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IDENTIFICATION OF BARRIERS IN INTERNATIONAL TRADE UNDER IMPERFECT COMPETITION

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ABSTRACT: The paper provides a means of estimating, with a given parameter of conjectural variation, international trade barriers under imperfect competition from data on market shares of different countries and producers in various markets, number of exporting firms and elasticities of demand. The method circumvents explicit specification of the production cost function. Both the cases of a homogeneous good and an industry with firms producing imperfect substitutes for each other are considered. Numerical illustrations on the barrier estimates between the EC and EFTA are also carried out.

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1. Introduction

The framework of international trade under imperfect competition has recently been developed and applied both in theoretical and empirical terms, i.a. to analyse the effects of European integration, by e.g. Venables (1987), Smith and Venables (1988) and Norman (1989,1990)[1)]. In the literature the empirical specification of the effective trade barriers has, however, received only limited attention, even though it is a basic element influencing our view on the nature of the international trade in the industry concerned and also on the potential for trade policy. In the present paper our aim is to address the problem of finding out the level of trade barriers implicit in the export decisions described by the imperfect competition trade model and to study how we can make inferences on these barriers using essentially data on market shares, number of firms in each country and the demand parameters.

The basic idea behind the paper is that the relative decision to export to two markets is independent from the marginal cost of a firm. In this way we are able to circumvent in one respect the problematic feature that the empirical applications of the imperfect competition trade model are often based on several quite strict assumptions. For example, it is assumed that factor movements have equalized costs between the producer countries. The results of the paper relate the

trade barriers to market share data in a straightforward manner and should be helpful in empirical efforts to estimate the existing barriers. Empirically, we apply the method developed in the paper to estimate the barriers in the trade between the EC and EFTA using the specification presented by Norman (1990).

The analysis also produces us an additional result on the economies of scale in an export industry. We see that typically the marginal cost function is declining, i.e. there are increasing returns to scale, even though in practice the situation may be quite near the case of constant returns to scale. We derive a simple way to extract this kind of information from data on total exports by the various firms.

The analysis runs in a straightforward manner in the case of a homogeneous good treated in the first part of the paper. However, of more practical importance is the case of an industry with firms producing imperfect substitutes. The results are quite similar, with proper modifications, as those presented in the case of a homogeneous good, but now we need more firm or country specific data on export prices in the various markets in order to be able to identify the trade barriers.

The empirical calibrations of the models of international trade, see Smith and Venables (1988) and Norman (1989), have encountered the difficulty of identifying the trade barrier terms apart from the shift parameters of the demand functions for products of different origin, which give rise to price differentials and differences in market shares between the various producers. We illustrate how essentially these price differentials influence our understanding of the

level of existing trade barriers. Related to a given price differential between the home and foreign market, we are able to derive an interval for the barrier related to exports to this market when the aggressivity of competition varies. The general result is the following. With given market shares, the more homogeneous the good is, i.e. the higher the elasticity of substitution, the narrower the barrier interval is, and the estimates of the barriers rapidly fall as the number of producers grows. On the other hand, in the case of a non-homogeneous good the degree of competition matters more, and the number of firms less, with respect to the trade barrier estimates.

The paper is organized in the following manner. In section 2 we present the general model for export decisions and derive the supply market shares of firms in the different markets. The key result regarding the relationship between the relative market shares of two countries in their respective markets, which gives us a method to estimate the existing trade barriers between these countries with a small amount of market information, is presented for the homogeneous goods case in section 3. Section 4 extends the analysis to the case of imperfect substitutes. As mentioned, the structure of production costs within an export industry can also be analyzed from data on export market shares, and this is done in section 5. In section 6 we carry out a numerical illustrations of the method developed in the paper applied to the material studied by Norman (1990) and by Smith and Venables (1988). Section 7 concludes.

2. The export market shares in the case of a homogeneous good

There are N countries, the country index being i, and K_i firms in the industry concerned in country i, k being the firm index. The volume of exports by firm k of country i to country j is denoted by Q_{ikj}. The total production of this firm is denoted by $Q_{ik} = \Sigma_k Q_{ikj}$ and the total exports from country i to country j by $Q_{ij} = \Sigma_k Q_{ikj}$. As mentioned above, one important aspect of our analysis is that the production technology need not be specified in an explicit way and thus we only assume that the cost minimizing use of production factors gives for each firm the total cost function $C_{ik}(Q_{ik})$ with the properties

$$(1) \qquad C'_{ik} > 0,\ C''_{ik} \geq 0 \text{ or } < 0 \quad .$$

Thus, we allow for constant marginal costs (constant returns to scale), and for diminishing marginal costs (increasing returns to scale), according to the limits imposed by the second order conditions for the firm optimum, see (6) below. Let further p_j be the price level in country j and t_{ij} the ad valorem barrier of trade, including transport costs, tariffs and other trade barriers less export subsidies, in exports from country i to country j. There may also be fixed costs F_{ikj} in exports from country i to j, describing i.a. the costs of setting up a distribution network in country j. The profit π to be maximized by the firm k in country i is now

$$(2) \qquad \pi_{ik} = \sum_j p_j(1-t_{ij})Q_{ikj} - \sum_j F_{ikj} - C_{ik}(Q_{ik}) \quad .$$

We specify all through the following analysis that competition in each market is independent from that in any other market and that it can be represented by a uniform conjectural variation parameter h in the output game. It is well known

that the assumption of market segmentation, which we also make here, and constant marginal cost produce the result that the games between the firms in different markets are completely separated from each other, see on this e.g. Dixit (1984). This formulation is in general too restrictive and unrealistic, and Venables (1990a,b) presents an alternative two-stage competition model where in the first stage the firm decides its total supply and then in the second stage the output is divided among the different markets. Anyway our analysis in section 5 shows that in practice we may be very near the case of constant marginal costs in an export industry. Also previous research to which we are mainly referring, namely Smith and Venables (1988) and Norman (1989), have taken recourse to the assumption of market segmentation. Like these studies, the conjectural variation parameter h is also taken to be the same in each market.

So the parameter h denotes the assumed rise in the total supply of the whole industry in the N countries to the specific market j as a reaction to a rise of one unit in the supply by the producer ik concerned to this market. If h is zero, we have perfect competition, and with h equal to unity we have Cournot competition. The first order optimality condition for the firm ik for producing and exporting to market j can now be stated as follows

$$(3) \qquad (1-t_{ij})p_j(1+\epsilon(p_j,Q_{ikj})) = C'_{ik},$$

where by ϵ is denoted in general the elasticity between the variables in the parentheses (which in (3) is in general non-positive). From (3) we see that a necessary condition for positive exports by the firm to market j is that the price, net of trading barriers (costs), exceeds the marginal cost in production.

If the price in this market heavily depends on the supply of the firm and if the fixed cost F is high enough, the situation of no exports may also emerge. The elasticity in (3) can be further written in the following form

$$(4) \qquad \epsilon(p_j, Q_{ikj}) = -\epsilon_{Dj}^{-1} h(Q_{ikj}/D_j),$$

where D_j denotes the total demand for the product in country j and ϵ_{Dj} is the absolute value of the price elasticity of demand in country j. Substituting (4) into (3) we can derive the market share s_{ikj} of the firm to be the following,

$$(5) \qquad s_{ikj} = \frac{Q_{ikj}}{D_j} = \epsilon_{Dj} h^{-1} \left(1 - \frac{C'_{ik}}{(1-t_{ij})p_j}\right) .$$

The sufficient condition for the export optimum can with some manipulation be derived to be the following,

$$(6) \qquad -(1-t_{ij})p_j (h\epsilon_{Dj}^{-1})[2-hs_{ikj}(1+\epsilon_{Dj}^{-1})+\epsilon_{Dj} h^{-1} D_j]/D_j - C''_{ik} < 0 .$$

As mentioned above, this allows for constant and also for increasing returns to scale to some extent, as the expression in square brackets is normally clearly positive.[2)]

The market share s_{ij} of exports from country i to country j can now be derived on the basis of (5) to be simply

$$(7) \qquad s_{ij} = \frac{Q_{ij}}{D_j} = \sum_k s_{ikj} = \epsilon_{Dj} h^{-1} K_i \left(1 - \frac{K_i^{-1} \Sigma_k C'_{ik}}{(1-t_{ij})p_j}\right) .$$

This result shows that the market share of country i in the market of country j is typically high if, first, there is a large number of producers in the exporting country i, i.e. if it is a large country, secondly, if it is an efficient producer of the good concerned with a low average marginal cost and, thirdly, if there are low barriers in trade between the two countries.

3. Identification of trade barriers from data on export market shares

Let us now turn after these preliminaries to analyse the relation between the market shares derived in (5) and (7). From expression (5) we see the property that the ratio of the market shares of an exporting firm in two markets j and m are not affected by the marginal costs prevailing in the production optimum. The same holds for the average marginal cost of a country if we make the assumption that the same firms in country i have exports to both these markets j and m.

From this notion we can derive a relation between the relative market shares of two exporting countries i and h in two markets j and m. The following expression can readily be derived from (7) as the prices are uniform within each market for all producers,

$$(8) \qquad \frac{K_i - h\epsilon_{Dj}^{-1} s_{im}}{K_i - h\epsilon_{Dm}^{-1} s_{ij}} = \frac{(1-t_{ij})/(1-t_{im})}{(1-t_{hj})/(1-t_{hi})} \frac{K_h - h\epsilon_{Dj}^{-1} s_{hm}}{K_h - h\epsilon_{Dm}^{-1} s_{hj}} .$$

Of special interest is the intra-industry trade between countries i and j, i.e. when we have in (8) i=m and h=j. We further suppose, in accordance with all

the above mentioned empirical applications of the imperfect competition trade model, that $t_{ii} = 0$ for all i. Then we can write (8) in the following form,

$$(9) \qquad \frac{K_i - h\epsilon_{Di}^{-1} s_{ii}}{K_i - h\epsilon_{Dj}^{-1} s_{ij}} = (1-t_{ij})(1-t_{ji}) \frac{K_j - h\epsilon_{Di}^{-1} s_{ji}}{K_j - h\epsilon_{Dj}^{-1} s_{jj}} .$$

On the basis of this result we can solve for the average of the trade barriers, defined as $t^*_{ij} = t^*_{ji} = 1-[(1-t_{ij})(1-t_{ji})]^{1/2}$, between countries i and j from data on market shares, the number of exporting firms and the elasticities of demand. The rationale behind (9) is that it neither requires information on the production costs nor on the relative price levels in the two countries and uses only aggregate (country level) market share data. From (9) we see that under perfect competition (h=0) we have the case of no (average) trade barriers, $t^*_{ij} = 0$ for all i,j. With less than perfect competition we have positive trade barriers if in the home market the aggregate market share of the domestic producers is higher than that of the foreign producers. If the reverse holds, there must be (net) export subsidization by the foreign country.

The limitation of (9) is that it can tell only the average of trade barriers between the two countries. To reach estimates of the individual barriers we can use directly the result (7), but now we also need data on the relative price levels between countries i and j. We get the result

$$(10) \qquad t_{ij} = 1 - \frac{p_i}{p_j} \frac{K_i - h\epsilon_{Di}^{-1} s_{ii}}{K_i - h\epsilon_{Dj}^{-1} s_{ij}} .$$

We should bear in mind in connection with (8), (9) and (10) our assumption of

the same set of firms operating in both markets i and j. This is precisely the fact that allows us to completely omit considerations related to the specification of marginal costs, which is often in practice a difficult and vague task, as well as the assumption of zero average profits, used in empirical calibrations in finding out the marginal cost function from average costs. Note that we do not assume that all firms export to all markets but that there is complete intra-industry trade between each pair of countries in the sense that each firm in these countries sells both to the home and export market.

If this assumption is not valid, we may still proceed along the lines presented above if we have data on the market shares of individual firms. We only need to find two firms in countries i and j supplying to both markets i and j. The expressions (8), (9) and (10) hold on the firm level as well and we can proceed in the same way as above. An interesting possibility is to use firm level data in econometric estimation of the conjectural variation parameter h, which can be done using (9) or (10) if the market shares of the various firms are not identical within each market.

4. The case of an industry producing imperfect substitutes

Let us now turn to the case of an industry producing imperfect substitutes. We assume in the manner of Smith and Venables (1988) that each of the K_i firms in country i produces m_i product types which are imperfect substitutes for each others and for all the other firms' products.

Let us denote by Q^*_j the quantity index, corresponding to the subutility function, of the various goods consumed in country j, and by p^*_j the corresponding price index. By Q_{ikj} is now denoted the quantity of a single product type exported by the firm ik to country j. As the models are taken to be symmetric, total exports by the firm concerned to country j is $m_i Q_{ikj}$. Analogously as above, let us assume that the demand function D^*_j in country j for the quantity index is iso-elastic, i.e.

$$(11) \qquad D^*_j = b_j p^{*\,-\epsilon}_j \ ,$$

where the positive constants b_j are related to the size of the various markets. We assume without limitation that the demand conditions are uniform in all markets. Let us now specify the analysis in a CES form along the lines of Smith and Venables (1988) and Norman (1989,1990) and assume that the subutility function of the products of the industry concerned can in each market be specified as a CES function. This utility function is identified as the quantity index and the corresponding price index is then also of the CES form. We have

$$(12) \qquad Q^*_j = \Big[\sum_{i,k} m_i d_{ikj}^{\,1-\phi} Q_{ikj}^{\,\phi}\Big]^{1/\phi} \quad \text{with} \quad \phi \le 1 \ , \text{ and}$$

$$(13) \qquad p^*_j = \Big[\sum_{i,k} m_i d_{ikj} p_{ikj}^{\,-\phi/(1-\phi)}\Big]^{-(1-\phi)/\phi} \ .$$

Here the d_{ikj}'s are parameters describing the preferences of consumers in country j for products of firm ik. Note that the preferences are not differentiated with respect to the different models.

The demand functions D_{ikj} for the quantity Q_{ikj} exported by the firm ik per each model to country j are now the following

$$(14) \qquad D_{ikj}/D^*_j = d_{ikj}[p_{ikj}/p^*_j]^{-1/(1-\phi)} \quad .$$

The profit function (3) of the firm is transformed into the following

$$(15) \qquad \pi_{ik} = \sum_j m_i p_{ikj}(1-t_{ij})Q_{ikj} - \sum_j F_{ikj} - C_{ik}(Q_{ik},m_i),$$

where $Q_{ik}=\Sigma_j Q_{ikj}$ is the total production of the firm per model and p_{ikj} is the price of the firm's product in market j. Differentiating (15) with respect to Q_{ikj} gives a similar first order condition as in (3) with m_i as an additional multiplier on the left hand side of the equation and the market price p_j substituted by the firm's price p_{ikj}.

Let us next solve in this case for the elasticity (4) between the price of the firm's product variety and its supply of a single model to market j. We first note that the elasticity between the quantity index and the quantity supplied by the firm to this market is equal to the market share s_{ikj} of the firm ik in country j, which is the normal situation in index number theory, i.e. we have

$$(16) \qquad \epsilon(Q^*_j,Q_{ikj}) = m_i d_{ikj}^{1-\phi}[Q_{ikj}/Q^*_j]^{\phi} = m_i p_{ikj} Q_{ikj}/p^*_j Q^*_j = s_{ikj} \quad .$$

It is now preferable to specify as in Smith and Venables (1988) the conjectural variation parameter h in a proportional form of reaction, rather than in the arithmetic form used above. Accordingly, we define h to be the relative rise in

the supply to market j concerned by each competitor when the firm ik raises its supply to market j by one per cent. It is now fairly simple to derive the elasticity needed for the export optimum using (14), (16) and (11),

$$(17) \qquad \epsilon(p_{ikj},Q_{ikj}) = -1 + \phi + [1-\phi-\epsilon^{-1}][s_{ikj}+(1-s_{ikj})h] \ .$$

By inserting this into (3) we have as the optimum condition for the export supply in the CES case

$$(18) \qquad p_{ikj}[\phi + (1-\phi-\epsilon^{-1})(s_{ikj}+(1-s_{ikj})h)] = \frac{C'_{ik}}{m_i(1-t_{ij})} \ .$$

We do not analyse decision making with respect to the number of models m_i produced by the firm as we do not need that here for our purposes. The parameters d_{ikj} in (12) and (13) play an important role in the determination of the prices p_{ikj}, as we can derive from the demand function (14) the relation

$$(19) \qquad \frac{p_{ikj}}{p^*_j} = (m_i d_{ikj}/s_{ikj})^{(1-\phi)/\phi} \ .$$

The method used by Smith and Venables (1988) and by Norman (1989) is to identify as a measure of 'effective discrimination' the terms $(1-d_{ikj}^{(1-\phi)/\phi}(1-t_{ij}))$ which can be identified on the basis of (18) and (19) from data on marginal costs, market shares and the demand parameters. This measure "says how much lower the producer price of a country-j product must be if it is to sell the same quantity as a home produced product variety. These tariff equivalents are all that can be determined through calibration." (Norman (1989, p. 461).[3)] This important unidentifiability between demand conditions (i.e. preferences concerning goods of dif-

ferent origin) and supply conditions, i.e. trade barriers, has been sharply recognized by Norman (1989) as an essential feature, or rather a weakness in the empirical analysis. If we are not able to identify d_{ikj} and t_{ij} from each other, it is difficult to tell the magnitude of potential gains and trade effects that can be achieved by market integration or trade policies reducing barriers, e.g. by the ongoing European integration process, see a demonstration on this by Norman (1989), pp. 442-3. However, if we have knowledge on the relative consumer prices of the different producers or countries, we can solve separately for the demand shift parameters d_{ikj} and the trade barriers once again without knowledge of the marginal costs, as is shown below in (20).

We next try to find out how important this factor of different demand shift parameters is for our understanding on the level of the existing trade barriers. We should first note that the preference parameters d themselves do not matter in this respect, but their effect on the price differentials. As we see from (19), the prices may be uniform even if there is a strong preference for, say the domestic producer, but simultaneously its market share is high. In this case the parameters d_{ikj} would not play any role at all in the export decisions and therefore they should not have a role in the determination of the trade barriers, either.

Let us denote by S_{ij} the sum of the terms on the left hand side of (18) over the firms k in country i. Now we can solve for the trade barriers between countries i and j if, as above, we assume that $t_{ii} = 0$ for all i,

$$(20) \qquad t_{ij} = 1 - \frac{S_{ii}}{S_{ij}} \quad , \; S_{ij} = \sum_k p_{ikj}[\phi+(1-\phi-\epsilon^{-1})(s_{ikj}+(1-s_{ikj})h)] \; .$$

Note that the number of models does not have any influence on this expression and so neither on the trade barriers. Note also that firm level data on market shares and prices can be used in a similar way as was mentioned above in finding out the barriers instead of the country level aggregation in (20).

The empirical estimates of the barriers essentially depend on the relative price between the home and foreign markets as we shall see in section 6. Let us therefore derive an expression for this important item. The export supply optimum (18) provides us with the following ratio between prices charged by the firm ik in two markets i and j,

$$(21) \qquad \frac{p_{iki}}{p_{ikj}} = 1-t_{ij} \frac{a_{ikj}}{a_{iki}} \quad , \text{ where}$$

by a_{ikj} is denoted the expression in square brackets in (18). From this we see that the prices charged in the home market are not necessarily higher than in the foreign, as exports face a trade barrier, but a high domestic market share is, ceteris paribus, related to a higher domestic than foreign price, as the multiplier of the market share in (18) is in general positive.

Let us illustrate diagrammatically the trade barrier line (20) as a function of the relative price p_{ii}/p_{ij} of the producers of the country i between its home and export market keeping the market shares s_{ii} and s_{ij} as fixed. We now interpret this price ratio to change as a result of a change in the d parameters (19)

related to country i's firms between their home and foreign markets (like Smith and Venables (1988) and Norman (1989,1990) we assume that there are identical preferences and prices related to all firms of country i in each market). As figure 1 shows, in general the trade barrier is the lower, the higher the domestic price with respect to the export price. The reason for this is that with a drop in the foreign price, the domestic producers cannot retain their foreign market share unless they face lower trade barriers. The line with a slope of minus unity is a special case, as it describes with any value of the conjectural variation parameter h the situation when the market shares in the the domestic and foreign markets are identical. The lines which lie above this line are related to the case where the domestic market share is higher than the the foreign, which is the normal case in practice, and the situation is the reverse with lines located below this line of slope minus unity.

The position of the trade barrier line also depends on the degree of competition. When h is unity we have the case of constant market shares, i.e. collusion. In this case, with any combination of the market shares s_{ii} and s_{ij}, the trade barrier line coincides with the line of slope minus unity (see (20)). This also gives for $s_{ii} > s_{ij}$ the minimum trade barrier with respect to the degree of competition. Thus we reach the conclusion that, when competition is of the type of a collusion and the demand conditions are identical in the various markets as we assume here, there is export subsidization (in net terms) whenever the foreign price of a firm is lower than its domestic price.

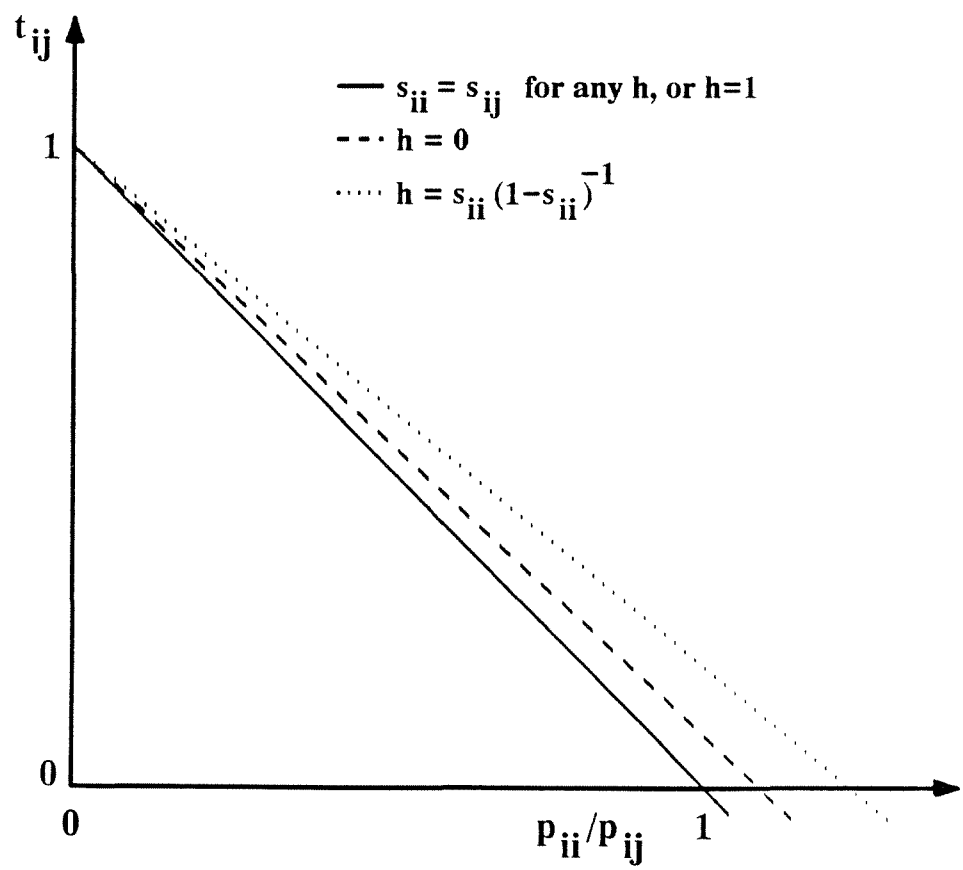
When h is lowered from unity towards zero, i.e. to the case of Cournot competition, and there is more competition, the trade barrier line rotates upwards

from the line representing the case of equal market shares. Its ultimate position is when there is perfect competition and h obtains the value $-s_{ii}(1-s_{ii})^{-1}$ and now we have the maximum trade barrier (for $s_{ii} > s_{ij}$). So, with more competition we have a higher trade barrier related to a given price differential between the domestic and foreign markets, as is natural.

In figure 1 we have used the values for the parameters ϕ and ϵ used by Norman (1990) in exports of other manufactures than metals and paper from EFTA to the EC. The number of firms is taken to be 3.33 in EFTA. As we can see, if prices are the same in the domestic and foreign market, the estimates of the trade barriers vary from zero to 20 per cent when the degree of competition rises from collusion to perfect competition.

In general we find that the number of the firms strongly influences the estimates of the barriers if the parameter ϕ is close to unity, which implies a high elasticity of substitution (which is here $1/(1-\phi)$) between the various goods, and the situation approaches the case of a homogeneous good. The case is, of course, the reverse with a low substitutability and low values of ϕ. However, we should bear in mind the condition that the absolute value of the elasticity (17) between the price and the supply of a firm should depend positively on the market share of the firm. This imposes a lower bound for the ϕ parameter with a given price elasticity ϵ. If we lower ϕ down to this value, the trade barriers would rise to unity. In the case of Norman (1990) this lower bound would be $\phi=0$, which corresponds to unitary elasticity between the various producers (see table 1).

Figure 1. The trade barrier line (20) in exports from EFTA (country i) to the EC (j) as a function of the conjectural variation parameter h using the specification by Norman (1990). The parameter values are ϵ=1 and ϕ=0.7, the market shares are fixed at s_{ii}=0.65 and s_{ij}=0.02 and the number of firms in EFTA is 3.33.



5. Analysis of production costs on the basis of export market shares

If the export market shares of different firms of country i in market j differ from each other, as is normally the case in practice, then (5) implies that the marginal production costs of different firms also differ from each other.

Let us return to the case of a homogeneous good and analyse on the basis of (5) the shares of different exporting firms in total exports of a country. The total exports E_{ik} of firm k in country i can now be derived to be following,

$$(22) \quad E_{ik} = \sum_{j \neq i} s_{ikj} D_j = h^{-1} \sum_{j \neq i} \epsilon_{Dj} D_j - h^{-1} C'_{ik} \sum_{j \neq i} D_j \epsilon_{Dj} ((1-t_{ij}) p_j)^{-1} .$$

From this we can with some manipulation derive the following relation between the marginal costs of two firms k and m in country i, if they have exports to the same countries j.

$$(23) \quad \frac{C'_{ik}}{C'_{im}} = \frac{\frac{h^{-1} \Sigma_j \epsilon_{Dj} D_j}{E_i} - e_{ik}}{\frac{h^{-1} \Sigma_j \epsilon_{Dj} D_j}{E_i} - e_{im}} .$$

Here by E_i is denoted the total exports of country i and by e_{ik} the share of firm k in the total exports of country i. In the nonhomogeneous goods case a similar kind of expression as (23) holds as an approximation. Thus we find a very straightforward way of analysing the industry structure of relative marginal costs on the basis of data on total exports and firm export shares. In

general, if h is positive, (23) implies to a situation with diminishing marginal costs in production: the big exporters have lower marginal costs in the production optimum than the smaller ones. It is easy to see that this difference is quite neglible in small countries with a small share in world exports. If we have Cournot competition and unitary price elasticities and if the share of a country in the world trade of the commodity concerned is a few per cent, there can indeed exist only very small differences in marginal costs between the firms. Let us then consider the case of a big country with a market share of 50 per cent in world trade. The marginal costs can still deviate by only some 5 per cent between a firm that has a 20 per cent share in the exports of this country and a firm with an export share of two per cent. Thus, we see that the imperfect competition trade model imposes the condition of increasing returns to scale, but this is not very marked, so we can rather speak of the case of a constant marginal cost.[4)]

6. Numerical illustrations

We apply the method derived above to two empirical analysis of European integration, to find out the barriers in trade, first, between the EC and EFTA using the specification of this trade presented by Norman (1990), and secondly, in the trade in electrical appliances studied by Smith and Venables (1988).

Norman studies the trade between the EC and EFTA by classifying the tradables sector into two categories: metals and paper, where there is perfect competition and no trade barriers, and other manufactures where the specification of the imperfect competition varies. The market share structure and the parameter speci-

fication is the following.[5)]

Table 1. The trade in other manufactures between the EC and the EFTA countries, for further details, see Norman (1990).

	Market share (per cent)		Number of firms	Elast. of subst.	Price elast.	Compe-tition
Producer	Consumer					
	EC	EFTA				
EC	88.8	22.8	20	3.05	1	Cournot
EFTA	2.0	65.0	3.33	3.54	1	Cournot

In the pure version of the reciprocal dumping oligopoly, the various products are taken to be homogeneous with each other, and so we can apply directly the result (9) in order to calculate the average of the barriers between EFTA and the EC. This average is 11.5 per cent. However, Norman finds that the barriers, derived from the assumption of equal marginal cost, are very much higher in EFTA (i.e. related to EC exports) than in the EC (related to EFTA exports), 24 and 4 per cent, respectively. In order to study this asymmetry by our framework we use expression (10). Now we need data on the relative price levels in these two areas. As the level of aggregation is in this specification high, we may use the purchasing power calculations carried out at the OECD, see OECD (1987). This allows us to estimate that the price level in other manufactures was on average some 10 per cent higher in EFTA than in the EC in 1985.[6)]

Using this information in expression (10) gives the trade barrier estimates in

table 2. We do not, however, know whether there is full pairwise trade by the firms between the trading areas concerned, but we assume this here. As can be seen from the results, with the mentioned price ratio 1.1 the estimates of the barriers are fairly similar between EFTA and the EC. However, it should be added that these estimates crucially depend on the estimate of the price level, as is also presented in table 2. If the price levels were the same in EFTA and the EC, the barriers would change dramatically and now the barriers for EFTA exports would be manifold as compared to those for EC exports. The reason for this is that a small country is, with equal prices and given market shares, more open to foreign competition than a big country as there are more foreign rivals in the domestic market of the small country.

Table 2. The estimates of the trade barriers (per cent) based on table 1. In parentheses in the left panel is presented the case of identical prices in the EC and EFTA.

	Reciprocal dumping		Monopolistic competition	
From	To		To	
	EC	EFTA	EC	EFTA
EC	0	12.1 (3.3)	0	9.5
EFTA	10.9 (19.0)	0	6.3	0

Let us next turn to the case of monopolistic competition. The elasticities of substitution and the price elasticitites are presented in table 1. According to

the calibration of Norman (1990) the preferences between the home and foreign producers are such that, on the basis of (19) with $m_i=1$, in the EFTA market the prices of the EFTA producers would have been 14 per cent higher than those of the EC producers, while in the EC market the EFTA producers would have sold at a 6 per cent higher price than the EC producers. Combining this information with the above relation of the price levels in these two areas we come to the estimate that the EFTA producers charged some 8 per cent higher prices in their home market than in the EC market. On the other hand, the EC firms would have priced equally in their home and in the EFTA market.[7] Feeding this information into the expression (20) we may solve for the trade barriers under Cournot competition shown in the right panel of table 2. The barriers are now clearly smaller than in the case of pure reciprocal dumping. In the present case this is a consequence of the difference in relative pricing between the home and export market by the two producer groups and the different substitution parameters in them.

In general, we find that EFTA exports face lower barriers in the EC than the reverse, even though the difference between these seems to be much smaller than that calibrated by Norman. However, this outcome quite essentially depends on the estimates of the relative price levels. The method used above to find out the prices between the home and export market is quite crude, and to study how sensitive the results are, we also calculated the barrier estimates by using a ratio of 1.15 (instead of 1.1) between the price levels of manufactures in EFTA and the EC in 1985. Now we get a barrier of only 1.5 per cent for EFTA exports, while that for the EC export rises to 15 per cent. Good price information is therefore necessary in order to reach reliable estimates of the trade barriers

in the case of monopolistic competition and product differentiation.

As another application we analysed the trade in electical appliances in the EC studied by Smith and Venables (1988). The market share structure is such that the domestic market shares are in all markets very high, of the order of 60 per cent or more. This would imply quite high trade barriers between the countries. However, the number of firms in each country is quite big, more than 20, and the elasticity of substitution is calibrated to be over 10. Application of (20) therefore gives the result that the barrier estimates are very small and all less than two per cent if we initially take the prices to be equal in the home and export markets.

If the elasticity of substitution is very high, as in this case, the barrier estimates with a given pattern of market shares, crucially depend on the number of firms in such a way that the barrier estimates rapidly become very small as the number of firms grows. If we considered the example presented by Smith and Venables to be one where the firms have higher prices abroad than in their home market, usually referred to be case in Europe, the estimates for the trade barriers would be even lower than those mentioned. In general, we should try to estimate the degree of substitution between the firms from actual firm level export data rather than calibrate it by roundabout means, as suggested also by Winters (1990).

7. Conclusions

In this paper we have derived from the model of international trade under imperfect competition a method how to estimate the existing trade barriers between countries mainly from data on country level market shares and elasticities of demand. Therefore, we claim that the method adds an element to the existing tools of empirical analysis of international trade and trade policies, e.g. in the analysis of effects of European integration. One important feature of the model is that it is independent of the often quite vague assumptions concerning the form and properties of the production cost functions. Of course, we also had to make some restictive assumptions concerning the trade model. One of them was the full intra-industry trade between the countries, i.e. that all the firms in both countries under consideration have home market sales and exports. However, this can be circumvented if we have access to firm level data. Further, it should be noted that we can only identify the multiplicative trade barriers t_{ij}, but not the fixed costs F_{ij} of exports, by the methods developed in the paper. In practice, tariffs and the transpost cost component of the trade barriers should first be evaluated on the basis of other information and the rest of the total barrier estimates t_{ij} be identified as NTBs.

We should mention some other lines of research based on the findings of the paper. We briefly referred to a statistical testing of the above model of international trade which could be done if we have access to firm level market share data. All the above analysis is valid at the firm level as well and the reason for aggregating to a national level was that there is much more data of this kind. Thus, we could test the trade model, especially the degree of competition, on the basis of the results (8), (9) and (20) which hold with due modification also for individual firms, using data on market shares by firms. Our empirical

calculations also suggest that efforts to compile reliable price data should be taken in applications of the imperfect competition trade model.

NOTES

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(1) A brief overview of this strand of research and its empirical results is given by Norman (1988).

(2) If k is the degree of returns to scale we have the property $(-C''/C')Q=1-1/k$.

Now we may write condition (6) in the form $k < [1-2(Q_{ik}/D_j)h\epsilon_{Dj}^{-1}(1+b)]^{-1}$,

where b is defined as $(\epsilon_{Dj}hD_j-hs_{ikj})/(1-h\epsilon_{Dj}^{-1}s_{ikj})$.

This allows the upper bound of k to be above unity.

(3) This can be seen as follows. Assume that $m_i=m_j$ and that the market share of a foreign firm is the same as that of a domestic firm so that $s_{ikj} = s_{jk'j}$, and normalize the preference d_{iki} for the home firm to unity. The export optimum (18) implies now the result stated in the text,

$$\frac{C'_{jk'}-C'_{ik}}{C'_{jk'}} = 1-(d_{ikj})^{(1-\phi)/\phi}(1-t_{ij}) \ .$$

(4) We are able to derive a simpler expression than that in (23) if we have access to data on sales to the home market by the different firms. On the basis of (5) we can directly derive the following expression by assuming as above that $t_{ii}=0$,

$$\frac{C'_{ik}}{C'_{im}} = \frac{1 - h\epsilon_{Di}^{-1}s_{iki}}{1 - h\epsilon_{Di}^{-1}s_{imi}} \ .$$

This is a somewhat simpler result to use in practice, as it only requires

data on the home market elasticity of demand and sales, which are on the other hand harder to get in practice than the export statistics. I owe this point to Pekka Ilmakunnas.

(5) Norman also varies the number of firms in the EC and EFTA keeping the EC 6 times bigger than EFTA. As the elasticity of substitution rises when there are more firms, the barrier estimates become lower in the manner referred to below.

(6) The calculation of the price ratios in other manufactures between the home and foreign market has started from the average ratio of the price level of GDP between EFTA and the EC which was 1.27 in 1985. The services in EFTA seem to be in relative terms somewhat more expensive than all goods in comparison to the EC, the corresponding price ratio estimated by means of government services being 1.34. From this figure and the assumption that the prices of metals and paper are the same in the two areas we may infer that the required price ratio of other manufactures was 1.09 between EFTA and the EC in 1985.

(7) We have used approximative Cobb-Doublas price indices for the aggregate price level and for the other manufactures in the EC and EFTA. In the latter index the price of the goods produced in the rest of the world are assumed to be identical in the EC and EFTA. It should also be noted that in the case of unitary price elasticity the substitution parameter ϕ does not have any influence on the trade barrier estimates if it is uniform in the home and export market (see (18)).

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