Chapter 1

PROPERTIES OF DISEQUILIBRIUM ADJUSTMENT IN DOUBLE AUCTION MARKETS

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The tendency of double auction markets to converge to the equilibrium of the associated competitive equilibrium model is well known, but the equilibration process is not understood. The reason for adjustment and the processes that are actively involved with the adjustment process are still a mystery. However, the study of many markets reported over the years by many different research groups have provided some properties of disequilibria and the dynamics of the adjustment process.

Double auction markets have properties that are closely associated with certain institutional and environmental features and have been studied extensively. First, there is a period structure to the markets: an open and a close. Second, major changes, such as parameter changes, occur between the close of one period and the open of the next and this fact is public information. That is, parameter changes do not occur during a period. Third, the commodity traded is like a service that does not have a life of over one period. Redemption values and costs are active for only one period at a time. If the commodity does have a time life – like a security – it will systematically change its value between periods, such as a dividend that is paid at the end of a period. While the discussion that follows does not specifically explore the dynamics of adjustment that occur in other market structures, the properties listed below are characteristic of the asset markets that have been studied: speculative markets, and economies characterized by overlapping generations.

1. *The "sawtooth" property of transactions price equilibration*: period open to period open, period close to period close, period open to period close and period close to period open relationships.

Markets that are not "near" the equilibrium price and quantity exhibit characteristic "sawtooth" properties of equilibration. Equilibration can be detected within periods and between periods; however, the process is not monotonic. It has a sawtooth property such as the illustrated line drawn in Figure 1.

Periods two, three and four of Figure 2 represent a typical pattern. The opening prices of a period are further from the equilibrium than are the closing prices. That is, during a period the movement of prices tends to be in the direction of the equilibrium price. However, while the movement within a period is generally toward the equilibrium, the transaction-to-transaction movement is up and down. This is like moving along a single tooth on the blade of a saw that has many smaller teeth built into it. This movement

Handbook of Experimental Economics Results, Volume 1

DOI: 10.1016/S1574-0722(07)00001-7

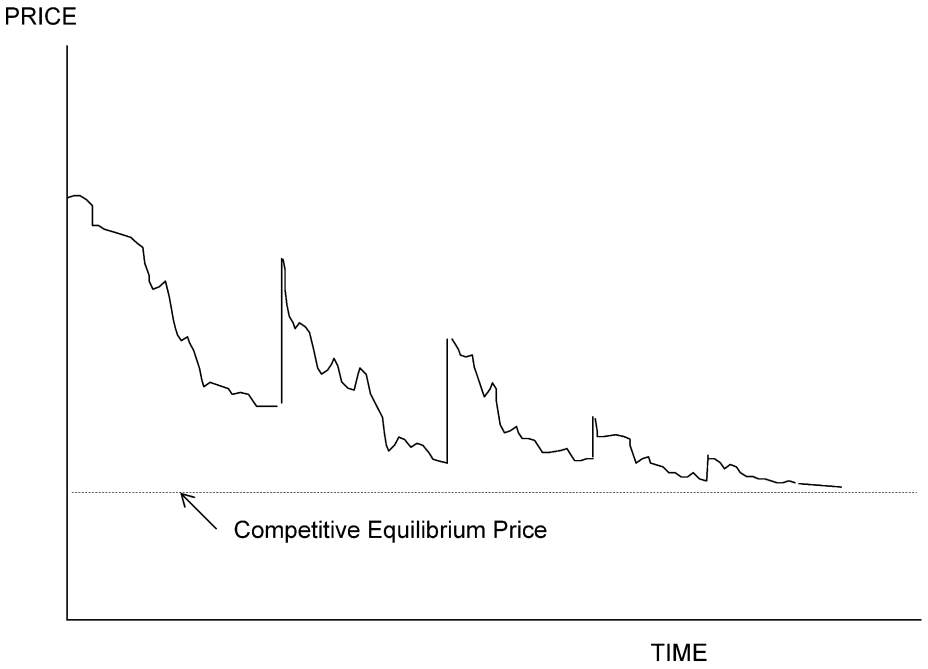

Figure 1. The sawtooth nature of the price adjustment path. Prices begin high and converge toward the competitive equilibrium price during a period. The following period prices start at prices above the price that existed at the end of the previous period.

within a period is often modeled as an exponential adjustment path and while such models capture much of the data, negative serial correlation is evident. Third period opening prices are closer to the equilibrium than were the opening prices of the second period. But the opening prices of the second period are further from the equilibrium than the closing price of the first period. After the open, the prices again move toward the equilibrium price, while following an up and down pattern. Typically opening price in period $t + 1$ is closer to the equilibrium price than was the opening price in period t. So, in each period the opening prices are closer to the equilibrium. The teeth of the saw get smaller and smaller until all data are near the equilibrium price. Ordinarily, the prices do not overshoot the equilibrium, but it can happen as in Figure 1 for periods two and six. Prices start slightly above equilibrium in period one; they then settle below equilibrium in period two and begin to work their way upward, overshooting equilibrium slightly in period six.

2. *The "beacon" property of end of period trades*. The last price movements in a period tend to point in the direction of the competitive equilibrium price (Aliprantis and Plott, 1992). If the prices are above the competitive equilibrium then the final prices

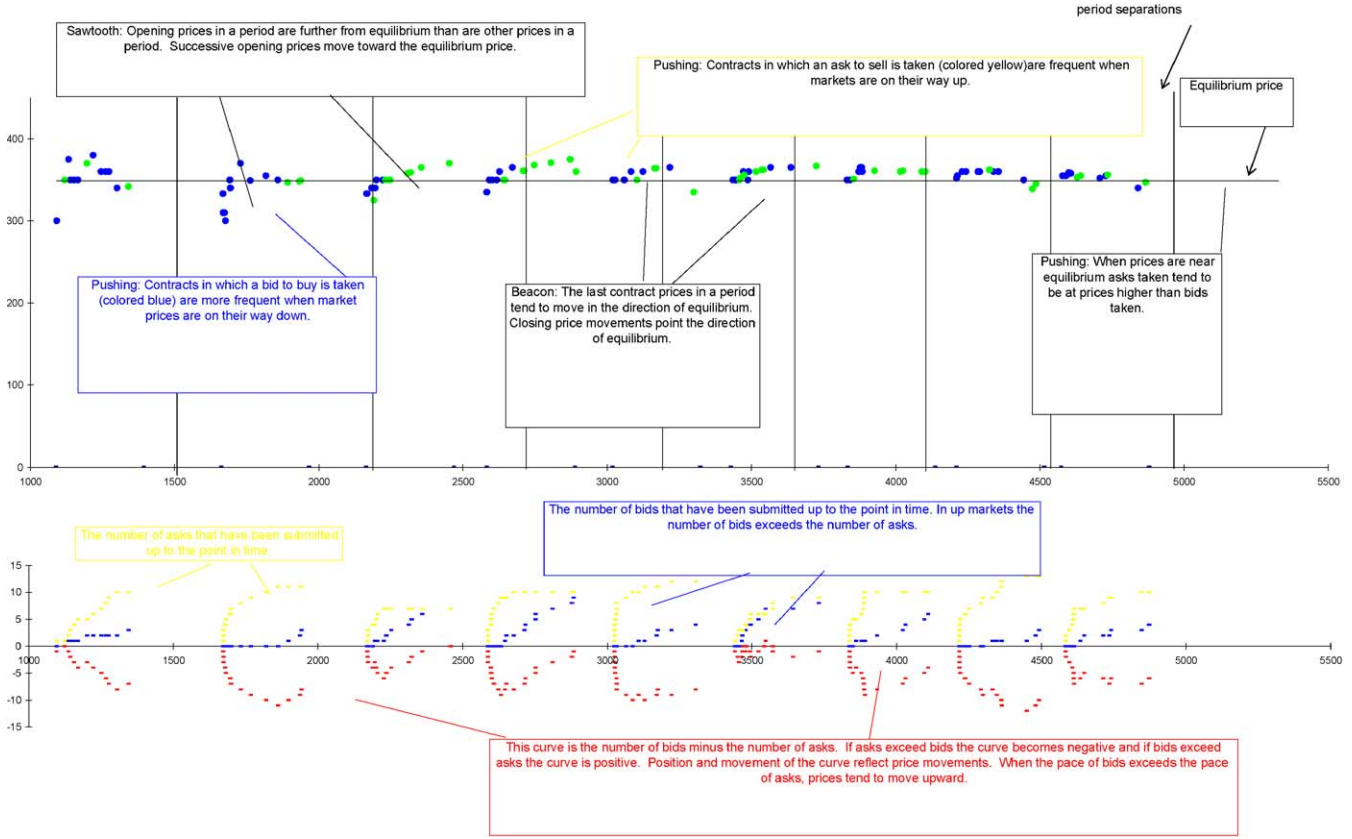

Figure 2. The time series of contract prices show the properties of adjustment in double auction markets: Markets that are in disequilibrium exhibit dynamic properties of adjustment.

tend to be lower than the other prices of the period. If prices are below equilibrium, then the final prices tend to increase relative to earlier prices. This property can be seen in Figure 2. Notice that the last price movements in almost every period are in the direction of the competitive equilibrium. The movement is down at the end of periods four, five (notice that overshooting points in the proper direction), six and seven. In these periods prices are above equilibrium as the end of the period approaches. The final movement is up in periods one, two, eight and nine. In these periods the prices have wandered below equilibrium near the end of the period so the movement is in an upward direction at the end.

3. *The "pushing" property of sale-making actions*. The market price is pushed away from the interests of the side that takes the final action in a transaction. To understand this property it is necessary to distinguish between offers that come in the form of bids to buy, offers that come in the form of asks to sell, and the market orders or actions that actually make a sale/transaction. These sale/transaction actions can be viewed as asks taken and bids taken. In the language of the Street, the sale is made when an ask is hit or a bid is hit. For example, a buyer who takes an ask pushes the price in a direction (up) that the buyer would prefer that the prices not go. Similarly a seller that takes a bid pushes the price in a direction (down) the seller would prefer that the market not go. Sometimes this property is interpreted as an "adverse selection" property of continuous, open outcry markets, in the sense that the person that made the original offer, the offer that was hit, would prefer to have waited.

3.1. *In stationary or equilibrated markets the prices of asks taken dominate prices of bids taken*. This is property is related to the work of Roll (1984) who noticed that such a dominance relationship exists in the U.S. securities markets.[1] In these previous studies the need for the market to be near equilibrium in order for the property to be clearly present was not fully appreciated.

3.2. *Markets with rising prices are characterized by asks taken and markets with falling prices are characterized by bids taken (Plott and Turocy, 1994)*. It is this property that leads to the adverse selection interpretation of the pushing property of closing actions can be understood. An individual placing an order is frequently going to be disappointed. A seller placing an order will make a sale if the market is on the way up and will thus "regret" having placed the order. Similarly a buyer who places an order and is hit will regret placing the order because the market is on the way down and thus the buyer could imagine himself/herself having been made better off by waiting.

[1] This relationship has also been studied by Cason and Friedman (1993).

4. *Relative volumes of bids and asks have predictive power*. That is, the difference between bid and ask volume predicts price movement. If the quantity of bids in period t is greater than the quantity of asks in period t, then there is a tendency for the average price in period $t + 1$ to be greater than the average price in period t. This was one of the first properties of the market equilibration process to be identified (Smith, Suchanek and Williams, 1988).

The lower panel of Figure 2 represents this property in a little different manner than has typically been used in the literature. The time structure of the graph is the same as in upper panel so the periods in the upper graph correspond to the sequences in the lower graph. The blue curve is the number of bids that have been tendered in the period; this curve grows as the period continues. The green curve is the total number of asks. The red curve is the number of bids that have occurred minus the number of asks. As the figure shows, the number of asks tends to exceed the number of bids as the market is involved in a downward trend in period one and the beginning of period two, but when the direction tends to reverse in period three the difference falls and the curve begins to move upward. In this experiment there is a general tendency for asks to exceed the bids. The general activity levels can differ from experiment to experiment. However, when the market is clearly pulling upward as it is at the end of periods three and four the relative number of bids is dramatically increasing. The market is holding slightly above the equilibrium in period six when the bids and asks are paced about equally and then, when the market starts its decent, the asks again exceed the bids in period seven and eight.

5. *The principle of full revelation*. The last bid and ask in a period tend to be demand revealing (Jamison and Plott, 1997). This property of markets was first postulated as an axiom by Easley and Ledyard (1993). The idea is that buyers and sellers facing the possibility of no trade at all will reveal their willingness to trade at the end of a period.

6. *Negative serial correlation exits*. Price changes are negatively correlated (Cason and Friedman, 1993). The small teeth in the sawtooth pattern show the sequential up and down pattern of individual transaction prices. This property could be interpreted as a consequence of the pushing property of contract completing actions as the action comes from a buyer who takes an ask and then from a seller who takes a bid. If a market is near equilibrium then the number of asks taken and the number of bids taken tend to be about equal and there seems to be no order in which these actions are exercised. Since bids taken are at prices below asks taken, negative serial correlation can be generated.

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