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Market Integration and Market Concentration in Horizontally Differentiated Industries

by

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Abstract

This paper derives the impact of market integration on equilibrium firm size, R&D expenditures and market concentration in horizontally differentiated industries. We show that market concentration (measured by the number of firms) can rise as a consequence of market integration if firms engage in excessive R&D competition. This result implies that the welfare effects of market integration are not unambiguously positive. Additionally, we illustrate that if market integration leads to market concentration, firms are more likely to penetrate foreign markets via foreign direct investment.

Keywords: Globalization, Market Structure, R&D, Multinational Enterprises

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1. Introduction

A widespread belief among economists is that globalization increases competition and reduces concentration. Recent developments, however, have cast doubts on these theories. UNCTAD (2000, pp. 127-129) reports mounting evidence that concentration in some highly globalized industries, such as automobiles, banking, pharmaceuticals, telecommunications, insurance and energy (including petroleum), is rising. Ernst (1997) provides evidence of growing concentration in the electronics industry. In particular, the total number of producers of hard disk drives worldwide has fallen rapidly from 59 in 1990 to 24 in 1995. Does globalization and market integration really lead to less concentration?

The impact of market integration on market concentration (measured by the number of competitors in a differentiated industry) has been studied in a number of papers. Krugman (1979, 1980), Dixit and Norman (1980), Helpman (1981), Helpman and Krugman (1985), and Anderson (1991) have all shown that an increase in the size of the market can lead to an increase in the number of firms producing a distinct variety of a horizontally differentiated good. The mechanism is very simple: If demand increases, firms go down their average cost curves and make positive profits. These profits attract new entrants and the number of firms rises.

However, this result depends critically on the assumption that an increase in output per firm leads to an increase in profits. New entrants are only attracted if profits rise as firms go down their average cost curve. But if firms do not only set the level of their output or the prices of their products, but also the level of R&D expenditures, they can spend their extra profits on additional R&D. Dasgupta and Stiglitz (1980) showed that such a mechanism can prevent entry because expenditures on R&D are fixed costs. The rise in fixed costs associated with R&D acts as a barrier to entry. We will show that firms have indeed an incentive to engage in additional R&D as the market expands, and we will show that this might not only effectively prevent further entry, but that it can also promote concentration.

Shaked and Sutton (1987) and Sutton (1991, 1998) have shown how endogenous sunk costs in the form of a firm's expenditures on advertising and R&D can influence the relationship between market size and market concentration in vertically differentiated industries. However, pure horizontal differentiation has always explicitly been excluded from these results (See Sutton, 1991, p. 37: "Within models of [horizontal product differentiation], if each firm is confined to producing a single product, a limited theorem holds regarding the relationship between concentration and market size... As market size increases, industry structure becomes fragmented." See also Matraves, 1999, p.171: "[In industries characterized by homogeneous and horizontally differentiated products], the net effect of an increase in market size must be a rise in firm numbers and reduced concentration."). In this paper we show that an increase in concentration as a consequence to a market expansion can also occur in models of pure horizontal differentiation. Single product firms compete on the basis of price only and the (perceived) quality of all products is assumed to be identical.

The analysis will be conducted in a framework of a horizontally differentiated industry that is characterized by monopolistic competition and free entry. Firms maximize their profits by setting marginal costs equal to marginal revenue and new firms will enter (or exit) the market until the market price equals average costs. A firm's average cost curve is assumed to be downward sloping so production exhibits internal economies of scale. The analysis is limited to symmetric equilibria where each firm produces exactly one distinct variety of the differentiated good.

In the next section we will introduce the production side of our model. We will assume that a firm's R&D expenditures (directed towards process innovations) are not exogenously given but that a firm sets its level of R&D in order to maximize profits. The R&D technology is very simple and follows Dasgupta and Stiglitz (1980): An increase in R&D leads to a reduction in marginal production costs. It should be pointed out that R&D expenditures are essentially fixed costs, so that with an R&D technology aimed at reducing variable costs, firms can set different levels of fixed costs so as to minimize overall production costs. We will show how, in equilibrium, firms' R&D decisions depend on the size of the market and in how far their decisions to engage in R&D affect market concentration.

Section 3 formalizes the demand side. Concerning demand we try to be as general as possible to include both the love of variety approach by Dixit and Stiglitz (1977) as well as Lancaster's (1979) ideal variety approach. Section 4 presents the equilibrium and discusses its features. Then, in Section 5, we conduct a comparative static analysis of the impact of an increase in the market size on optimal firm size, R&D expenditures and market concentration. In this section we will also show that some of the prominent models mentioned above can be described as special cases of the model presented here. Sections 6 and 7 present some interesting implications of our findings for the welfare effects of market integration and for the theory of multinational enterprises before concluding the paper.

2. Production Costs and R&D Expenditures

Following Dasgupta and Stiglitz (1980), we assume that a firm's total costs C consist of fixed costs F, stemming from R&D expenditures, and variable costs associated with the actual production of a particular variety X of a differentiated good. The cost function has the following form:

$$C = F + cX . \qquad (1)$$

R&D is directed towards process innovation. We assume that there is no risk involved in R&D and that any increase in R&D will lead to a reduction of marginal costs c. So marginal costs can be expressed as a function of total R&D expenditures:

$$c = c(F), \qquad (2)$$

where $c'(F) < 0$ and $c''(F) > 0$. Equation (2) can be interpreted as an R&D production function with decreasing returns to R&D.

Minimizing (1) subject to (2) leads to:

$$-c'(F)X = 1 . \qquad (3)$$

Equation (3) shows that firms set their level of R&D (F) so that the marginal benefits of R&D (left hand side) equal the marginal costs (of one). The second order condition is easily verified $[c''(F) > 0]$. The optimal level of R&D is depicted in figure 1.

[Figure 1]

Let the optimal level of R&D be denoted by F^*. It can now be shown that there is a positive relation between a firm's output and its optimal level of R&D. Total differentiation of (3) yields

$$\frac{dF^*}{dX} = \frac{1}{c''(F^*)X^2} = -\frac{c'(F^*)}{c''(F^*)X} > 0. \tag{4}$$

Equations (1)-(4) help us to establish lemma 1:

Lemma 1: *With an endogenous R&D technology, a firm's cost function with respect to its output is upward sloping and concave, i.e.* $C'(X) > 0$ *and* $C''(X) < 0$.

Proof: From (1)-(4) it follows that

$$C'(X) = c[F^*(X)] > 0, \tag{5}$$

$$C''(X) = c'[F^*(X)]\frac{dF^*}{dX} = \frac{c'[F^*(X)]}{c''[F^*(X)]X^2} < 0. \tag{6}$$

Figure 2 provides a graphical description of a firm's cost curve when R&D expenditures are determined endogenously. It shows how R&D expenditures change as output expands. Figure 2 also illustrates the incentive to engage in additional R&D: As output increases, the share of variable costs to fixed costs rises. Therefore, it pays for the firm to increase its fixed costs in order to reduce its variable costs. In figure 2, Δ denotes the cost savings of a firm that increases its R&D expenditures from F_0 to F_1 as output expands from X_0 to X_1.

[Figure 2]

As we will see later, the elasticity (γ) of marginal costs with respect to a firm's output plays a crucial role. It is defined as

$$\gamma = C''(X)\frac{X}{C'(X)} = -\frac{c'\left[F^*(X)\right]c'\left[F^*(X)\right]}{c''\left[F^*(X)\right]c\left[F^*(X)\right]} < 0\,, \tag{7}$$

and, as (7) shows, it depends solely on the shape of the R&D production function $c(F)$.

3. Demand for Varieties

We assume that the demand facing a producer of a particular variety is given by

$$X = \phi(p, n)\frac{E}{p}, \tag{8}$$

where p is the product price, n stands for the number of varieties offered and E denotes total expenditures on the differentiated good. Generally, two demand-based sources of horizontal differentiation are dominating the literature on intra-industry trade: the love of variety approach (Dixit and Stiglitz, 1977) and the ideal variety approach (Lancaster, 1979). Our demand function is consistent with both approaches if the underlying utility function is homothetic and of Cobb-Douglas type, i.e. when consumers spend a given fraction of their income on varieties of the differentiated good (see Helpman and Krugman, 1985, chapter 6). However, the function ϕ has to be interpreted slightly differently for the two approaches. In the Dixit-Stiglitz love of variety approach, where all consumers demand as many varieties as they can get, ϕ represents each consumer's share of spending allocated to a particular variety, whereas in Lancaster's ideal variety approach, where each costumer buys only one particular variety, ϕ denotes the market depth, i.e. the portion of consumers who buy this particular variety. In both cases, however, ϕ reduces to $1/n$ in a symmetric equilibrium, so that all firms and all varieties, respectively, have an equal market share of $pX/E = 1/n$.

Two features of (8) should be highlighted. First, ϕ depends negatively on n, so that demand for a single variety depends negatively on the total number of varieties available, i.e.

$$\frac{dX}{dn} = \frac{E}{p}\frac{\partial\phi}{\partial n} < 0, \tag{9}$$

which reduces to $dX/dn = -(1/n^2)(E/p) < 0$ in a symmetric equilibrium where $\phi = 1/n$.

Secondly, the elasticity of demand for a single variety with respect to its own price (assuming that all other prices remain constant) is given by

$$\sigma = -\frac{dX}{dp}\frac{p}{X} = -\left(\varepsilon_{\phi,p} - 1\right), \tag{10}$$

where $\varepsilon_{\phi,p} = (\partial\phi/\partial p)(p/\phi)$.

The price elasticity σ (and thus $\varepsilon_{\phi,p}$) is determined by the specifications of the underlying utility function. In the Dixit-Stiglitz case, it is equal to the elasticity of substitution between varieties, which is assumed to be exogenously given. In order to justify the assumption that the various varieties are only different specifications of the same type of product, it is generally assumed that the elasticity of substitution, and thus σ, is larger than one, i.e. $\sigma > 1$.

In the Lancaster case, the elasticity $\varepsilon_{\phi,p}(p, n)$ is the price elasticity of the market width. Helpman (1981) has shown that it is negative if evaluated at a symmetric equilibrium. This is sufficient to establish that $\sigma > 1$ holds in the ideal variety approach as well. Additionally, Helpman and Krugman (1985) have shown that if consumers spend a given fraction of their income on the differentiated good (Cobb-Douglas case) $\varepsilon_{\phi,p}$ is a function of the total number of available varieties n only, i.e. $\varepsilon_{\phi,p} = \varepsilon_{\phi,p}(n)$. Therefore, $\sigma(n) = -\varepsilon_{\phi,p}(n) + 1$. We follow Helpman (1981) and Helpman and Krugman (1985) and assume that the price elasticity of demand increases in the Lancaster case if the number of available varieties rises, i.e. $\sigma'(n) > 0$.

Combining both approaches we can establish that $\sigma(n) > 1$ and that $\sigma'(n) \geq 0$, where $\sigma' = 0$ in the love of variety approach and $\sigma'(n) > 0$ in the ideal variety approach.

4. Market Equilibrium

In a monopolistically competitive market, firms set their prices so as to maximize their profits subject to the demand conditions as specified in (8) and production costs as described in lemma 1:

$$\max_{p}\{pX(p) - C[X(p)]\}. \tag{11}$$

Maximizing (11) requires that firms equate marginal revenue to marginal costs:

$$p\left(1 - \frac{1}{\sigma}\right) = C'(X). \tag{12}$$

As $\sigma > 1$, (12) implies that $p > C'(X)$.

In a free entry equilibrium firms will enter (or exit) until no firm makes any profits. This zero profit condition implies

$$p = \frac{C(X)}{X}. \tag{13}$$

Combining (12) and (13) provides the well-known free entry profit-maximizing equilibrium condition

$$\left(1 - \frac{1}{\sigma}\right) = \frac{C'(X)X}{C(X)}. \tag{14}$$

The left-hand side of (14) indicates in how far firms can set their prices above marginal costs. This can be interpreted as a measure of a firm's market power. Define

$R = p/C'(X) = (1-\sigma^{-1})^{-1}$, so that R increases as a firm's market power rises. As R is strictly decreasing in σ, and σ is non-decreasing in n, R must be non-increasing in n, i.e. $R = R(n)$, with $R'(n) \leq 0$.

The right hand side of (14) relates a firm's average costs to its marginal costs. The lower is this ration, the steeper fall average costs as output increases. This can be interpreted as a measure of the economies of scale of production. Again, define this measure as $\theta = C(C'X)^{-1}$, so that θ is an increasing function of the economies of scale. The change of θ with respect to the level of output depends on the functional form of the cost function. If marginal costs are non-decreasing in X (a standard assumption in much of the literature on monopolistic competition), θ is clearly a strictly decreasing function of output because average costs fall as output increases. In lemma 1, however, we have established that the cost function is concave, so that marginal costs are actually decreasing in X. Therefore, $\theta(X)$ can be either decreasing, constant, or increasing in X, depending on the concavity of $C(X)$. We will return to this shortly.

In equilibrium, a firm's market power equals its economies of scale. We can rewrite the first order condition as

$$R(n) = \theta(X). \tag{15}$$

Since there are no profits in equilibrium, market clearing implies that total expenditures on the differentiated good must equal total production costs:

$$nC(X) = E. \tag{16}$$

Equations (15) and (16) simultaneously determine the equilibrium output per firm (variety) X and the number of firms (varieties) n. The product price p of X is then determined by (13), and total industry output is given by nX.

We have yet to verify that the equilibrium determined by (15) and (16) is indeed a profit maximizing equilibrium. The second order condition of the profit maximization program is given by (see appendix)

$$-\frac{nC'(X)}{C(X)}R'(n) > \theta'(X). \tag{17}$$

It turns out that the second order condition is non-trivial. In fact, if $\theta' > 0$, (17) establishes an upper boundary to the increase in the economies of scale. If θ' exceeds this boundary, the equilibrium becomes unstable. However, contrary to some statements in the literature [e.g., Lancaster (1980, note 4): "It is not surprising that economies of scale which themselves increase with scale will cause destabilizing problems."], (17) also shows that $\theta' > 0$ is indeed consistent with a stable equilibrium if $R' < 0$ (Lancaster case). If $R' = 0$, (17) requires $\theta' < 0$.

5. The Impact of Market Integration

International market integration leads to an increase in the size of the market and, provided that international demand structures are identical, raises the overall sales of an industry. In our specific model, let an increase in the size of the market be denoted by an increase in expenditures E, i.e. $dE > 0$.

The impact of market integration on the number of firms (varieties) and on output per firm (variety) is given by

$$\frac{dn}{dE} = \frac{1}{\Delta}\theta', \tag{18}$$

$$\frac{dX}{dE} = \frac{1}{\Delta}R', \tag{19}$$

where $\Delta = nC'R' + C\theta' < 0$ (second order condition).

It is immediately obvious that the impact of market integration depends crucially on the signs of both θ' and R'. We have already established above that $R(n)$ is non-increasing in n, i.e. $R' \leq 0$. It is now time to take a closer look at θ'. It is given by (see appendix):

$$\theta' = \frac{\theta}{X}\left(\theta^{-1} - 1 - \gamma\right), \tag{20}$$

where γ denotes the elasticity of marginal costs with respect to output [see (7)].

The sign of θ' depends on the sign of the term in the parentheses. As $\theta > 1$, $\theta^{-1} - 1 < 0$. Thus, if marginal costs are non-decreasing, so that the cost curve is non-concave and $\gamma \geq 0$, the sign of θ' is clearly negative. This is the case in most of the literature on monopolistic competition. However, if the cost curve is concave, as established in lemma 1, $\gamma < 0$ and the sign of θ' is ambiguous. It depends on the absolute value of the elasticity of marginal costs with respect to output γ, and thus on the shape of the R&D production function. The ambiguity of θ' can be traced back to two countervailing effects. The first effect $(\theta^{-1} - 1)$ arises from the fact that average costs fall as output increases. A decrease of average costs has a negative impact on θ $(\theta^{-1} - 1 < 0)$. The second effect stems from the endogeneity of R&D and from its impact on marginal costs. As output expands, firms spend more money on R&D in order to reduce marginal costs. This reduction in marginal costs has a positive impact on θ $(-\gamma > 0)$.

Depending on the possible specifications of θ' and R', we can differentiate between four cases:

1. $R' = 0$ *and* $\theta' < 0$ *: The Dixit-Norman/Krugman case:*

Dixit and Norman (1980) as well as Krugman (1980) presented a model of monopolistic competition based on the Dixit-Stiglitz love of variety approach $(R' = 0)$ where increasing returns emanate from an exogenously given fixed costs and some constant marginal costs $(\theta' < 0)$. Given these specifications, the impact of market integration on the equilibrium number of firms and output per firm can easily be replicated using (18) and (19) above: The equilibrium number of firms and varieties increases $(dn/dE > 0)$ whereas firm size (output per firm) remains unaffected $(dX/dE = 0)$.

2. $R' < 0$ *and* $\theta' < 0$*: The Helpman-Krugman case:*

In Helpman (1981) and Helpman and Krugman (1985), the authors use Lancaster's ideal variety approach, thereby endogenizing a firm's market power $(R' < 0)$. The assumptions about technology are the same as in the previous case $(\theta' < 0)$. Accordingly, the number of firms rises $(dn/dE > 0)$ and output per firm increases $(dX/dE > 0)$, too.

3. $R' < 0$ *and* $\theta' = 0$*: The Dasgupta-Stiglitz case:*

Even though Dasgupta and Stiglitz (1980) use a slightly different framework (homogenous goods, Cournot competition), their results can be replicated in our model as well. In order to explore interdependencies between an industry's market structure and the amount of innovative activities by its firms, they study an oligopolistic industry where R&D is determined endogenously (see section 2). However, for much of their analysis they use a very special R&D function, so that the measure of the economies of scale (θ) is exogenously fixed (see appendix). As $R' < 0$ holds in their model as well (a single firm's market power depends negatively on the number of firms in the industry), output per firm increases with the market size $(dX/dE > 0)$, whereas the number of firms is exogenously fixed $(dn/dE = 0)$.

4. $R' < 0$ *and* $0 < \theta' < -nC'C^{-1}R'$*: The Concentration case:*

This case is most interesting for our analysis. If $R' < 0$ and the absolute value of γ is large enough so that $\theta' > 0$ (but not too large to violate the second order condition), an increase in the size of the market leads to a large increase in the output per firm $(dX/dE > 0)$ and the equilibrium number of firms actually *decreases* $(dn/dE < 0)$. In this case, market concentration rises.

[Figure 3]

The results of the four cases can be illustrated graphically in an X-n diagram (see figure 3). Here, the product market clearing condition (16) is plotted as a downward sloping demand curve D. It indicates that for a given market size E demand per variety X increases as the number of available varieties falls. Total differentiation of (16) yields

$$\frac{dn}{dX} = -\frac{nC'}{C} < 0 . \tag{21}$$

The slope of the curve representing equilibrium condition (15) depends on the specifications of the model. It is given by

$$\frac{dn}{dX} = \frac{\theta'}{R'} . \tag{22}$$

It is obvious that the slope of (22) depends on the concrete values of θ' and R'. In the Dixit-Norman/Krugman (DNK) case, where $R' = 0$ and $\theta' < 0$, the slope is $dn/dX = \infty$. In the Helpman-Krugman (HK) case, where $R' < 0$ and $\theta' < 0$, the slope is $dn/dX > 0$. In the Dasgupta-Stiglitz (DS) case, where $R' < 0$ and $\theta' = 0$, the slope is $dn/dX = 0$. And finally, in the Concentration (C) case, where $R' < 0$ and $\theta' > 0$, the slope is negative $(dn/dX < 0)$. Theoretically, the slope of (22) could also be negative and steeper than (21), but this would mean that $-nC'C^{-1} > \theta'/R'$. In this case, the equilibrium would be unstable (violation of second order condition), as is illustrated in figures 4a and 4b.

[Figures 4a and 4b]

What are the economic mechanisms behind these results? We have already established that the impact of an increase in the market size on the economies of scale depends on two countervailing effects, one of which is determined by the R&D technology. But why is the impact on the returns of scale so important in the first place? The mathematical solution (18) and the four cases above suggest a very simple relationship: If returns to scale rise (fall) as output increases, the number of firms decreases (increases).

The link between the economies of scale and the market structure stems from the fact that firms have to raise their prices above marginal costs in order to cover their fixed costs. How much they have to raise their prices to break even depends on the ratio of fixed costs to total costs. However, the extent to which firms can raise their prices is limited by their market power. So if the ratio of fixed costs to total costs increases as a consequence of a market expansion, but their market power does not, firms will not be able to cover their additional fixed costs. They will make losses, and some firms will exit. The reduction in the number of active firms increases the market power of the remaining firms, so that they can raise their prices to cover their additional fixed costs.

An increase in the ratio of fixed costs to total costs is also associated with an increase in the economies of scale. As $C = F + C'X$, θ can be shown to be a function of this ratio:

$$\theta = \frac{C}{C'X} = \frac{C}{C - F} = \left(1 - \frac{F}{C}\right)^{-1}. \tag{23}$$

Therefore, an increase in the ratio of fixed costs to total costs increases a firm's returns to scale while, at the same time, reduces the number of profitable firms in the market. Thus, the change of this ratio is a crucial parameter for the impact of market integration on market concentration. Clearly, if fixed costs are exogenously given and constant, an increase in output always leads to a decrease in the ratio of F/C. But if fixed costs increase as output expands, this ratio can actually increase, giving rise to both increasing economies to scale as well as to increasing market concentration.

We should keep in mind that fixed costs arise from expenditures on R&D. Therefore, the ratio of fixed costs to total costs can be interpreted as a measure of an industry's R&D intensity. An increase in this ratio is then associated with an increase in the R&D intensity. Whether an industry's R&D intensity decreases or increases depends on its production function of R&D. Thus, the question of whether market integration leads to higher market concentration must ultimately be traceable to features of the R&D production function. From (1), (3) and (23) we obtain:

$$\theta = 1 - c'(F)\frac{F}{c(F)} = 1 + \varepsilon_{c,F} \,. \tag{24}$$

where $\varepsilon_{c,F} = -c'(F)\frac{F}{c(F)}$ is the elasticity of marginal costs c with respect to fixed costs F, i.e. with respect to R&D. According to (24), θ increases if the elasticity of c with respect to F increases. In economic terms, this means that θ' is larger than zero if the returns to scale in R&D are in themselves increasing.

We can summarize our results in proposition 1:

Proposition 1: *(i) Market integration can lead to an increase in market concentration if it leads to an increase in an industry's R&D intensity. (ii) An industry's R&D intensity will rise if the returns to scale in R&D are in themselves increasing.*

Proposition 1 underlines our earlier assessment of the Dasgupta-Stiglitz case (see appendix). In much of their analysis, the authors use the functional form $c(F) = \beta F^{-\alpha}$ for the R&D production function. Therefore, $\varepsilon_{c,F} = \alpha$ and thus $\theta = 1 + \alpha$. As long as α is exogenously given, θ is also exogenously given. An example for a simple R&D function leading to the concentration case is $c(F) = (\alpha + F)^{-1}$. In this case, $\varepsilon_{c,F} = \frac{F}{\alpha + F}$, which is increasing in F. This example also illustrates that it is not important whether returns to scale in R&D are increasing, constant, or decreasing. It is the change in this elasticity, not its value that determines whether concentration rises or falls.

Finally, it should be pointed out that the impact of market integration on the optimal firm size also depends on θ'. Figure 3 illustrates that the increase in firm size depends on the slope of (22). The lower is the slope of (22), the larger is the increase in firms size. This can be confirmed mathematically by differentiating (19) with respect to θ':

$$\frac{d^2X}{dEd\theta'} = -\frac{R'C}{\Delta^2} > 0. \tag{25}$$

Thus, the impact of market integration on the size of firms also depends on the development of the cost structure of firms. Even though the sign is independent of the cost structure (firm size always increases as long as $R' < 0$), the scope of the increase is the larger, the more (less) the R&D intensity of firms increases (decreases).

6. Implications for the Welfare Effects of Market Integration

The results derived above have serious implications for the welfare effects of market integration. Helpman and Krugman (1985) have shown that the welfare effects of market integration depend both on the change in output per firm as well as on the change in the number of firms. They depend on output per firm because with economies of scale average costs - and thus prices - fall with output per firm. If output per firm rises, firms go down their average cost curves and prices fall. This increases welfare because it increases the efficiency of production and raises consumers' real income. Welfare also increases with an increase in the number of varieties offered. The reason depends on the approach. In the Dixit-Stiglitz case consumers value variety itself, so that an increase in variety increases the utility of all consumers. In the Lancaster case, where consumers possess the perception of an ideal variety, an increase in variety leads to an increase in average consumer utility. More consumers can find their ideal varieties and the remaining consumers can find varieties with specifications closer to their most preferred specification.

Based on that, Helpman and Krugman (1985) have stated that the welfare effects of market integration are non-negative if the number of varieties and output per firm are both non-decreasing. As was shown above, both the number and the size of firms increases in the Helpman-Krugman case, so that they found that market integration is clearly welfare increasing.

This is different in the concentration case. We showed that under certain specifications, market concentration can actually increase as the size of the market expands. In this case, the welfare effects are not unambiguously positive. In fact, they depend on the concrete specifications of the welfare function. We have two countervailing effects. In the concentration case, the size of firms still increases. This raises welfare. But the number of varieties declines, thereby reducing welfare. As the concentration case can only occur under the ideal variety approach, the welfare effects depend on how much disutility consumers get from purchasing a product that is slightly different from their ideal variety. It should be pointed out that average costs - and thus prices - fall most in the concentration case, so that consumers get some compensation for the loss of variety in terms of a higher real income, but the general trade-off nevertheless persists.

7. Implications for the Theory of Multinational Enterprises

Firms can either penetrate foreign markets via exporting or via foreign investment. If exports to foreign markets are subject to considerable transport costs, firms may decide to penetrate those markets by setting up a production plant within the market to serve customers locally from this unit. This is known in the literature as the proximity-concentration trade-off approach to multinational enterprises (Krugman, 1983; Horstman and Markusen, 1992, Brainard, 1993, 1997). Firms have to choose between either incurring some fixed set-up costs of a foreign production facility (plant-level fixed costs) in order to avoid transport costs and gain proximity to the customer, or they have to carry the transport costs, if they want to take advantage of economies of scale at the plant level by concentrating production at one site. The advantage of this theory is that it provides an explanation for the existence of multinational enterprises between identical economies: if the foreign market is large enough, companies penetrate those markets via foreign investment to save on variable costs.

Horstman and Markusen (1992) as well as Brainard (1993, 1997) have stressed that under these assumptions multinational enterprises are more likely to penetrate foreign markets via multinational investment if transport costs are high, if the foreign market is large, if plant-level fixed costs are low, and if corporate-level fixed costs are high. The fact that corporate-level fixed costs play a role in determining the type of market penetration is surprising at first because they do not affect production costs of either alternative directly. But corporate-level fixed costs limit the total number of firms that the market supports and, by doing so, affect the equilibrium size of firms. The higher these fixed costs, the larger firms have to be in order to break even. And larger firms are more likely to be multinational firms as the importance of plant-level fixed costs decreases with size.

Fixed costs associated with R&D are usually thought of as corporate-level fixed costs. Results of in house R&D can easily be applied to more than just one production site without significant costs. So our results above suggest that corporate-level fixed costs are not exogenously given but are rather determined by the size of the market. Therefore, our results should have some implications on firms' decisions of how to penetrate foreign markets.

First of all, if costs for R&D are corporate-level fixed costs, they depend on corporate-level output, and not just on plant-level output. According to our results above, these fixed costs should increase with the level of corporate output. It is not important whether the increase in corporate output is due to an increase in foreign production or in domestic production. Therefore, our results suggest a certain impact of the size of a firm's home market on the decision of how to penetrate foreign markets: The larger the home market, the higher will be corporate-level fixed costs, and, according to the proximity-concentration trade-off, the more likely firms are going to penetrate foreign markets via foreign investment. This finding extends Brainard (1993, 1997) who sees a market size effect only with respect to the destination market. It also extends Krugman's (1980) "home market" effect in international trade ("countries will tend to export the goods for which they have large domestic markets") to multinational enterprises: countries with large "home markets" will tend to have more multinational enterprises.

Finally, our results imply a certain relationship between market concentration and the appearance of multinational enterprises. We showed above that firm output increases most in the concentration case. And according to the proximity-concentration trade-off, large firms are more likely to be multinational firms. Putting these two together suggests that an increase in market concentration should come hand in hand with more multinational production. However, it should be made clear that there is no direct causality from the appearance of multinational enterprises to an increase in concentration. The appearance of multinational enterprises and the change in market structure are both endogenous variables, determined by changes in the R&D intensity of firms.

8. Conclusions

The findings presented in this paper are important in three respects: they provide insights into the relationship between market size and market concentration in horizontally differentiated industries, they revise the welfare effects of international market integration, and they show how endogenous fixed costs influence a firm's decision to become multinational.

Concerning the relationship between market size and the number of firms we extend Sutton's work on endogenous fixed costs in vertically differentiated industries to the case of horizontal product differentiation. The general mechanism that leads to an increase in concentration depends on features of the cost function only. The advantage of our approach is that it can easily be imposed on a variety of models with imperfect competition. This makes it an important tool in a number of fields. We gave two examples for applications of this tool: the welfare analysis of international trade and the theory of multinational enterprises.

Our results suggest that the answer to the question of whether market integration increases or reduces concentration is "it depends". We illustrated that it depends on the concrete functional form of the R&D production function. These functional forms are most likely to differ between sectors. So, in reality, we should expect to see some sectors experience a rise in concentration whereas concentration in other sectors falls. In fact, it is most likely that all of the four cases described in Section 5 can be observed in one industry or the other. But we should distance ourselves from the perception that market integration must reduce concentration.

Appendix

Second Order Condition

Let the profits of a representative firm be given by $\pi = pX(p) - C[X(p)]$. The first order condition of maximizing π is derived from

$$\frac{d\pi}{dp} = p\frac{dX}{dp} + X - C'(X)\frac{dX}{dp} = p\frac{dX}{dp}\left(1 + \frac{X}{dX/dp}\frac{1}{p} - \frac{1}{p}C'(X)\right)$$

Using $1/p = X/C$, $R = \left(1-\sigma^{-1}\right)^{-1}$ and $\theta = C(C'X)^{-1}$, this reduces to

$$\frac{d\pi}{dp} = p\frac{dX}{dp}\left(R^{-1} - \theta^{-1}\right)$$

Clearly, $d\pi/dp = 0$ if $R = \theta$ (first order condition). The second derivative of the profit function is given by

$$\frac{d^2\pi}{dp^2} = \left(R^{-1} - \theta^{-1}\right)\left(p\frac{d^2X}{dp^2} + \frac{dX}{dp}\right) + p\frac{dX}{dp}\left(-R^{-2}R'\frac{dn}{dX}\frac{dX}{dp} + \theta^{-2}\theta'\frac{dX}{dp}\right)$$

As $R = \theta$ holds in equilibrium, the first term on the right hand side equals zero. Thus, the second derivative reduces to

$$\frac{d^2\pi}{dp^2} = p\left(\frac{dX}{dp}\right)^2 R^{-2}\left(-R'\frac{dn}{dX} + \theta'\right)$$

Any equilibrium is profit maximizing if the second derivative of the profit function, evaluated at the equilibrium, is negative. Thus, the second order condition for a maximum is fulfilled if

$$-R'\frac{dn}{dX}+\theta'<0$$

The term dn/dX can be derived from $nC(X)=E$. Thus, $dn/dX=-nC'C^{-1}$, and the second order condition becomes

$$-\frac{nC'}{C}R'>\theta'$$

Q.E.D.

The derivative of θ

As $\theta=C(C'X)^{-1}$ the first derivative is

$$\theta'=\frac{C'C'X-C(C''X+C')}{(C'X)^2}=\frac{C'C'X-CC''X-CC'}{(C'X)^2}=\frac{CC'}{(C'X)^2}\left(\frac{C'X}{C}-1-C''\frac{X}{C'}\right)$$

Now substituting $\theta=C(C'X)^{-1}$ and $\gamma=C''XC'^{-1}$, we obtain

$$\theta'=\frac{\theta}{X}\left(\theta^{-1}-1-\gamma\right)$$

Q.E.D.

The determination of θ in Dasgupta and Stiglitz (1980)

Dasgupta and Stiglitz use the following R&D production function (see equation (9) in Dasgupta and Stiglitz, 1980, p. 273):

$$c(F) = \beta F^{-\alpha}$$

where α, β>0.

The corresponding cost function is given by

$$C = F + \beta F^{-\alpha} X$$

Cost minimizing R&D expenditures are then given by

$$F^{*} = (\alpha\beta X)^{\frac{1}{1+\alpha}}$$

It follows that the optimal cost structure is given by

$$\frac{C}{F} = 1 + \beta F^{-(1+\alpha)} X = 1 + \beta(\alpha\beta X)^{-1} X = \frac{\alpha + 1}{\alpha}$$

As $\theta = \left(1 - \frac{F}{C}\right)^{-1}$, this can be transformed into

$$\theta = \left(1 - \frac{F}{C}\right)^{-1} = 1 + \alpha$$

It is now obvious that θ is exogenously given (θ' is zero) as α is an exogenous variable.

Q.E.D.

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Figures

Figure 1:

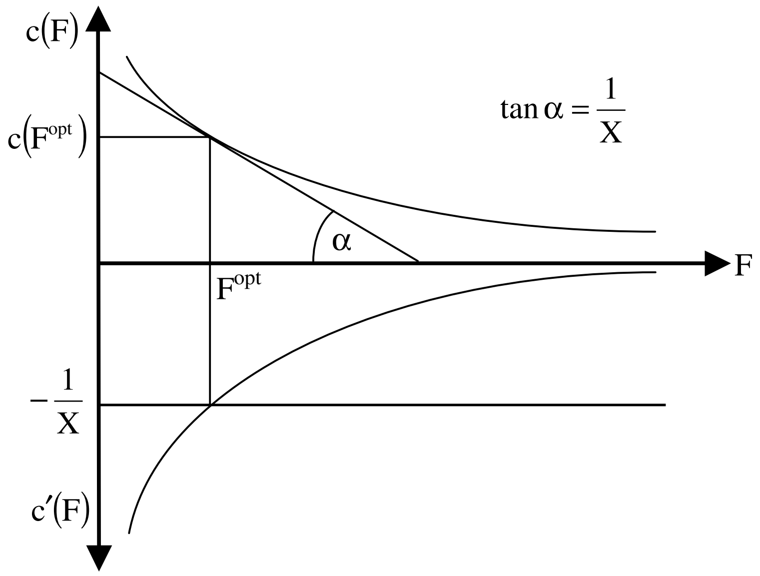
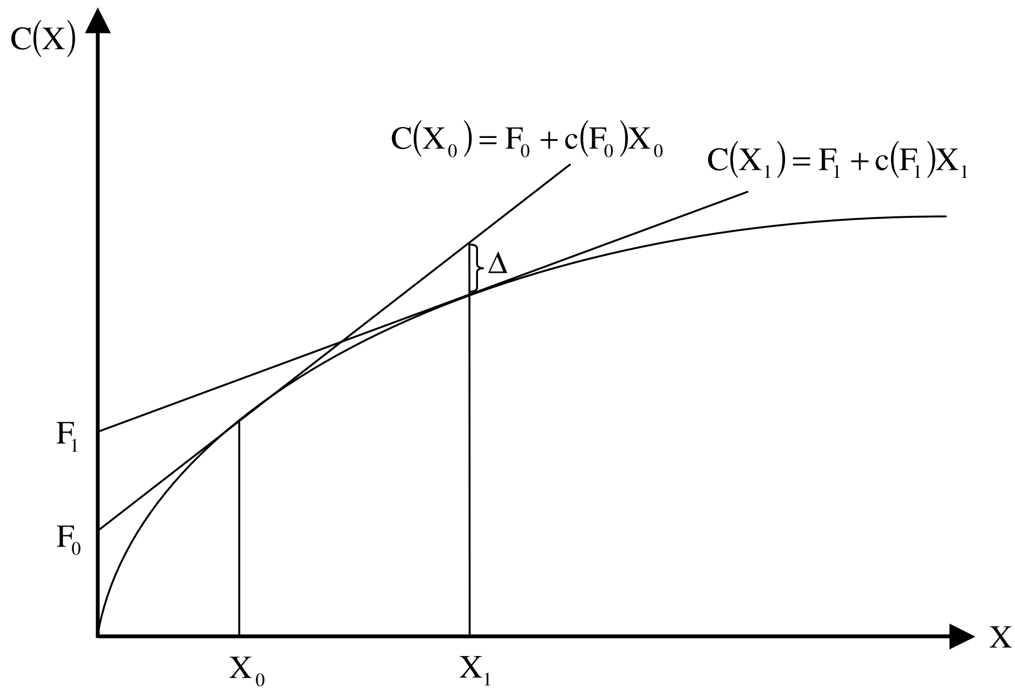


Figure 2:



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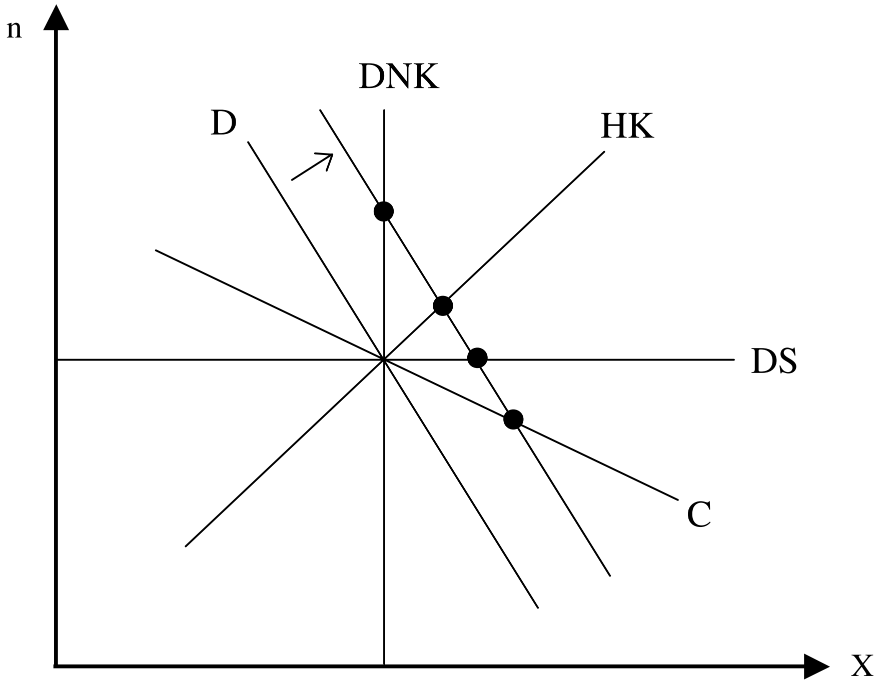
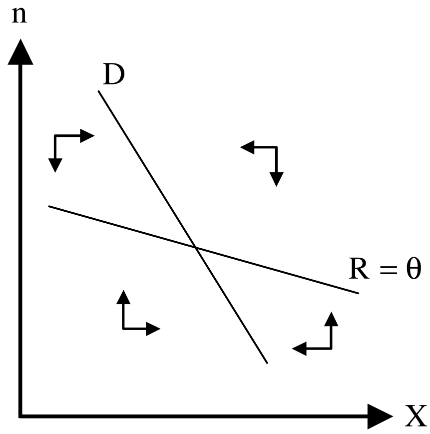
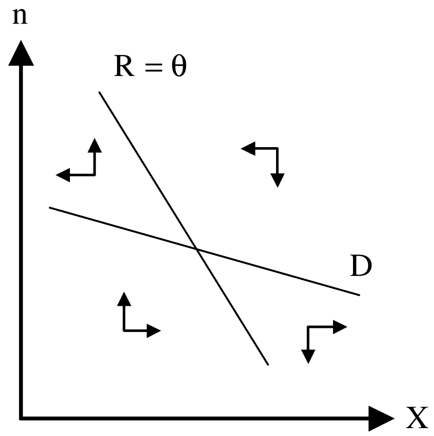


Figures 4a and 4b:



stable equilibrium



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