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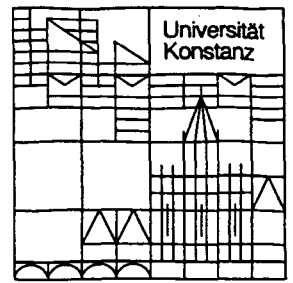
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**Sonderforschungsbereich 178**  
**„Internationalisierung der Wirtschaft“**

Diskussionsbeiträge



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Helmut Zink

**International Overhead Cost Sharing**

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# **International Overhead Cost Sharing**

**Helmut Zink**

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# INTERNATIONAL OVERHEAD COST SHARING

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## Abstract

In this paper I investigate the effect of different stages of international trade on market structure and prices when production involves overhead cost, markets are intransparent, and customers have to search for offers. I show that two stages have to be distinguished: a first stage where each firm can offer its product in any country but customers cannot search in foreign countries and a second stage where each firm can offer in any country and each customer can search and buy in any country. In particular I investigate who benefits if one country increases its degree of market transparency and who benefits if the second stage of international trade is introduced.

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## International Overhead Cost Sharing

### 1. INTRODUCTION

In this paper I investigate the effect of different stages of international trade on market structure and prices when production involves increasing returns to scale and customers are imperfectly informed about offers but they can search for offers. In the first stage of international trade each firm can offer its product in any country but customers cannot search in foreign countries, in the second stage of international trade each firm can offer in any country and each customer can search and buy in any country. Insurance markets form one example for markets with imperfectly informed customers. I will consider mainly insurance markets but also discuss extensions. In particular I will analyze how improved market transparency in one country affects customers of other countries.

Presently in many national insurance markets we witness a fundamental change. Since three years the guidelines of the European Maastricht treaty on trade in international services are integrated in national law. While earlier all home and foreign firms offering insurance in the home country were subject to the national regulation of the home country, now the national supervision of the foreign firm's home country suffices. While earlier in several countries all contract conditions had to be approved beforehand by national control boards, now contract conditions of a firm can at worst be challenged subsequently by the control board of this firm's home country. According to the new World Trade Order, for the first time member countries mutually grant each other the right to export services, although with many rules of exception.

For the investigation of insurance markets I will emphasize two of its properties. First, in markets for private households there is an extremely small degree of market transparency. To sell insurance each firm has intensively to engage in marketing and consulting. The offers of different insurers do differ from each other significantly. To compare these offers

customers must have a minimum of theoretical understanding of insurance. An investigation of the Allensbach opinion poll institute found that in German life insurance more than 70% of all customers did not compare two or more offers before buying.

Second, each insurance company produces with increasing returns to scale. That is, there will be a decrease in a firm's average cost per unit of insurance sold as the number of its customers increases. This product cost structure is due to the law of large numbers according to which the variance of the average risk declines and the risk premium becomes smaller. Further it also results from the high degree of overhead administration and marketing cost.

These features of the market, falling average cost and imperfect transparency are also essential in many other industries, e.g. certain credit markets, pharmacy, air traffic, large areas of investment goods. To make the model applicable to a large class of industries I will restrict myself to the above two building blocks.

In the literature there are several approaches to explain pricing in the presence of overhead costs. An essential element of most of these models are frictions by which the degree of competition is reduced. Such frictions can result from transportation costs, e.g. as utilized by Launhardt (1885) and Hotelling (1929), or from heterogeneities of product characteristics or preferences, e.g. as utilized by Lancaster (1979). In the approach presented here I derive the buying behavior of customers explicitly from market intransparency, i.e. incomplete information of customers about offers.

It should be noted how the approach differs from that of Dixit and Stiglitz (1977) which forms the main tool in modern theory of international trade. Dixit and Stiglitz consider a market which consists of many product classes with each customer having a preference for diversifying his demand over all

these classes and with each class having only one monopolistic supplier. I consider the dual case where in each class there is an endogenous number of firms  $i$  offering a homogeneous good and each customer buys from one firm only. In this approach it is imperfect information which will guarantee the existence of an equilibrium in face of overhead costs.

The following Sections 2 and 3 present the assumptions of the basic model and develop an intuition for its operation.<sup>1</sup> The two polar stages of international trade are introduced in Section 4. In Sections 5 and 6 I will use the basic model in a partial equilibrium framework to investigate short- and long-run effects of the two stages of international trade. In particular, I investigate who benefits if one country increases its degree of market transparency and who benefits if the second stage of international trade is introduced. As a rule, first I only give intuitive arguments while formal proofs follow subsequently or in an Appendix. Extensions and conclusions are discussed at the end of the paper in Sections 8 and 9.

## 2. ASSUMPTIONS OF THE BASIC MODEL

I consider a market for a homogeneous, non-storable good which can be produced with positive marginal costs of  $c$  and positive overhead costs of  $b$  per period. In this market there will be an endogenous number of firms each of which sets its offer price deterministically. Different firms can set different prices. Thus prices are described by a distribution function.

There are  $\kappa$  customers each of whom buys one unit of the product.<sup>2</sup> Initially each customer is uninformed about the offers of individual firms. However, he can undertake search steps in order to find offers. Search steps are undertaken sequentially and each step costs  $\delta > 0$ . With each search step the offer of each firm is made known to him with probability  $\rho$  where  $0 < \rho < 1$ . I denote  $\rho$  as publicity degree of firms and as degree of market transparency. Each customer is informed about the distribution of firms over prices. He uses

this information to calculate the expected return of an additional search step taking into account all offers known to him already. Each customer searches as long as this expected return from search is larger than the cost of an additional search step. Each firm sets its price such that its expected profit is maximal where prices of competing firms are taken as given.

It is a characteristic of the above search process that by each search step the customer might get information about several firms including those already known to him. This assumption refers to the observation that in reality customers undertake activities which increase their knowledge about many offers simultaneously and gradually. This sort of search occurs in particular if the quality of offers is difficult to assess. For example, customers then listen to advertisements on radio, they watch TV, they buy and study consumer journals, they contact and interview specialists and friends, and so on.

### 3. ANALYSIS OF THE BASIC MODEL

First I give an intuition for why there can be no equilibrium with a single price. Suppose all firms offer a common price above marginal cost. Then any single firm can increase its profit by slightly reducing its price. With a marginal price reduction this firm can increase its expected number of customers while its revenues per customer remain approximately invariant provided all other firms stick to their prices. Now suppose all firms offer a price equal to marginal cost. Then any single firm can increase its profit by increasing its price by such an amount that no customer prefers searching for the other firms.<sup>3</sup> This firm will sell only to those customers who have not found any other firm, but since this number of customers and mark-ups are positive it makes positive profit.

Second I give an intuition for why there can be price dispersion. Suppose a given number of firms is arranged according to a certain distribution. A



customer buys from a given firm if (a) he is informed about that firm but not about any cheaper firm and (b) for him the expected return from a further search step is smaller than or equal to the cost of that search step. Thus a firm can get customers with positive probability even if there are cheaper firms. If a firm increases its price then on the one hand it increases its average return per attracted customer. On the other hand it reduces the expected number of its customers since at a higher price there are more firms who have cheaper offers and thus might attract away customers. At too high a price no customer buys because all customers prefer searching for cheaper firms. With a smaller number of customers average cost per unit sold are higher. This second effect is higher the higher the density of the distribution of the firms in the neighborhood of the considered firm. In equilibrium the distribution is such that (within the support of the distribution) both effects on the expected profit of the firm just balance.

In a continuous version of the model, the existence and uniqueness of an equilibrium distribution of firms can be proven.<sup>4</sup> Under this distribution no firm can increase its expected profit by a variation of its price: If the firm varies its price within the support of the distribution then its expected profit remains invariant. If the firm sets its price below the support then it reduces its return without increasing the probability to receive customers. If the firm sets its price above the support of the distribution then no customer will buy from this firm: In equilibrium the upper endpoint of the support forms a reservation price for customers. That is, for a customer who is only informed of such an offer the expected return from an additional search step is equal to search cost. Customers thus prefer searching over buying at a price above the reservation price.

For the analysis of short-run price behavior I take the number of firms  $N$  as exogenous and the common level of expected profit  $\gamma$  as endogenous. For the long run I set  $\gamma$  equal to zero and take  $N$  as endogenous. In both cases the

average price to be paid by a randomly chosen customer is given by

$$(1) \quad p = c + N(b+\gamma)/\kappa$$

which follows immediately from the following book keeping identity: Aggregate profits  $N\gamma$  have to be equal to aggregate sales  $\kappa p$  minus aggregate production costs  $Nb+\kappa c$ .

To investigate short- and long-run responses of the average price to parameter variations the model has to be analyzed in more detail. First I determine for each firm the expected profits and expected number of customers and for each customer the expected returns from search. The expected profit of a firm  $i$  with offer price  $p_i$  and expected number of customers  $q_i$  is given by

$$(2) \quad g_i = (p_i - c)q_i - b.$$

To determine the expected number of customers suppose that the distribution of prices is given by a function  $H$  such that for any price  $p$  the deterministic number of firms offering a price below  $p$  is  $H(p)$ . Suppose further the distribution is such that each customer stops searching once at least one offer of the  $N$  firms is known to him. Then with offer price  $p_i$  the expected number of customers of firm  $i$  is

$$(3) \quad q_i = q(p_i | H) = \kappa \rho (1-\rho)^{H(p)} / [1-(1-\rho)^N].$$

In this equation  $\rho(1-\rho)^{H(p)}$  describes the probability that with one search step he gets known to firm  $i$  but not to any of the  $H(p)$  cheaper offers. The term  $1/[1-(1-\rho)^N]$  describes the expected number of search steps needed to get known to at least one of the  $N$  offers.

Finally I determine the expected return from a search step for a customer. Let  $p'$  be the smallest price known to this customer and  $p_s$  the uncertain smallest price known to this customer after that search step. Then his expected return is given by his expected expenditure reduction

$$(4) \quad R(p' | H) = E(p' - p_s | H)$$

where  $E(\cdot | H)$  denotes the expectation operator under  $H$ .

Short-run profit level  $\gamma$  and long-run number of firms, respectively, can be calculated from the condition that the upper endpoint of the support forms the reservation price. Consider a customer who is only informed about an offer at the upper endpoint  $\bar{p}$  of the price distribution. The following reservation price equation states that this customer is indifferent between buying at  $\bar{p}$  and undertaking a further search step,

$$(5) \quad \delta = R(\bar{p}|H).$$

Since  $R(p|H)$  increases continuously in  $p$  there exists a unique solution to (5). This solution can be shown to be finite. Equation (5) ensures that (a) each firm from the distribution can attract customers with positive probability and (b) no firm can increase its expected profit by setting its price above the equilibrium support.

In Appendix A I show that reservation price equation (5) is equivalent to

$$(6) \quad \delta = \frac{b+\gamma}{\kappa\rho} \psi(\rho N),$$

where

$$(7) \quad \psi(\rho N) := [1-(1-\rho)^N][((1-\rho)^{-N}-(1+\rho N))]$$

with  $d\psi/d(\rho N) > 0$ ,  $d^2\psi/d(\rho N)^2 > 0$ ,  $d[\psi(\rho N)/(\rho N)]/d(\rho N) > 0$  for  $N > 0$ , and  $\psi(0)=0$  and  $\psi(p) \rightarrow \infty$  for  $p \rightarrow \infty$ .

With the help of (1) and (6) short-run price behavior is given by

$$(8) \quad p = c + \delta \frac{\rho N}{\psi(\rho N)}.$$

To determine long-run price behavior,  $N$  in (8) has to be replaced by its long-run equilibrium value which follows from (6) for  $\gamma=0$ ,

$$(9) \quad N = \frac{1}{\rho} \psi^{-1}\left(\frac{\delta\kappa\rho}{b}\right).$$

Finally it should be remarked that the equilibrium distribution can also be shown to be stable. If after some disturbance the actual distribution deviates from the equilibrium distribution, then, at certain prices in the support of the distribution, expected profits are higher than at other prices

in the support. If, in response, firms vary their prices to exploit these profit possibilities then the distribution adapts such that the deviation is corrected.

#### 4. DISTINCTION OF TWO POLAR STAGES OF INTERNATIONAL TRADE

In the following I consider  $M$  countries  $k=1,2,\dots,M$  all of which produce a certain homogeneous good. In each country the production function and the market of this good fulfills the assumptions stated in Section 2. Countries may differ with respect to the number of customers  $\kappa_k$  and the degree of market transparency  $\rho_k$ ,  $k=1,2,\dots,M$ , they are equal with respect to production cost parameters  $c$  and  $b$  and search cost  $\delta$ . To concentrate on the issues raised in the introduction I restrict myself to a partial model with only one good, no labor market, and a common currency in all countries.

I distinguish two polar stages of international trade. As first stage I define the possibility of unrestricted international sale. That is, each firm can offer its products and services in each country and it can set country-specific prices. Customers, though, may not purchase in foreign countries and each search step makes known only about offers presented in the home country of the customer. All firms offering in a given country have the same publicity degree for customers in this country.

As second stage of international trade I define the possibility of unrestricted international sale and purchase. That is, each firm can offer its product in any country and each customer can search and buy in any country. If some customer from country  $j$  searches for firms in country  $k$  then the costs of each search step are given by  $\delta_k$ , the search cost of country  $k$ , and he finds each firm offering in country  $k$  with probability  $\rho_k$ , the transparency degree of country  $k$ . Thus, if price distributions and transparency degrees vary over countries then each customer will search and buy only in that country where total expected costs of searching and buying are minimal. Consequently each

firm will set only one offer and this offer is valid for customers of all countries. The second stage of international trade hence describes a state of complete economic integration. While the model will determine the country which attracts the market it will not determine the location of production or the origin of firms.

Suppose that customers search for offers by reading journals. Then, under first stage international trade journals have to be considered as country specific. Any journal is only read by customers of one country and, hence, advertised offers can be country specific. During the process of integration there is an increasing number of journals which are read by customers of several countries. Hence, customers have increasing opportunities to learn about offers from other countries. Correspondingly, international price differentiation becomes increasingly difficult. In the extreme case we have second stage international trade where each customer will search and buy only in one country. Customers choose the country which offers best purchasing opportunities. In the present simple model this country turns out to be the one with maximal marketing transparency.<sup>5</sup>

While international price differentiation is an essential element of first stage international trade, it has been challenged in the EU in several cases by the EU-Commission as an abuse of a dominant firm position which is illegal according to Article 86 of the treaty of Rome. It is interesting to see that in the present model international price differentiation is not an indication of market power.

In the EU, insurance markets for private households have presently reached a state which resembles the first stage of international trade. Insurance companies can offer in each country of the EU without being subject to the national regulation of the foreign customer countries. For private households, though, in general it is still prohibitively complicated to buy insurance

contracts which are offered in a foreign country. These difficulties result both from a more difficult comparison of such offers and from more difficult liquidation in case of damage. In addition each insurance company can prevent intermediaries from selling its product in foreign countries without its approval. In these markets international price differentiation is possible.

## 5. THE EFFECTS OF FIRST-STAGE INTERNATIONAL TRADE

In this section I investigate the effects of first stage international trade. In first stage international trade there is only the possibility of unrestricted international sale, that is each firm will offer in each of the  $M$  countries  $k=1,2,\dots,M$  but each firm may set different offer prices in different countries.

A vector of price distributions  $(H_k)_{k=1,\dots,M}$  forms an equilibrium with  $N$  firms if for each  $k$  the distribution  $H_k$  forms an equilibrium with  $N$  firms with respect to market size  $\kappa_k$ , transparency degree  $\rho_k$ , and search cost  $\delta$ . In the short-run after introducing first stage international trade the number of firms is given by  $\sum_{k=1}^M N_k$  where  $N_k$  describes the long-run autarkic firm number in country  $k$ . In the long-run the firm number is given by the requirement that the level of expected profit is zero.

To describe these  $M$  markets I first determine how profit equation (2), price equation (1), and reservation price equation (6) have to be modified for the present case. As expected gross profit of firm  $i$  from country  $k$ ,  $\Gamma_{ik}$ , I define the mark-ups which firm  $i$  can expect to accumulate in country  $k$ ,

$$(10) \quad \Gamma_{ik} = q_{ik}(p_{ik} - c),$$

where  $q_{ik}$  and  $p_{ik}$  are the expected number of customers and the offer price, respectively, of firm  $i$  in country  $k$ . In each country  $k$  expected gross profits are the same for all firms,  $\Gamma_{ik} = \Gamma_k$  for all  $i=1,\dots,M$ . The expected (net) profit of any firm  $i$  is then given by

$$(11) \quad \bar{\Gamma} = \left( \sum_{k=1}^M \Gamma_k \right) - b.$$

To apply price equation (1) and reservation price equation (6) one has to substitute the sum of overhead cost and profit level  $b+\gamma$  by the expected gross profit from country  $k$ ,  $\Gamma_k$ . Thus in any country  $k$  the average price to be paid by a randomly chosen customer is given by

$$(12) \quad p_k = c + N\Gamma_k/\kappa_k$$

and the reservation price equation reads

$$(13) \quad \delta = \frac{\Gamma_k}{\kappa_k \rho_k} \psi(\rho_k N) \quad .^6$$

Now price behavior can be described. For the exogenous firm number  $N$  the short-run average price is determined by solving (13) for  $\Gamma_k$  and substituting it into (12),

$$(14) \quad p_k = c + N\Gamma_k/\kappa_k = c + \delta_k \frac{\rho_k N}{\psi(\rho_k N)} .$$

For the long run, price equation (14) remains valid but  $N$  has to be replaced by the long-run equilibrium firm number under first-stage international trade which is determined by the zero profit condition,  $\bar{\Gamma}=0$ . Using profit equation (11) and reservation price equation (13) this condition reads

$$(15) \quad 0 = \sum_{k=1}^M \delta \kappa_k \rho_k / \psi(\rho_k N) - b$$

which has a unique solution for  $N$  since the right side of (15) decreases continuously in  $N$ .

Now the effect of first stage international trade on prices and firm numbers can be studied. I will show that for each country the introduction of first stage international trade lowers the average price both in the short run and in the long run while the short-run effect is overshooting.

The short-run effect results immediately from noting that in each country  $k$  the number of firms increases from  $N_k$  to  $\sum_{k=1}^M N_k$  and then comparing price equations (14) and (8) where (8) describes the autarkic case with  $N=N_k$  and (13) describes the case of international trade with  $N=\sum_{k=1}^M N_k$ . The short-run effect of prices is plausible because, with a higher density of firms over

prices, firms will prefer offering lower prices, which drives down the reservation price of customers. For a larger number of firms there is again an equilibrium distribution of prices, but the support of this distribution is at lower prices and the corresponding profit level is negative.

To investigate the long-run effect first note that the long-run firm number decreases from  $\sum_{k=1}^M N_k$  but remains above the autarkic number  $N_k$  for any country  $k$ .<sup>7</sup> The decrease of the long-run firm number from its short-run level is plausible since in the short run all firms make losses. These losses occur because in all countries the short-run average price is smaller than in the autarkic case while production costs are invariant. Using this behavior of the firm number, a comparison of price equations (14) and (8) implies that in each country in the long-run the average price increases from its short-run level but remains below the autarkic level.

The difference between the autarky price and the long-run price under first-stage international trade is largest for countries with a relatively small number of firms in autarky and, hence, with a relatively small number of customers.<sup>8 9</sup>

## 6. THE EFFECTS OF SECOND-STAGE INTERNATIONAL TRADE

In this section I investigate the effects of second-stage international trade on prices and firm numbers in a country which is otherwise in first-stage international trade. In the special case of all countries having the same transparency degree (and the same search cost) short- and long-run equilibria of the first-stage system are equal to those of the second-stage systems. This equality results from the fact that under first-stage international trade all countries have the same price distribution and the same cost of finding an offer. Thus there is no incentive for customers to search and buy in other countries. If some customers search and buy abroad then in all countries the reservation price remains invariant and the overall profit of each firm, too,



remains invariant. The equality of the two stages in case of equal informational frictions remains also valid if countries have different numbers of customers, as can be seen from price equation (14) the right side of which is independent of the number of customers  $\kappa$ .

The introduction of second-stage international trade into a system of first-stage international trade does have an effect if countries differ with respect to the degree of transparency (or search cost). In that case, under first-stage international trade price distributions would differ over countries. Now customers have an incentive and the opportunity to search and buy in that country where the total expected cost of searching and buying is minimal. According to price equation (14) this expected searching and buying cost is given by

$$(16) \quad C_k = c + \delta \frac{\rho_k^N}{\psi(\rho_k^N)} + \delta \frac{1}{1 - (1 - \rho_k)^N}$$

where  $1/[1 - (1 - \rho_k)^N]$  describes the expected number of search steps needed to find an offer as in (3). (16) shows that some country has minimal expected searching and buying cost if its transparency degree is maximal. The country with maximal transparency degree is the country with the smallest average price  $p_k = c + \delta \rho_k^N / \psi(\rho_k^N)$ . Market sizes  $\kappa_k$  are irrelevant for the choice of the country with minimal expected searching and buying cost since under first-stage international trade all firms are already offering in each country.

Without loss of generality suppose that country 1 has the smallest transparency degree of all  $M$  countries. Then the customers of all countries will search and buy in country 1. In the short run the price distribution in country 1 is not affected since the number of firms offering in country 1 is invariant and all customers have the same reservation price. In the short run, thus, all customers from countries  $k \neq 1$  profit from the introduction of second-stage international trade. However, the profit level will decrease in response because all firms now sell to all customers at the relatively low prices of

country 1, the country with minimal average price. Thus in the long run the number of firms will decrease and prices will increase again in all countries. Consequently, in the long run prices in country 1 will be higher than under first-stage international trade. The same will be true for other countries with relatively high transparency degree. Thus, in the long run customers from countries with relatively small transparency degree will gain at the expense of those from countries with relatively high transparency degree. This is plausible since during the first stage of international trade customers from countries with relatively small degree of transparency were paying a higher share of aggregate overhead cost and the introduction of second stage international trade removes this disadvantage.

## 7. THE EFFECTS OF MARKET TRANSPARENCY IMPROVEMENTS

Now I assume that in some country the publicity degree of firms is increased by some exogenous action, e.g. some economic policy which improves marketing activities of firms or search possibilities of customers. I will show that in case of first-stage international trade such a policy is to the advantage of the acting country at the expense of the other countries.

As a preparation for the explanation of this effect first I consider a country without international trade. After the increase of market transparency, in the short run the distribution of prices will decrease. This can be made plausible as follows. Since each search step will make known each firm with higher probability, the expected return of each search step will be higher. Thus customers at the upper end of the old price distribution prefer searching over buying and the reservation price of customers will fall. Subsequently, firms have to reduce their prices.

These price reductions imply that all firms make losses. Hence in the long run the number of firms will fall. With decreasing firm number the average price will increase again to some extent. The long-run average price remains below

its old level before the increase of market transparency because with a smaller number of firms, aggregate overhead costs are lower and thus the average zero profit price must be smaller.

Formally the short-run price response to the variation of the transparency degree  $\rho$  follows immediately from price equation (8). For the long-run response note that according to (9)  $\rho N$  increases in  $\rho$ , and according to (8) the increase of  $\rho N$  results in a lower average price.

The above mechanism changes if the country is in first-stage international trade. Suppose without loss of generality that it is country 1 where the degree of market transparency  $\rho_1$  increases. In the short-run response prices will decrease in this country since the expected return from search increases and the reservation price of customers falls. Prices in other countries remain invariant since the number of firms remains invariant in the short run.

Formally the short-run price response can be calculated from price equation (14) where  $N$  is the long-run equilibrium total number of firms. This firm number is given by (15) where  $\rho_1$ , however, is equal to the old level of transparency. Thus the short-run price response is analogous to that in the autarky case.

The long-run response differs from the autarky case. In the autarky case, in the long run the total number of firms decreases and prices move upwards in response. With first-stage international trade this upward movement of prices is diminished. Now each firm finances its overhead costs by the mark-ups accumulated in all  $M$  countries. Hence the decrease of the total number of firms is now more moderate and the extent of the long-run price decrease in country 1 is greater.

There is another more critical aspect of this effect. In case of first-stage

international trade all other countries  $k \neq 1$  are affected. As the overall number of firms  $N$  decreases, the average price will increase in all  $M$  countries. Thus the long-run price decrease in country 1 is partly financed by the long-run price increase of all remaining countries.

Formally the long-run behavior of the number of firms follows from (15),  $\sum_{k=1}^M [\delta \kappa_k \rho_k / \psi(\rho_k N)] - b = 0$ . Since  $\psi$  increases in  $\rho_1$  more than proportionally, this equation implies that with increasing publicity degree  $\rho_1$  in country 1 the firm number  $N$  decreases while the product  $\rho_1 N$  increases.<sup>10</sup> In each country  $k=1, \dots, M$  the long-run average price is given by (14)  $p_k = c + N \Gamma_k / \kappa_k = c + \delta \rho_k N / \psi(\rho_k N)$ . Hence, in country 1 the average price will decrease because  $\rho_1 N$  increases in  $\rho_1$ . In all other countries  $k \neq 1$  the long-run average price will increase since  $N$  decreases while  $\rho_k$  remains invariant.

## 8. GENERALIZATIONS

I want to emphasize that the above model allows interpretations which suggest that the above results can be applied to a larger class of markets than those with a small degree of transparency. For example, even with a high degree of transparency in the above model there always exists a unique equilibrium in mixed strategies (Zink, 1996). Average price, profit level, and firm number of this equilibrium can be described by formulas which are identical with those derived above. This version of the model allows a description of markets where large buyers invite tender offers from sellers. More specifically, in such markets sellers (i) do not know exactly the offers posed by competing sellers and (ii) make individual offers which may differ over customers. Mixed strategies then form a straightforward pricing strategy.<sup>11</sup>

Industry insurance markets form an example for this type of market. Here contracts are of much higher amount than in markets for private households. Insurers are more willing to take into account individual risk characteristics of the customer. Customers are experts in acquiring information about all

offers and comparing them. Classification of individual insurance objects into the schemes of the insurer is nevertheless regularly influenced by subjective judgment. Thus offers are not set uniformly for all customers but negotiated individually and are not known to competitors in advance. Hence a description of these markets by mixed strategy equilibria is suitable.<sup>12</sup>

## 9. SUMMARY AND CONCLUSIONS

While the two stages of international trade considered in the present paper form highly abstract polar cases, in reality the set of competing markets and their interaction are much more complex. At present we witness a phase of development where the technology of search and marketing is improving rapidly, and worldwide in many markets there is a cascade of private and public initiatives to improve transparency and publicity degrees. In many areas we are approaching a stage of complete economic integration. The present paper concentrates on those aspects of this process which are common to all markets with overhead cost and market transparency.

We have seen that the introduction of first-stage international trade will benefit customers of all participating countries. Since each firm will offer in each country, in each country the number of firms increases and thereby prices fall. The fall in prices is consistent with zero profits because the total number of firms and, hence, aggregate overhead cost decrease.

The introduction of second stage international trade into a first-stage system does not benefit all customers. All customers make use of the possibility to search and buy in the country with the smallest purchasing costs, which is the country with the highest degree of market transparency. In the short run, the price distribution of this country does not respond and, thus, all customers of other countries benefit. As a consequence, all firms sell at lower prices to such customers and make losses. In the long run, the total number of firms decreases and thereby prices rise. Thus, in the long run customers from

relatively expensive countries benefit at the expense of customers from relatively cheap countries. By second-stage international trade countries with a relatively small degree of market transparency can get rid of their informational disadvantage.

If the degree of market transparency is increased in one country under first-stage international trade, then home customers of this country will benefit. With improved transparency search becomes more profitable and, in the short run, prices decrease in the home country while they remain invariant abroad. However, in response, firms of all countries make losses and the total number of firms decreases in the long run. This firm number reduction results in rising prices in all countries. While in the home country prices remain reduced in the long run, in other countries prices end up on a higher level. Hence the country which improves its market transparency shifts part of its share in international aggregate overhead cost to other countries. This conflict does only arise at the first stage of international trade. At the second stage customers have chosen to search and buy in one market only. At this stage of complete economic integration there are no longer national transparency degrees or national price distributions, there emerges one international market with one transparency degree.

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## APPENDIX A

In this appendix I give a sketch of the formal analysis of the basic model.

DEFINITION 1: A distribution  $H$  of  $N$  firms is an equilibrium with respect to  $N$  firms if there exists a profit level  $\gamma > -b$  such that

$$(A1) \quad g(p|H) \begin{cases} = \gamma & \text{for } p \in S(H) \\ \leq \gamma & \text{for any } p \geq 0, \end{cases}$$

where  $S(H)$  is the support of  $H$ ,  $S(H) := \{p \in [0, \infty) : H(p-\epsilon) < H(p+\epsilon) \text{ for all } \epsilon > 0\}$ .  $\square$

THEOREM 1: For each number of firms  $N \in [1, \infty)$  there exists a unique equilibrium distribution  $H^*$  with respect to  $N$ .  $H^*$  has the density

$$(A2) \quad h^*(p) = \begin{cases} \frac{1}{- \ln(1-\rho) p^{-c}} & \text{for } p \in [p, \bar{p}] \\ 0 & \text{else} \end{cases}$$

where  $-\ln(1-\rho)$  is positive and approximately equal to  $\rho$  for small  $\rho$ , where the support  $[p, \bar{p}]$  is determined by

$$(A3) \quad p^{-c} = \frac{b+\gamma}{\theta \kappa \rho} [1 - (1-\rho)^N], \quad \bar{p}^{-c} = (p^{-c}) (1-\rho)^{-N},$$

where the profit level  $\gamma$  is given by

$$(A4) \quad \delta = \frac{b+\gamma}{\kappa \rho} \psi(N),$$

and where  $\psi$  is defined by

$$(A5) \quad \psi(N) = [1 - (1-\rho)^N] [(1-\rho)^{-N} - (1+\rho N)].$$

SKETCH OF PROOF: 1. Uniqueness: First I show by contradiction that an equilibrium distribution  $H$  has no atom and that its support is convex: If  $H$  had an atom at some price  $p^\circ > c$  and some firm  $i$  offered at this price then by a marginal price reduction the customer stock of firm  $i$  would jump upward and thereby its profit would increase. If  $H$  had an atom at  $p^\circ = c$  then firms offering there would make profits of  $-b$ . If the support of  $H$  had a gap  $(p', p'')$  then any firm offering at  $p'$  could increase its price without losing customers and thus increase its profit.

If  $H$  is known to have no atom and to be differentiable then the shape of its density can easily be derived: Equations (2), (3) and (A1) imply for each  $p$  in



the support

$$(A6) \quad \gamma = \theta \kappa \rho (1-\rho)^{H(p)} \frac{1}{1-(1-\rho)^N} (p-c) - b .$$

Solving for  $H(p)$  yields

$$(A7) \quad H(p) = \frac{-1}{-\ln(1-\rho)} \ln \left[ \frac{b+\gamma}{\theta \kappa \rho} \frac{1-(1-\rho)^N}{p-c} \right]$$

the derivative of which is equal to (A2).

Now I show that  $H$  fulfills equations (A3) to (A5). The support equation (A3) follows from  $H(p)=0$  and  $H(\bar{p})=N$  since (1) and (3) yield for prices within the support  $p-c=(b+\gamma)/(\theta \kappa \rho)=[(b+\gamma)/(\theta \kappa \rho)][1-(1-\rho)^N]/(1-\rho)^{H(p)}$ .

The reservation price equation (A4) follows from three observations. First, the upper endpoint  $\bar{p}$  must be a reservation price for customers, that is  $\delta=R(\bar{p}|H)$ : In case of  $\delta > R(\bar{p}|H)$  any firm at  $\bar{p}$  could profitably increase its price above  $\bar{p}$  without losing customers since  $R(p|H)$  is continuously increasing in  $p$ . In case of  $\delta < R(\bar{p}|H)$  any firm at  $\bar{p}$  would not get any customers. Second, expected gains from one search step at  $\bar{p}$  are given by  $R(\bar{p}|H)=[1-(1-\rho)^N]\theta(\bar{p}-p^*)$  where  $p^*$  is the average price to be paid by a randomly chosen customer. This equality results from two properties: (i)  $1-(1-\rho)^N$  is the success probability that the search step informs about at least one offer and (ii) the price of the best offer found by search is probabilistically distributed over prices like randomly chosen customers. Third, for the evaluation of the gain  $[1-(1-\rho)^N]\theta(\bar{p}-p^*)$  note that according to (A3)  $\bar{p}-c=[(b+\gamma)/(\theta \kappa \rho)][(1-\rho)^{-N}-1]$  and according to (1)  $p^*-c=[(b+\gamma)/(\theta \kappa \rho)]\rho N$  which yields (A4) and (A5).

2. Existence: Properties (A2) to (A5) of  $H^*$  imply that under  $H^*$  expected profits for prices in the support  $[p, \bar{p}]$  are equal to  $\gamma > -b$ , while elsewhere they are smaller than  $\gamma$ . This proves existence.

## APPENDIX B

In this Appendix I investigate the effects of economic integration in case of endogenous market transparency. Suppose each firm can increase its publicity degree  $\rho_i$  at the expense of increasing overhead costs,  $b=b(\rho_i, \kappa)$  with  $db/d\rho > 0$  and  $d^2b/d\rho^2 > 0$ . One can show straightforwardly that then for each firm the optimal publicity degree is independent of the price of this firm and given by  $\rho = \underset{r}{\operatorname{argmin}} b(r, \kappa)/r$ . For simplicity, suppose further that overhead costs are given by  $b(\rho, \kappa) = \beta e^{\nu \xi(\kappa) \rho}$  for some function  $\xi$  of  $\kappa$ . Then the optimal publicity degree is  $\rho = 1/(\nu \xi(\kappa))$  and overhead costs are equal to  $\beta$ . The average mark-up is then given by  $p - c = \delta[\psi^{-1}(\delta \kappa \rho / b) / (\delta \kappa \rho / b)] = \delta[\psi^{-1}(\delta \kappa / (\beta \nu \xi)) / (\delta \kappa / (\beta \nu \xi))]$ . Thus the average mark-up decreases with market size  $\kappa$  if  $\xi(\kappa)$  increases less than proportionally in  $\kappa$ .  $\kappa$  can be interpreted as size of the integrated market.

## ENDNOTES

- 1 For a more detailed analysis of the basic model see Zink (1993).
- 2 Considering time, we would assume that in each period there are  $\kappa$  new customers and each customer stays at the market for only one period.
- 3 The price increase has to be smaller than expected search cost for finding at least one of the other firms,  $\Delta p < \delta / [1 - (1 - \rho)^{N-1}]$ .
- 4 A sketch of this analysis is given in Appendix A. It should be noted that this equilibrium is meaningful economically only if the publicity degree is small enough. For higher publicity degrees see Zink (1996).
- 5 The model suggests that, in a static world, welfare is maximal if market transparency is highest. With high transparency, however, the number of firms is small and this may negatively affect innovation.
- 6 From  $\sum_{i=1}^N q_{ik} = \kappa_k$ ,  $p_k = \sum_{i=1}^N q_{ik} p_{ik} / \kappa_k$ ,  $\Gamma_{ik} = q_{ik} (p_{ik} - c)$  and  $\Gamma_{ik} = \Gamma$ , one gets  $\Gamma_k = \sum_{i=1}^N \Gamma_{ik} / N = \kappa_k (\kappa_k / N) (p_k - c)$  which is equivalent to (12).
- 7 This behavior of the long-run firm number results from comparing reservation price equations (17) and (9). Each autarkic firm number  $N_k$  is given by (9')  $b = \delta \kappa_k \rho_k / \psi(\rho_k N_k)$ , the short-run firm number by  $\sum_{k=1}^M N_k$ , and the long-run firm number  $N$  by (17')  $b = \sum_{k=1}^M \delta \kappa_k \rho_k / \psi(\rho_k N)$ . Thus we get immediately  $N > N_k$  for any  $k=1, \dots, M$ . The inequality  $N < \sum_{k=1}^M N_k$  can be proved by contradiction. Substituting (9') into (17') and using  $\psi(\rho_k N_k) / N_k < \psi(\rho_k \sum_{l=1}^M N_l) / \sum_{l=1}^M N_l$  yields
$$1 = \sum_{k=1}^M \frac{\psi(\rho_k N_k)}{\psi(\rho_k N)} < \sum_{k=1}^M \frac{\psi(\rho_k \sum_{l=1}^M N_l)}{\psi(\rho_k N)} \frac{N_k}{\sum_{l=1}^M N_l}$$
the right side of which would be smaller than unity in case of  $N > \sum_{k=1}^M N_k$ .
- 8 With  $N$  being the new long-run equilibrium number of firms,  $N_k$  being the corresponding autarkic number, and  $p_k^1$  and  $p_k^0$  being the corresponding equilibrium average prices, equations (8) and (16) show that  $(p_k^1 - c) / (p_k^0 - c) = N \psi(\rho_k N_k) / [N_k \psi(\rho_k N)]$  which increases in  $N_k$ . The effect of  $\kappa_k$  on  $N_k$  can be seen directly from (9).

9 The model is indifferent with respect to the home countries of those firms which survive in the long run after trade is taken up.

10 Condition  $\sum_{k=1}^M [\delta_k \kappa_k \rho_k / \psi(\rho_k N)] - b = 0$  determines  $N$  as a function of  $\rho_j$ . With  $\xi(\rho_j, N) := \sum_{k=1}^M [\delta_k \kappa_k \rho_k / \psi(\rho_k N)] - b$  we have  $d\xi/d\rho_j < 0$  and  $d\xi/dN < 0$  and thus  $dN/d\rho_j = -(d\xi/d\rho_j) / (d\xi/dN) < 0$ . With  $\eta(N, [\rho_j N]) := \{\sum_{k \neq j} [\delta_k \kappa_k \rho_k / \psi(\rho_k N)] + \delta_j \kappa_j [\rho_j N] / \{N\psi([\rho_j N])\} - b$  we have  $d\eta/d[\rho_j N] < 0$  and  $d\eta/dN < 0$  and thus  $d[\rho_j N]/d\rho_j = \{d[\rho_j N]/dN\rho_j\} \{dN/d\rho_j\} > 0$ .

11 For a justification of mixed strategies see also Harsanyi (1973).

12 Even with perfect information of customers we get the same formulas for average prices, profit levels and firm numbers, provided products and preferences are sufficiently heterogeneous, see Zink (1993).