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Marshall and Walras, disequilibrium trades and the dynamics of equilibration in the continuous double auction market☆

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ABSTRACT

Prices and quantities converge to the theoretical competitive equilibria in continuous, double auction markets. The double auction is not a tatonnement mechanism. Disequilibrium trades take place. The absence of any influence of disequilibrium trades, which have the capacity to change the theoretical equilibrium, appears to be due to a property found in the Marshallian model of single market adjustments. The Marshallian model incorporates a principle of self-organizing, coordination that mysteriously determines the sequence in which specific pairs of agents trade in an environment in which market identities and agent preferences are not public. Disequilibrium trades along the Marshallian path of trades do not change the theoretical equilibrium. The substance of this paper is to demonstrate that the Marshallian principle captures a natural tendency of the adjustment in single, continuous, double auction markets and to suggest how it takes place. The Marshallian model of quantity adjustment and the Walrasian model of market price adjustment can be seen as companion theories that explain the allocation and price processes of a market. The Marshallian model explains the evolution of the allocation, who will meet and trade, and the Walrasian excess demand explains the evolution of prices when they do.

1. Introduction

In this paper, we explore the possibility that an empirical regularity of the market convergence process removes the theoretical need to assume that markets are organized by the Walrasian tatonnement. Of course, the idea of tatonnement and the assumption that no trades take place at disequilibrium prices are deeply engrained in economic theory. Indeed, it is sometimes asserted that the theory works only if the market mechanism is the fictional Walrasian auctioneer. The results reported here suggest that, at least in the case of a single market, the almost universally employed abstraction of tatonnement is unnecessary. Substantial parts of market level behavior can be successfully modeled by an empirical assumption made by Marshall even though many questions about individual behavior remain unanswered.

The use of the Walrasian auctioneer and tatonnement metaphors seems to have taken their modern form in a controversy between Walras and Edgeworth about the nature of market convergence. The controversy turned on the possibility that the equilibrium itself would shift in response to disequilibrium trades. Edgeworth maintained that there is no general dynamical

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theory determining the path of the economic system from any point assigned at random to a position of equilibrium. He looked to a theory of recontracting as the foundations of a dynamical theory.[1] Walras looked to the application of special instruments and market processes and from those discussions the metaphorical auctioneer took form. Interestingly, at about the same time, the 1890s, Marshall advanced a theory of dynamics that resolves the Walras–Edgeworth controversy (refer to Appendix H of Marshall, 1961 eighth edition, p. 806) in the case of a single market. However, the Marshallian theory was not examined as part of the controversy and seems to have gone substantially unnoticed in the literature that followed. Marshall was not challenged to generalize to the simultaneous equilibrium of multiple markets, the primary concern of Walras and Edgeworth. The oversight might be due to the fact that the Marshallian theory rests on a very special behavioral assumption that the order in which traders make purchases and sales is dictated by the relative size of their demand and supply prices. On the surface, the behavioral property seems very implausible. However, the results reported here demonstrate that the Marshallian behavioral assumption is not only plausible, but also it can be observed operating in experimental, double auction markets.

Kaldor seems to have anticipated the evolution of theory in light of the controversy with the summary "While Edgeworth's analysis may be slightly obscure and Walras' assumption slightly ridiculous, the main idea stands clear: in so far as there is any initial 'haggling and bargaining' this should be done by playing with 'chips' and not with 'hard cash'." (See Walker, 1973, p. 138.) The tatonnement model, in which no trades take place at disequilibrium prices and is widely applied to general equilibrium, suggests resolution of the issue in terms of current theory (see Arrow and Hahn, 1971, pp. 264–270). Of course, special theoretical efforts exist to explore convergence through non-tatonnement; as examples see Hahn and Negishi (1962), Fisher (1972), Levine (1996) and recontracting (Uzawa, 1962; Green, 1974). However, theory notwithstanding, experimental work has largely proceeded through a study of the non-tatonnement, continuous double auction in which disequilibrium trades are made. Continuous double auction markets are observed converging to the competitive equilibrium with great reliability. However, the reason for the convergence is unknown and regarded as a pressing question, especially in the light of the Walras and Edgeworth discussions.

In order to appreciate the challenge to theory presented by the observed equilibration together with the perplexing nature of the equilibration process, some details of the continuous double auction trading mechanism are needed as background information. The continuous double auction allows agents to publicly submit bids to buy and asks to sell in continuous time. Bids to buy are typically arranged from high to low in an order book and asks to sell are arranged from low to high. The identity of the agents and the preferences of agents are all private information. Trades occur when a buyer tenders a bid to buy that is above the lowest offer to sell that exists in the order book or when a seller tenders an ask to sell that is below the highest bid to buy that exists in the order book. Trade prices are public but the identities of the traders are known only in the form of abstract identification numbers if they are known at all. Of significance in this institutional setting is the general lack of information about trading partners that one might think necessary for coordination and for the development of trading strategies. Indeed, information required for the level of coordination assumed by the Marshallian theory would seem to be entirely absent. Continuous double auctions without the order book have been studied but will not be considered here.

A modern representation[2] of the two classical theories, Marshall and Walras, are illustrated in Fig. 1. Walras is found in almost any current textbook. Market demand and supply are displayed in the usual sense. If the price is P^* then the excess demand is $D(P^*) - S(P^*)$ as shown. The Walrasian tatonnement adjustment process holds that dP is a function of excess demand, $dP = f(D(P) - S(P))$. Equilibrium in the model is a P^{**} such that $D(P^{**}) - S(P^{**}) = 0$. It is important to notice that the model has no facility for identifying trading partners. Individuals appear in no particular order in this construction since both $D(P^*)$ and $S(P^*)$ depend only on the quantity individuals demand at P^* (the sums) and not in some particular order dictated by preference or personal indicator. There is no theory about who trades with whom or the order in which trades occur. If trades do take place at prices other than the equilibrium, the presumption is that the functions will change form and the equilibrium itself will change.

Marshall has a different approach.[3] While the Marshallian theory appears to be just the inverse of the Walrasian theory, in fact, it is much more. Marshall places his theory on quantity adjustment – volume. Volume will increase if demand price is greater than supply price. In Fig. 1, let Q^* be the existing quantity. The demand price is $P_d(Q^*)$ and the supply price is $P_s(Q^*)$. The Marshallian market adjustment model holds that dQ depends on the difference between the demand price and the supply price. If $P_d(Q^*) - P_s(Q^*) > 0$ then quantity increases and equilibrium in the model is the Q^{**} such that $P_d(Q^{**}) - P_s(Q^{**}) = 0$. Marshall makes no assumptions about price, other than the trade price is between the demand price and the supply price. Unlike the Walrasian model, the Marshallian model does not assume that all trades take place at the same price so multiple prices can emerge. However, the Marshallian model by construction incorporates the implicit assumption that the trades

[1] Details of this controversy are found in Walker (1996). Discussions of Walras's ideas of tatonnement can be found in Walker (1987).

[2] Both Marshall and Walras produced detailed variations of their theories as well as the types of institutions that might support the processes that they imagined. See Walker (1996).

[3] His theory is most clearly seen when he discusses the conditions for stability. See Marshall Appendix H, eighth edition, p. 806 where he gives his multiple equilibrium stability graph. Our interpretations of the Marshallian market model are focused only on the market level aggregation of individual demand and supply curves as opposed to how the market aggregations might be derived from or related to individual incentives, bidding strategies or market instruments. Similarly, when interpreting the Marshallian dynamics theory, we are only considering market level adjustments as opposed to how individual decisions might make them come about. Different discussions at the individual level of analysis can be found at Svensson (1984), Vroey (1999), and Zaratiegui (2002).