7 Competitive Equilibrium in a Market with Decentralized Trade and Strategic Behavior: An Introduction

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1 INTRODUCTION

Is there any diagram more familiar to economists than the following?

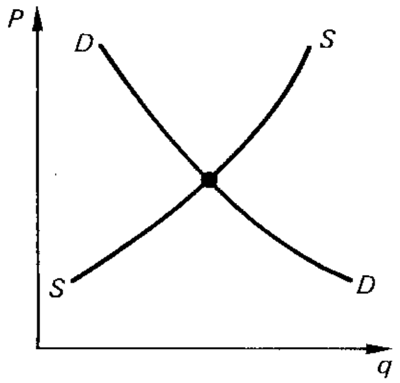

Figure 7.1

Still, I feel puzzled as to what we economists mean by the diagram and by the magic intersection of the curves. This paper is an attempt to introduce the reader to some recent studies in which game-theoretic tools are used to discuss the diagram's scope and meaning.

The origin of the difficulties lies in the generality of the competitive analysis approach. While attempting to cover a wide scope of economic situations, the analysis leaves unspecified the process by means of which the prices are formed. The economic agents are assumed to take the prices as

*My work in this field of the 'mini-micro' foundations for market equilibrium was accomplished together with Asher Wolinsky. Most of the ideas in this paper were developed jointly with Asher. I am deeply grateful to Asher for the many insights I got from him.

I am grateful to Ken Binmore and Ching-to Ma for many valuable suggestions.

It should be clarified that the paper is not an attempt to survey the literature but rather to serve as an introduction. Thus the list of references does not pretend to be comprehensive.

given. The equilibrium prices are announced by a hidden process which equalizes demand and supply of the market commodity. Textbooks tend to use an auctioneer as an example of an institution which justifies competitive price formation. However, the auctioneer story is quite unpersuasive because, first, it is not clear why the agents should take the prices as given – (for any specific auction rules, manipulative behavior may be possible) – and second, the auctioneer is quite a rare institution in the real world.

Time does not appear explicitly in the diagram. When coming to fill in the squares of the supply–demand curves with data about a market for a particular commodity, we must choose the units of the commodities we plug in. But then, are the 'correct' units, units of 'stock' or units of 'flow'? If stock, then over what period? If flow, flow of entrants to the market or flow of agents considering entering the market?

Another source of confusion is in defining the boundaries of a market. Jevons (quoted by Marshall, 1920) says: 'Originally a market was a public place in a town where provisions and other objects were exposed for sale; but the word has been generalized, so as to mean any body of persons who are in intimate business relations and carry on extensive transactions in any commodity.' What are sensible limits to the 'body of persons' included in the analysis?

Obviously it is a matter of judgment to decide when a market outcome is well described by the 'competitive price' model, to decide what the units appearing on the quantity axis of Figure 7.1 are and where to define the boundary of a market. The literature I am speaking about in this paper aims to assist us with this judgment (and to suggest other solution concepts for those cases in which the competitive price seems to be a poor approximation). The method we use starts by specifying in detail the process by which the terms of transactions are determined. Generally speaking, we will describe the process by means of a game. Then game-theoretic, non-cooperative solution concepts will be studied. Finally, we will check under what circumstances the solution is close to the competitive outcome.

There were many previous attempts to start this sort of inquiry by assuming that the economic agents interact non-cooperatively. In many of these attempts the institution for the price formation is a *centralized* mechanism. Clear expositions of this literature may be found in Mas-Colell (1982) and Wilson (1987).

The current paper deals only with models in which the institution of price formation is *decentralized.* Agents are matched and in each match an option for trade is available. The pioneering works of this type are, to my knowledge, those of Diamond–Maskin (1979), Diamond (1981) and Mortensen (1982). In these works, the events after a match occurs are not modelled. Rather, the authors assume that the parties reach an agreement immediately on the terms of the contract suggested by the Nash Bargaining

Solution. A pioneering work in which the negotiation was part of the game is that of Butters (1977).

Our basic image of a market is that of an ocean of traders looking for opportunities to bargain over the exact terms of trade. Throughout the paper, we consider a market in which a single commodity is traded for money. It is assumed that all the sellers in the market are identical. All the sellers have one unit of the good and their reservation price is 0. All the buyers are identical, having the desire to buy one and only one unit of the good and having a reservation price of 1. The special demand–supply diagram we refer to is thus of the type illustrated in Figure 7.2.

We will avoid the assumption that the market operates instantaneously. Rather we will specify the exact relationship between the traders' presence in the market and time. The three main options we are about to consider are:

1. The market is in a steady state in terms of the numbers of sellers and buyers in it. The completion of one transaction is immediately followed by the pairing of a new buyer and seller.
2. All the traders enter the market at one single time and the market continues to operate until all possible transactions are completed.
3. The number of sellers and buyers considering entering the market is constant over time.

The three options correspond to three different interpretations of the quantity axis in the demand–supply diagram.

In the first option, the market operates perpetually and the steady phenomena are the demand and supply opportunities available there.

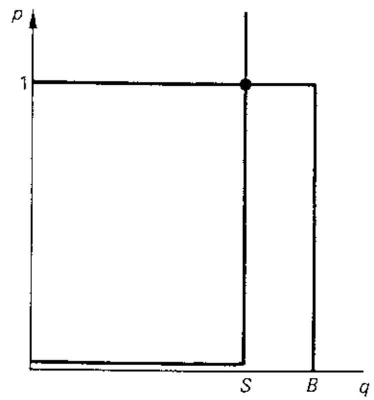

Figure 7.2

Under this option the quantities in the diagram should be interpreted as stock numbers of sellers and buyers existing in the market. This option will be relevant when we wish to consider, say, a market for apartments in a town in which it is known that the number of sellers and buyers searching there remain stable over a long period of time.

In the second option, the market operates only once and during its period of operation demand and supply are not steady. There are no interactions between the market and similar markets taking place in other periods. The markets for flowers in a town on Christmas Eve are more or less the type of markets we have in mind here.

In the third option, the markets operate constantly and the intensities of the flows of sellers and buyers considering entering the market are kept constant over time. A typical illustration is a market for a domestic good which may be imported or exported at prices 0 and 1 respectively. Each trader then has to decide whether he is interested in shopping in the local market or in trading abroad at the given prices.

What are the competitive equilibrium prices under each of the options when, let us say, *the number of the buyers is strictly larger than the number of sellers?*

It may be helpful at this stage if the reader pauses to consider what a competitive equilibrium would be in each of these cases. Is it true that the equilibrium price is equal to unity under all three options?

Before seeking to answer this question, it should be noted that the description of the markets given so far neglects certain important elements. Among them are:

1. the information the traders hold at each point of time;
2. the bargaining procedure used by the agents when they are matched;
3. the matching process.

There are endless reasonable possibilities from which to choose in the selection of these elements. In deciding which of those to study, we face a modelling dilemma of a familiar kind. In what follows, an attempt is made to consider some of the leading alternative assumptions that can be made.

2 TWO BASIC STATIONARY MODELS

In economics as in any other science we investigate phenomena which have some regularity. We study situations in which some stationarity is observed. The level at which stationarity is assumed is a matter for the modeller's good judgment. In this section we demonstrate two different models in which two distinct stationarity assumptions are assumed. There

are several common factors shared by the models which will be spelled out first:

Commodity: The subject of the trade is a single indivisible good which is traded for a divisible good (money). At any given time the agents in the economy are split into two groups. In the sellers' group we gather all the agents who hold one unit of the good and wish to sell it. In the buyers' group are included all the agents who are interested in buying the good. The buyers have an unrestricted amount of money in the relevant range.

Time: Time is a discrete and is indexed by the integers. An instant of time is called a period.

Economic agents: Let B and S denote the sets of buyers and sellers. The symbols B and S are also used to denote the number of elements in the corresponding sets. All the agents of a particular type are assumed to have identical preferences. Whenever a seller sells a unit to a buyer at price p, at the t-th period of his life in the market he derives a von Neumann–Morgenstern utility of $p\delta^t$ where δ is a fixed discount factor. For the buyers the utility derived from such an outcome is $(1-p)\delta^t$. The discount factors are equal for all agents in the market.

The asymmetry between sellers and buyers: The only asymmetry between the sellers and the buyers in this model is that; *the sellers are on the short side of the market*. That is, the number of sellers in the market will always be smaller than the number of buyers.

Matching technology: In each period, all the sellers (the short side) active in the market in that period are matched with active buyers. Each agent is matched with at most one agent of the opposite type. The probability that a buyer is matched with a particular seller is not affected by the identity of the seller or of the buyer. This is a very special matching technology. Many of the substantive results in the paper could be extended to other matching technologies. However, in general, the results are sensitive to the specification of the technology.

Bargaining:. Whenever a buyer and a seller are matched they hold a bargaining session which is assumed to have the following simple structure:

stage 1: one of the parties is selected (with equal probabilities) to make a proposal, namely to quote a price between 0 and 1;
stage 2: the selected party makes a proposal;
stage 3: the responder says 'Yes' or 'No'.

The previous remark about the choice of matching technology is valid here as well. Some of the results are sensitive to alteration of the bargaining procedure.

Information: At each stage, all the agents have a full record of all the events that occurred in the market up to that stage. This assumption is very powerful and will be discussed later.

We now turn to the differences between the two models:

Model A (constant numbers of sellers and buyers)

The numbers of sellers and buyers in the market is kept constant over time. This assumption has two possible interpretations. The most naive is that, whenever a pair completes a transaction, a new pair springs into existence in the market. A better interpretation is that the numbers of sellers and buyers are kept approximately steady, but the fluctuations are small enough to give the agents the impression that numbers are constant. With our assumption on matching technology, this means that the probability of a match for each period is 1 for a seller and only S/B for a buyer. The probabilities are kept constant through time.

Model B (one entry period)

All the sellers and buyers enter the market at time 0 and no additional agents join the market later. The numbers of sellers and buyers are changed endogenously until all the sellers execute a transaction.

Model A is a variation on models presented by Diamond, Maskin and Mortensen (see, for example, Diamond and Maskin (1979) and Mortensen (1982)). Model B was presented by Binmore and Herrero (1988) and is discussed further by Gale (1987).

We still have to explain what a strategy is in these models. To avoid cumbersome formal notation let us make do with an intuitive definition. A strategy is an agent's plan in which he specifies what offer to make and how to respond to any possible offer whenever it is his turn to act. The action planned will depend on the entire history preceding the relevant decision node.

We turn now to the solution concept. We will be interested in equilibria which satisfy two properties:

(a) All the agents of a particular type use the same strategy.

(b) Strategies depend only on time. More precisely, when a player makes an offer, the offer must depend only on time and on the numbers of buyers and sellers in the market at that time. When a player makes a response to an offer, the response must depend only on the offer, on time and on the numbers of sellers and buyers in the market. Although the players hold full information about the events preceding a decision node, they are assumed to base their behavior only on time. This assumption appears to be crucial and will be discussed in detail later.

By a Market Equilibrium in this context, we mean a pair of strategies, one to be used by all the sellers and one to be used by all the buyers, which constitute a (subgame) Perfect Equilibrium in the sense of Selten. The requirement for such an equilibrium is that the strategies have to generate optimal behavior for each agent at each point of time after every possible history, whether realized or not, given that other sellers and buyers follow the equilibrium strategies.

Remark: For very interesting and thorough discussions of these models with divisible goods see Gale (1986a;1986b). In Gale's model each agent enters the market with an initial bundle (like in Arrow–Debreu economy) and he may make several transactions before he decides to leave it.

3 ANALYSIS OF THE TWO MODELS

In the previous section we required that, in equilibrium, an action at time t depends on time and on the numbers of sellers and buyers only. The analytical advantage of this assumption is that one can talk now about the value of being a buyer (and similarly of being a seller) in the market at time t, given the numbers of sellers and buyers. In Model A, the numbers of sellers and buyers are fixed and thus we can denote by $V_b(t)$ and by $V_s(t)$ the expected utility discounted to period t from optimal behavior to a buyer and to a seller from participation in the market. Model B is more complicated, largely because of the dependence of behavior on the numbers of sellers and buyers. Therefore, in order to simplify the representation we will deal here only with the case $S = 1$. Then for as long as the market remains open we can define $V_s(t)$ and $V_b(t)$ as above.

Model A

The analysis of the model starts with the observation that, for all t, $\delta V_s(t) + \delta V_b(t) < 1$. This follows from the fact that the total surplus to be divided by a pair of one seller and one buyer cannot exceed 1. Therefore, in Market Equilibrium, every match must end with a transaction. Assume this is not the case, then, there is a time t and at least one proposer that suggests a price which, in equilibrium, is to be rejected. But, if the proposer deviates and makes an offer of a price p satisfying both $p > \delta V_s(t+1)$ and $1-p > \delta V_b(t+1)$, then the responder's best action will be to accept the offer, contradicting the perfectness assumption.

Now, it is clear that, in equilibrium, the price offered by a buyer to a seller at period t will be $\delta V_s(t+1)$ and the price offered by the seller will be $1-\delta V_b(t+1)$.

Denote by p^* the average price paid by a buyer to a seller. For all t the following three equations must hold:

$$p^*(t) = (1-\delta V_b(t+1))/2 + \delta V_s(t+1)/2 \tag{1}$$

$$V_s(t) = p^*(t) \tag{2}$$

$$V_b(t) = (S/B)(1-p^*(t)) + (1-S/B)\delta V_b(t+1) =$$
$$(S/2B)(1-\delta V_s(t+1)) + (S/2B)(\delta V_s(t+1)) + (1-S/B)\delta V_b(t+1) \tag{3}$$

Taking into account the constraint that the price be between 0 and 1, it is possible to show that the only solution to the above set of equations satisfies

$$p^*(t) = 1/[2-\delta+\delta S/B].$$

Thus the price (and hence the value functions) are stationary. The equilibrium price is sensitive as one would expect: increasing in the ration S/B decreases the price and increasing the discount factor increases the price (and hence V_s). Taking the limit as $\delta \to 1$ leads to the particularly attractive formula $p^* = B/(S+B)$.

Notice that, for $\delta = 1$, there are many equilibria in this model. Actually, all prices between 0 and 1 can be attained as price equilibria.

Notice also that the results depend only on the matching probabilities, $s = 1$ for the seller and $b = S/B$ for the buyer. For other matching technologies with arbitrary probabilities s and b, we get the set of equations (1), (2′) and (3′) where,

$$V_s(t) = sp^*(t) + (1-s)\delta V_s(t+1) \tag{2′}$$

$$V_b(t) = b(1-p^*(t)) + (1-b)\delta V_b(t+1). \tag{3′}$$

It is easy to see that there is a unique solution for this set of equations and the limit of the price as $\delta \to 1$, is $s/(s+b)$.

Model B

Assume $S = 1$. Given a Market Equilibrium, the notion of the value of remaining in the market at time t is well defined here. The case $\delta < 1$ is especially simple here since $\delta V_b(t) + \delta V_s(t) < 1$ for all t. This implies that all matches end with an agreement and that the price is $\delta V_s(t+1)$ if a buyer makes the offer and $1-\delta V_b(t+1)$ if the seller makes the offer. We get the following sequence of equations (compare it to the set of equations for Model A):

$$V_s(t) = [1-\delta V_b(t+1)]/2 + \delta V_s(t+1)/2$$

$$V_b(t) = [1-\delta V_s(t+1)]/2B + \delta V_b(t+1)/2B$$

It is easy to see that this set of equations has a unique solution which is stationary and has the property that $V_s \to 1$ as $\delta \to 1$. That is, the expected price goes to 1 as the impatience of the agents becomes negligible.

The proof for $S > 1$ is done by induction and is omitted.

The existence of a unique equilibrium for a Model B type market remains true under a much wider set of conditions which includes the case of $\delta = 1$ (see Rubinstein and Wolinsky, 1986).

The result for Model A is not consistent with the intuition that price be equal to one. This fact seems at first glance to be disturbing. Here we have a model in which the traditional assumptions about a competitive environment are fulfilled and still, when we take the frictions in the market to be very small, we do not get the competitive outcome.

At second thought there is nothing disturbing in this result. Obviously we do not have to conclude that the competitive approach is wrong but that given an observation that the market's environment is kept constant, the competitive equilibrium solution should not be applied to the data about the demand–supply at each instant.

Model B does lead to a competitive outcome. Thus we may conclude that the analysis supports the idea that given the data about the demand and supply at the beginning of a 'market day' and given that the market is separated from other markets we may apply the formula of the competitive price to this data.

4 MARKET ENTRY

In Section 3, we studied models in which the primitives were the stocks of buyers and sellers in the market. In Model A, the primitives were the stocks at each moment and it was assumed that these stocks are steady over time.

In Model B, the primitives were the stocks at the beginning date of the market.

In many markets we observe a pre-market decision-making problem in which the agents decide whether to enter the market or not. A typical example is a firm production decision. Given that the firm produced a unit of the good, it will appear in the market as a trader trying to get rid of the unit for the best price. The decision to produce is a pre-market decision. We may start the model from the decision of the agents to enter or not to enter the market. Then the primitives should be the volumes of traders who *consider* entering the market.

The origin of the distinction between market behavior and pre-market decision is very old. It appears very clearly in Marshall (1920). Marshall defines 'temporary equilibrium' to be the equilibrium in one market day (book 5, chapter 2). Later (chapter 3), he speaks about the origins of demand and supply curves and defines 'equilibrium' relative to 'pre-market' supply and demand.

Recently, within the literature on strategic behavior in markets, this distinction was made by Douglas Gale (1987). Gale used the distinction mainly to refute a claim that the results of Model A contradict the competitive approach.

Gale analyses a situation where, in each period, there are S sellers and B buyers who consider entering the market. If they do not enter the market, they disappear; that is, there is no accumulation of agents at the 'gates' of the market. A decision to enter the market involves a 'small' cost of $e > 0$. Assume that the market itself is in a steady state; that is, the numbers of sellers and buyers are steady (although they are determined endogenously in the model) and assume that the agents do not believe that their own entry decision influences the market environment. Their decision whether to enter the market or not, will then be just a comparison between e and the value of being in the market.

Obviously, there is a degenerate equilibrium in this model in which all the agents decide not to enter into the market. In order to characterize the other equilibria, denote by S' and B' the (strictly positive) numbers of sellers and buyers who stay in the market at any one time. The formulae for the values and the price in Model A yield that:

$$V_s = s/[2(1-\delta) + \delta s + \delta b]$$

$$V_b = b/[2(1-\delta) + \delta s + \delta b]$$

where $s = \min\{S',B'\}/S'$ and $b = \min\{S',B'\}/B'$. To achieve a steady state in the numbers of sellers and buyers, the number of sellers and buyers entering the market at each period must be equal. Therefore it must be true that both V_s and V_b are at least e. In addition $B > S$ and therefore $V_b = e$. Now we can verify that b, the ratio between numbers of sellers and buyers in the market, must be equal to $[(2-\delta)e]/[1-\delta e]$ and $V_s = [1-\delta e]/[2-\delta]$. When $\delta \to 1$ and $e \to 0$ the limits of V_s and of the average price in the market approach 1 (the competitive price). Notice that the source which generates the ratio b is not explained in this model. It must be created to give consistency to the assumptions in the model.

Thus, Gale's argument claims a coincidence between the strategic approach and the competitive equilibrium concept where the supply–demand curves are interpreted as information about the sellers and buyers who consider entering the market.

We may add a pre-market stage to Model B as well. Assume that before the market starts, the S sellers and the B buyers consider spending the e which is necessary to enter the market. Assume first that the agents who enter the market do not know the actual number of sellers and buyers who enter the market. Then, fixing $e > 0$, and having δ very close to 1, we find that the only equilibrium is one where all the buyers and sellers decide not to enter into the market. Assume next that the agents are notified about the actual number of sellers and buyers who enter the market. Then for all $E \leqslant S$ there is an equilibrium in which E sellers and E buyers enter the market and the expected price is $\frac{1}{2}$.

5 SIMULTANEOUS BARGAINING AND MATCHING

In Section 3 we considered a model in which the bargaining model was extremely simple. One of the agents is selected to make a proposal, the other responds, and a rejection implies a return of the agents to the pool of unmatched agents. This assumption seems to be highly restrictive. In this section we wish to allow the agents to continue the negotiation if they fail to reach an agreement. This section follows Rubinstein–Wolinsky (1985).

We keep the basic structure of Model A with the exception of the bargaining process. We assume that at each period a seller has an exogenous probability, s, to be matched with a new buyer and each buyer has an exogenous probability, b, of being matched with a new seller (s is not necessarily 1). The players are assumed to continue negotiating until either they reach an agreement or they are matched with another partner. When an agent is matched with a new partner he is *forced to leave* his current negotiator and to start bargaining with the new partner.

The exact order of events in each period is the following: first, the matching process determines who is matched with whom. Then, for each matched pair, one of the agents is selected to make a proposal. The selected agent then makes an offer and finally his opponent reacts by accepting or rejecting the offer.

A matched pair faces a sequential bargaining game in which two factors impel an agent to prefer an early agreement: (i) his time preference (as in Model A) and (ii) the fear that his partner will abandon him. Notice that a matched seller at period t, who does not conclude any agreement at time t, starts bargaining with a new partner at period $t+1$ with probability s. With probability $(1-s)(1-b)$ he continues to bargain with his old partner and with probability $(1-s)b$ he finds himself unmatched at period $t+1$. The last possibility is an additional source of pressure on the seller in addition to his impatience with the passage of time.

A candidate for a Market Equilibrium in this model is a pair of strategies, one for each of the sellers and one for each of the buyers, which prescribe the rules of behavior for all the sellers and for all the buyers after all possible personal histories. A pair of strategies is a Market Equilibrium if no agent has a feasible personal history after which he can make a profitable deviation.

It was proved that in this model there is a unique Market Equilibrium (see Rubinstein–Wolinsky (1985) for a proof for 'semi-stationary' strategies and Binmore–Herrero (1988) for non-stationary strategies). There are numbers x^* and y^* such that, in this equilibrium, the sellers always make the offer x^* and the buyers always make the offer y^*. The acceptance policy for the seller is to accept only y^* or more, and for the buyer to accept only x^* or less. Both numbers x^* and y^* tend to $s/(s+b)$ as $\delta \rightarrow 1$.

Thus the sequential model leads to pretty much the same outcome as the simpler Model A. Nevertheless, we find the sequential model attractive because it justifies Model A's outcome by being more realistic and furthermore, since the model is richer, it provides us with a tool for answering questions which could not be asked in Model A (see for example Gul, 1986). As is claimed in Wolinsky (1987), the fact that the sequential bargaining market model and Model A lead to the same results is a 'razor edge' fact. Wolinsky (1987) extends the model by allowing all the agents to choose in each period the intensity with which he will pursue the (costly) search for a partner. Then the limit of the Market Equilibrium price is not equal to Model A's price.

The decision to abandon an old agent is not a strategic decision in this model. Nevertheless, it is a rational decision in the sense that an agent would not gain if he decided not to abandon the old partner when he is matched with a new partner. If we allow the breakdown of the negotiation to be a strategic decision in the model, we get more equilibria. In particular we get an equilibrium in which no agent leaves an old partner. Then the bargaining situation between a seller and a buyer is like that in a sequential bargaining game with outside options (see Shaked–Sutton, 1984; and Binmore, 1985) and the average price in the outcome of each bargaining game would be 1/2 independently of the probabilities of matching (this is a by-product of a general phenomenon called by Binmore, Shaked and Sutton 'the outside options principle'). In other words, in this equilibrium, the bargaining outcome is just like that in a bargaining model with a seller and buyer totally isolated from the market.

6 THE ANONYMITY ASSUMPTION

In the analysis of Model B in Section 4, it was assumed that a strategy of an agent must be 'impersonal' in the sense that it depends solely on the number of sellers, the number of buyers and on the date, but not on the agent's personal history. Even without impatience we could derive the result that the only Market Equilibrium is competitive. However, we made quite strong restrictions on the set of possible strategies. We did not allow any equilibrium in which some 'personal' arrangements might emerge in the course of the game. The interactions between the agents were assumed by these restrictions to be impersonal (see Ben-Porath (1980) for a detailed informal discussion of the distinction between personal and impersonal interactions in markets).

This section (which follows section 3 in Rubinstein–Wolinksy (1986)) demonstrates that, if we allow the players' strategies to depend on the entire history, then equilibrium outcomes other than the competitive outcome are possible.

For the sake of simplicity, let us focus on the special case of Model B with $S=1$ and $B>1$. For this model, there is one perfect equilibrium in which the price is the competitive price: the seller always requires price 1 and rejects all other offers. A buyer always offers 1 and accepts all possible offers. Obviously, this is a perfect equilibrium and its outcome is an immediate agreement on the competitive price.

We turn now to a description of a perfect equilibrium in which the equilibrium price is an arbitrary price p^* in the interval [0,1]. In interpreting this equilibrium, it may be helpful to imagine that some buyers may acquire a 'right' (option) to buy the good at price p^*. This is not an exogenously imposed legal 'right' but appears endogenously as an equilibrium phenomenon. Initially this right is 'granted' to some buyer called i^*. The 'right' is transferred to another buyer if the seller makes him an offer strictly greater than p^*. The 'right' will be lost without being transferred if a buyer without a 'right' makes an offer higher than p^*.

As long as one of the buyers is holding the 'right', the seller's offer is p^* to the buyer who holds the 'right' and the seller's offer is 1 to all other buyers. The seller refuses any offer made by all buyers other than the 'right' holder and he accepts no offer less than p^* from the 'right' holder. The holder offers p^* if he is selected to make an offer and he refuses any demand above p^*. The other buyers accept all prices below p^* and they reject any price above p^*. Their offers are 0.

If no buyer holds the 'right', the continuation of the game is as in the equilibrium with the competitive outcome which has been described above.

Notice, that an attempt by a buyer who does not hold the 'right' to compete for the good by making a high offer is interpreted in this equilibrium as a sign that the players are moving to the competitive equilibrium. Otherwise, the market norm suggests that the seller and the right 'holder' settle the transaction between themselves.

Notice also it is essential that the 'right' is transferred from one buyer to another buyer in the equilibrium which supports a non-competitive price. Otherwise, a seller would not be deterred from offering a high price to a buyer who is not supposed to receive the good.

The fact that the players' identities are not suppressed in this model in the sense that they recognize and remember one another, enables us to construct an equilibrium in which a non-competitive price prevails. In Rubinstein–Wolinsky (1986) we showed that even if the agents have only personal recall and the sellers do not identify with buyers, any price could be the outcome of an equilibrium (actually a sequential equilibrium, since the game becomes a game with imperfect information).

Our conclusion from these examples is that the assertion of the competitive price as a good approximation for markets like that of Model B should be qualified when the frictions in the model are very small. Impersonal interactions are required to make this proposition valid.

7 TOWARDS AN ALTERNATIVE MARKET SET-UP

Traditionally, we describe a market of a commodity in terms of the numbers of sellers and buyers and their preference relations. (In the context of this paper the preferences are summarized by their reservation values.) In this section, I would like to speculate on whether there may be another natural framework within which to discuss the market price.

One possible framework is suggested by the previous discussion. The suggested primitives of an alternative model would be descriptions of the sellers' and buyers' 'personal environments'. By a 'personal environment', I refer to the parameters of the random process which creates opportunities to trade, and a specification of the distribution of the potential trading partners.

In the usual framework, it is assumed that the total supply is equally relevant for all buyers. Similarly, it is assumed that the personal environment is common for all buyers (and analogously for all sellers). For the scenario of Model A, a seller's 'personal environment' is the prospect of meeting a buyer with reservation value 1 in every period with probability s. A buyer's 'personal environment' is characterized by the prospect of meeting a seller with probability equal to b in all periods. Recall that for Model A, given the personal environments (i.e. the probabilities s and b) the solution price is $s/(s+b)$.

Such an approach is not restricted to the case where all the sellers and all the buyers are equal. In Gale (1987) the analysis of Section 3 is extended for all step-wise supply and demand curves. It was shown by Gale that, if the matching probability of an agent of a particular type is proportional to the quantities of agents of each type, then the price will be the number p^* which equates 'supply surplus' with 'demand surplus'. By supply (demand) surplus we refer to the area above (below) the supply (demand) curve and below (above) the horizontal line p^* (see Figure 7.3).

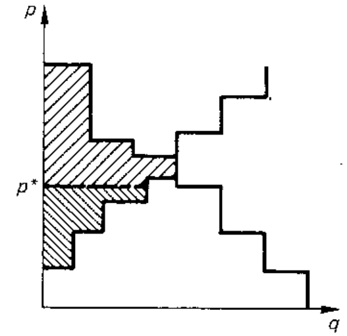

Figure 7.3

I find the alternative set-up plausible for situations where the personal environments remain constant over time. It does not suit models like Model B, where it is difficult to think about the personal environment at subsequent dates without specifying the quantities and the matching technology. However, notice that the traditional framework suffers from a dual problem: if the matching technology is not specified the quantities may give insufficient information for determining the market solution.

8 CONCLUSION

This paper has dealt only with the abstract relationship between strategic market models and competitive equilibrium. However, it should be made clear that a major aim of the strategic approach is also to provide tools for analysis of economic problems which cannot be analyzed by other approaches. (See for example, Shaked and Sutton (1984) on involuntary unemployment, Rubinstein and Wolinksy (1987) on middlemen, and Horn and Wolinksy (1986) and Jun (1986) on the size of the unions.)

As a guide to the user, may I express my impression that simple models based on the Diamond–Mortensen approach (where the Nash Bargaining

Solution is used in place of a detailed bargaining game) are very powerful models. An introduction to the economic uses of this type of model may be found in Diamond (1984). One problem with that approach is that we have to be very careful in the selection of the disagreement point when we apply the static Nash Bargaining Solution (see Binmore, Rubinstein and Wolinksy, 1986; and Sutton, 1986). As explained in the two papers cited above, many applications of the Nash Bargaining Theory suffer from an imprecise use of the very attractive Nash Bargaining Solution.

Needless to say, the strategic decentralized approach is not meant to compete with the competitive approach but is complementary to it. The strategic approach contributes to the understanding of the competitive equilibrium in at least two ways: (i) discussions like Section 6 clarify the limits of the range of applications of the competitive solution, and (ii) when the competitive solution does apply, strategic discussions can clarify the manner in which it should be applied. For example, Gale's argument in Gale (1987) summarized in Section 4 is reminiscent of the question of whether the relevant units on the quantity axis should be units of stocks or units of flows.

In this chapter I have tried to give the flavor of some basic ideas which have appeared in the recent literature. Since the topic stimulates the imagination, I am confident that much more exciting research in the area is still on its way.

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