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Market segmentation as a screening mechanism

Gautam Bose*

School of Economics
University of New South Wales
Sydney, NSW 2052
Australia

e-mail: g.bose@unsw.edu.au

Abstract

In a model of pairwise trade where traders of different sizes arrive sequentially on the market, the existence of small traders imposes a negative externality on the trading options available to large traders. When the relative arrival rate of large traders is sufficiently high, they may prefer to segment themselves in order to avoid trading with the others, and entry into their market segment may command a price. In equilibrium, segmentation is effected because the two types differ in their willingness to pay the entry price. Such segregation happens even when large traders are a minority of the total population. Alternatively, large traders may voluntarily decline small trades.

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1 Introduction

In many markets, traders who want to make transactions of different sizes often populate different market segments. These segments are sometimes separated by real barriers such as distance or entry cost. Thus wholesale and retail merchants often set up shop in different locations. Large traders in agricultural commodities deal on a commodities exchange, while small traders may conduct transactions on the street. In other markets, the separation is enforced because traders of one type voluntarily decline trades with other types. Firms which produce items on a large scale deal directly only with distributors and retail chains, but may refer smaller buyers of their products to other outlets.

This paper presents a model of pairwise matching and trade in a market with traders of different sizes, where the existence of small traders imposes a negative externality on the trading options available to large traders. We focus on a market where traders arrive sequentially, so at any time there is at most one potential partner that a trader can trade with (for the case where all traders enter the market simultaneously, see Bose, 2003). We show that, depending upon the relative rates of arrival of large and small traders in the market, there are three different trading configurations that may emerge in equilibrium. Two of these involve a segmentation of the market between small and large traders.

A mixed market, in which all traders trade with each other regardless of type, is always an equilibrium. When the density of large traders is sufficiently high, however, there is a second equilibrium in which these traders segment themselves in a separate market in order to avoid encounters with the smaller traders. To screen these traders out, they may make entry into their market segment costly. In equilibrium, segmentation is effected because the two types differ in their willingness to pay the entry price. A third equilibrium emerges when the density of large traders is very high. In this equilibrium, the large traders are not institutionally segregated, but nevertheless voluntarily refuse to trade with the small agents.

Each of these trading patterns is observed in real-life markets. The contribution of this paper is to explain this variety of configurations as a function of the relative density of the different types of traders, and in explaining the nature of the externality that causes the variations.

The basic externality which drives our results is explained as follows. We consider a market where traders arrive sequentially, with variously one or two units of a good to trade. All traders have the same good, but a taboo prevents them from consuming their own output. This necessitates exchange without unnecessarily cluttering the model (Diamond 1982). If a two-unit trader meets a one-unit trader and exchanges one of his two units, then she has to wait for another trader to arrive before she can conclude exchange. But in the meantime she has been transformed into a one-unit trader. If she now meets another two-unit trader, then the latter will similarly have to wait for another encounter. However, if the first two-unit trader hadn't made the small trade in the first

place, then the two large traders would both leave the market at this time. Thus the existence of the small traders imposes an externality on the large ones. If this effect is sufficiently strong, then the large traders might prefer to foreclose the possibility of trading with the smaller ones altogether, either by voluntarily declining small trades, or by segregating themselves in a separate market.

In his classic paper, Demsetz (1968) investigates the role of market-makers in reducing waiting costs. In his model, traders arrive in the market sequentially, and must wait for other traders to arrive in order to exchange their endowments. Since future utility is discounted, traders are willing to pay a premium for the option of conducting trade immediately. Market-makers who hold stocks of goods and money to trade can therefore profit by standing ready to buy and sell at different prices. Rubinstein and Wolinsky (1987) show that the existence of middlemen in matching markets thickens the market and reduces the expected waiting time of traders. Variations in expected waiting time can have serious implications regarding the efficiency of production decisions (Diamond 1982).

The present paper continues this direction by showing that considerations associated with waiting time may induce market-makers to establish separate markets for different types of traders. Thus while Demsetz explains the existence of market-makers operating within an exchange, this paper provides one explanation for the existence of an exchange which nevertheless excludes many small traders. The function of the exchange (or formal market) here is to screen out these small traders and allow large agents to deal exclusively with each other.

The analysis here has a superficial resemblance to the literature on search and matching (SM), but the present model is designed to address somewhat different questions. In SM models, each agent seeks to be matched with one other agent (of an "opposite" type), and the payoff depends on the type of the partner. This is appropriate for analyzing markets such as marriage matches and employer-employee matches. In contrast, this paper considers a market in which matching is followed by trade in a physical commodity. A mismatched trader must return to the market to conduct further trades in order to exhaust her inventory, which is not the case in SM models.

A robust result in the search and matching models is that, if there is an intermediary who can match agents according to type, then in equilibrium the agents are segmented into a finite number of connected subsets, with matches occurring only between corresponding subsets of the opposite types (Bloch and Ryder 2000, Burdett and Coles 1997). The present paper shows that this result generalizes beyond the SM context. In this paper agents do not use the services of an active matchmaking intermediary, nor do they end their search by the same rule as in the SM models. Nevertheless, the segmentation that occurs in equilibrium has a resemblance to that in the SM models.

This indicates that the segmentation result obtained in SM models may obtain independent of the information services provided by the intermediary. In particular, segmen-

tation can occur purely as a consequence of imposing appropriate prices for entry into different segments of the market.

Section 2 sets out the model and establishes the equilibrium payoffs in the unseparated market. Section 4 investigates the possibility of an equilibrium in which large traders voluntarily decline to trade with small traders. Section 5 contains the main result, that even when voluntary separation is not sustainable, large traders would prefer a separate market–and pay a fee to do so—if their density is sufficiently high. Both types of segmentation are socially inefficient, as shown in section 6. The final section concludes.

2 Model

We consider a market where agents (also called traders) arrive sequentially according to a Poisson process with arrival rate λ. An agent is endowed with either one unit or two units of a homogeneous good. Depending on his/her endowment, s/he is designated a "big" ("large") or a "small" agent. Each arriving trader is large with probability π and small with probability $1 - \pi$. This is equivalent to considering two independent Poisson processes with rates $\lambda\pi$ and $\lambda(1 - \pi)$ respectively.

In the marketplace, the trader exchanges his endowment against that of others, and consumes once his entire endowment has been exchanged.[1] Each agent has an endowment of a second good called "money", which can be transferred along with the good in an exchange. An agent's utility in consumption is $x + p$, where x is the number of units of the good consumed, and p is the net amount of money received in the exchange. Agents discount the future at an instantaneous rate r. Since all agents possess the same homogeneous good, we assume that the price in exchanges is unity, though an amount of money may be transferred as an inducement to trade. Effecting the exchange is in itself costless.

We assume there is a market-maker (who is not explicitly modeled) who can set up a trading area in which traders are physically separated from the main marketplace. We will call this a *formal* market. Entry into the formal market may be free, or it may be conditional on the payment of an entry fee determined by the market-maker. The market-maker cannot distinguish the type of an agent (large or small), and must charge the fee from any trader who wishes to enter the formal market. The main (*informal*) marketplace always allows free and unconditional entry.

The market-maker decides whether or not to set up a second market, and determines a fee to charge for entry into this market. Each trader decides which market to enter (if a formal market is available), which type of partner (large, small, or both) to trade

[1] We could allow agents to consume each unit as soon as it is exchanged. The qualitative results would continue to hold, and the efficiency result would hold without qualification. However, the algebra becomes extremely turgid, which is why I have chosen this specification.

with, and the maximum transfer of money, in addition to a unit of the good, to offer to (minimum transfer to claim from) each type of partner. When two agents are matched, the largest trade that can take place is of the size of the smaller of the two endowments. Agents do not know the endowment types of potential partners before matching.

A choice of strategy by the market-maker and each agent leads to a *state* of the economy, which is described by the following:
(i) A configuration of markets (one or two), and an entry fee for the formal market if it exists,
(ii) An allocation of each arriving agent to an existing market,
(iii) for each market and each possible matching of pairs of agents, a proposed pair of transfers.

A state of the economy is an *equilibrium* if (i) a strictly positive number of agents enter each existing market, (ii) for each agent, his/her choice of strategy maximizes his/her expected utility, given the strategy choices of the other agents, (iii) after being matched with another agent, his/her choice of maximum transfer to offer continues to maximize his/her expected utility.

When two agents of the same endowment type meet each other, they can immediately exchange their entire endowment. It is also clear that, in such a case, a non-zero net transfer cannot simultaneously be optimal for both agents. We will therefore only consider non-zero transfers when two unlike agents meet each other. If a large agent meets a small agent, she can at most trade one of the two units in her endowment, and must then wait for another trading opportunity. In the process she is transformed into a small agent. Since waiting is costly, a large agent would rather meet another large agent than a small agent.

3 The unsegmented market

Proposition 3.1 *The following state is an equilibrium: only the main market is active, and each matched pair conducts the largest feasible trade with zero net transfers being made.*

The proof is obvious once we verify that a large trader cannot credibly demand a positive transfer from a small partner. For such a claim to be credible, it must be true that trade without the transfer will reduce the large trader's expected utility, as opposed to not trading at all. However, if the large trader does make the present trade, then he will definitely leave the market when he next meets a partner, whereas if he does not conduct the present trade, he will have to wait for two successive partners with positive probability. Thus conducting the present trade increases the large agent's expected utility, and he cannot credibly demand a transfer.

This equilibrium, in which all agents trade on the same market and with any available partner regardless of type, is the benchmark, and it is useful to establish some of its properties. An arriving agent may find the marketplace empty, in which case s/he must wait for the next arrival. Otherwise s/he will find an agent already waiting, in which case the two will trade. If the two agents have similar endowments, then both will leave, and the market will be empty until the next arrival. If they have unequal endowments (large/small), then the large agent will be reduced to a small one, and will wait for the next arrival. Under no circumstances will there be more than one agent waiting to trade.

At any given time, the market is thus in one of three states – it is either empty, or it has a small agent waiting to trade, or it has a large agent waiting to trade. Refer to these as states s_0, s_1, and s_2 respectively (by the number of units available for trade). The expected payoff of a given agent who arrives on the market will depend upon the probabilities of each of these states prevailing, as well as on λ and π. Our propositions will hinge on a comparison of these expected payoffs with those that could be obtained on a separated market.

Denote the probabilities of the three states $p_0,\ p_1,\ p_2$ which sum to unity. There is a change of state each time a new agent arrives on the market. Now consider the state s_0. This may have occurred in two ways: either the previous state was s_1 (probability p_1) and the last arrival was a small trader (probability $1-\pi$), or the previous state was s_2 (probability p_2) and the last arrival was a large trader (probability π). Thus we have:

$$p_0 = (1-\pi)p_1 + \pi p_2 \tag{1}$$

Similarly, state s_1 can occur in three ways: state s_0 followed by the arrival of a small trader, state s_1 followed by the arrival of a large trader, or state s_2 followed by the arrival of a small trader. Finally, state s_2 can occur only if the previous state was s_0 and the last arrival was a large trader. These yield two further conditions:

$$p_1 = (1-\pi)p_0 + \pi p_1 + (1-\pi)p_2 \tag{2}$$

$$p_2 = \pi p_0 \tag{3}$$

Only two of the three above equations are independent, but since the three states are exhaustive we can solve for the probabilities, which turn out to be:

$$p_0 = \frac{1}{2(1+\pi)}, \qquad p_1 = \frac{1}{2}, \qquad p_2 = \frac{\pi}{2(1+\pi)} \tag{4}$$

It is interesting to note that the probability of state s_1—that a small trader will be in the market—is independent of the density of small traders in the population. The intuition for this is as follows. Suppose that at some given time, the state of the market is *not* s_1, and a small trader arrives. Then the state must change to s_1. Now if a large

trader arrives he will find a small trader to trade with, and hence will remain on the market with one unit of the good to exchange, i.e., the state will remain s_1. A change out of this state requires that another small trader must arrive on the market.

Thus each time a small trader arrives on the market, the state switches between s_1 and not-s_1 and stays so until the next arrival. Hence on average the state must be s_1 half the time, regardless of the relative density of small traders (as long as this density is positive).

To compute the expected utility of the large trader in this equilibrium (which will be useful in what follows), consider a large trader arriving in the market. With probability p_2 he finds another large trader waiting in the market, and concludes trade instantaneously. With probability p_1 he finds a small trader and trades half his endowment, then waits for the next arrival to conclude trade. With probability p_0, the market is empty. If the next trader to arrive is large (probability π) he concludes trade, if the next arrival is small, he has to wait until the second trader arrives to conclude.

Note that with a Poisson process with arrival rate λ, the density function for the time to the first arrival is $\lambda e^{-\lambda t}$, and for the second arrival it is $\lambda^2 t e^{-\lambda t}$. If consumption occurs after the first arrival, then the expected discounted payoff per unit consumed is

$$\int_0^\infty \lambda e^{-\lambda t} e^{-rt} dt \;=\; \frac{\lambda}{\lambda + r}$$

and the expected discounted payoff when one unit is consumed after the second arrival is similarly $\frac{\lambda^2}{(\lambda+r)^2}$. The large trader gets two units of instantaneous utility when he consumes. Using (4) and noting that any arriving trader is large with probability π, we get the large trader's expected utility as:

$$\begin{aligned} V_0^L &= 2[\frac{\pi}{2(1+\pi)} + (\frac{1}{2} + \frac{\pi}{2(1+\pi)})(\frac{\lambda}{\lambda+r}) + \frac{1-\pi}{2(1+\pi)}(\frac{\lambda}{\lambda+r})^2] \qquad (5) \\ &= \frac{\lambda}{\lambda+r} + \frac{1}{1+\pi}[\pi + \pi\frac{\lambda}{\lambda+r} + (1-\pi)(\frac{\lambda}{\lambda+r})^2] \end{aligned}$$

4 Voluntary Separation

If the arrival rate of large traders is sufficiently high, then there is an equilibrium in which large traders only trade with other large traders, and voluntarily decline trades with small traders. An individual large trader who meets a small trader will decline trade because she expects that, if she becomes "small" by trading one of the units in her endowment, then other large traders will in turn decline trade with her. Since she must wait for a second partner to arrive in either case, declining is a better strategy for her if the arrival rate of large traders is higher than that of small traders.

However, $\pi > \frac{1}{2}$ is not a sufficient condition to ensure this for the following reason. Consider a small trader who has just met a large trader. If he can induce the latter to trade, then he leaves the market immediately, and gets unit utility from consumption. Otherwise, he stays in the market until the next small agent arrives. The large partner will stay in the market whether she trades or not, the difference on her part being that between waiting for a small as opposed to a large partner. If this difference is not too large, then the small trader will be able to compensate her for the expected loss in utility and still retain a benefit. Thus for voluntary separation to be an equilibrium, the difference in expected arrival times of the two types must be sufficiently large, i.e. π must be sufficiently greater than $\frac{1}{2}$.

For the purpose of the following proposition, note that the rate of arrival of large and small traders is $\lambda\pi$ and $\lambda(1-\pi)$ respectively. Hence, if large traders only trade with other large traders, then the expected utility of an individual agent of that type who is searching for a like partner is $2\frac{\lambda\pi}{\lambda\pi+r}$, while for a small trader it is $\frac{\lambda(1-\pi)}{\lambda(1-\pi)+r}$.

Proposition 4.1 *If $\pi > \frac{2\lambda+r}{3\lambda}$, then there is an equilibrium in which only the informal market is active, and large traders voluntarily decline trades with small traders.*

proof: If the large agent were to trade with the small agent, knowing that other large agents would then refuse to trade with her, then her net decline in expected utility is

$$\Delta^L \;=\; 2[\frac{\lambda\pi}{\lambda\pi+r} \;-\; \frac{\lambda(1-\pi)}{\lambda(1-\pi)+r}]$$

whereas the small trader's gain is that he gets utility instantly rather than later, i.e.

$$\Delta^S \;=\; 1 \;-\; \frac{\lambda(1-\pi)}{\lambda(1-\pi)+r}$$

The latter will bribe the former, and the voluntary separation equilibrium will break down, if $\Delta^S > \Delta^L$, which on simplification yields the condition in the proposition. ■

This requires a value of π which is greater than $2/3$ for $r > 0$. In particular, if r is sufficiently high, then voluntary separation is not an equilibrium for any π. However, formal separation can occur under much weaker conditions, as shown in the next section.

5 Segmentation by market

We want to show that, under suitable conditions, it would be in the interest of the large traders to trade exclusively on the formal market. If the small traders continue to trade on the informal market, then an individual small trader will either have no interest

in deviating to the formal market, or the market-maker can successfully charge a fee which would dissuade the small traders (but not the large traders) from entering the formal market.

Suppose a formal market exists and all the large traders trade on that market, while all small traders trade in the informal market. The rate of arrival of traders in the formal market is $\lambda\pi$, and each trader needs only one encounter to conclude trade. A newly arrived trader either finds a partner already waiting, or waits for the next arrival—each contingency occurring with equal probability. Thus the expected payoff of the large trader is:

$$V_F^L \;=\; 2[\frac{1}{2} + \frac{1}{2}\frac{\lambda\pi}{\lambda\pi + r}] \;=\; 1 + \frac{\lambda\pi}{\lambda\pi + r} \tag{6}$$

The large trader's gain from establishing a formal market is $V_F^L - V_0^L$. It turns out that:

$$V_F^L - V_0^L \;\geq\; 0 \tag{7}$$

$$\Leftrightarrow \quad \lambda r^2\pi^2 \;+\; 2\lambda^2\pi \;+\; \lambda^2 \;+\; \lambda r \;+\; r^2 \;\geq\; 0 \tag{8}$$

Let $\hat{\pi}$ be the value of π such that the inequality in equation (7) is satisfied for all $\pi \geq \hat{\pi}$. The expression on the LHS of the second line of 7 is a quadratic in π. Thus there are two solutions for $\hat{\pi}$, which are real if and only if $r < \lambda$. Assuming that this holds, one of the solutions is unequivocally negative, while the other is:

$$\hat{\pi} \;=\; \frac{(\lambda + r)\sqrt{\lambda(\lambda - r)}}{\lambda r} \;-\; \frac{\lambda}{r} \tag{9}$$

Segregation is attractive to the large traders if the fraction of large traders is greater than $\hat{\pi}$. Note that the second line of (7) can be written as:

$$\pi \;\geq\; \frac{1}{2} \;-\; \frac{\lambda r\pi^2 + r^2 + \lambda r}{2\lambda^2} \tag{10}$$

Since the second term on the right of (10) is non-negative, it follows that the threshold value $\hat{\pi}$ cannot exceed one-half. This means that the large traders would prefer to be segregated on a formal market even when they are in a minority (i.e. when $\hat{\pi} < \pi < \frac{1}{2}$), and certainly when they are in the majority.

Observation 1 *Suppose that condition (7) is fulfilled, (i.e. $\pi \geq \hat{\pi}$ as defined in (9)),a formal market is active, all large traders trade in the formal market, and all small traders trade in the informal market. Then the expected payoff to a large trader is greater than his expected payoff in the unseparated market.*

Thus the large traders would prefer the market-maker to establish a formal market. We next need to establish that the separation described in observation 1 is an equilibrium, by verifying that neither type of trader has an incentive to deviate from his/her assigned market and enter the market earmarked for the other type. As indicated earlier, the market-maker may charge a fee to ensure this.

If the large traders are in a minority (i.e. $\hat{\pi} \leq \pi \leq \frac{1}{2}$), then the small traders will be content to trade in the informal market, since the arrival rate there is thicker, and this is all that matters to them. By (7) large traders will prefer to trade on the formal market. However, if $\pi > \frac{1}{2}$, then the small traders would rather trade on the formal market. One way to deter them from entering is to charge a price for entry which makes the formal market unattractive to the small traders but not the large ones.

To do this, we calculate the gain that a small trader makes by trading in the formal market rather than on the informal market, and compare it with the corresponding gain for the large trader. If the latter gain is larger than the former, then a price situated between the two would deter the small traders from entering the formal market, but would not discourage the large traders.

In either the formal or the informal market, an arriving trader finds a ready partner with probability half, and has to wait for the next arrival with probability half. For a small trader, a single encounter concludes trade on either forum. For a large trader a single encounter is sufficient in the formal market, but two encounters are necessary in the informal market since all traders on the informal market are small. Together with the different arrival rates, this yields the gain from trading in the formal market rather than on the informal market for the two types:

$$\Gamma^L = 1 + \frac{\lambda\pi}{\lambda\pi + r} - \frac{\lambda(1-\pi)}{\lambda(1-\pi) + r} - [\frac{\lambda(1-\pi)}{\lambda(1-\pi) + r}]^2 \tag{11}$$

$$\Gamma^S = \frac{1}{2}[\frac{\lambda\pi}{\lambda\pi + r} - \frac{\lambda(1-\pi)}{\lambda(1-\pi) + r}] \tag{12}$$

From the two equations above we get

$$\Gamma^L - \Gamma^S = \{1 - [\frac{\lambda(1-\pi)}{\lambda(1-\pi) + r}]^2\} + \frac{1}{2}[\frac{\lambda\pi}{\lambda\pi + r} - \frac{\lambda(1-\pi)}{\lambda(1-\pi) + r}] \tag{13}$$

The term in braces on the RHS is always positive, so a sufficient condition for the whole expression on the RHS to be positive is that the term in square brackets be non-negative, which is true if $\pi \geq \frac{1}{2}$, i.e., if the density of large traders is at least as great as that of small traders. Then an entry fee $t \in [\Gamma^S, \Gamma^L]$ will separate the two types, because t will exceed the gain of the small trader from switching to the formal market, but not

the loss of the large trader from switching to the informal market. But $p \geq \frac{1}{2}$ is the only case where the small traders would want to infiltrate the formal market anyway. Thus separation can be sustained whenever it is in the interest of the large traders to do so.

Next, note that Γ^L—the benefit to the large trader of entering the formal market rather than the informal one, is larger than $V_F^L - V_0^L$. The latter is her gain from trading in the formal market as opposed to the unseparated market, where she may meet both large and small traders. In the segmented structure, she would meet only small traders in the informal market, which is even less attractive. It follows that, in the absence of a fee, the large trader would prefer to enter the formal market rather than the informal market if $\Gamma^L \geq 0$. Define $\bar{\pi}$ by:

$$\pi \;\geq\; \bar{\pi} \quad \longrightarrow \quad \Gamma^L \;\geq\; 0 \tag{14}$$

It is easily verified that $\bar{\pi} < \hat{\pi}$.

Proposition 5.1 *If $\pi \geq \bar{\pi}$ then there is an equilibrium which separates the large and small traders between the formal market and the informal markets with the following entry fees:*
(a) If $\pi \in [\bar{\pi}, \frac{1}{2}]$ then the fee for entry into the formal market is zero, and neither type of trader has an incentive to deviate from his assigned trading place.
(b) If $\pi > \frac{1}{2}$, and the entry fee is $t \in [\Gamma^S, \Gamma^L]$, then the large traders will prefer to pay the fee and trade in the formal market, while small traders will prefer not to pay the fee and will trade in the informal market.

The proof follows directly from the arguments preceding the proposition.

Observation 2 *If $\pi \in [\bar{\pi}, \hat{\pi}]$, then separation by market is strictly pareto-inferior to an unseparated market. If $\pi > \hat{\pi}$, then separation by market increases the payoff of the large traders, but decreases that of the small traders.*

This indicates that, if $\pi \in [\bar{\pi}, \hat{\pi}]$, then large traders will not encourage the establishment of a separate market if one does not already exist, but will trade in it if it does. If $\pi > \hat{\pi}$, they will encourage the founding of a separate market if one is not already present.

Observation 3 *The conditions under which voluntary separation is an equilibrium form a strict subset of the conditions under which separation by market is an equilibrium.*

6 Efficiency

Under the appropriate conditions, both voluntary segmentation and segmentation by establishing a separate market increases the utility of the large traders, but makes the small traders worse off. Thus a direct pareto-comparison is not possible between the segmented and unsegmented structures, and some other metric must be used for welfare comparison.

The source of inefficiency lies in the fact that the good cannot be consumed while agents are waiting to conduct exchanges. The average length of time for which a unit of output remains unconsumed is a measure of inefficiency that is generated in either market. This is directly proportional to the average outstanding number of unconsumed units in the steady-state. We will use the latter as a measure of inefficiency that is generated by the market structure.

This number is easily determined when the market is segmented. In each of the two segments–populated by the large and small traders respectively–the market is empty half the time, and has one outstanding agent the other half of the the time. An agent who is in the small trader segment carries one unit of the good, so on average the number of units carried is $\frac{1}{2}.1 + \frac{1}{2}.0 = \frac{1}{2}$. An agent in the large segment carries two units, so the average number carried is 1. Thus for the segmented market, the average number of units carried in aggregate is:

$$Y = \frac{3}{2} \tag{15}$$

In the unsegmented market, the number of units carried at any given time is clearly 2 when the state is s_2, and 0 if the state is s_0. When the state is s_1, the number depends on the original endowment of the agent who is in the market. This can be determined by considering the state preceding the last arrival and the endowment of the last arriving agent. Specifically, the number of outstanding units is 1 if the previous state was s_0 and the last agent to arrive was small, which has the probability $p_0(1-\pi)$. For any other sequence of events leading to state s_1, the agent on the market was originally large, and two units are outstanding.

Using the information above, the probability that two unconsumed units are being carried is $\frac{3\pi}{2(1+\pi)}$, the probability that one unit is being carried is $\frac{1-\pi}{2(1+\pi)}$, and that of an empty market is $\frac{1}{2(1+\pi)}$. This yields the expected number of unconsumed units in the unsegmented market to be

$$Y_0 = \frac{1+5\pi}{2(1+\pi)} \tag{16}$$

Comparing the two expressions above, we find that $Y > Y_0$ for all values of $\pi < 1$. Thus the unsegmented market is always more efficient than a segmented market, even

though the latter is an equilibrium for a wide range of parameter values.

Proposition 6.1 *If the proportion of small agents is strictly positive, then a segmented market is strictly less efficient than the unsegmented market. Further, if* $\pi \in [\bar{\pi}, \hat{\pi}]$*, then a separated market is strictly pareto-inferior to the unseparated market.*

proof: The first part follows from the calculation preceding the proposition. The second part is a restatement of observation 2.■

7 Conclusion

We have shown that the mixing of different types of agents in a trading environment may give rise to negative externalities for some of the types. The example in this paper is cast in terms of large and small agents, but other examples can easily be constructed.

In such situations, the offended types may find it profitable to decline trades with agents other than their own type, or to establish a separate trading forum with costly entry to keep the others out. Such segmentation is observed in many markets. The contention of this paper is that there are indeed conditions under which segmentation can perform such a screening function.

An interesting finding of this paper is that, while segmentation may be engineered consciously by economic agents who establish the corresponding formal institutions, and while it is beneficial for these agents, the outcome is a reduction in the surplus generated in the economy. Thus it is suggested that institutional change, even when it comes about by design, need not improve economic efficiency. This relates to the question—whether institutional changes that occur spontaneously can reduce aggregate efficiency—is of some interest in the literature concerned with the evolution of institutions. The welfare conclusions in this paper suggests that such spontaneous change is indeed possible.

This paper explicitly addresses heterogeneity in size of trade. In actual markets, traders may also segment themselves according to characteristics other than size—this separation being facilitated by the existence (or lack thereof) of mediators and warranties. For example, knowledgeable buyers and sellers of used cars prefer to deal directly with each other, while others transact indirectly through a used-car dealer. Other variations can be analyzed similarly (see e.g. Bose and Pingle (1995) for differences in bargaining ability, and Bose (1996) for different degrees of patience).

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