a fundamentally erroneous conception of economic studies. His opinion, according to Walras, "shows that he has no idea of the object and proper goal of pure economics, which consists above all and before all in the demonstration to which I refer" (*ibid.*). Walras pointed out again that dynamic theorizing is not only a legitimate but also a necessary part of economic science. He was aware that a detailed dynamic model is difficult to construct but he also correctly believed that his dynamic theoretical objective could be attained without such a model. For his purposes, the precise path of the price in each market need not be known. Edgeworth should have seen that a discussion on the level of abstraction of the theory of tatonnement is sufficient to establish the general features of the dynamics of competitive markets and, in particular, to establish their stability. He had not, he explained, tried to give a complete description of reality, but only to sketch its outlines, and he left the task of finishing the picture to others (Walras to Fisher, July 28, 1892, L1064, p. 499; Walras 1895, pp. 629–30).

v. Edgeworth argued that the tatonnement process is not the only way that markets reach equilibrium. "Prof. Walras's laboured lessons indicate *a* way, not *the* way of descent to equilibrium" (Edgeworth 1889a, p. 435; and see Edgeworth 1891, p. 20). The idea of tatonnement, Edgeworth contended, is not an appropriate conception of its object because, unlike the idea of equilibrium, it does not typify reality (Edgeworth 1891, p. 20). In fact, Edgeworth claimed, he had provided a better description, not precisely of the dynamic path, but of the economic behavior underlying it: "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, the process of *recontract*" (Edgeworth 1925, 2, p. 311). No real market behaves in the way described in the theory of purely competitive exchange (Edgeworth 1891, p. 12).

To show that there are other types of markets which could equally well be taken as having some generality, Edgeworth constructed a number of examples in which the different structural features of the markets give rise to different dynamic processes and equilibrium outcomes (ibid., pp. 15–17). He also pointed out the unique characteristics of a number of real markets. In the market for government securities in England, for example, there are two prices, one for the seller and one for the buyer. In the English labor market there are coalitions that can exercise a great influence over the price (ibid., p. 12). In some markets different prices are cried simultaneously. In some markets there are quantity reactions, in others there are price reactions. In some markets there are few traders, in others there are many. Some markets use the English auction system; some use the Dutch auction system (ibid., pp. 13, 16, 17 n.1). Edgeworth consequently refused to admit that there is any single method of empirical solution of the equilibrium equations. The determination of prices cannot be brought under one rule (ibid., p. 20, n. 1). Thus the question raised by Edgeworth, and answered in the negative, was whether it is useful to construct a model of the economy on the assumption that it is purely competitive.

Walras's position on that issue was explained in part by Bortkiewicz, who argued that Edgeworth was wrong to say that it was not a good idea for Walras to have supposed that the competitive mechanism of raising and lowering prices is the way that the equations of equilibrium are solved. Is there, Bortkiewicz asked, another process that actually occurs on the market and that can be regarded as a way of solution of the equilibrium equations? No, he declared (Bortkiewicz 1890, p. 85). It is obvious that the market system adjusts by changes of prices (ibid., p. 86). The tatonnement process is not *a* way, but *the* way that real markets do in fact move toward equilibrium (ibid., p. 85). Pareto agreed: "M^r Walras has shown that the bargaining established with free competition is the means of solving the equations of exchange by successive attempts. M^r Edgeworth has objected that the tatonnement process is only *one* way. He is right; but the way indicated by M^r Walras is truly that which describes most cases" (Pareto 1896/1897, I, pp. 24–25). Pareto therefore disagreed with Edgeworth's view that Walras's theory of tatonnement was unrealistic and lacked sufficient generality.

Repeating and enlarging upon Bortkiewicz's argument, Walras indicated his disagreement with Edgeworth's assertion that the tatonnement theory does not deal with a representative equilibrating process. "Pure analytical economics," Walras maintained, "is essentially the theory of the determination of prices in a hypothetical regime of absolutely free competition" (Walras 1926, p. xi). He rejected Edgeworth's view that such a theory is rendered useless by the variety of actual pricing processes. Walras recognized the existence of non-competitive markets, and had a vivid appreciation of their complexity. He even developed a theory of monopoly pricing and production (Walras 1877b, pp. 376–88; Walras 1926, §§ 376–84), but he had to leave it outside of his general equilibrium model. The state of the discipline, he explained, did not permit the incorporation into a general equilibrium model of market structures in which there are impediments to competition, although he hoped that would eventually be possible. In his theory of general equilibrium, he wrote, he accordingly did not have the objective of constructing a mathematical theory of all the possible ways of conducting trade but of developing a theory of those markets that follow the pricing process described in his theory of tatonnement (Walras 1877b, p. 267; Walras 1926 § 222; and see Walker 1984a, p. 467). It was,

he believed, perfectly legitimate to leave the non-competitive market structures aside in developing that general model, for the reason that pure competition is the principal mode of exchange in the real world, practiced on all markets with more or less precision and accordingly with less or more frictions (Walras 1895, p. 630). He assumed it, therefore, as a reasonable simplification, believing that "the secret of science is to give primary importance to the general case and to relegate particular cases and exceptions to a secondary level of importance." That was, he declared, the basis of his quarrel with Edgeworth. "In the question of tatonnement, for example," Walras elaborated,

I take the almost universal regime of free competition in regard to exchange, that which was described by John Stuart Mill, and which consists in raising the price in the case of the quantity demanded exceeding the quantity supplied and lowering it in the case of the quantity supplied exceeding the quantity demanded, and I demonstrate that the process leads to equilibrium by establishing the equality of the quantities supplied and demanded. Whereupon there is thrown at my head the market for English public debt, the system of English auctions, the system of Dutch auctions, etc., etc. (Walras to Bortkiewicz, February 27, 1891, L 999, pp. 434–35).

The point of contention was whether economics should be broken up into the study of particular market structures or be concerned with a purely competitive general equilibrium model. Walras's assumption of pure competition throughout the non-monopolized parts of the economy and the treatment of them as a single system had great merit. It recognized and generalized the fact that price competition was extensive in the economy of his time. It enabled him to construct a model that provided a very substantial beginning for general equilibrium analysis, serving as a stepping stone for a more comprehensive theory which will eventually deal satisfactorily with disequilibrium exchange and production and imperfectly-competitive behavior. His model is also the origin of general equilibrium models which can be adapted for statistical implementation in the manner of Wassily Leontief's input-output system and in other ways also (Piggott and Whalley 1985). The clearly defined properties of a purely competitive model approximate those of reasonably competitive sectors of our economy, and furnish conditions and standards in the light of which we can conceive of imperfectly competitive models and evaluate the conditions they generate. The conclusion that the purely competitive assumption is useful for these and other well-known reasons (Walker 1970, p. 690) was reached by many of Walras's great contemporaries, including Alfred Marshall, Vilfredo Pareto, and Knut Wicksell, and by many subsequent economists, including J. M. Keynes and J. R. Hicks.

Edgeworth was unable to incorporate the different pricing processes that he identified into a single manageable model, nor did he wish to do so. His rejection of the purely competitive tatonnement model, coupled with his refusal to entertain the possibility of dynamic theorizing, led him to reject the goal of achieving a general theory of the economy of his day. Nevertheless, the alternative approach that he recommended has great merit. His point that there are a variety of pricing processes is valid, and it is important because it leads to the analysis of different market structures in a partial equilibrium setting.

It would be inappropriate to pronounce Walras's analysis as right and Edgeworth's as wrong, or the reverse. To reject one approach or the other, as did the original protagonists, would lead to an impoverishment of economics. There are many questions aimed at discovering the impact of changes upon the various parts of the economy that can be answered only with a general microeconomic model. There are many questions of limited scope that are best treated by the examination of a particular market structure. The conclusions of this section are therefore that both Walras and Edgeworth were right, inasmuch as they both identified

important fields of economic analysis and approaches to the study of economic behavior, and that they were both wrong in condemning each other's field of inquiry.

III. CONCLUSION

Edgeworth alleged that the theory of tatonnement is unimportant, that it had very little content, that it was methodologically unsound because it tried to derive dynamics from statics, that it was a failure because the dynamics of the market place are not amenable to scientific formulation, and that it was useless because it was concerned with the equilibrating process of an unrepresentative model. Walras brought forward arguments against all those propositions, summarizing his response by charging that Edgeworth had not taken the trouble to read the *Eléments* with care. He answers me, Walras complained, without supporting evidence on one of the points "on which I am most confident: the theory of tatonnements, which is the essence of the theory of the determination of prices" (Walras to Gide, November 3, 1889, L 933). Walras nurtured the hope that the theory would not be unfavorably judged by the public, because all the points of Edgeworth's critique appeared to him to be extremely weak (Walras to Edgeworth, March 8, 1890, L 964).

Without deprecating Edgeworth's many and important contributions to the theory of market behavior, and without forgetting that there were deficiencies in Walras's theory of tatonnement that are not considered here because Edgeworth did not mention them (see Walker 1987b), the conclusion reached in this essay is that Walras was right in the position he took in opposition to Edgeworth on the first four points of contention. The conclusion is also reached that both Walras and Edgeworth were advocating worthwhile analytical approaches in their discussions of the fifth point.

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FOOTNOTES

1. The word "tatonnement" is now increasingly being anglicized in print to avoid the distracting and unintentionally emphatic appearance of an italicized word repeated many times. I have followed that practice by eliminating the circumflex over the "a" and by having the word set in roman type.
2. Hereafter this source is cited as *Eléments*.
3. All correspondence cited in this essay is published in Jaffé 1965. In the three volumes of that work the letters ("L") are numbered consecutively, so they are identified simply by their number. The pagination of the citation is given only if the letter is lengthy. Walras's letters and papers and those of continental economists cited in this essay are in French; Edgeworth's letters are in English. I have translated all French writings quoted in this essay.
4. Edgeworth identified the discovery of marginal utility as Walras's major contribution (Edgeworth 1889a, p. 435; Edgeworth 1891, p. 11).
5. Articles of Edgeworth's that are reprinted in his *Papers Relating to Political Economy* (1925) are cited by first giving the date of original publication. This identifies the chronology and enables the article to be found in the list of references. Then the volume of the *Papers* is given, and the pages in that volume where the material appears.
6. The edition of the *Eléments* that is cited first in the parentheses is the first one in which the relevant material appeared. If the same material appeared in the 1926 edition, it is also cited. That edition is cited by section numbers, if the material appears under such a number, in order to enable the reader to locate the material in William Jaffé's translation (Walras 1954) of that edition.
7. Edgeworth mistakenly referred (1891, p. 14, n. 1) to the seventh instead of the fifth appendix to his *Mathematical Psychics* as the place where his interpretation of Jevons's theory of exchange appears.

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