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NATURAL OLIGOPOLY

IN

INTERMEDIATED MARKETS

by

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revised version: January 1993

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"The way to make money is to get, if you can, a monopoly for yourself"

(Aristoteles, 384-322 B.C., The Politics)

Abstract

The industrial structure of an intermediation industry is analyzed, in brokerage markets, where intermediaries help to reduce search frictions. The aspect of competition in intermediated markets is analyzed in an "island economy", in which intermediaries invest in information networks, which allow them to inform the market about their price offers. Larger networks allow them to reach more markets and potential customers. This enhances trading probabilities. Thus the size of the information network may be viewed as a quality attribute by market participants. Price competition among intermediaries therefore exhibits features of imperfect price competition in markets of vertically differentiated products.

It is shown that the number of intermediaries active in a symmetric equilibrium is bounded independently of the size of the market, as long as investments are costly. Thus, the market constitutes a natural oligopoly in the sense of Shaked and Sutton (1983) and convergence to a fragmented industrial structure does not obtain as the economy grows large. In particular, we find a natural oligopoly in which in general there are three larger intermediaries of similar size and one smaller intermediary occupying niche markets. Nevertheless, as the number of islands increases, spreads shrink to zero and almost competitive allocations arise.

JEL-classification numbers: D43, L11, L13

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Natural Oligopoly in Intermediated Markets

1. Introduction

It is frequently held that intermediated markets constitute the industrial structure of natural monopolies [1] . Yet, except for regulatory reasons, few intermediated markets exhibit the features of monopoly. In this paper we present a model, in which a concentrated but truly oligopolistic market structure emerges in the market for brokerage services.

While the general presumption on intermediated markets implicitly relies on the notion of price competition in homogenous product markets with fixed costs of entry, we allow brokers also to vary the quality of their products. In order to offer their services efficiently brokers need to build up a network to potential clients. It is costly to establish a large network, but there are two attractions to incur these costs. Besides participating in a larger market brokers with larger networks also can offer their matching services more efficiently, since they can search for trading partners from a larger set. In the model we consider, network size affects the matching probability of the brokerage service. A large intermediary can match customers with a higher probability than a small intermediary. In this sense network size acts as to differentiate the quality of brokerage services. Accordingly, intermediaries may relax price competition by selecting networks of different size and offering products of different quality.

As is known from the work of Shaked and Sutton (1982,1983) industrial structure in vertically differentiated markets differs sharply from the industrial structure in markets for horizontally differentiated products when markets grow large. While the former tend to remain oligopolistic the latter tend to become fragmented.

Financial markets offer a wide variety of markets, in which networks of poten-

[1] As prominent examples see Demsetz (1968), Diamond (1984).

tial clients play an important role. Typically, large block transactions in American stocks are not traded at the floor of the NYSE. They are brokered at the so-called "upstairs market" by few investment banks, like Merrill Lynch, Goldman, Sachs or Salomon Brothers. These investment houses rely on their networks of contacts to institutional clients in order to manage directly block transactions, which because of their sheer size could easily exceed any specialist's capacity to absorb risks. This example also illustrates the type of intermediary we are interested in. It is not the market maker or specialist who actively engages in commitments to buy or sell stocks at a the prices quoted but it is the broker who attempts to find a matching trade on a commission fee basis. In the case of bad luck the broker's loss is restricted to the comission fee foregone. He has no further obligations.

Brokerage also is an important aspect of the corporate activities of banks in continental Europe. Interestingly, the banking structure in many European countries is characterized by few dominant banks and a wide class of small banks. So in Germany and Switzerland, for example, three banks of similar size dominate the industry. These dominant banks also appear to possess the largest networks of branches and foreign affiliations and command larger margins. A common explanation given by bankers of the larger institutions to justify such extra margins is the superior quality of their products. Our model validates such an argument for brokerage services.[2]

Furthermore the model also applies to real estate brokers or even to car manufacturers, who can affect the image of their products by maintaining service networks of different sizes.

Section 2 describes the model. Price competition is analyzed in section 3 while the central results on industrial structure are discussed in section 4. Even in a concentrated industrial structure we find that equilibrium prices converge to marginal costs. This seems to contradict the earlier findings of Shaked, Sutton

[2] However care has to be taken since both in Germany and in Switzerland universal banking is common and banks' pricing policies traditionally are based on mixed accounting (Krümmel, 1964). In such an industry it is difficult to analyze single product lines in isolation.

(1982). Therefore, in section 5 the relation to their model is discussed. Section 6 concludes with comments on welfare.

2. The Model

Consider a segmented market for perishable products.

Potential market participants are located on one of M potential islands $m \in \{1, ..., M\}$. Transportation and communication across islands is expensive. In order to establish a trading facility across islands a fixed cost has to be incurred prior to trading. Agents who choose to establish such trading facilities are termed intermediaries. An intermediary i may choose to construct a trading network $M_i \subseteq \{1, ..., M\}$ consisting of several islands. In this case we assume that fixed costs are proportional to the number of islands included in a network. Denote the cost per island in a network by $k > 0$. Then the overall set up cost of network M_i amount to $k\#M_i$. We shall see that due to these costs only few agents will choose to become intermediaries.

Trading opportunities are short lived and may be described by liquidity events. Assume that agents for some exogenous (liquidity) reason would like to buy or sell one unit of a given block of stocks in a given company. There are A different companies and liquidity shocks occur in the stocks for each company.[3]

The liquidity shocks are such that exactly one agent would like to buy the stocks of a given firm and exactly one agent would like to sell the same amount of stocks of the same company. Furthermore, the economic gains can be captured only when buyer and seller transact in the same period. The private values to buyer and seller are described by reservation values r and $1 - r$ respectively. The

[3] We could also think liquidity shocks occurring over time in the stocks of the same company. This intertemporal structure induces a finitely repeated game in the stocks of the same company. It can be shown that the constituent price game has a unique Nash equilibrium. Hence, according to the results of Benoit, Krishna (1985) the equilibria of the repeated game coincide with equilibria of the constituent game.

liquidity event now describes both the locations of buyer and seller as well as the value of r. For the sake of simplicity we assume that buyers and sellers are uniformly distributed across islands and that in each period r is drawn from a uniform distribution on the intervall $r \in [\frac{1}{2}, 1]$. These assumptions are strong, but they are meant to stress the nature of a liquidity event. The valuations are symmetric around the Walrasian equilibrium price of $\frac{1}{2}$ and by simply matching buyer and seller the Walrasian auctioneer could maintain that price.

The interest in this paper derives from the absence of such a Walrasian auctioneer. Buyer and seller have to find each other before trading. This match is complicated by the segmented nature of the market. Once buyer and seller experience liquidity events they need to employ the brokerage services offered by intermediaries. We assume that the construction of trading networks is lengthy relative to the urgency to trade. Therefore, once agents experience liquidity shocks either they possess already a network, i.e. they are intermediaries, or they need to approach an intermediary.

Having established their trading networks M_i at the initial stage, intermediaries quote commission charges $P_i(m)$ in the trading stage. These commissions may differ across islands $m \in M_i$ in their network. They do not entail any commitment towards trade. In contrast to a market maker, who becomes a party of trade, the intermediary we consider is a broker or simply a match maker. In case of success he is awarded the commission fee. Otherwise, he foregoes the commission but he is free of any further obligation.

Now, who is going to select which intermediary? We assume that one trading partner learns his shock before his counterpart does. Without loss of generality assume that always the buyer will learn first. This agent then selects exactly one intermediary, who in return for the commission fee will search for the seller on the islands in his network.

If the intermediary is successful the trading partners are matched after the intermediary is paid his posted fee and in subsequent bilateral negotiations buyer and seller agree to split the remaining surplus equally. Otherwise, the trading opportunity is lost for all participants.

The process of search should be viewed as "direct search" in the sense that intermediaries directly contact their potential customers and inform them about the possibility of a trading opportunity without disclosing the identity of their client before concluding the match. Intermediaries can only search on islands included in their network. Implicitly we assume that successful search requires some "intimate" knowledge of the local market, which can be acquired only when being present on the local market. Furthermore we assume an efficient search mechanism. So whenever the trading partner wanted happens to live on one of the islands $m \in M_i$ we assume intermediary i will find him with certainty. Thus intermediary i's probability of concluding a trade is given by $\frac{\# M_i}{M}$.

This defines a two-stage game. In the first stage agents decide about the size of their trading networks. We shall see that most of them prefer not to establish such a network and hence do not become intermediaries. In the second stage having established their networks intermediaries compete in commission charges. Finally, nature reveals the realizations of the liquidity events and agents select an intermediary, who may or may not match them with their trading partner.

We are interested in the subgame perfect Nash equilibria of this game.

3. Price Competition

In our model intermediaries undertake two strategic decisions. Initially, they decide about the scale of their operations and establish a trading network across the islands they plan to engage in business on. Having established their presence in the market they compete for market shares by quoting prices. To solve for the subgame perfect Nash equilibria we solve the game backwards. In this section we focus on the last subgame and analyze the nature of short run competition in prices for given investment decisions. Long run competition and the choice of the network is the topic of the next section.

Note that agents cannot expect to trade at the quoted commission fees with certainty. In fact the probability of trade $\frac{\# M_i}{M}$ depends on the size of the chosen intermediary's network. At a common price for all intermediaries, clearly, market participants prefer to deal with the intermediary who enjoys the highest probability of trade, which is the intermediary with the largest network. Thus, the intermediaries' services of immediate exchange exhibit the feature of *vertically differentiated products* as defined by Gabszewicz, Thisse (1979) and Shaked, Sutton (1982). Intermediaries with larger networks offer a higher probability of trade and consequently a better product. Thus, they gain market power and may command higher prices than their less reliable rivals.

We assume that market participants are informed about the identity and, in particular, about the network M_i of each intermediary active on their island. They do not observe their price quotes on other islands however. For a buyer r residing on island m the expected utility from trading with intermediary i is determined as the product of the probability of trade $\frac{\#M_i}{M}$ and the surplus the trader can achieve from trade with intermediary i at the price $P_i(m) = 2p_i(m)$, given the expected outcome of negotiations with his trading partner. It reads $W_i(r,m) = \frac{\#M_i}{M}(r - \frac{1}{2} - p_i(m))$. Since the buyer cannot travel across islands he cannot take advantage of possibly better prices at another island.

Accordingly, buyer r on island m selects the value maximizing offer $d(r,m)$. Using the convention $W_{l+1}(r,m) = 0$, and interpreting $l+1 = 0$ as "no trade", we can write $d(r,m) := \text{argmax}_i\{W_i(r,m)\}$. In case of indifference between several intermediaries he chooses randomly between those alternatives.

Consider island m and relabel intermediaries active on island m such that they are ranked in decreasing size $\#M_1 \geq \#M_2 \geq ... \geq \#M_l \geq 1$. For the moment we allow l different intermediaries to trade on island m. Observe that the individual value functions $W_i(r,m) = \frac{\#M_i}{M}\left(r - \frac{1}{2} - p_i(m)\right)$, $i \in \{j \mid m \in M_j\}$ are linear in r. Hence, following Shaked and Sutton (1983), we can define critical buyers $t_i(m)$ who are just indifferent between intermediary i and $i+1$. Buyers with larger valuations $r - \frac{1}{2} > t_i(m)$ prefer trade with the larger intermediary and buyers with lower valuations will trade with the smaller intermediary. Indifferent consumers select randomly from those firms among which they are indifferent. In equilibrium the solution obviously requires $P_i(m) \geq P_{i+1}(m)$. Buyers with valuations less than $P_l(m)$ cannot gain from intermediated trade. Since we do not allow them to engage in private search they remain inactive.

The critical buyers are defined as the solution to the system of indifference relations at given price quotes:

$$W_i(t_i(m), m) \;=\; W_{i+1}(t_i(m), m) \quad , \quad i = 1, ..., l$$

By employing the definition for $W_i(r, m)$ this equation system can be rewritten.

$$\frac{\#M_i}{M}\left(t_i(m) - p_i(m)\right) \;=\; \frac{\#M_{i+1}}{M}\left(t_i(m) - p_{i+1}(m)\right) \quad , \quad i = 1, ..., l$$

Expressing the $t_i(m)$ in terms of the strategic variables we find [4]

$$t_i(m) \;=\; \frac{1}{\#M_i - \#M_{i+1}}\left(\#M_i p_i(m) - \#M_{i+1} p_{i+1}(m)\right) \quad , i = 1, ..., l$$

Given the choice of market participants, the market shares of the intermediaries can be determined. On island m intermediary i expects a share of $q_1(m) = 1 - t_1(m)$ and $q_i(m) = t_{i-1}(m) - t_i(m)$ for $i \geq 2$. His expected revenue on that island is $R_i(m) = \frac{\#M_i}{M} q_i(m) P_i(m)$.

Intermediaries' expected revenues R_i consist of the sum of expected revenues on each island $R_i = \sum_{m \in M_i} R_i(m)$. Those again can be calculated as the product of market size A, the expected trading volume per period $q_i(m)$ on island m and the price advertised, $R_i(m) = A\frac{\#M_i}{M} q_i(m) P_i(m)$. By $q_i(m)$ and $R_i(m)$ we mean explicitly the expected volume of trade and the revenue intermediary i expects

[4] In equilibrium consistency requires $t_i(m) \geq 0$. Out of equilibrium a negative $t_i(m)$ implies that intermediary $i + 1$ cannot attract any client on island m.

to originate on island m. So in our framework it refers to the number of buyers, intermediary i expects to attract on island m.

Accordingly, by interpreting the trading probability $\frac{\#M_i}{M}$ the price game on each single island has the same structure as in Shaked, Sutton (1982). Therefore, we note that a pure strategy equilibrium in prices exists for any given *industrial structure* $(M_i)_{i \in I\!N}$.

Observation 1

For each industrial structure $(M_i)_{i \in I\!N}$, $M_i \subseteq \{1, ..., M\}$ *there is a Nash equilibrium in prices.*

Proof:

Note that the price games on each island are independant of each other and do not affect matching probabilities. Then on each island the result of Shaked, Sutton (1982) applies.

Q.E.D.

In equilibrium intermediaries with smaller networks have to compensate a lower likelihood of concluding a successful trade by offering more attractive prices. Accordingly, in equilibrium $\#M_i > \#M_j$ implies $P_i(m) > P_j(m)$ for $m \in M_i \cap M_j$.

Competition on say island m between two intermediaries i and j with networks of identical size, $\#M_i = \#M_j$, drives commissions down to zero and the classical Bertrand type result obtains on island m for all intermediaries with networks of the same or smaller sizes. From the viewpoint of the market participants intermediaries i and j are identical competitors. In this situation they strictly prefer the cheaper offer. Hence, each intermediary has an incentive to undercut any positive price offer of his rival and the competitive allocation with zero spreads obtains. We summarize these properties of equilibrium in the following observation.

Observation 2

In equilibrium
$\#M_i > \#M_j$ *implies* $P_i(m) > P_j(m)$ *and* $R_i(m) > R_j(m)$, $m \in M_j \cap M_i$
$\#M_i = \#M_j$ *implies* $P_i(m) = P_j(m) = 0$ *and* $R_i(m) = R_j(m) = 0$, $\forall m \in M_i \cap M_j$.

Proof:

Using the argument of Shaked and Sutton (1982, lemma 1) it can be readily verified that in equilibrium $q_i(m) \geq q_j(m)$. Hence the revenue implications follow directly from the price implications.

Q.E.D.

The result implies that in equilibrium at most finitely many intermediaries can earn positive prices on each island because the number of islands is finite.

4. Industrial Structure

Based on their expectations about the ensuing price games intermediaries decide about their network investment. Since it is costly to establish a trading network, only investments are undertaken which allow to recoup the outlays. Given positive fixed costs, only a finite number of competitors can be active in a market of finite size. However, as market size relative to fixed costs increases also the number of active competitors should increase. In the limit in large markets competitive equilibria may emerge. While this intuition is borne out in the Cournot model of imperfect competition it is not true in general in models of price competition with vertically differentiated products [5] . Likewise in our model the number of competitors is limited as the market grows in size. In fact, the equilibrium number of active intermediaries is limited as we shall see.

At a given market size A and given fixed costs k per trading technology

[5] See for example Shaked, Sutton, 1982.

and per island only a limited number of intermediaries enters the industry at the investment stage 0. As long as the market is relatively small multiple industrial structures are compatible with equilibrium. For example, suppose that each island can support only a single intermediary in the sense that the monopolistic rents on a particular island barely exceed the fixed expenses and assume further that only independent non-overlapping networks of monopolistic intermediaries are profitable. In this situation a global monopoly as well as M local monopolies could be equilibrium industrial structures. But also in larger markets, which allow several competitors to earn positive revenues, in general no unique industrial structure can be expected, as long as the markets are not too large relative to costs.

Multiple industrial structures are possible in small markets because the incentives to expand a given network are weakened by the force of price competition. The transaction volume achievable at low margins in a competitive environment on a given island may not compensate for the costs of entry into the island concerned. As the market grows, however, the role of costs is reduced. The larger transaction volume may help to generate the revenue necessary to render entry into a particular island profitable. The monopolistic structures of the preceding example do not obtain in large markets. A global monopoly will always be challenged by small intermediaries, who need to acquire only small market shares to justify entry. Hence, in large markets the industrial structure is truly oligopolistic.

The next result presents an industrial structure which is the unique equilibrium structure for "most" islands when A is large enough relative to k. This structure is not affected by a further increase in market size. We shall view this constellation as the *natural industrial structure*. It is characterized for the brokerage market under consideration in the next result.

Result 1

For any M there is a critical level $\gamma(M) > 0$ (large enough) such that in any equilibrium for $\frac{A}{k} > \gamma(M)$ a natural oligopoly obtains. It has the following features:

a) If $M = 1$ it features a natural monopoly, i.e. $M_1 = \{1\}$ with $P_1(1) = \frac{A}{2}$

b) If $M = 2$ exactly three firms are active in equilibrium: $M_1 = \{1,2\}$, $M_2 = \{1\}$ and $M_3 = \{2\}$. Equilibrium prices and revenues are positive and larger for the large intermediary: $P_1(m) > P_i(m) > 0$ and $R_1(m) > R_i(m) > 0$ for $i = 2, 3$.

c) If $M \geq 3$ exactly three intermediaries $i = 1, 2, 3$ attract positive market shares $q_i(m) > 0$ on all islands $m \in M_i$ they serve. Their network sizes are either M for intermediary 1 or $M - 1$ for intermediaries 2 and 3. Let $M_2 = \{1, ..., M - 1\}$ and $M_3 = \{2, ..., M\}$.

Furthermore, there are either one or two intermediaries of any size between 1 and $M - 2$. These attract customers on the two "niche islands" $\{1, M\}$ only.

Prices and revenues per island are positively related to the firm's size. Moreover:

$$\begin{aligned} P_1(m) > P_2(m) = P_3(m) = P_i(m) = 0 \qquad & m \in \{2, ..., M-1\} \\ R_1(m) > R_2(m) = R_3(m) = R_i(m) = 0 \qquad & \end{aligned}$$

$$\begin{aligned} P_1(m) > P_2(1) = P_3(M) > P_i(m) > 0 \qquad & m \in \{1, M\} \\ R_1(m) > R_2(1) = R_3(M) > R_i(m) > 0 \qquad & \end{aligned}$$

where i is any intermediary with network size $1 \leq \#M_i \leq M - 2$.

Proof:

1) In the case $M = 1$ no possibility of differentiation exists for intermediaries. Hence, monopoly is the unique and natural industrial structure. The charac-

terization of equilibrium follows immediately from $t_1 = p_1$, $P_1 = 2p_1$ and $p_1 = \text{argmax}_p A(\frac{1}{2} - p)2p = \frac{A}{4}$.

2) For $M \geq 2$, there is exactly one intermediary, labelled 1, with a network of size M. Suppose that all but one of the potential intermediaries select networks of size strictly less than M. Then the best response of the remaining intermediary is to choose a network of size M, since according to observation 2 he will earn the (strictly) highest revenues on each single island, and, as k is small, revenues exceed the set-up costs.

On the other hand, also according to observation 2, there can be only one intermediary covering all islands, and generating positive revenues.

3) Given, in equilibrium one intermediary covers all M islands, when $\frac{A}{k}$ is sufficiently large, there are exactly two intermediaries with networks of size $M - 1$.

Obviously, more intermediaries of this size cannot avoid direct Bertrand competition on all islands. So, suppose there is at most one intermediary with a network of size $M - 1$. Given the finite number of islands, only a finite number of intermediaries can earn positive revenues in the market. So in equilibrium, there will be inactive firms, whose best reply is not to enter the market. By selecting a network of size $M - 1$, however, such an inactive firm j can profitably deviate from this hypothetical equilibrium, provided it includes one island, which is not covered by another intermediary of size $M - 1$. On this island, the deviant is the second largest intermediary and no further intermediary of the same size is active. So when he can charge positive prices and earn positive revenues, for k sufficiently low, this deviation is profitable.

Label the niche island "1". We establish $\hat{p}_j(1) > 0$. [6] So, assume to the contrary, $\hat{p}_j(1) = 0$.If under the maintained assumption $\hat{t}_1(1) > 0$ because of the continuity of the function defining the critical agent $t_1(1)$ with respect to $p_j(1)$ there is a profitable deviation $\tilde{p}_j(1) = \epsilon$, which yields $\tilde{R}_j(1) > 0$ for small enough ϵ. This establishes the contradiction provided $p_1(1) > 0$. On the other side

[6] $\hat{p}$, $\hat{t}$, $\hat{R}$ refers to (hypothetical) equilibrium values.

$\hat{t}_1(1) = 0$, by definition of $t_1(1)$, implies $\frac{1}{M-(M-1)}(M\hat{p}_1(1) - (M-1)\hat{p}_j(1)) = 0$. Therefore, $\hat{p}_1(1) = 0$ and $\hat{R}_1(1) = 0$. Now the same type of deviation is profitable for intermediary 1, i.e. $\tilde{p}_1(1) = \epsilon$ yields $\tilde{R}_1(1) > 0$ if ϵ is small enough contradicting equilibrium.

4) So, when $\frac{A}{k}$ is sufficiently small, in equilibrium there are precisely two intermediaries, i=2,3, with networks of size $M-1$. Let $M_2 = \{1, ..., M-1\}$ and $M_3 = \{2, ..., M\}$ denote their respective networks. They overlap on $M-2$ islands. Since on these islands these two intermediaries are identical competitors, according to observation 2, they charge zero commissions on those islands. Their only source of revenue are the respective niche islands.

5) If $M \geq 3$ the niche islands 1 and M provide space for further intermediaries operating on both niche islands. On these islands they can generate positive revenues by demanding positive equilibrium prices as argued in step 3.

They cannot profitably quote prices on the remaining islands $\{2, ..., M-1\}$. Nevertheless, they can maintain a presence on these islands in order to search for buyers. In fact, they have an incentive to establish a large network for search in order to increase their attraction for sellers on the niche islands and thus boost revenues. Accordingly, they establish a trading system not only on the niche islands but also on islands where they cannot attract any trade. In order to differentiate themselves from their competitors they have to select networks of different size. Provided all of them offer different trading probabilities, all of them can earn possibly "small" but positive revenues in trade generated on the niche islands.

Q.E.D.

In the case of a single island the natural industrial structure is a monopoly since competitors cannot differentiate themselves by size. In the case of two islands intermediaries can select either size 2 or 1. Accordingly, exactly three intermediaries are active.

There is always one globally active intermediary. The second and third largest intermediaries need to differentiate themselves from the largest one by offering a smaller network. On the other side the competitive threat of entry forces them to maintain both networks of size $M-1$. Hence, if $M>2$ these two intermediaries engage in Bertrand like competition on $M-2$ islands leaving space for relaxation of price competition on one island in each of their networks only.

Smaller intermediaries attract positive market shares only on those two "niche islands". Those need to care for their trading probabilities to attract clients on the niche islands. Accordingly, on each "niche island" intermediaries of any size from 1 to $M-2$ are active. Depending on, whether there are one or two of those "niche" players of the same size the natural industrial structure remains somewhat ambiguous for small firms. For example there is an equilibrium, where intermediary 4 has a network of size M-2, which includes the islands 1 and M, and there is another equilibrium, two intermediaries 4 and 5 of size M- 2, where $1 \in M_4 \ \wedge \ 1 \notin M_5$ and $2 \in M_5 \ \wedge \ 2 \notin M_4$.

Summarizing the natural industrial structure consists of precisely 3 large intermediaries and at least $M-1$ or at most $2(M-2)$ small intermediaries. In this sense the natural industrial structure is fairly concentrated. Also no convergence to a fragmented structure obtains on islands $\{2, ..., M-1\}$. Rather, as M grows the relative importance of the smaller intermediaries diminishes while the degree of differentiation, as measured by the difference in trading probabilities, among the three large intermediaries vanishes. As they become increasingly similar price competition among the "big three" tightens and equilibrium prices converge to Walrasian prices.

Result 2

$\forall \epsilon > 0$ there is a $\bar{M}(\epsilon)$ such that for any $M > \bar{M}(\epsilon)$ the corresponding equilibrium prices $P_i^M(m) < \epsilon$, $\forall i$ and equilibrium revenues $R_i^M(m) < \epsilon$, $i \geq 2$. Only $R_1^M \geq \frac{A}{2}$, $\forall M$.

Proof:

Given the industrial structure of result 1 on each island intermediary 1 has a lower neighbour with trading probability of $\frac{M-1}{M}$. As M increases this probability tends to 1 and competitions tightens. To see this rewrite intermediary 1's revenue function:

$$R_1(m) = \big(1 - t_1(m)\big)\, P_1(m)$$

where

$$t_1(m) = \frac{1}{M-(M-1)} \big(MP_1(m) - (M-1)P_i(m)\big) \quad , \quad i \in \{2,3\}$$

The first order condition for profit maximization on island $m \in \{1, ..., M\}$ yields

$$1 - t_1(m) - MP_1(m) = 0$$

or equivalently

$$P_1(m) = \frac{1-t_1(m)}{M} \to 0 \quad (M \to \infty)$$

Since $P_1(m) > P_i(m)$ for $m \in M_i$ we have established the first claim.

The second claim follows from the observation that $t_1(m) \leq \frac{1}{2}$ [7] and $R_1 \geq P_1(m)MA = A(1 - t_1(m))$.

Q.E.D.

Accordingly, the convergence of prices does not result from increased entry of intermediaries in the niche markets but from increased competition among the big intermediaries.

[7] Again this follows directly the argument of Shaked, Sutton (1982, lemma 1).

It is worth noting that result 2 holds for the case of small setup costs $k < K(M)$, where $K(M)$ is some upper bound. As M increases $K(M)$ needs to be decreased in order to obtain a natural industrial structure. If k were fixed (and small) an increase in the number of islands M cannot support the industrial structure of result 1. Increased competition between the top firms reduces price margins on the niche islands 1 and M, while the costs of maintaining a network of size $M - 1$ increase linearly in M. So there is a critical number of islands $\bar{M}$, for which the industrial structure with two intermediaries of size $\bar{M} - 1$ can no longer be maintained. In this case the equilibrium industrial structure would crucially depend on the value of k. For example, if k were large enough, monopoly would result. For lower k there is room for an entrant. Because of free entry this entrant maintains a network of size $M - 1$. A further entrant would maintain a network of size $M-2$. This process is continued until entry is no longer profitable. Obviously, this structure, according to result 1, is not robust to a change in k.

Increasing the number of islands implies an increase in networking costs. Therefore, the bound $K(M)$ needs to be adjusted, when the industrial structure in "large" markets is compared.

Interestingly, the competitiveness of our brokerage industry cannot be judged by concentration ratios or by counting the number of competitors alone. In fact these measures may be misleading. As M increases both the concentration ratio CR_3, defined as the market share of the three largest firms relative to the whole market, and the number of active firms rises, while equilibrium spreads converge to their competitive level. Rather the existence and the profitability of niche markets is decisive in determining the degree of competitiveness in the industry.

The empirical question concerning the "number of islands" and the possibility of creating niche markets is likely to be a difficult one. According to our model, for example, where islands essentially are defined by a lack of communication and information links between subgroups of potential traders, the task of counting islands would amount to analyze the micro structure of the communication and information system between the potential market participants.

5. Related Literature

There is an important difference between our model of network competition and Shaked and Sutton's (1982) model of vertical product differentiation. In our model the 'qualities' of the top firms are 'very close' as $M \to \infty$ and equilibrium prices converge to marginal costs. No result of this kind occurs in Shaked, Sutton, though it should be made clear that a precise analogy between the models is not possible, as there is no analog in Shaked, Sutton to our 'number of islands' M.

That said it is still of interest to ask why the present convergence result holds. We start by providing a short account of Shaked and Sutton's basic model (1982). They analyze competition in a market with vertically differentiated products as the subgame perfect Nash equilibrium of a three stage game. In the first stage firms decide about entry. Entry is costly. In the second stage they select a product quality u from an intervall of technologically available qualities $[\underline{u}, \bar{u}]$. Finally at stage three competition in prices takes place.

As important differences Shaked and Sutton use a continuum of qualities and the gameform of a three stage game. If u is to be chosen from a discrete set $\{u_1, ..., u_n\}$ such that $u_1 > ... > u_n$ their results are not seriously impaired. This is readily seen, since their proof of existence of a Nash equilibrium in qualities only requires u to be selected from a compact set and does not depend on the fact that u is drawn from a continuum (1982, pp.9,10).

Now an important difference between Shaked, Sutton and the present model lies in our use of a two stage game. The three stage game allows competitors to react to changes in the number of entrants in their choice of quality. In the two stage game used here a potential entrant cannot take as given the quality of incumbents. This has the effect of forcing the 'second highest' quality higher, since if this quality is 'far below' the top quality, then any such configuration can be 'broken' by the entry of a new firm offering a higher quality. It is this feature which in our model leads the second largest intermediary to select a network of size $M - 1$. Hence, we get 'convergence in qualities' as $M \to \infty$.

6. A Note on Welfare

Results 1 and 2 highlight the tension between market power and cost efficiency. Under the threat of entry prices converge to marginal costs when there are many islands. On the other hand the amount of fixed costs incurred is quite high. Depending on the precise structure of the small intermediaries fixed costs amount to at least $(3M - 2 + \sum_{\mu=2}^{M-2} \mu + 2)k = \frac{1}{2}(M^2 - 3M + 2)k$, when all intermediaries of size 2 to $M-2$ include both niche islands in their network, and at most to $(3M - 2 + \sum_{\mu=1}^{M-2} 2\mu)k = M^2 k$, when all intermediaries of size 2 to $M-2$ include only one niche island in their network. In any case total fixed costs grow quadratically with the number of islands.

Since most of these costs are borne by small firms in an attempt to serve well clients in the two niche markets and since those costs do not affect the allocation in most (i.e. in $M-2$) markets regulatory concern is justified. In the social optimum a single monopolist would serve all islands at marginal cost prices. The optimum requires an outlay of Mk in fixed costs only.

Regulators hence might be tempted to restrict the number of competitors to some fixed number, probably at least three. If this number where fixed exogenously, however, both competition in quality and in prices could be seriously affected. Basically, such intervention could give the same result as the three stage game of Shaked and Sutton (1982). In this case again intermediaries 2 and 3 might have an incentive to offer networks smaller than $M-1$ in order to relax price competition. Accordingly, equilibrium spreads are higher. The driving force behind the competitive pricing of result 2 really is free entry.

References

[1] BENOIT, KRISHNA [1985]:
"Finitely Repeated Games", Econometrica, 53 (1985), pp.890-904.

[2] DEMSETZ, H. [1968]:
"The Cost of Transacting", Quarterly Journal of Economics, 1968, pp. 33-53.

[3] DIAMOND, D. [1984]:
"Financial Intermediation and Delegated Monitoring", Review of Economic Studies, pp. 393-414.

[4] GABSZEWICZ, THISSE [1979]:
"Price Competition, Quality and Income Disparities", Journal of Economic Theory, 20 pp.340-359.

[5] KRUEMMEL, H.J. [1964]
"Bankzinsen: Untersuchungen ueber die Preispolitik von Universalbanken", Annales Universitatis Saraviensis, Schriftenreihe Rechts- Und Wirtschaftswissenschaftliche Abteilung, H. 11, Saarbruecken, 1964.

[6] SHAKED, SUTTON [1982]:
"Relaxing Price Competition Through Product Differentiation", Review of Economic Studies, 1982, pp. 3-13.

[7] SHAKED, SUTTON [1983]:
"Natural Oligopoly", Econometrica, Vol.51.5, pp. 1469-83.