Economies of Scale and Scope, Firm Heterogeneity and Exports

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Abstract

This paper develops an international trade model where firms in an oligopoly may diversify their technologies in equilibrium. The firms choose between establishing single-product or multi-product plants taking into account scale and scope economies. This may leave the market with firms with high and low marginal production costs, where firms with low marginal production costs are more export-oriented than firms with high marginal production costs. Market integration where variable per unit trade costs decrease may induce a technological restructuring towards firms with lower marginal production costs. The technological restructuring triggered by market integration benefits social welfare for the participating countries as a whole, although in some cases individual countries may experience a loss of welfare.

1. Introduction

The role of trade for intra-industry specialization has attracted much interest in recent research in international trade theory. The basic analytical framework is imperfect competitive markets as in the 'new' trade theory from the last three decades, but the distinctive feature for recent research is firm heterogeneity caused by different productivities among firms of the specific industry. This new offshoot of trade theory has therefore been termed the 'new new' trade theory, see Schmitt and Yu (2001), Montagna (2001), Melitz (2003) and Helpman et al. (2004) for some of the initial papers in this branch of literature.

The 'new new' trade theory specifically assumes that the industry is characterized by moderate scale economies and monopolistic competition therefore prevails on the market. In equilibrium the productivities sort out the firms in size and export performance. The productivity of the individual firm is perceived as a stochastic outcome of an initial investment of sunk costs. The prospective entrant at the market invests a given amount and then the firm draws its productivity parameter from a common distribution (Melitz, 2003).[1] In equilibrium, the most productive firms are the biggest (larger output and revenues) and the firms most involved in exports compared with less productive firms. These results are supported by empirical evidence; see e.g. Bernhard et al. (2003), Bernhard and Jensen (2004), and Greenaway and Kneller (2005).

The aim of this paper is to offer an alternative view on firm productivities related to economies of scope and scale within the framework of oligopoly. Most of the literature on international trade is based on the assumption that the individual firm only produces one good. However, this is in stark contrast to reality where multi-product lines exist in nearly all manufacturing firms. The basic technology choice therefore relates to the number of goods the firm will undertake to produce. In choosing the number of product

[1]Heterogeneity of productivities materializes in the parameters of the costs functions. The works by Schmitt and Yu (2001) and Jørgensen and Schröder (2006) use fixed cost heterogeneity in the form of firm-specific fixed export costs, while Montagna (2001), Melitz (2003) and Helpman et al. (2004) use marginal costs heterogeneity.

lines the firm faces a trade-off between marginal costs and fixed costs. Reducing the number of product lines offers the advantage of lower marginal cost as the firm's resources may be more specialized in producing a more narrow range of products. On the other hand, fixed unit costs may be high, when market size and hence output runs are limited. The relevance of a technology with few product lines therefore depends crucially on the possibilities to exploit scale economies. On a market of limited size, the firm will be more inclined to choose more product lines to exploit economies of scope i.e. lower fixed costs per product line. This saving of fixed costs per product line is at the expense of larger marginal production costs. Market size and trade are thus highly relevant for the firm's technology choice (Hansen and Jørgensen, 2001; Zhou, 2002).

The basic factor behind economies of scope is the presence of a sharable, "quasi-public" input that may enter into the production process of more than one type of output, see Panzar and Willig (1981) for a more detailed discussion of this concept. Resources for top management and some R&D activities are obvious examples of sharable inputs. Sharable inputs may also be embedded in fixed capital, where fixed equipment in many cases is designed to deliver services for production of more types of output.

In recent years trade models with multi-product firms have received increasing interest. Baldwin and Gu (2006), Eckel and Neary (2006), Nocke and Yeaple (2006) and Bernard et al. (2006) are important examples. These papers focuse on how trade liberalisation influence firm scope endogenously. The paper by Baldwin and Gu (2006) is in the tradition of the 'new new' trade theory by extending Melitz and Ottaviano (2005)[2] to a multi-product firm framework leading to the result that trade liberalization leads to specialization in fewer product lines with larger output per product line.

Also firm heterogeneity in (single product) oligopoly has been researched intensively in recent years; see e.g. Lahiri and Ono (1997), Falvey (1998), Yeaple (2005) and Collie (2006). Of these papers, only in the paper by Yeaple (2005) firm heterogeneity arises

[2] Melitz and Ottaviano (2005) deviates from Melitz (2003) primarily by using a variable elasticity of substitution framework, instead of the constant elasticity of substitution assumption.

endogenously, when firms choose to employ different technologies and then systematically hire different types of workers. Yeaple (2005) is also the only oligopoly model introducing fixed export costs, which is a central element in the ’new new’ trade theory. In none of the mentioned papers economies of scope are involved. This is on the other hand the case in Eckel and Neary (2006) mentioned above, but they operate with homogeneous firms.

Our model builds on a duopoly model by Mills and Smith (1996). In their paper, two firms produce a homogenous product. Two technologies are available based on a trade-off between (constant) marginal costs and fixed costs, i.e. technologies of which one has high marginal costs, but low fixed costs, and the opposite holds for the other technology.[3] The two firms are involved in a two-stage game. Technology is chosen in the first game and output in the second, where firms play Cournot-Nash. It is shown that for a range of costs structures each of the two producers may have different technologies without incentive for neither of them to change technology. Contrary to the lottery allocation of productivities in the ‘new new’ trade theory, the differences of productivities in the model by Mills and Smith are an outcome of the strategic game between the firms.

We assume like Mills and Smith (1996) that firms basically have access to the same set of technologies. The choice of technology is thus a result of the strategic game between the firms. However, two important differences exist between our model and the model by Mills and Smith. First, available technologies include sharable inputs, and hence economies of scope exist. To keep the analysis simple, we assume that sharable inputs in top management make it rational for each firm to provide the market with two goods. Furthermore, the fixed equipment may be designed to produce one or alternatively both goods, so economies of scope in production may also in some cases be utilized. Second, foreign trade is included in the analysis as the two producers may supply both a domestic

[3] The general set-up in Mills and Smith (1996) is that the technology choice of firms is a continuous trade-off between fixed and variable costs. But in their specific analysis they rely on the case, where the continuous technology set is insufficient convex, so equilibria only support two extreme technologies – those with minimal (maximal) fixed costs and maximal (minimal) variable costs.

and a foreign market. Per unit trade costs as well as fixed market access costs exist when operating on the foreign market.

These assumptions allow co-existence of different technologies for some cost structures just as in the model of Mills and Smith. Furthermore, by introducing trade in this paper, it is shown that both variable and fixed trade costs influence the performance of the firms as well as their strategic choice of technologies. In case of technology heterogeneity we show the firm with low marginal costs to be the most export-oriented and the largest. Furthermore, trade liberalization through a reduction in variable trade costs may induce a shift in technology from high to low marginal costs. These results are very similar to the main conclusion in the 'new-new' trade theory based on exogenous productivity differences and monopolistic competition.

The paper is organized as follows. Section 2 develops the basic model. Market equilibrium is illustrated and cost structures consistent with co-existence of different technologies are described. Section 3 analyzes the impacts of market integration, i.e. a decrease of the variable trade costs and the fixed market access costs. Section 4 analyzes the welfare economic consequences of market integration and technology choice. Section 5 concludes.

2. The basic model

We look at a two-country, two-good, partial equilibrium model with two firms both located in the home country *H*, for which reason the foreign country *F* is a pure importing country of the specific goods. The two countries may differ with respect to market size and are separated by specific trade costs *g* per unit of good *A* or *B*, including transport and trade barriers costs.

Demand for each of the two products in the two countries is given by:

$$Q_i^H = (a - p_i^H)\ ;\ i = A, B \tag{1a}$$

$$Q_i^F = S(a - p_i^F)\ ;\ i = A,B \qquad (1b)$$

where Q_i^j is quantity demanded; p_i^j consumer price (i= A,B, and j=H,F) and S a constant measuring the size of the foreign market relative to the home market. To simplify, the demand functions in each country for the two products are identical, and furthermore the demand for the two products is independent (two different homogeneous products).[4]

Turning to supply, we assume the goods and the firms (*1* and *2*) to belong to the same industry.[5] Caused by economies of scope in management, the two firms are both producing good *A* and *B*, but scope economies also exist at plant level, as the producers may choose between two types of production technologies: to produce either at two single-product plants or at a multi-product plant.[6]

If a producer decides to produce the two goods at two independent plants, his costs functions are:

$$C_i = cq_i + f \qquad i = A,B \qquad (2)$$

C_i is total costs, c marginal costs and f fixed costs. To simplify, we assume the single-plant costs functions for the two goods to be identical.

[4] By making this simplification, the possibility of multi-product plants/firms is solely a result of costs considerations and not, as in Brander and Eaton (1984), a result of demand-side differences for products and the associated strategic effects. In case the products were differentiated instead of being homogeneous as in our case, we would have four products, and the firms have to decide on *scope* (how many products), *line* (which particular products) and *quantity* (or price), in general making the model rather complicated (a three-stage instead of a two-stage game).

[5] The goods could e.g. be tables and beds, both belonging to the furniture industry and probably with highly independent demand functions.

[6] We use the concept economies of scope somewhat different than traditionally done in the literature. In Panzar and Willig (1975, 1981), there are economies of scope where it is less costly to combine two or more product lines in one firm than to produce them separately. Also, according to Brander and Eaton (1984), the scope decision is about how many products to produce. In this paper, the definition of scope is related not to the number of products, but to the number of plants *within* the firm. So, the difference is mainly related to the definition (or the boundaries) of the firm.

In case a producer decides to produce both goods at one plant, his total costs function is the following:

$$C^* = c^* q_A + c^* q_B + f^* \qquad (3)$$

where $c^*>c$ and $f<f^*<2f$.

To operate in the foreign market, the home producers have to pay a variable trade cost at g per unit of output sold in the foreign market and a market access fixed cost of marketing of both products.[7] Product symmetry is assumed to prevail for marketing activities in the foreign market and scope economies may exist, i.e. the market access costs for marketing of only one product in the foreign market are at least half of the market access costs of marketing both products. The firm will therefore enter the foreign market with two products if it is profitable to enter with one. The combined market access costs for both goods are denoted $2m$.

Market equilibrium

Depending on the strategic choice of production technology, the following four outcomes may be considered: Both firms establish two single-product plants each (I); firm *1* establishes two single-product plants, firm *2* establishes a multi-product plant (II); firm *1* establishes a multi-product plant, firm *2* establishes two single-product plants (III); both firms establish a multi-product plant (IV). Case (II) and (III) are symmetric and hence only the cases (I), (II) and (IV) will be dealt with in the following.

The firms play a two-stage duopoly game for each good. In the first stage, they decide on technology ((2) or (3)), and in the second stage they optimize output by playing Cournot. The model is solved similar to Mills and Smith (1996) by backward induction, i.e. quantities, prices and operating profits for the foreign and home markets are determined for a given technology in the first step. The next step is then to consider whether any of the firms have an incentive to change their technology or to leave one or both markets.

[7] Melitz (2003) operates with fixed market access cost for both the domestic and foreign market, with the latter of the largest size.

Using the standard Cournot analysis, *Table 1* shows the solutions for profits for the cases, where both producers are active on the home market as well as on the foreign market (see Appendix for the full solutions for output, prices and operating profits).

Table 1. Profit matrix for alternative divisions of technologies across producers.

		Firm 2	
		Single-product plants	*Multi-product plant*
Firm 1	*Single-product plants*	(I) $2\left(\frac{a-c}{3}\right)^2+2S\left(\frac{a-c-g}{3}\right)^2-2f-2m;$ $2\left(\frac{a-c}{3}\right)^2+2S\left(\frac{a-c-g}{3}\right)^2-2f-2m$	(II) $2\left(\frac{a-2c+c^*}{3}\right)^2+2S\left(\frac{a-2c+c^*-g}{3}\right)^2-2f-2m;$ $2\left(\frac{a-2c^*+c}{3}\right)^2+2S\left(\frac{a-2c^*+c-g}{3}\right)^2-f^*-2m$
	Multi-product plant	(III) $2\left(\frac{a-2c^*+c}{3}\right)^2+2S\left(\frac{a-2c^*+c-g}{3}\right)^2-f^*-2m;$ $2\left(\frac{a-2c+c^*}{3}\right)^2+2S\left(\frac{a-2c+c^*-g}{3}\right)^2-2f-2m;$	(IV) $2\left(\frac{a-c^*}{3}\right)^2+2S\left(\frac{a-c^*-g}{3}\right)^2-f^*-2m;$ $2\left(\frac{a-c^*}{3}\right)^2+2S\left(\frac{a-c^*-g}{3}\right)^2-f^*-2m$

Note: Both producers *1* and *2* produce goods *A* and *B*, and sell in both markets *H* and *F*.

Technology choice

Having solved the second stage, the Cournot optimization, we now turn to the first stage of choice of technology. The interesting result is that firm heterogeneity may turn out to be possible market equilibrium, i.e. one of the firms establishes two single-product plants and the other a multi-product plant. Case II (or case III) may thus be a sub-game perfect Nash-equilibrium for some values of the parameters.

As the cases II and III are symmetric, we only look at case II. If case II should be a sub-game perfect Nash equilibrium, neither of the two producers should have an incentive to reconsider their technology choice. This requires the following conditions for each of the two producers. Producer *1* will stay in *II*, if the profit in the single-product plant case is higher than in the multiple-product plant case shown in cell *IV*. We are particularly interested in the role of trade costs for the optimum technology, and with this focus we get the following condition for producer *1* to abstain from shifting technology to a multi-product plant:

$$
\begin{aligned}
&2\left(\frac{a-2c+c^*}{3}\right)^2 + 2S\left(\frac{a-2c+c^*-g}{3}\right)^2 - 2f - 2m > \\
&2\left(\frac{a-c^*}{3}\right)^2 + 2S\left(\frac{a-c^*-g}{3}\right)^2 - f^* - 2m \qquad \Rightarrow \\
&\frac{(c^*-c)}{(f+m)-(½f^*+m)} > \frac{9/4}{(a-c)+(a-(c+g))S} \Rightarrow \\
&g < g_{max} = (\frac{1+S}{S})(a-c) - \frac{9}{4S}(\frac{(f+m)-(½f^*+m)}{(c^*-c)}) \\
&= (\frac{1+S}{S})(a-c) - \frac{9}{4S}r; \\
&\text{where: } r = \frac{(f+m)-(½f^*+m)}{(c^*-c)} > 0
\end{aligned}
\qquad (4)
$$

The interpretation is the following: The advantage of single-product plants is contingent on large production runs, and low variable trade costs are associated with large total production runs. To deter firm *1*, which uses two single-product plants, from shifting to a multi-product plant, trade costs should therefore not exceed a specific threshold value called g_{max}. The threshold value, g_{max}, depends positively on the size of the total market (*a* and/or *S*), because a larger market makes it more easy to realize large total production runs.[8] The threshold value depends negatively on a ratio of cost parameters, *r*, which illustrates the cost advantage of using a multi-product plant compared to single-product plants. A small value of *r* caused by a large marginal cost difference (c^*-c) and/or a small fixed cost difference (f+m)-(½f^*+m) indicates a favourable cost structure for a technology based on single-product plants.[9]

Similarly, the condition for firm *2* to keep its multi-product plant technology in cell *II* is:

[8] An increase in *S* (for given *a*) is both an absolute and a relative increase in the foreign market, while an increase in *a* is an absolute increase in the size of both markets, with unchanged relative sizes.
[9] Given our assumption on identical fixed market access costs for the two products and no economies of scope in foreign market access (i.e. m_A=m_B=m^*=m), the fixed costs difference (f+m)-(½f^*+m) = (f-½f^*).

$$2\left(\frac{a-2c^*+c}{3}\right)^2+2S\left(\frac{a-2c^*+c-g}{3}\right)^2-½f^*-2m>$$

$$2\left(\frac{a-c}{3}\right)^2+2S\left(\frac{a-c-g}{3}\right)^2-2f-2m \quad \Rightarrow$$

$$\frac{(c^*-c)}{(f+m)-(½f^*+m)}) < \frac{9/4}{(a-c^*)+(a-(c^*+g))S} \Rightarrow \qquad (5)$$

$$g > g_{min} = (\frac{1+S}{S})(a-c^*) - \frac{9}{4S}(\frac{(f+m)-(½f^*+m)}{(c^*-c)})$$

$$= (\frac{1+S}{S})(a-c^*) - \frac{9}{4S}r$$

The interpretation is similar to that of firm *1* above. Now the problem is that to deter producer *2*, using a multi-product plant, from changing to two single-product plants, total production should be relatively limited. This demands trade costs g to be above threshold value of g_{min}, where g_{min} depends positively on total market size (a and/or S) and negatively on the relative cost advantage, r, operating on a multi-product plant.

To sum up, if the marginal trade costs, g, are in the interval $g_{min}<g<g_{max}$, both firms will, as shown in *Figure 1*, keep their initially chosen technology that is to produce on two single-product plants and one multi-product plant, respectively. Below g_{min} both firms will choose single-product plants, and above g_{max} both will choose multi-product plants. The important determinants of technology are the trade-off between fixed and variable production costs for the two technologies and the market sizes. Both g_{min} and g_{max} increase with market size (a and/or S), i.e. on a larger market the producers are more inclined to produce with single-product plants. This result is similar to previous theoretical and empirical literature on this issue, see e.g. Zhou (2002), Baldwin and Gu (2006), and Baldwin et al. (2005). The fixed market access costs are basically irrelevant for the results, as the choice of technology only relates to the plant level, i.e. the market access costs are identical for the two alternative technologies.[10]

[10] However, the market access costs are relevant, as discussed later, for the producers' decision on presence on the export market, and this decision affects total output and hence choice of technology.

Figure 1. The structure of technologies and trade costs.

Firm size and exports

The heterogeneity of technology in case II (and III) translates into differences in firm size and export status. Measured by output, the firm using single-product plants is larger than the firm using a multiple-product plant, because of the relative lower marginal costs of production of the former. This follows from calculating the difference of total output of the firm using single-product plants, $Q^{1,II}$, and the firm using a multi-product plant, $Q^{2,II}$ (see the Appendix). The difference in output of the two firms is proportionate to the differences in marginal costs of production, i.e.:

$$Q^{1,II} - Q^{2,II} = (1+S)(c^* - c) > 0 \qquad (6)$$

The firm using single-product plants is also more export-oriented than the firm using a multi-product plant. This follows from inspection of the ratio of export to output on the home market for each of the two firms (see the Appendix). We get:

$$\frac{q^{1,F,II}}{q^{1,H,II}} - \frac{q^{2,F,II}}{q^{2,H,II}} = \frac{Sg(2a+3(c^*-c))}{(a-2c^*+c)(a-2c+c^*)} > 0 \qquad (7)$$

and hence, in relative (and also in absolute) terms, firm *1* is more oriented towards export than firm *2*. This pattern of size and export orientation of firms is similar to the conclusions of models based on monopolistic competition in the 'new new' trade theory.

Long-term conditions for only two operating firms

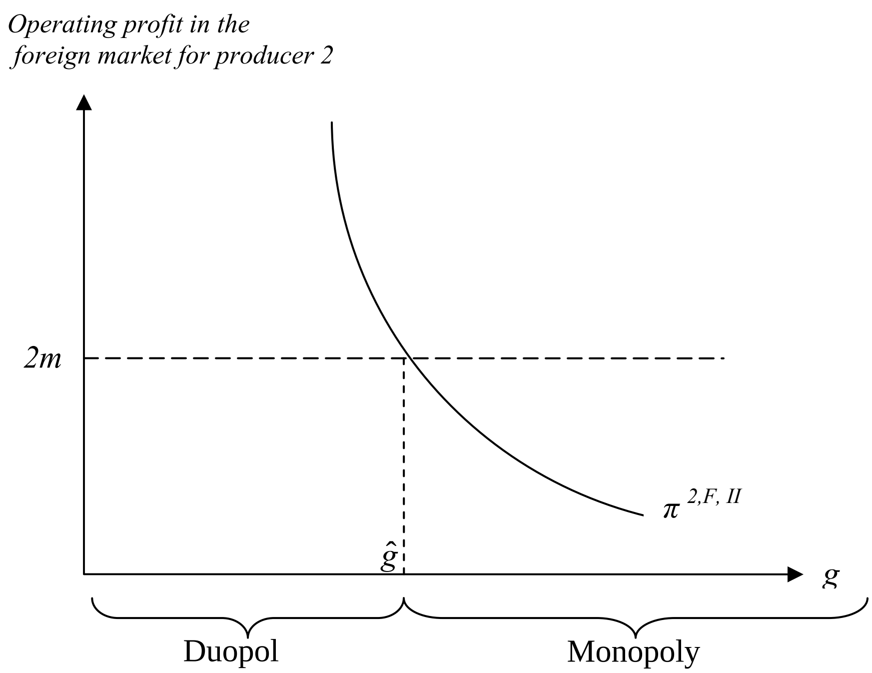
In the above analysis, no attention has been paid to the option not to produce at all on one or both markets, or entry of more firms. The Appendix reports the supplementary conditions for the short and long run for the existence of solutions, where only two firms will produce on each market. In the short run, operating profit for each firm must be non-negative for being active on each market, and in the long run total profit must be non-negative for incumbent firms, and perceived profit negative for potential firms.

In the mixed technology case, interesting special cases arise, when both firms are active on the home market, but only one firm on the export market. In the short run, the multi-product plant producer will only produce if the operating profit on the foreign market, $\pi^{2,F,II}$, is positive, which is the case when $g<(a\text{-}c^*)-(c^*\text{-}c)$. In the long run, the condition is more demanding, as the operating profit for the firm, $\pi^{2,F,II}$, must be sufficient to cover market access costs *2m*, i.e.:

$$g < \hat{g} = (a - c^*) - (c^* - c) - 3\sqrt{\frac{m}{S}} \tag{8}$$

For substantial market access costs, there may therefore be cases in the long run, where the firm using single-product plants supplies the foreign market as monopolist, whereas both companies supply the home market in a duopoly. In *Figure 2* the two alternative cases are illustrated. The following section on market integration includes this special case in the analysis.

Figure 2. Monopoly or duopoly in the foreign market?



3. Market integration

The firms meet two barriers, when they sell on foreign markets: variable unit trade costs, *g*, and fixed market access costs, *2m*. The variable trade costs capture transport costs as well as tariffs, duties and other institutional costs for selling on foreign markets. Fixed market access costs are the costs of participation in foreign markets independent of the volume of exports. It consists of the costs of acquiring information on foreign markets and to create a distribution network in the foreign country. It may also be costly to adapt products to foreign markets to ensure they are conforming to the foreign standards and regulations (testing, packaging and labeling requirements). If the importing country hosts domestic producers in the industry, such costs may even be manipulated by governments to function as protection of the domestic industry.

Market integration may materialize through a decrease of per unit trade costs *g* and/or by a decrease of fixed market access costs *2m*. A decrease in per unit trade costs, *g*, may be a result of a real costs reduction (e.g. transportation costs) or a tariff or non-tariff reduction through bilateral (multilateral) trade negotiation. A decrease of the market access costs may follow from smoothing the legal procedures for being allowed to operate on the foreign market. Lower regulatory barriers through WTO measures against non-tariff barriers or EU initiatives like the Single Market Program are examples.

Market integration may trigger strategic changes of both firms' choice of technologies, as well as their decisions on whether or not to operate in the foreign market. Let us first look at the effects of a decrease of variable unit trade costs, g, and assume that both producers find it profitable to operate both in the home and the foreign markets. To be more specific, we assume that the market access costs are small so g is initially below $\hat{g}$, see (8). The effects of a decrease of g then follow straightforwardly from the previous section on Nash-equilibrium see *Figure 1*. If both companies initially use a multi-product plant (g is initially above g_{max}), a decrease in trade costs may in some cases induce one or both of the producers to shifts to single-product plants (move from IV to II/III or I in *Table 1*). Similarly, in cases of initially mixed technologies (g is initially above g_{min}, but below g_{max}) a decrease in trade costs may induce the producer with a multi-product plant to shift to single-product plants (move from II/ III to I in *Table 1*).

In the case of mixed technologies before and after market integration, market integration also changes the relative firm size (and market shares) and their export intensities. While the absolute difference in size of firms is independent of variable trade costs (see (6)), market integration increases the relative size (and market share) of the firm with the multi-product technology. The disadvantage of having high marginal costs of production decreases with better access to the foreign market, and hence the relative export orientation of the multi-product technology firm increases with increasing market integration (see (7)).

However, special cases appear if market access costs are relatively large, i.e., if g initially is above $\hat{g}$ (see (8)). If initially $g_{min} < \hat{g} < g < g_{max}$, only the firm using single-product plants will operate on the foreign market. If market integration reduces g below $\hat{g}$, the firm using a multi-product plant will enter the foreign market, and hence the market structure on this market changes from monopoly to duopoly. However, in this case the change of market structure is not associated with a change in technology.[11]

A decrease in the fixed market access costs does not have any influence on the export behaviour of the firms, if both firms initially are active on the foreign market. Both firms will in this case reap more profit without any effects on allocation. However, in the cases, where one or both firms are absent from the foreign market, a decrease of market access costs may induce one or both of the firms to start exporting.[12] The market structure in the foreign market then changes from monopoly to duopoly (if one producer initially).

4. Welfare

The analysis of market integration and technology choice also provides some conclusions on welfare of the home country and the foreign country. For the home country social welfare is made up by consumer surplus in the home market and total producer surplus, which consists of operating profit in the two markets minus total fixed costs (fixed production costs plus market access costs). For the foreign country, the contribution to social welfare of the market consists of the consumer surplus exclusively, as we disregard production in this industry in the foreign country. The expressions for all elements of social welfare in the two countries are reported in the Appendix.

Let us first look at the case, where both firms produce for the home market as well as for foreign market, i.e. the market access costs do not deter any of the firms from being absent from the foreign market. If variable unit trade costs g are gradually reduced from a

[11] Special cases also exist, where market structure and technology shift simultaneously. If g initially is above $\hat{g}$, which again is above g_{max}, one of the producers will be a monopolist on the export market. Because of being the sole supplier on the foreign market, the total output for the exporting firm may be so large that it induces the producer to use single-products plants, while a duopoly configuration on the export market would not have allowed for that. If g in this situation is reduced slightly below $\hat{g}$, both producers will operate on the foreign market using multi-product plants.

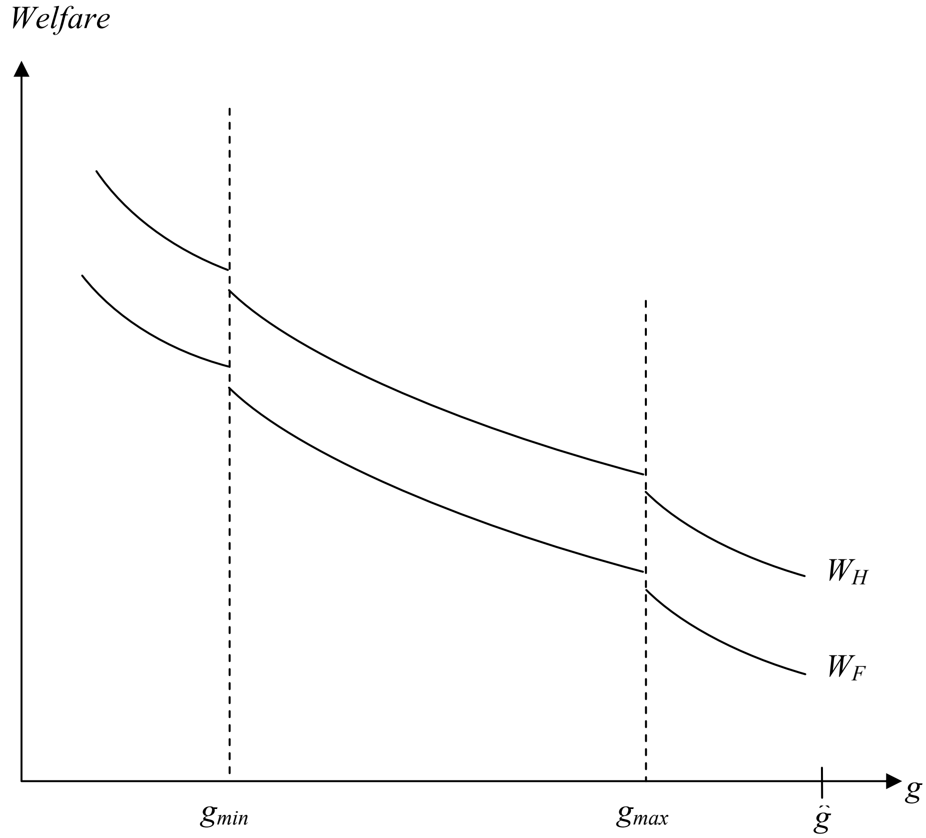
[12] As the total sale changes, when the firm(s) begins to export, the change of market structure and export behaviour may be associated with a change in technology.

relatively high level to a low level, the two firms will go through three stages of technologies, starting from a stage with a uniform multi-product plant technology, to a stage of mixed technologies of multiple- and single-product plants and a final stage of uniform technology of single-product plants. For decreases of g in the intervals, where technology is unchanged, consumer and producer surplus in the home country is unaffected. In the foreign market, the producers' profit increases monotonically with the decrease of g. Total welfare in the home country, $W_{H,}$ therefore increases monotonically with the decrease of g. The welfare impact in the foreign country, W_F, only relates to consumer surplus. A part of the lower costs caused by lower variable trade costs translates to the foreign consumers through a lower price, so welfare of the foreign country therefore also increases monotonically with the decrease of g. If a decrease of g triggers a shift of technology, consumer surplus jumps discontinuously upwards in both countries in the wake of the drop in prices. *Figure 3* summarizes the above analyzed welfare impacts of market integration.[13]

The case where market access costs play a role for the market structure is more difficult to analyze. Let us assume that at the initial level of trade costs g_0, $g_{min} < \hat{g} < g_0 < g_{max}$, i.e. the technologies are mixed, and the firm using single-product plants provides the foreign market as a monopolist. A decrease of g may in this case lead to entrance of the other producer on the foreign market. The intensified competition benefits the consumers in the foreign country, but at expense of profits for the previous monopolist. The change of the market structure therefore discontinuously reduces welfare in home country, but increases welfare in the foreign country. The effects are illustrated in *Figure 4.*

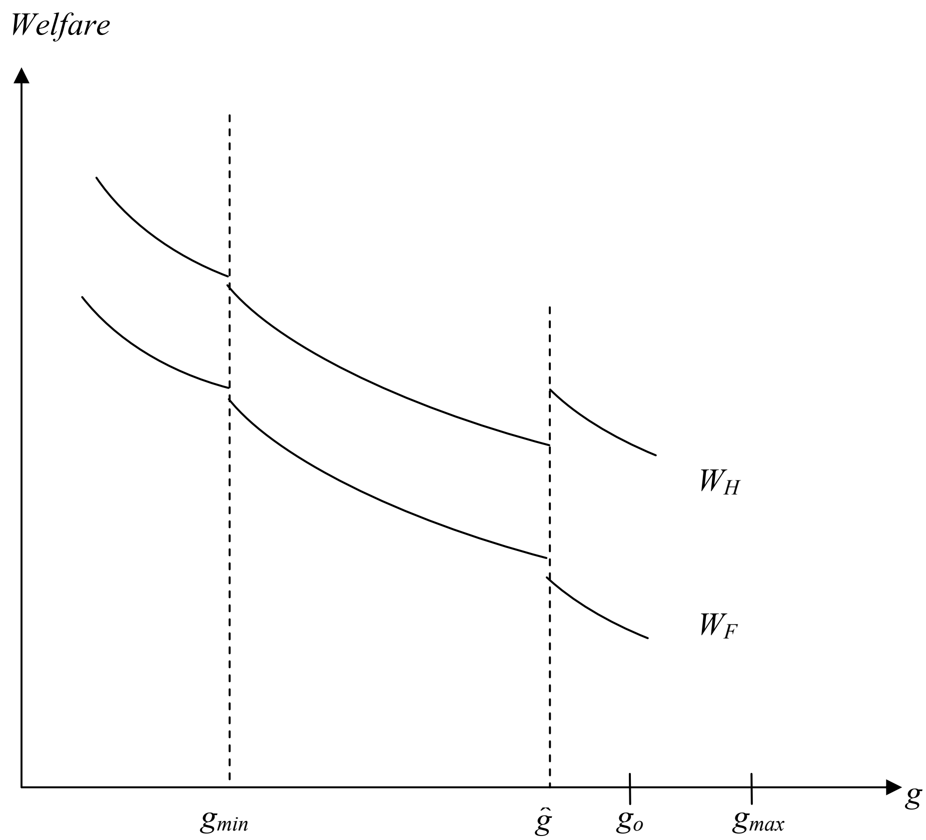
[13] These results assume that g is a real trade cost like e.g. transport costs, but not a financial trade barrier like a tariff.

Figure 3: Welfare and variable trade costs: Both firms export



A reduction of the market access costs may result in similar cases as illustrated in *Figure 4*. In case of monopoly, a decrease of the fixed market access costs may induce a change in the market structure by entrance of the second firm in the foreign market. This redistributes welfare in favour of the foreign country.

Figure 4. Welfare and variable trade costs: Both firms export for low trade costs, but only one firm exports for high trade costs



5. Conclusions

The analysis in this paper rests on two main assumptions. First, the firms face a set of technologies based on a trade-off between marginal production costs and fixed costs. Higher fixed production costs are associated with lower marginal production costs because the capital equipment may be specialized in various degrees. In our model, this specialization has been related to the number of different goods the plant is able to produce. Second, markets are of limited size, and this constrains the number of firms which may operate without loss on markets with oligopoly.

Combining market size with blueprints of technologies illustrates, as already demonstrated by Mills and Smith (1996), that firms may diversify their technologies in market equilibrium. In this paper, we introduce a foreign market and show that in case of technology heterogeneity a firm with low marginal production costs is more export-oriented compared with firms with high marginal production costs. This pattern of export orientation is similar to one of the main conclusions in the ‘new new’ trade theory based on exogenous productivity differences in models where monopolistic competition prevails. The model in our paper also allows for conclusions on impacts on technology of market integration. Lowering unit variable trade costs may induce a shift towards more efficient technologies with respect to marginal production costs. This improves welfare, at least at a global scale.

There are obvious routes for extending the analysis. The model may be expanded to introduce more than two firms, e.g by assuming producers in both countries resulting in intra-industry trade. However, such an extension will not change the fundamental conclusion of this paper that market integration may trigger changes in technology and affect the size of firms.

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Appendix: The solution of the Cournot model

The Cournot-solution is derived below for the three cases *I*, *II*, and *IV* in *Table 1*. In case *I* and *IV*, the producers are symmetric with marginal production costs at *c* and *c**, respectively. In case *II*, the producers are asymmetric, as producer *1* produces with marginal production costs at c and producer *2* with marginal production costs at *c**. The demand on each of the two markets is given by (1) and trade costs by *g* per unit sold on the foreign market. Using standard Cournot maximization gives the following set of solutions with q_i, p_i, π_i and CS_i as quantity, consumer price, operating profit and consumer surplus for good *i* (*i*= *A,B*) in home and foreign country respectively:

I: Both producers produce at two single-product plants.

$$q_i^{1,H,I} = q_i^{2,H,I} = \frac{(a-c)}{3}; q_i^{1,F,I} = q_i^{2,F,I} = \frac{S(a-c-g)}{3}$$

$$Q_i^{1,I} = (q_i^{1,H,I} + q_i^{1,F,I}) = Q_i^{2,I} = (q_i^{2,H,I} + q_i^{2,F,I}) = \frac{(1+S)(a-c)-Sg}{3}$$

$$p_i^{H,I} = \frac{(a+2c)}{3}$$

$$p_i^{F,I} = \frac{(a+2c+2g)}{3}$$

$$\pi_i^{1,H,I} = \pi_i^{2,H,I} = 2\left(\frac{a-c}{3}\right)^2; \pi_i^{1,F,I} = \pi_i^{2,F,I} = 2S\left(\frac{a-c-g}{3}\right)^2$$

$$\pi_i^{1,I} = \pi_i^{2,I} = 2\left(\frac{a-c}{3}\right)^2 + 2S\left(\frac{a-c-g}{3}\right)^2$$

$$CS_i^{H,I} = ½(a - p_i^{H,I})(q_i^{1,H,I} + q_i^{2,H,I}) = \frac{2}{9}(a-c)^2$$

$$CS_i^{F,I} = ½(a - p_i^{F,I})(q_i^{1,F,I} + q_i^{2,F,I}) = \frac{2S}{9}(a-c-g)^2$$

II: Producer 1 produces at two single-product plants; producer 2 produces at a multi-product plant.

$$q_i^{1,H,II} = \frac{(a-2c+c^*)}{3}; q_i^{1,F,II} = \frac{S(a-2c+c^*-g)}{3}; Q_i^{1,II} = (q_i^{1,H,II} + q_i^{1,F,II}) = \frac{(1+S)(a-2c+c^*)-Sg}{3}$$

$$q_i^{2,H,II} = \frac{(a-2c^*+c)}{3}; q_i^{2,F,II} = \frac{S(a-2c^*+c-g)}{3}; Q_i^{2,II} = (q_i^{2,H,II} + q_i^{2,F,II}) = \frac{(1+S)(a-2c^*+c)-Sg}{3}$$

$$p_i^{H,II} = \frac{(a+c+c^*)}{3}$$

$$p_i^{F,II} = \frac{(a+c+c^*+2g)}{3}$$

$$\pi_i^{1,H,II} = 2\left(\frac{a-2c+c^*}{3}\right)^2; \pi_i^{1,F,II} = 2S\left(\frac{a-2c+c^*-g}{3}\right)^2$$

$$\pi_i^{1,II} = 2\left(\frac{a-2c+c^*}{3}\right)^2 + 2S\left(\frac{a-2c+c^*-g}{3}\right)^2$$

$$\pi_i^{2,H,II} = 2\left(\frac{a-2c^*+c}{3}\right)^2; \pi_i^{2,F,II} = 2S\left(\frac{a-2c^*+c-g}{3}\right)^2$$

$$\pi_i^{2,II} = 2\left(\frac{a-2c^*+c}{3}\right)^2 + 2S\left(\frac{a-2c^*+c-g}{3}\right)^2$$

$$CS_i^{H,II} = ½(a - p_i^{H,II})(q_i^{1,H,II} + q_i^{2,H,II}) = \frac{1}{9}(a - c^* - c)^2$$

$$CS_i^{F,II} = ½(a - p_i^{F,II})(q_i^{1,F,II} + q_i^{2,F,II}) = \frac{S}{9}(a - c^* - c - g)^2$$

IV: Both producers produce at a multi-product plant.

$$q_i^{1,H,IV} = q_i^{2,H,IV} = \frac{(a-c^*)}{3}; q_i^{1,F,IV} = q_i^{2,F,IV} = \frac{S(a-c^*-g)}{3};$$

$$Q_i^{1,III} = (q_i^{1,H,IV} + q_i^{1,F,IV}) = Q_i^{2,III} = (q_i^{2,H,IV} + q_i^{2,F,IV}) = \frac{(1+S)(a-c^*)-Sg}{3}$$

$$p_i^{H,IV} = \frac{(a+2c^*)}{3}$$

$$p_i^{F,IV} = \frac{(a+2c^*+2g)}{3};$$

$$\pi_i^{1,H,IV} = \pi_i^{2,H,IV} = 2\left(\frac{a-c^*}{3}\right)^2; \pi_i^{1,F,IV} = \pi_i^{2,F,IV} = 2S\left(\frac{a-c^*-g}{3}\right)^2$$

$$\pi_i^{1,IV} = \pi_i^{2,IV} = 2\left(\frac{a-c^*}{3}\right)^2 + 2S\left(\frac{a-c^*-g}{3}\right)^2$$

$$CS_i^{H,IV} = ½(a - p_i^{H,IV})(q_i^{1,H,IV} + q_i^{2,H,IV}) = \frac{2}{9}(a - c^*)^2$$

$$CS_i^{F,IV} = ½(a - p_i^{F,IV})(q_i^{1,F,IV} + q_i^{2,F,IV}) = \frac{2S}{9}(a - c^* - g)^2$$

Conditions for only two firms operating on both markets.

a) Non-exit condition

In the *short run*, the companies should have non-negative operating profits on both markets. This is the case if

$$a - 2c^* + c - g \geq 0$$

or

$$(c^* + g) + (c^* - c) \leq a.$$

The marginal costs of serving customers in the foreign market from a multi-product plant (c^*+g) plus the difference in marginal costs between a multi-product and a single-product plant (c^*-c) should not exceed a specific threshold value given by demand (a).

In the *long run*, total profit of both firms should be non-negative. Inspection of *Table 1* gives the following rankings of operating profits for the two producers

$$\pi^{1,II} > \pi^{1,I} > \pi^{1,IV}$$

$$\pi^{2,I} > \pi^{2,IV} > \pi^{2,II}$$

Hence, total profit is non-negative if

$\pi^{1,I} \geq 2(f + m)$ and

$\pi^{2,II} \geq (f^* + 2m)$

Using the expressing for operating profits, this condition may be written as:

$$\frac{(a - c)^2 + S(a - c - g)^2}{9} \geq (f + m)$$

and

$$\frac{(a - 2c^* + c)^2 + S(a - 2c^* + c - g)^2}{9} \geq (\frac{f^*}{2} + m)$$

Zero or positive profit in all alternative cases is thus only possible if the fixed plant costs plus market access costs are moderate relative to obtainable operating profit.

b) Non-entry condition

Potential new firms should not have an incentive to enter. If a new firm enters, the operating profit of the new firm will be lower than the operating profit for any of the incumbent firms in duopoly, because of the intensified competition. To deter potential firms from entering, potential operating profit of the new firm should thus be lower than the total fixed costs irrespective of choice of plant. This is the case if fixed plant and market access costs are substantial relative to operating profit for the two firms in duopoly.