Markets Versus Negotiations: the Predominance of Centralized Markets*

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Abstract

The paper considers the consequences of competition between two widely used exchange mechanisms, a "decentralized bargaining" market, and a "centralized" market. In every period, members of a large heterogenous group of privately-informed traders who each wish to buy or sell one unit of some homogenous good may opt for trading through one exchange mechanism. Traders may also postpone their trade to a future period. It is shown that trade outside the centralized market completely unravels. In every perfect-like equilibrium, all trade takes place in the centralized market. No trade ever occurs through direct negotiations.

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1. Introduction

This paper considers the consequences of competition between two widely used exchange mechanisms, a "decentralized bargaining" market, and a "centralized" market. Competition assumes the following form: in every period, surviving and new members of a large heterogenous group of privately-informed traders who each wish to buy or sell one unit of some homogenous good may opt for trading through either (1) direct negotiations with other buyers and sellers (a decentralized bargaining market), or (2) a centralized market. If they so wish, traders may also postpone their trade to a future period.

A *decentralized bargaining market* is an idealization of what takes place in a bazaar, or a Middle-Eastern Suq. Buyers and sellers are matched with each other and bargain over the terms of trade. If an agreement is reached, the traders leave the market. Otherwise, they return to the general pool of traders, are possibly re-matched with another trader, and so on. Importantly, transaction prices in such a market typically vary across the different matches depending, among other things, on the individual traders' costs and willingness to pay. Consequently, decentralized bargaining is characterized by the fact that different traders may transact at *different* prices at the same time. In contrast, a *centralized market* is a form of exchange with a single price and centralized clearing. It is characterized by the fact that in any point in time, all those traders who transact do so at the *same* price. Examples include the undergraduate textbook definition of a competitive market, a sealed-bid double-auction, and a *call market*.[1]

The study of the outcome of such a competition is of interest for two reasons. First, the question of what form of exchange is likely to attract large volumes of trade is an important theoretical and practical problem. To solve this problem, it is not enough to analyze the properties of different exchange mechanisms in isolation. Because traders' choices of where to trade are endogenous, the very existence of a competing exchange mechanism may affect the outcome in any given mechanism. In other words, the question is what kind of exchange mechanisms will flourish when traders are free to choose the exchange mechanism through which to transact. Obviously, because exchange mechanisms that may initially be attractive to sellers may be shunned by buyers and vice-versa, mechanisms that generate large volumes of trade must be sufficiently attractive to *both* buyers and sellers. Second, although the description of the two competing exchange mechanisms in this paper is extremely stylized, the comparison is between a "traditional" and a "modern" form of exchange. Understanding

[1] Call markets are used, among other things, to determine the daily opening prices of the stocks listed in the New York Stock Exchange, and to fix copper and gold price in London (Schwartz, 1988).

the forces that determine the consequences of such a competition may shed some light on the development of actual market mechanisms.

The main result of this paper is that under fairly general conditions, in every perfect-like equilibrium, all trade is conducted through the centralized market – no opportunities for mutually advantageous trade exist outside the centralized marketplace. Obviously, because traders cannot trade alone, there also exists an (non-perfect-like) equilibrium in which all traders trade only through direct negotiations, however, our result implies that such an equilibrium is "unstable." If in some period traders "tremble" with a small probability and opt, by accident, into the centralized market, then many other traders would want to follow them there, which would undermine this equilibrium.

The approach in this paper is distinguished by the fact that, in contrast to standard models that impose assumptions about traders' *behavior* and then derive the implications of these assumptions with respect to market structure, here the assumptions are imposed directly on the distribution of transaction prices under the two competing mechanisms. This "reduced-form" approach allows us to bypass the main difficulty associated with the standard approach, namely the characterization of equilibrium properties, which seems intractable in all but the simplest models. In contrast, the approach followed in this paper permits the consideration of a general dynamic setup with heterogenous traders who are have private information about their willingness to pay and cost and face aggregate uncertainty.

There is a vast literature on the microstructure of markets and trading institutions. This literature can be divided into several broad categories. First, there is a large literature that has confined its attention to the analysis of different market mechanisms in isolation. In this literature, comparisons between different market mechanisms are usually done from the perspective of the seller, asking which mechanism a single seller would prefer under the assumption that buyers have no choice but to participate in the chosen mechanism (as in, e.g., Milgrom and Weber, 1982). A second category, into which this paper belongs, consists of papers that consider the case in which traders choose through which one of a small number of given mechanisms to conduct their trades (see, e.g., Gehrig, 1993; Rust and Hall, 2003, and the references therein). A number of papers permit traders to choose from a large number of possible trade mechanisms (see, e.g., McAfee, 1993; Peters, 1994; and subsequent literature) but in models where competing sellers choose a type of auction through which to sell and buyers select in which seller's auction to participate. Finally, there exists a voluminous related literature in finance, which emphasizes the importance of transaction costs, information, adverse selection, and transparency, but which pays less attention to the strategic issues considered here (for a recent survey of this literature, see Madhavan, 2000).

The paper that is most closely related to ours is Rust and Hall (2003) who consider a stationary environment in which buyers and sellers can in each period choose between trading through "middlemen" or a "market maker." As we show below, trading through middlemen, or as they are sometimes called, dealers or brokers, is a particular example of what we call direct negotiations. Trading through the market maker in Rust and Hall's paper is similar to trading through the centralized market in our model, except that the monopolistic market maker in Rust and Hall (2003) charges a positive bid-ask spread, which introduces a small wedge between the price paid by buyers and the price received by sellers. The pattern of trade described by Rust and Hall (2003) is similar to the one described in this paper. Buyers with high willingness to pay and sellers with low costs trade through the market maker, while others resort to searching and trading through the decentralized "search" market. However, while in our model the unraveling of the decentralized search market is complete, in Rust and Hall's model, the wedge that the market maker introduces between the price paid by buyers and received by sellers prevents their search market from completely unraveling.

The rest of the paper proceeds as follows. In the next section, we describe a simple example that illustrates our main insight. In Section 3, we present the general model and the details of modelling the centralized market and direct negotiations. Analysis of the model is presented in Section 4, and a few concluding remarks are offered in Section 5.

2. An Example

We describe a simple static example that provides an intuition for our main result. The general model is dynamic, has a large number of heterogenous traders, and unlike the example, which employs a specific model of direct negotiations, is consistent with many different models of direct negotiations.

Consider an environment with six traders, three buyers and three sellers. Each buyer wants to buy, and each seller wants to sell, one unit of some homogenous good. The buyers' willingness to pay for the good are 10, 9, and 2, respectively; and the sellers' costs of producing the good are 0, 1, and 8, respectively. Note that the static nature of the example implies that there is no reason to abstain from trade.

If all the traders trade in a centralized market where they behave as price-takers, then any price $p \in [2, 8]$ can serve as a market clearing price. Suppose, for simplicity, that the price that prevails in the centralized market is $p = 5$. The two buyer's types with the willingness to pay of 10 and 9 trade with the two seller's types whose costs are 0 and 1. The payoff to the buyer whose willingness to pay is 10 and to the seller whose cost is 0, is 5; and the payoff to the buyer whose willingness to pay is 9 and to the seller whose cost is 1, is 4. The other buyer's and seller's types do not trade in the market, and obtain, each, a payoff of 0.

Suppose on the other hand that the traders engage in direct negotiations with each other. Suppose further that this negotiation assumes the following form: a first stage of random matching between the buyers and sellers, followed by a second stage of split-the-surplus bargaining. In this case, the expected payoff to the buyer whose willingness to pay is 10 is 3.5 because with probability $\frac{1}{3}$, the buyer is matched with the seller whose cost is 8, trades at the price 9, and obtains a payoff of 1, with probability $\frac{1}{3}$, it is matched with the seller whose cost is 1, trades at the price $\frac{11}{2}$, and obtains a payoff of $\frac{9}{2}$, and with probability $\frac{1}{3}$, the buyer is matched with the seller whose cost is 0, trades at the price 5, and obtains a payoff of 5. Similarly, the expected payoff to the buyer whose willingness to pay is 9 is 3, and the expected payoff to the buyer whose willingness to pay is 2 is $\frac{1}{2}$ because when this buyer is matched with the seller whose cost is 8, no trade takes place. Similarly, the expected payoff to the seller whose cost is 8 is $\frac{1}{2}$ and the expected payoffs to the sellers whose costs are 0 and 1 are 3.5 and 3, respectively.

Obviously, the two buyer's types with the high willingness to pay and the two seller's types with the low costs (the "weak" types) are better off in the centralized market compared to direct negotiations. Even if they alone switch to trading through the centralized market, they are still better off as they can still trade at the competitive equilibrium price $p = 5$. However, once they switch, the remaining buyer and seller become worse off since they lose their ability to trade. They, too, may switch to the centralized market, but this will not improve their situation, because they do not get to trade in the centralized market either.

Intuitively, what makes the centralized market more attractive to the two buyer's types with the high willingness to pay and the two seller's types with the low cost is that, relative to direct negotiations, the extent to which their high willingness to pay and low cost is translated into higher and lower prices, respectively, is smaller. Consequently, the weak types of the buyer and seller are led into trading in the centralized market, which in turn, leads to the unraveling of trade through direct negotiations.

In this simple example, it is easy to imagine a direct negotiation procedure that would lead to exactly the same outcome as the centralized market (simply change the matching process to one that ensures that the buyer with willingness to pay 10 is matched with the seller whose cost is 0, and the buyer with willingness to pay 9 is matched with the seller whose cost is 1). Obviously, in this case we cannot obtain our result that all trade must take place in the centralized market. The literature on decentralized bargaining (surveyed in Osborne and Rubinstein, 1990, and discussed in more detail at the end of section 3.2) has devoted much attention to the question of how likely is "frictionless" decentralized bargaining to give rise to the centralized market (Walrasian) outcome. In any case, the assumptions imposed below preclude this possibility.

Finally, it is important to emphasize that what makes the centralized market more attractive to the weak traders' types is not just the fact that it offers a potentially more efficient form of matching than direct negotiations, but also the way in which the surplus from trade is distributed among the different traders' types. More specifically, the distribution of surplus in the centralized market is biased in favor of weak traders' types, which is what starts the process of unraveling. This can be best seen by comparing the expected payoff to different traders' types under the centralized market and under direct negotiations with efficient matching. Suppose for example that direct negotiation assumes the following form: a first stage of matching in which with probability $\frac{1}{2}$ the buyers with willingness to pay 10, 9, and 2 are matched with the sellers whose costs are 0, 1, and 8, respectively; and with probability $\frac{1}{2}$ the buyers with willingness to pay 10, 9, and 2 are matched with the sellers whose costs are 1, 0, and 8, respectively. Under this direct negotiation procedure, the expected payoffs to the buyers with willingness to pay 10, 9, and 0, and to the sellers with costs 0, 1, and 8, are 4.75, 4.25, and 0, respectively. The buyer with willingness to pay 9 and the seller with cost 1 are better off with this type of direct negotiations than under the centralized market, but the buyer with willingness to pay 10 and the seller with cost 0, or the weakest types of traders, are worse off, and once they switch into trading in the centralized market, the other types would be better off following them there.

3. The Model

We consider a dynamic model with a large number of buyers and sellers of some discrete homogenous good. Time is also discrete and is indexed by $t \in \{1, 2, ...\}$. In each period, each seller has one unit to sell, and each buyer is interested in buying one unit.[2] Traders are characterized by their types: their willingness to pay for one unit of the good if buyers, and their cost of producing one unit if sellers. It is commonly known that sellers' costs and buyers' willingness to pay are stochastically independent and range from 0 to 1. "Weak"

[2] This implies no loss of generality compared with the assumption that traders are each interested in trading a finite number of units of the good. Traders that are interested in trading $k < \infty$ units of the good can be treated as k different traders.

buyer types have high willingness to pay, and "weak" seller types have low costs.

We assume that in every period t, N_t^B new buyers and N_t^S new sellers appear; the numbers of traders N_t^B and N_t^S may be stochastic, but we assume that they are "large" and independent of traders' types. The cumulative distributions of the new buyers' and sellers' types in every period are assumed to be increasing, differentiable, and to be equal to zero at zero. They need not be symmetric or identical across buyers and sellers. In addition to the new traders, the group of traders at t may also include traders that have appeared in the previous period but who for some reason did not trade. The cumulative distributions of buyers' and sellers' types in every period are therefore increasing, differentiable, and equal to zero at zero. Every trader knows its own type but may be uncertain about the number of other traders and their types. Note that the fact that N_t^B and N_t^S are stochastic implies that the model admits aggregate uncertainty.

Every period, buyers and sellers may either attempt to trade through a centralized market or through direct negotiations. Traders may also refrain from trade and wait for the next period. A trader who for some reason does not trade in any given period re-appears in the next period (with the same type) with probability $0 \leq \delta \leq 1$. The parameter δ may also be interpreted as the traders' discount factor. Buyers and sellers are assumed to be (risk neutral) expected utility maximizers. A buyer with a willingness to pay v who transacts at the price p, τ periods after it first appeared in the market, obtains the payoff $\delta^\tau (v-p)$, and a seller with cost c who transacts at the price p, τ periods after it first appeared in the market, obtains the payoff $\delta^\tau (p-c)$. Traders who disappear without trading, or who never trade, obtain the payoff zero.

In every period $t \geq 1$, the traders' choices about whether to attempt to trade through the centralized market or through direct negotiations may depend on their own type, and on the history of trade in the centralized market and direct negotiations, respectively, in the periods prior to t. Obviously, traders' choices may also depend on their beliefs about what other traders, "new" and "old," would do. A Nash equilibrium is a sequence of profiles of traders' choices of if and where to trade, where each trader's choice is optimal given other traders' choices. To simplify the analysis, we assume that traders who are indifferent between trading in the centralized market and direct negotiation in some period t, opt for trading, if at all, through direct negotiations.

We describe the details of trade in the centralized market and through direct negotiations in the next two subsections.

3.1. Centralized Markets

For our purposes, a centralized market may be idealized as follows: in every period $t \in \{1, 2, ...\}$, each buyer and each seller who opts for the centralized market specifies a bid and an ask price, respectively. Trade takes place at a Walrasian (market-clearing) price, denoted p_t^M, between the buyers whose bids are higher than or equal to this centralized market price, and the sellers whose asks are lower than or equal to the centralized market price. In case of a shortage or a surplus, the allocation is carried out as far as possible by assigning priority to sellers whose asks are the smallest and buyers whose bids are the largest. If this does not complete the allocation, then a fair lottery determines which of the remaining traders on the long side of the market trade.

Traders may possibly recognize their ability to influence the centralized market price in their favor. They may do so by submitting ask prices that are higher than their true costs if they are sellers, and bids that are lower than their true willingness to pay if they are buyers. We denote the ask price quoted by a seller with cost c by $a(c)$ and the bid made by a buyer with willingness to pay v by $b(v)$. We assume that $a(c)$ and $b(v)$ are monotone nondecreasing in c and v, respectively.

For every $c, v \in [0, 1]$, denote the expected centralized market price, taking into account the possibility of manipulation, as perceived by a buyer with willingness to pay v and by a seller with cost c by $E\left[p_t^M \,|v\right]$ and $E\left[p_t^M \,|c\right]$, respectively.

We make two important assumptions about what happens in the centralized market as the number of traders who opt to trade there increases:

1. **Convergence of Beliefs.** We assume that the difference

$$E\left[p_t^M \,|v = 1\right] - E\left[p_t^M \,|c = 0\right]$$

   decreases to zero as the number of traders who plan to participate in the centralized market increases; and

2. **Convergence to Price-Taking Behavior.** We assume that for every $c, v \in [0, 1]$, $a(c) \searrow c$ and $b(v) \nearrow v$ as the number of traders who plan to participate in the centralized market increases

Both assumptions are due to the fact that it becomes more and more difficult for a trader to gain by manipulating the price as the number of traders in the centralized market increases. In the first assumption, this inability to manipulate the price implies that the different traders' beliefs about the market price converge.[3] In the second assumption, the inability to manipulate the price implies that traders might as well bid their true cost and willingness to pay.[4]

Both of these assumptions are consistent with the description of a competitive market with privately informed traders in Rustichini, Satterthwaite, and Williams (1994) who, under the assumption that the number of traders in the market is exogenously given, derived our two assumptions as results. In fact, Rustichini et al. showed that price-taking behavior is to be expected also when the number of traders is not very large. They report the results of simulations that show that the convergence to "truthful" bidding occurs already when there are as few as three traders on each side of the market.

For every $v, c \in [0,1]$, denote the equilibrium expected payoff to a buyer whose willingness to pay is v and to a seller whose cost is c from participating in the centralized market in period t by $B_t^M(v)$ and $S_t^M(c)$, respectively. The fact that a buyer with willingness to pay $v' > v$ (seller with cost $c' < c$) can behave in the exact same way as a buyer with willingness to pay v (seller with cost c) and because it has a higher willingness to pay (lower cost), obtain an expected payoff that is at least as large, implies that we may assume that $B_t^M(v)$ and $S_t^M(c)$ are nondecreasing in v and c, respectively.

Let $Q_t(c)(\cdot)$ denote the distribution of the centralized market price as perceived by a seller with cost c. Recall that the fact that the seller may attempt to manipulate the price implies that it would submit an ask price $a(c) \geq c$ and would trade, in a Walrasian market,

[3] More specifically, a buyer with willingness to pay one has the same beliefs as a seller with cost zero about the distribution of other traders' costs and willingness to pay. This implies that the difference in their beliefs about the centralized market price is due to the fact that: (i) while the seller believes that the buyer with willigness to pay one has a randomly drawn willigness to pay, the buyer knows its willigness to pay is one; and (ii) while the buyer believes that the seller with cost zero has a randomly drawn cost, the seller knows its cost is zero. The fact that the Walrasian price is nondecreasing in the buyers' bids and the sellers' ask prices (and the assumption that the latter are monotone nondecreasing in their willingness to pay and cost, respectively) implies that $E\left[p_t^M \,|v=1\right] \geq E\left[p_t^M \,|c=0\right]$. As the number of traders in the market increases, the effect that any single trader has on the Walrasian price decreases, and so the difference $E\left[p_t^M \,|v=1\right] - E\left[p_t^M \,|c=0\right]$ decreases to zero.

[4] We abstract away from consideration of strategic behavior accross different periods. For example, a buyer with willingness to pay .7 who expects the centralized price in the next period to be .3 cannot bid close to .3 in the current period if it expects the number of traders in the centralized market to be large. Instead, such a buyer can simply wait for the next period rather than bid close to its true willingness to pay and risk trading at a high price in the current period.

if and only if the price is larger than or equal to $a(c)$. This implies that for every $c \in [0,1]$,

$$\begin{aligned} S_t^M(c) &= \int_{a(c)}^{1} (p-c)\, dQ_t(c)(p) \\ &= \int_0^1 (p-c)\, dQ_t(c)(p) - \int_0^{a(c)} (p-c)\, dQ_t(c)(p) \\ &\geq E\left[p_t^M | c\right] - c - \int_c^{a(c)} (p-c)\, dQ_t(c)(p) \end{aligned}$$

Similarly, let $Q_t(v)(\cdot)$ denote the distribution of the centralized market price as perceived by a buyer with willingness to pay v. The fact that the buyer may attempt to manipulate the price implies that it would bid $b(v) \leq v$ and would trade, in a Walrasian market, if and only if the price is smaller than or equal to $b(v)$. This implies that for every $v \in [0,1]$,

$$\begin{aligned} B_t^M(v) &= \int_0^{b(v)} (v-p)\, dQ_t(v)(p) \\ &= \int_0^1 (v-p)\, dQ_t(v)(p) - \int_{b(v)}^1 (v-p)\, dQ_t(v)(p) \\ &\geq v - E\left[p_t^M | v\right] - \int_{b(v)}^{v} (v-p)\, dQ_t(v)(p) \end{aligned}$$

Together, the previous two inequalities imply that

$$B_t^M(v) + S_t^M(c) \geq v - c - \left(E\left[p_t^M | v\right] - E\left[p_t^M | c\right]\right) - \int_{b(v)}^{v} (v-p)\, dQ_t(v)(p) - \int_c^{a(c)} (p-c)\, dQ_t(c)(p)$$

for every $v, c \in [0,1]$. The two assumptions we made about the centralized market imply that for every $\varepsilon > 0$, there exists a number of traders such that for any larger expected number of traders in the centralized market,

$$B_t^M(v) + S_t^M(c) \geq v - c - \varepsilon \tag{1}$$

for every $v, c \in [0,1]$.

3.2. Direct Negotiation

As in the case of centralized markets, we also adopt a reduced form approach to model the process of direct negotiations among the traders. For every willingness to pay v and cost c, let $\mu_t^B(v)$ and $\mu_t^S(c)$ denote the distribution of buyers and sellers with willingness to pay and costs smaller or equal to v and c, respectively, who opt for trading through direct negotiations in period t. We assume that in every period traders who opted to participate in direct negotiations are matched into pairs of one buyer and one seller according to a density function $f_t(v,c)$.[5] Conditional on being matched, a buyer and seller with types v and c, respectively, trade with each other with probability $x_t(v,c)$, at an expected price $p_t^N(v,c)$.

We assume that:

1. For every $t \geq 1$, $f_t(\cdot,\cdot)$, $x_t(\cdot,\cdot)$, and $p_t^N(\cdot,\cdot)$, are continuous functions. The density $f_t(\cdot,\cdot)$ is bounded away from zero, and the probability $x_t(\cdot,\cdot)$ is bounded away from zero for every pair of types $v, c \in [0,1]$ that are such that $v \geq c$.

2. For every $t \geq 1$, and buyer's and seller's types $v, c \in [0,1]$,

$$c \leq p_t^N(v,c) \leq v.$$

   That is, trader prefer not to trade rather than trade at a price that generates a negative payoff.

3. The price function $p_t^N(v,c)$ is nondecreasing in v and c, and strictly increasing with a slope that is bounded away from zero in either v or c.

The last assumption captures the intuition that exactly because of their "weakness," weak buyer types (i.e., buyers with a high willingness to pay) are likely to pay relatively higher prices and weak seller types (seller with low costs) are likely to accept relatively lower prices. This assumption is satisfied in many models of bargaining including Nash's (1950) model of axiomatic bargaining, Rubinstein's (1982) model of alternating offers bargaining, and Myerson and Satterthwaite's (1983) optimal mechanism for bilateral bargaining under asymmetric information. The assumption that the slope of $p_t^N(v,c)$ is bounded away from zero is the main assumption that distinguishes our model of direct negotiations from our model of a centralized market, where the effect that individual traders have on the price

[5] That is, conditional on being matched with a positive probability, a buyer with willingness to pay v is matched with a seller with cost $c \in [c', c'']$ with probability

$$\frac{\int_{c'}^{c''} f_t(v,c)\, d\mu_t^S(c)}{\int_0^1 f_t(v,c)\, d\mu_t^S(c)},$$

and a seller with cost c is matched with a buyer with willingness to pay $v \in [v', v'']$ with probability

$$\frac{\int_{v'}^{v''} f_t(v,c)\, d\mu_t^B(v)}{\int_0^1 f_t(v,c)\, d\mu_t^B(v)}.$$

at which they transact is assumed to vanish as the centralized market becomes large, and consequently, weaker types are not relatively disadvantaged because of their weakness.

Given $\mu_t^B(v)$, $\mu_t^S(c)$, $f_t(\cdot,\cdot)$, $x_t(\cdot,\cdot)$, and $p_t^N(\cdot,\cdot)$, denote the expected payoffs conditional on trade from engaging in direct negotiations in period t of the buyers and sellers by $B_t^{N|trade}(v)$ and $S_t^{N|trade}(c)$, respectively.[6] Our assumptions about $f_t(\cdot,\cdot)$, $x_t(\cdot,\cdot)$, and $p_t^N(\cdot,\cdot)$, imply that the two functions, $B_t^{N|trade}(v)$ and $S_t^{N|trade}(c)$, are continuous, and satisfy the following property, which we employ repeatedly in the proof below.

Lemma 1. *For any cost and willingness to pay* $0 \leq c^* < v^* \leq 1$, *if all the sellers with costs* $c \geq c^*$ *who opt for direct negotiations at* t *trade with buyers with willingness to pay* $v \leq v^*$, *and all the buyers with willingness to pay* $v \leq v^*$ *who opt for direct negotiations at* t *trade with sellers with costs* $c \geq c^*$, *then*

$$B_t^{N|trade}(v^*) + S_t^{N|trade}(c^*) \leq v^* - c^* - \Delta. \tag{2}$$

for some $\Delta > 0$.

Proof. If no buyer with willingness to pay $v \leq v^*$ trades through direct negotiations with a positive probability at t, then no seller with cost $c \geq c^*$ may trade through direct negotiations with a positive probability at t either, and vice-versa. Because in this case all buyers and sellers trade through direct negotiations with probability zero, $B_t^{N|trade}(v) = S_t^{N|trade}(c) = 0$ for every willingness to pay $v \leq v^*$ and cost $c \geq c^*$, and the conclusion of the lemma follows.

If some buyers with willingness to pay $v \leq v^*$ trade through direct negotiations with a positive probability at t, then also some sellers with costs $c \geq c^*$ must trade through direct negotiations at t with a positive probability, and vice-versa. We say that a seller's type, c', is *isolated* if there exists an open set of sellers' types, O, such that $O \cap \{c \in [0,1] : c \text{ opts for direct negotiation}\} = \{c'\}$. The fact that the distribution of sellers' types is increasing implies

[6] That is, $B_t^{N|trade}$ is given by

$$B_t^{N|trade}(v) = \frac{\int_0^1 \left(v - p_t^N(v,c)\right) x_t(v,c)\, f_t(v,c)\, d\mu_t^S(c)}{\int_0^1 x_t(v,c)\, f_t(v,c)\, d\mu_t^S(c)}$$

if buyer v trades with a positive probability ($\int_0^1 x_t(v,c)\, f_t(v,c)\, d\mu_t^S(c) > 0$) and is assumed to be equal to zero otherwise, and $S_t^{N|trade}$ is given by

$$S_t^{N|trade}(c) = \frac{\int_0^1 \left(p_t^N(v,c) - c\right) x_t(v,c)\, f_t(v,c)\, d\mu_t^B(v)}{\int_0^1 x_t(v,c)\, f_t(v,c)\, d\mu_t^B(v)}$$

if seller c trades with a positive probability and is assumed to equal to zero otherwise.

that the probability that a seller has an isolated type is zero. Therefore, the probability that any buyer trades through direct negotiations with a positive probability with a seller with an isolated type is zero as well. Hence, with probability one, all the buyers who trade through direct negotiations trade with non-isolated sellers' types. Similarly, with probability one, all the sellers who trade through direct negotiations trade with non-isolated buyers' types.

Continuity of $f_t(\cdot,\cdot)$ and $x_t(\cdot,\cdot)$ therefore implies that for every trader with type $v \leq v^*$ or $c \geq c^*$ who opts for direct negotiations at t and who trades with a positive probability, and for every $\varepsilon > 0$,

$$\Pr\left(v \text{ trades with } \widehat{c} \in \left(\widehat{\widehat{c}}, \widehat{\widehat{c}} + \varepsilon\right)\right) > 0,$$

for some $\widehat{\widehat{c}} \geq c^*$, and

$$\Pr\left(c \text{ trades with } \widehat{v} \in \left(\widehat{\widehat{v}} - \varepsilon, \widehat{\widehat{v}}\right)\right) > 0.$$

for some $\widehat{\widehat{v}} \leq v^*$.

The monotonicity of the price function $p_t^N(\cdot,\cdot)$ then implies that

$$B_t^{N|trade}(v) \leq v - p_t^N(v, c^*),$$

for every $v \leq v^*$, because conditional on trade, every buyer v pays a price that is almost surely larger than $p_t^N(v, c^*)$. A similar argument implies that,

$$S_t^{N|trade}(c) \leq p_t^N(v^*, c) - c,$$

for every seller $c \geq c^*$. Moreover, the fact that $p_t^N(\cdot,\cdot)$ is strictly increasing in v or c implies that at least one of the previous two inequalities is strict. Adding these two inequalities together, it follows that

$$B_t^{N|trade}(v) + S_t^{N|trade}(c) < v - c + p_t^N(v^*, c) - p_t^N(v, c^*)$$

for every $v \leq v^*$ and $c \geq c^*$. In particular,

$$B_t^{N|trade}(v^*) + S_t^{N|trade}(c^*) < v^* - c^*.$$

Finally, inspection of the argument above reveals that the fact that $f_t(\cdot,\cdot)$, $x_t(\cdot,\cdot)$, and the slope of $p_t^N(\cdot,\cdot)$ are all assumed to be bounded away from zero implies that the lower bound

$$\Delta = \inf\left\{v^* - c^* - B_t^{N|trade}(v^*) - S_t^{N|trade}(c^*)\right\}$$

where the infimum is taken over all the pairs $c^* < v^*$ that satisfy the conditions of the lemma is positive. ■

Note that the conclusion of Lemma 1 is not satisfied if the price in a bilateral transaction is fixed independently of the willingness to pay and cost of the buyer and seller, as would be the case if the price were exogenously fixed.

Many different forms of direct negotiations satisfy inequality (2) above. We describe three examples of such direct negotiation procedures below.

Example 1 (Direct Negotiations). Fix a sequence of real numbers $\{\alpha_t\}_{t\in\{1,2...\}}$ such that for every t, $\alpha_t \in (0,1)$. Suppose that in every period t the procedure of direct negotiations between the buyers and sellers assumes the form of random matching into pairs of one buyer and one seller, followed by split-the-surplus bilateral bargaining where buyers capture a fraction $\alpha_t \in (0,1)$ of the available surplus, and the sellers get the rest. When a buyer with willingness to pay v and a seller with cost c are matched in period t, they transact at the price $\alpha_t c + (1-\alpha_t)\, v$ if $v \geq c$ and refrain from trade otherwise.

The price function continues to satisfy the restrictions specified above also if each period is divided into $n \geq 1$ sub-periods, and traders who were matched with partners with whom they could not profitably trade in any sub-period, are randomly re-matched again in the next sub-period. Traders discount the payoffs obtained at the k-th sub-period, $0 \leq k \leq n$, at the rate $1 - \frac{k}{n}(1-\delta)$.

Example 2 (A Dealers' Market). This example is based on Spulber (1996). A dealer market consists of continuums of measure one of heterogenous buyers, sellers, and middlemen. Traders and middlemen discount future profits at a rate $\delta < 1$, and in every period, each trader exits the market with an exogenously specified probability $\lambda > 0$. The initial distribution of buyers' and sellers' types is the uniform distribution on $[0,1]$, and whenever a buyer or seller trades or exits the market, he is replaced by another buyer or seller whose type is drawn from the uniform distribution on $[0,1]$. The only way for buyers and sellers to trade is through middlemen who quote bid and ask prices. Thus, a match in this market is between a trader and a middleman. The middlemen are infinitely lived and each set a pair of stationary bid and ask prices to maximize their expected discounted profits. The middlemen are each characterized by their transaction costs which are uniformly distributed over the interval $[0,1]$. A middlemen with transaction cost (type) $k \in [0,1]$ sets bid and ask prices $a(k)$ and $b(k)$, respectively. Buyers and sellers engage in sequential search. Each period, a searcher obtains a single price quote from one, randomly drawn, middleman. It can be shown that this market has a unique stationary equilibrium. In this equilibrium, bid and ask prices are uniformly distributed over some interval. The fact that in this equilibrium buyers with a higher willingness to pay and sellers with lower costs are willing to buy from middlemen who quote higher and lower ask and bid prices, respectively, implies that inequality (2) is satisfied.

Example 3 (An Auctions' Market). In every period t, each seller sells his object through an auction, and buyers choose in which seller's auction to participate. Suppose that sellers' may each specify a reserve price, and buyers choose randomly among sellers who specified the same reserve price. The fact that in equilibrium, in all standard auctions (English, Dutch, first-price, second-price, all-pay) buyers with high willingness to pay pay more in expectation, and that sellers' optimal reservation prices are nondecreasing in their costs, implies that inequality (2) is satisfied.

A large literature has analyzed the conditions under which "frictionless" decentralized bargaining may give rise to the Walrasian outcome, in which all buyers with willingness to pay above the Walrasian price and all sellers with costs below the Walrasian price trade at the Walrasian price (for a survey of this literature, see Osborne and Rubinstein, 1990). This literature has shown that in environments with a large number of infinitely patient and anonymous traders and with no aggregate uncertainty, the Walrasian outcome, which is obviously incompatible with our assumptions because it is incompatible with the conclusion of Lemma 1,[7] may prevail (see, e.g., Gale, 1986, 1987). The Walrasian outcome However, if decentralized bargaining is not "frictionless," or more specifically, if traders are *not* infinitely patient (that is, traders' discount factor δ is strictly less than 1) or if there is aggregate uncertainty, then the conclusion of this literature is that the Walrasian outcome is impossible (Gale, 2000). Therefore, the fact that our assumptions about direct negotiations preclude the Walrasian outcome does not invalidate our analysis.

4. Equilibrium Analysis

In this section, we show that in any given period, only two types of outcome are consistent with equilibrium: either all those traders who trade do so through the centralized market, or possibly some traders, but not many, trade through the centralized market, while all the others trade through direct negotiation. We show that while the former type of equilibrium outcome can be associated with a *perfect*-like equilibrium, the latter cannot. That is, while equilibria in which in every period all trade occurs through the centralized market are robust

[7] For the same reason, a direct negotiation procedure in which in every period, trade is taking place at the expected price in the centralized market in the same period, is also inconsistent with our assumptions.

to "trembles," or uncertainty about traders' choices, other equilibria are not. Equilibria in which all trade occurs through the centralized market are therefore more "reasonable [...] for rational and intelligent players to choose in this game" (Myerson, 1991, p. 213).

The idea of the proof is to show that in any period in which the centralized market attracts a sufficiently large number of traders, trade through direct negotiations "unravels" as traders with relatively weak types switch to the centralized market. If, however, the centralized market fails to attract a sufficiently large number of traders in any given period, then some traders, but not too many, might trade through the centralized market while others might trade through direct negotiations.

Because a trader who fails to trade at t may trade at a future period, it does not necessarily follow that traders would prefer to trade through the exchange mechanism that provides the higher expected payoff at t.[8] However, as the next lemma shows, traders would prefer the centralized market if their (unconditional) expected payoff there is larger than their expected payoff conditional on trade in direct negotiations.

Lemma 2. *For every period $t \in \{1, 2, ...\}$ and for every buyer with willingness to pay v who opts for trading in period t: if $B_t^M(v) > B_t^{N|trade}(v)$, then the buyer strictly prefers to trade through the centralized market than to trade through direct negotiations at t. Similarly, for a seller with cost c, if $S_t^M(c) > S_t^{N|trade}(c)$, then the seller strictly prefers to trade through the centralized market than to engage in direct negotiations at t.*

Proof. We prove the lemma for buyers. The proof for sellers is similar. Suppose that

$$B_t^M(v) > B_t^{N|trade}(v).$$

[8] Suppose for example that in every period, in the centralized market a trader trades with probability $\frac{2}{3}$ and obtains an expected payoff conditional on trade of $\frac{1}{2}$, and in direct negotiations, the trader trades with probability $\frac{1}{9}$ and obtains an expected payoff conditional on trade of $\frac{9}{10}$. Although in any given period the expected payoff from trading in the centralized market is higher $\left(\frac{1}{3} > \frac{1}{10}\right)$, a patient trader would maximize his payoff by repeatedly trying to trade though direct negotiations.

We introduce the following notation: let

$$\begin{aligned}
B_t^{M|trade}(v) &= \text{the expected payoff conditional on trade of a buyer whose willingness to} \\
&\quad\ \text{pay is } v \text{ from participating in the centralized market in period } t; \\
B_t^N(v) &= \text{the expected payoff of a buyer with willingness to pay } v \text{ from engaging in} \\
&\quad\ \text{direct negotiations in period } t; \\
P_t^M(v) &= \text{the probability that a buyer with a willingness to pay } v \text{ trades in the centralized} \\
&\quad\ \text{market in period } t; \\
P_t^N(v) &= \text{the probability that a buyer with a willingness to pay } v \text{ trades through direct} \\
&\quad\ \text{negotiations in period } t; \\
B_{t\to\infty}(v) &= \text{the expected discounted payoff of a buyer with willingness to pay } v \text{ in period} \\
&\quad\ t \text{ who chooses optimally whether and where to trade.}
\end{aligned}$$

For any period t, a buyer with willingness to pay v strictly prefers to trade through the centralized market than to engage in direct negotiations if and only if his expected discounted payoff from doing so is higher, or

$$\begin{aligned}
&P_t^M(v)B_t^{M|trade}(v) + \left(1 - P_t^M(v)\right)\delta B_{t+1\to\infty}(v) \\
&\qquad > P_t^N(v)B_t^{N|trade}(v) + \left(1 - P_t^N(v)\right)\delta B_{t+1\to\infty}(v). \quad (3)
\end{aligned}$$

Because $B_t^M(v) = P_t^M(v)B_t^{M|trade}(v) \geq 0$, and $0 \leq P_t^M(v) \leq 1$,

$$B_t^{M|trade}(v) \geq B_t^M(v).$$

Similarly,

$$B_t^{N|trade}(v) = \frac{B_t^N(v)}{P_t^N(v)} \geq B_t^N(v).$$

The fact that $B_t^M(v) > B_t^{N|trade}(v)$ implies that both

$$B_t^{M|trade}(v) > B_t^{N|trade}(v)$$

and

$$B_t^M(v) > B_t^N(v).$$

Unless $B_t^{M|trade}(v) \geq \delta B_{t+1\to\infty}(v)$ the buyer is better off refraining from trade in period t. Because the Lemma only applies to buyers who opt for trading at t, we may also assume that $B_t^{M|trade}(v) > \delta B_{t+1\to\infty}(v)$ (note that if $B_t^{M|trade}(v) = \delta B_{t+1\to\infty}(v)$, then $B_t^{M|trade}(v) >$

$B_t^{N|trade}(v)$ implies that the buyer is strictly better off trading through the centralized market at t).

Observe that inequality (3) can be rewritten as

$$P_t^M(v) > P_t^N(v)\frac{B_t^{N|trade}(v) - \delta B_{t+1\to\infty}(v)}{B_t^{M|trade}(v) - \delta B_{t+1\to\infty}(v)}, \tag{4}$$

and because $P_t^M(v)B_t^{M|trade}(v) = B_t^M(v)$ and $P_t^N(v)B_t^{N|trade}(v) = B_t^N(v)$, also as

$$P_t^M(v) < P_t^N(v) + \frac{B_t^M(v) - B_t^N(v)}{\delta B_{t+1\to\infty}(v)}. \tag{5}$$

Finally, if $P_t^M(v) \geq P_t^N(v)$, then $B_t^{M|trade}(v) > B_t^{N|trade}(v)$ implies (4) and so (3). And if $P_t^M(v) \leq P_t^N(v)$, then $B_t^M(v) > B_t^N(v)$ implies (5) and so again (3). ■

Every Nash equilibrium sequence of distributions of buyers' and sellers' types in the centralized market and direct negotiations, respectively, induces a sequence of continuous functions $\left\{B_t^M(\cdot)\right\}_{t\geq1}$, $\left\{S_t^M(\cdot)\right\}_{t\geq1}$, $\left\{B_t^{N|trade}(\cdot)\right\}_{t\geq1}$, and $\left\{S_t^{N|trade}(\cdot)\right\}_{t\geq1}$ which denote the expected payoffs to buyers and sellers if they were to trade through the centralized market or direct negotiations, respectively. Given these sequences of functions define two sequences of thresholds $\{v_t^*\}_{t\geq1}$ and $\{c_t^*\}_{t\geq1}$ as follows: for every $t \geq 1$,

$$v_t^* \equiv \min\left\{v \in [0,1] : B_t^M(v') > B_t^{N|trade}(v') \text{ for every } v' > v\right\},$$

and

$$c_t^* \equiv \max\left\{c \in [0,1] : S_t^M(c') > S_t^{N|trade}(c') \text{ for every } c' < c\right\}.$$

Lemma 2 implies that v_t^* is (the lowest possible) threshold willingness to pay above which every buyer's type who opts for trading at t opts for the centralized market, and c_t^* is (the highest possible) threshold cost below which every seller's type who opts for trading at t opts for the centralized market.

Note that continuity of the functions $B_t^M(\cdot)$, $S_t^M(\cdot)$, $B_t^{N|trade}(\cdot)$, and $S_t^{N|trade}(\cdot)$ ensures that both v_t^* and c_t^* are well defined for every $t \geq 1$. The threshold v_t^* may possibly be equal to one and the threshold c_t^* may possibly be equal to zero, but if $v_t^* < 1$, then $B_t^M(v_t^*) = B_t^{N|trade}(v_t^*)$, and if $c_t^* > 0$, then $S_t^M(c_t^*) = S_t^{N|trade}(c_t^*)$, respectively.

We show that for every $t \in \{1, 2, ...\}$ in which the centralized market attracts a sufficiently large number of traders, $0 \leq v_t^* \leq c_t^* \leq 1$.

Lemma 3. *In every Nash equilibrium, in every period $t \in \{1, 2, ...\}$ in which the centralized market attracts a sufficiently large number of traders so that $B_t^M(v) + S_t^M(c) \geq v - c - \frac{\Delta}{2}$ for every $v, c \in [0,1]$, $0 \leq v_t^* \leq c_t^* \leq 1$.*

Proof. Fix some Nash equilibrium. Fix some $t \in \{1, 2, ...\}$ in which the number of traders who opt for the centralized market is sufficiently large so that $B_t^M(v) + S_t^M(c) \geq v - c - \frac{\Delta}{2}$ for every $v, c \in [0, 1]$. Suppose that $c_t^* < v_t^*$. We show that this implies a contradiction. The definitions of c_t^* and v_t^* imply that all the sellers with costs $c \geq c_t^*$ who opt for direct negotiations at t trade with buyers with willingness to pay $v \leq v_t^*$, and all the buyers with willingness to pay $v \leq v_t^*$ who opt for direct negotiations at t trade with sellers with costs $c \geq c_t^*$. It therefore follows that

$$\begin{aligned}
v_t^* - c_t^* &\leq B_t^M(v_t^*) + S_t^M(c_t^*) + \frac{\Delta}{2} \\
&\leq B_t^{N|trade}(v_t^*) + S_t^{N|trade}(c_t^*) + \frac{\Delta}{2} \\
&< v_t^* - c_t^*,
\end{aligned}$$

where the first inequality follows from the condition of the lemma, the second inequality follows from the definitions of c_t^* and v_t^*, and the third inequality follows from Lemma 1. A contradiction. ■

Because in every period t in which the centralized market attracts a sufficiently large number of traders all the buyers and sellers that engage in direct negotiations have willingness to pay smaller than or equal to v_t^*, and costs larger than or equal to c_t^*, respectively, the inequality $v_t^* \leq c_t^*$ implies that no opportunities for mutually beneficial trade exist outside the centralized marketplace at t. We summarize our results in the following proposition.

Proposition. *In every Nash equilibrium, in every period in which the centralized market attracts a sufficiently large number of traders so that* $B_t^M(v) + S_t^M(c) \geq v - c - \frac{\Delta}{2}$ *for every* $v, c \in [0, 1]$, *all those buyers and sellers that trade, trade through the centralized market. No trade occurs through direct negotiations.*[9]

The intuition for this result is the following. The surplus that is generated by a buyer of type v and a seller of type c is $\max\{v - c, 0\}$. Inequality (1) may thus be interpreted as implying that centralized markets allow high value traders to keep almost the entire surplus they generate. In contrast, in direct negotiations, as Lemma 1 shows, relatively weak types of traders are forced to share the surplus they generate with others. This difference between the centralized market and direct negotiation, which causes relatively weak types of traders to prefer the centralized market and the unraveling of direct negotiations, is due to the

[9] The multiplicity of Nash equilibria is due to the fact that traders may "coordinate" on declining to trade through both mechanisms in certain periods.

stronger impact that a higher willingness to pay and cost have on transaction prices in direct negotiations compared to a large centralized market.

Specifically, fix for some period t distributions of buyers' and sellers' types in the centralized market and direct negotiations, respectively. Suppose that the induced functions $B_t^M(\cdot)$, $S_t^M(\cdot)$, $B_t^{N|trade}(\cdot)$, and $S_t^{N|trade}(\cdot)$, give rise to the thresholds $v_t^* < 1$ and $c_t^* > 0$, respectively. These functions and bounds are depicted in the following figure.

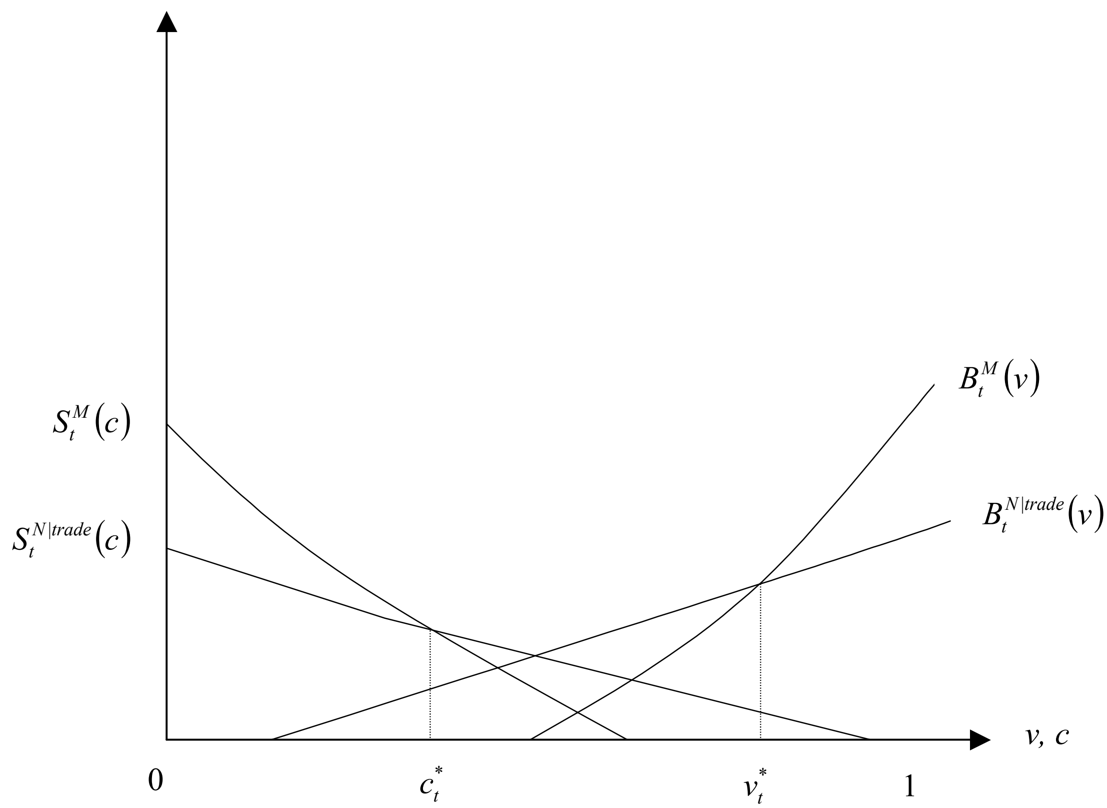

Figure 1: B_t^M, S_t^M, $B_t^{N|trade}$, $S_t^{N|trade}$, v_t^*, and c_t^*

As can be seen in the figure, buyers with willingness to pay above v_t^* and sellers with costs below c_t^*, who according to the original distributions opted for direct negotiations would be better off switching to the centralized market. The functions $B_t^M(\cdot)$, $S_t^M(\cdot)$, $B_t^{N|trade}(\cdot)$, and $S_t^{N|trade}(\cdot)$, and the bounds v_t^* and c_t^* should therefore be recomputed given this switch. The expected price in the centralized market and so also $B_t^M(\cdot)$ and $S_t^M(\cdot)$ may not be much affected by such a switch. But, because it is the buyers with relatively high willingness to pay and sellers with relatively low cost (the weak types) who switch to the centralized market, the switch would have a more dramatic effect on the expected payoffs in direct negotiations, $B_t^{N|trade}(\cdot)$ and $S_t^{N|trade}(\cdot)$, because after the switch the distributions of buyers' and sellers' types in direct negotiations would be more concentrated on buyer types with low willingness to pay and seller types with high cost. Consequently, both the recomputed functions $B_t^{N|trade}(\cdot)$ and $S_t^{N|trade}(\cdot)$, and the recomputed threshold v_t^* would be lower than they were before, and the recomputed threshold c_t^* would be higher than it was before. The process of unraveling would then continue as buyers with willingness to pay above the recomputed v_t^* and sellers with cost below the recomputed c_t^* would want to switch to the centralized market and so on, until the recomputed v_t^* and c_t^* would be such that $0 \leq v_t^* \leq c_t^* \leq 1$. At this point all the "serious" traders, that is all the traders' types that are in fact likely to trade in the centralized market if they were to opt to trade there, would trade through the centralized market, so that no opportunities for mutually beneficial trade would remain under direct negotiations.

The Proposition implies that there exist two types of equilibria: one in which in all those who trade opt for the centralized market in every period, and one in which in some periods, the number of traders who opt for the centralized market is small, and consequently either most of those who trade do so through direct negotiations, or not much trade is taking place.

A *perfect* equilibrium (Selten, 1975) is a refinement of Nash equilibrium that requires that traders' strategies be robust against trembles or small uncertainty about other traders' strategies (Myerson, 1991, p. 216). In a "large" economy, the equilibrium in which in some periods a large volume is traded through direct negotiations is not perfect-like in the following sense. If at some period t, traders "tremble" by, say, choosing to trade through the centralized market, direct negotiations, or not to trade at all, with probability at least ε for some small $\varepsilon > 0$, then if the overall number of potential traders is sufficiently large,[10] then a large number of traders would opt for trading in the centralized market, and the Proposition above would apply. It therefore follows that opting for direct negotiations cannot possibly be a best response to such a profile of strategies and the equilibrium where some serious traders adopts such a strategy is not perfect-like. In contrast, the equilibrium in which all the serious traders opt for trading in the centralized market is robust to such trembles and is therefore perfect-like.

5. Concluding Remarks

The argument presented here is that when faced with the choice, buyers and sellers will opt for trading through a centralized market over engaging in (some form of) direct negotiations. Nevertheless, some transactions, even in homogenous goods, are still conducted through

[10] The smaller ε, the larger the overall number of potential traders needs to be.

direct negotiations. A number of possible explanations may be given for this. We discuss these explanations in the context of the model described in this paper.

First, it may be that the traded good is not really homogenous. Problems associated with quality and credibility may arise, and traders may prefer the relative security of establishing long term trading relationships with a small number of trustworthy trading partners, where the prospect of engaging in future trade serves as a disciplinary device against opportunistic behavior, to trading in an anonymous centralized market where relatively little protection against opportunistic behavior is provided (Kranton, 1996).[11]

Second, participation in a centralized market may entail some costs that we have not taken into account here (transportation costs and the fact that some markets convene only infrequently are possible examples). However, if these costs are similar to those incurred under direct negotiations, our main result should still hold.

Third, ensuring the constant operation of the centralized market, which is necessary for our main result, is a public good, or more precisely, a public service. A centralized market may not dominate other forms of exchange if no one is willing to assume the responsibility for the orderly provision of this public service. As shown by Rust and Hall (2003), if the centralized market is organized by a market maker who charges a positive bid-ask spread, then the unraveling of direct negotiations will not be complete.

Fourth, we have assumed in our analysis that traders are risk neutral. Another reason to prefer direct negotiations over a centralized market is that the former may allow *risk averse* traders to reduce their exposure to the centralized market's volatility by directly negotiating to trade at the *expected* centralized market price. However, because more risk averse or pessimistic traders should also be willing to pay to reduce their exposure to risk, an argument similar to the one presented in this paper implies that a centralized *futures* market that insures against this volatility will again dominate decentralized private mutual insurance agreements.

Finally, even when, say, because of the presence of transaction costs in the centralized market, the unraveling of trade outside the centralized market does not go all the way towards eliminating trade through direct negotiations, our model still provides an insight about the relative willingness of different types of traders to trade through different forms of exchange. Centralized markets are characterized by the fact that high value traders keep almost the entire additional marginal surplus generated by their type. In contrast, in many models

[11]However, even in Kranton's (1996) model, all trade will eventually be conducted through the centralized market if its initial size is sufficiently large.

of negotiations (Nash, Rubinstein, Myerson-Satterthwaite) traders are forced to share this surplus with others. This causes weak types of traders to prefer centralized markets which would cause direct negotiations to unravel, wholly or partially.

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