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A THEORY OF NATURAL MARKET STRUCTURES: REGULATION, R&D, FDI, INTERNATIONAL TRADE AND A FEW CURIOSITIES

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Abstract

The theories of natural market structures have been well known in economics for a long time. In this paper, a framework for such natural market structures is developed, where natural monopoly, natural oligopoly, perfect competition and monopolistic competition are special cases. The paper explains why with increasing returns to scale at the level of the firm; a given market size; a continuum of firms; complete information and homogeneous goods, there is usually a margin for regulation –most notably when the number of firms in the market is low. The paper shows that R&D, FDI and trade liberalization can improve welfare, and that they can be complements or imperfect substitutes to the need for market regulation. It is argued that when markets are expected to grow, or technologies to change, avoiding policies that prevent entry of firms –such as licences- can reduce significantly the need for regulation while allowing for a more efficient allocation of resources. It is also argued that the need for market regulation can be better explained by the exploitation of economies of scale, than by the existence of economic rents. Finally, the paper shows that when there is a discrete number of firms, the level of profits and the regulatory margins, can be described by a "saw".

Key Words: Economies of Scale, Natural Monopoly, Natural Oligopoly, Monopolistic Competition, Regulation, International Trade, Profit Saw, Regulation Saw.

JEL Classification: L10, L50, F10, F20.

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UNA TEORÍA SOBRE ESTRUCTURAS DE MERCADOS NATURALES: REGULACIÓN, I&D, IED, COMERCIO INTERNACIONAL Y ALGUNAS CURIOSIDADES

Resumen

Las teorías sobre estructuras de mercados naturales han sido conocidas en economía desde hace bastante tiempo. En este documento se desarrolla un marco general para tales estructuras de mercados naturales, donde monopolio natural, oligopolio natural, competencia perfecta y competencia monopolística son casos especiales. El documento explica por qué con rendimientos crecientes a escala al nivel de la firma; un tamaño de mercado dado; un número continuo de firmas; información completa y un producto homogéneo, usualmente hay un margen para la regulación –más notablemente cuando el número de firmas en el mercado es bajo. El documento muestra que la I&D, la IED y el comercio internacional pueden mejorar el bienestar, y que pueden ser complementos o sustitutos imperfectos a la necesidad de regular el mercado. Se argumenta que cuando se espera que los mercados crezcan, o que cambien las tecnologías, evitar políticas que impiden la entrada de otras firmas –como las licencias- puede reducir significativamente la necesidad de regular y permitir a la vez una asignación más eficiente de recursos. También se argumenta que la necesidad de regular el mercado puede ser explicada mejor por la explotación de economías de escala, que por la existencia de rentas económicas. Finalmente, el documento muestra que cuando hay un número discreto de firmas, el nivel de ganancias y los márgenes regulatorios, pueden ser descritos por una “sierra”.

Palabras clave: Economías de escala, monopolio natural, oligopolio natural, competencia monopolística, regulación, comercio internacional, sierra de ganancias, sierra de regulación.

Clasificación JEL: L10, L50, F10, F20.

I. INTRODUCTION

The theories of natural market structures have been well known in economics for a long time. In this paper, a framework for such natural market structures is developed, where natural monopoly, natural oligopoly, perfect competition and monopolistic competition are special cases. The paper explains why with increasing returns to scale at the level of the firm; a given market size; a continuum of firms; complete information and homogeneous goods, there is usually a margin for regulation –most notably when the number of firms in the market is low.

The paper shows that research and development (R&D), foreign direct investment (FDI) and trade liberalization can improve welfare, and that they can be complements or imperfect substitutes to the need for market regulation. It is argued that when markets are expected to grow, or technologies to change, avoiding policies that prevent entry of firms –such as licences- can reduce significantly the need for regulation while allowing for a more efficient allocation of resources. It is also argued that the need for market regulation may be better explained by the exploitation of economies of scale, than by the existence of economic rents. Finally, the paper shows that when there is a discrete number of firms, the level of profits and the regulatory margins, can be described by a “saw”.

This research builds on the theoretical framework of Sutton (1991), in order to develop a simple but general model for analysing a wide range of natural market structures. The model also gives insights into the role of regulation, trade, foreign investment and R&D policies, and some of their interactions.

The content is organized as follows: the next section reviews the previous literature; then the basic theoretical framework is spelled out, followed by three sections that look at the role of regulation; R&D and FDI; and international trade in goods and services and international migration. The paper ends with some conclusions.

II. PREVIOUS LITERATURE

The theory of natural monopoly has been well known in economics for a long time. According to Berg and Tschirahart (1988), early investigations of natural monopoly include Farrer (1902), Clark (1923, 1939) and Glaeser (1927). More recent literature on natural monopoly and its regulation include Demsetz (1968), Kahn (1971), Baumol (1977), and Sharkey (1982).

As pointed out by Hotelling (1938) and Dupuit (1952), the first best natural monopoly equilibrium is generated when price is set equal to marginal cost, and the monopolist is reimbursed –for example by the government- its fixed costs. However, such a solution is not always fiscally and politically viable, and thus, as Braeutigam (1989) has pointed out, setting prices equal to average costs is a second best solution to the regulation of natural monopolies. Mankiw (2001) has explained that in practice regulators tend to fix prices above average costs in order to promote cost reductions[2].

The theory of natural oligopoly (oligopoly with free entry and exit of firms) has been developed by authors such as Seade (1980), Frank (1965), Ruffin (1971) and Novshek (1980). Perry (1984) has shown within oligopoly, that regulation with average cost pricing and a single producer can be an optimal policy when there are economies of scale in the relevant range of production.

Perfect competition has been a benchmark market structure, at least for neoclassical economics. Its development includes –not without controversy- contributions from many authors, including classical economists; marginalist economists such as Jevons (1871), Menger (1871), Cournot (1838), and Walras (1874); and Marshall (1920).

With regard to monopolistic competition, which is also natural in the sense that there is free entry and exit of firms, first contributions are attributed to Chamberlin (1937 and 1956), with a more recent wave of contributions headed by Dixit and Stiglitz (1977).

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[2] Setting price equal to average costs would also induce cost reductions if the price set is fixed for a sufficiently long period of time.

In terms of models that attempt to cover several market structures, two references that are relevant for the purpose at hand are Sutton (1991) and von Weizsacker (1980). Sutton develops a two stage game model with increasing returns to scale and an isoelastic demand curve and finds that larger markets lead to a greater number of firms at equilibrium. Von Weizacker develops a model with “U” shaped average cost curves and concludes that with such costs, the endogenous number of firms may be greater than the welfare maximizing number of firms.

III. BASIC THEORETICAL FRAMEWORK

The market structure assumed in this paper is one with a homogeneous good. In order to concentrate on the main insights, the framework used in this paper is simplified as much as possible. With that in mind, the paper uses a linear market demand as follows:

$$p = a - bQ$$

$$Q = \sum_{i=1}^{n} q_i$$

The paper also assumes that all firms operating in the market have identical cost structures with increasing returns to scale at the level of the firm, as follows:

$$TC_i = c + dq_i$$

The model generates natural market structures in the sense that the number of firms in the market is determined endogenously by the level of the fixed costs and the size of the market. It is assumed that there are no other entry barriers established by the government or by the incumbents, and that technological and resource constraints are embedded in the cost structures of the firm. It is also assumed to begin with, that when there is scope for strategic interactions, the existing firms compete in quantities as in Cournot.

A. Short Run Equilibrium: Profit Maximization

In this model, firms are assumed to maximize profits in the short -and in the long- run. The Cournot profit maximization condition will be:

$$
\begin{aligned}
&p = a - b(q_1 + q_2 + ... + q_n) \\
&\Pi_1 = [a - b(q_1 + q_2 + ... + q_n)]q_1 - c - dq_1 \\
&\frac{\partial \Pi_1}{\partial q_1} = [a - b(q_2 + ... + q_n)] - 2bq_1 - d \\
&\text{F.O.C.:} \quad 2bq_1 = [a - b(q_2 + ... + q_n)] - d \\
&q_1 = \frac{[a - b(q_2 + q_3 + ... + q_n)] - d}{2b}
\end{aligned}
$$

Equally for the other *n* firms:

$$
\begin{aligned}
&q_2 = \frac{[a - b(q_1 + q_3 + ... + q_n)] - d}{2b} \\
&\vdots \\
&q_n = \frac{[a - b(q_1 + q_2 + ... + q_{n-1})] - d}{2b}
\end{aligned}
$$

Summing across all *n* firms:

$$
\begin{aligned}
&Q = \sum_{i=1}^{n} q_i \qquad \forall \text{ i} \\
&Q = \frac{an - b(n-1)(q_1 + q_2 + ... + q_n) - nd}{2b} \\
&Q = \frac{an - b(n-1)Q - nd}{2b}
\end{aligned}
$$

Thus, the total Cournot quantities provided in the market as a function of the number of firms will be:

$$Q = \frac{(a-d)n}{(1+n)b} \tag{1}$$

And the output per firm will be:

$$qi = \frac{(a-d)}{(1+n)b}$$

The market price as a function of the number of firms will be:

$$p = a - b\left[\frac{(a-d)n}{(1+n)b}\right]$$

$$p = \frac{a+nd}{1+n} \tag{2}$$

B Long Run Equilibrium: Zero Profit Condition

The level of production in which price equals average cost for a profit maximizing firm is:

$$p = \frac{a+nd}{1+n} = \frac{c}{q} + d$$

$$q_{\Pi=0} = \frac{c(1+n)}{a-d}$$

The number of firms that will be able to operate in the market with zero profits will be:

$$qi = q_{\Pi=0}$$

$$\frac{(a-d)}{(1+n)b} = \frac{c(1+n)}{a-d}$$

$$n^* = \frac{(a-d)}{\sqrt{cb}} - 1$$

For the market not to collapse, the following condition must be met with a continuum of firms.

$$n^* > 0$$

$$a - d > \sqrt{cb}$$

Note that for *n* to be greater or equal to 1, the condition required is:

$$n^* \geq 1$$

$$a - d \geq 2\sqrt{cb}$$

Summarizing, natural imperfect competition equilibrium prices, quantities and the number of firms can be expressed in terms of the parameters as:

$$n^* = \frac{(a-d)}{\sqrt{cb}} - 1 \tag{3}$$

$$Q = \frac{a - d - \sqrt{cb}}{b} \tag{4}$$

$$q_i = \sqrt{\frac{c}{b}} \tag{5}$$

$$p = d + \sqrt{cb} \tag{6}$$

This means that in the long run equilibrium, the number of firms and the total quantities produced will increase –and the price will decrease- the larger is the demand (greater *a* and/or lower *b*) and the lower are the cost structures (lower *c* and/or lower *d*), and vice versa.

Note that in this context with identical cost structures and free entry and exit, a Cartel is not a long run equilibrium, since new firms would enter the market. As the Cartel breaks, the final equilibrium will depend on whether the firms compete in quantities as in Cournot, or in prices as in Bertrand. The Bertrand equilibrium would lead to only one firm operating and setting price equal to average cost, since any other configuration would not be a Nash Equilibrium in prices.

Note also that if the fixed costs *c* are zero, the equilibrium price will be equal to the marginal cost, and the number of firms will tend to infinity, replicating the perfect equilibrium model.

Finally, product differentiation can be introduced by simply assuming that each firm produces a differentiated good or service. The model fits accurately in the monopolistic competition framework given that it already has embedded the profit maximization and the zero profit conditions.

Table 1 shows different market structures as a special case of this generalized equilibrium.

Table 1

Natural Market Structures as a Special Case of the Model's Equilibrium

	Number of Firms	Product	Price	Quantity
Monopoly	1	Homogeneous	$\frac{a+d}{2}$	$\sqrt{\frac{c}{b}}$
Cournot Oligopoly	$\frac{(a-d)}{\sqrt{cb}}-1$	Homogeneous	$d+\sqrt{cb}$	$\frac{a-d-\sqrt{cb}}{b}$
Bertrand Oligopoly	1	Homogeneous	$\frac{a+d-\sqrt{(a-d)^2-4bc}}{2}$	$\frac{(a-d)+\sqrt{(a-d)^2-4bc}}{2b}$
Mon. Competition[3]	$\frac{(a-d)}{\sqrt{cb}}-1$	Differentiated	$d+\sqrt{cb}$	$\frac{a-d-\sqrt{cb}}{b}$
Perfect Competition[4]	Not defined	Homogeneous	d	$\frac{a-d}{b}$

3 Oligopoly with differentiated products can also be analysed using this same framework.

C Welfare Analysis

Given that firms have zero profits, and that all factors of production are paid their opportunity costs, welfare changes can be expressed in terms of changes in consumer surplus. These changes in consumer's surplus can be expressed as the difference between the final consumers' surplus, and the initial consumers' surplus. To do so, the demand in the initial period *0* can be written as

$$p_0 = a_0 - b_0 Q_0$$

and the demand in the final period *1* can be written as:

$$p_1 = a_1 - b_1 Q_1$$

With this notation, changes in welfare *W* can be written as:

$$\Delta W = \frac{[a_1 - p_1] * Q_1 - [a_0 - p_0] * Q_0}{2}$$

Replacing p_1 and p_0 from the corresponding demand equations, changes in welfare can be written as:

$$\Delta W = \frac{b_1 Q_1^2 - b_0 Q_0^2}{2}$$

Given that all quantities are non-negative, welfare will improve if

4 Perfect competition can be simulated in this model by considering the case where *c* tends to zero (no fixed costs).

$$\Delta Q > Q_0\left[\sqrt{\frac{b_0}{b_1}} - 1\right] \tag{7}$$

This means that if b remains unchanged, increases in equilibrium quantities are enough to guarantee increases in welfare. Thus, from equation (4), increases in the demand intercept a, and decreases in the fixed costs c and the marginal costs d, would lead to increases in welfare. Note also from equation (3), that these changes would also increase the equilibrium number of firms and with product differentiation and a taste for variety, this could reinforce even more the positive effects on welfare.

If *b* changes –holding everything else constant-, welfare will improve if

$$\frac{a - d - \sqrt{cb_1}}{b_1} > \frac{a - d - \sqrt{cb_0}}{b_0}\sqrt{\frac{b_0}{b_1}}$$

So the condition for welfare improvement will be

$$\frac{1}{\sqrt{b_1}} > \frac{1}{\sqrt{b_0}}$$

This means that welfare increases in this model when b decreases. Summarizing, welfare in this model increases (decreases) when a increases (decreases) and when b, c and d decrease (increase).

D. Efficiency Analysis

Consider how efficient is the allocation generated at the different market equilibriums. If there are no fixed costs, setting price equal to marginal cost will be a first best allocation, as is the case in the perfect competition scenario. As shown before, in this case

$$p_{FB} = d$$

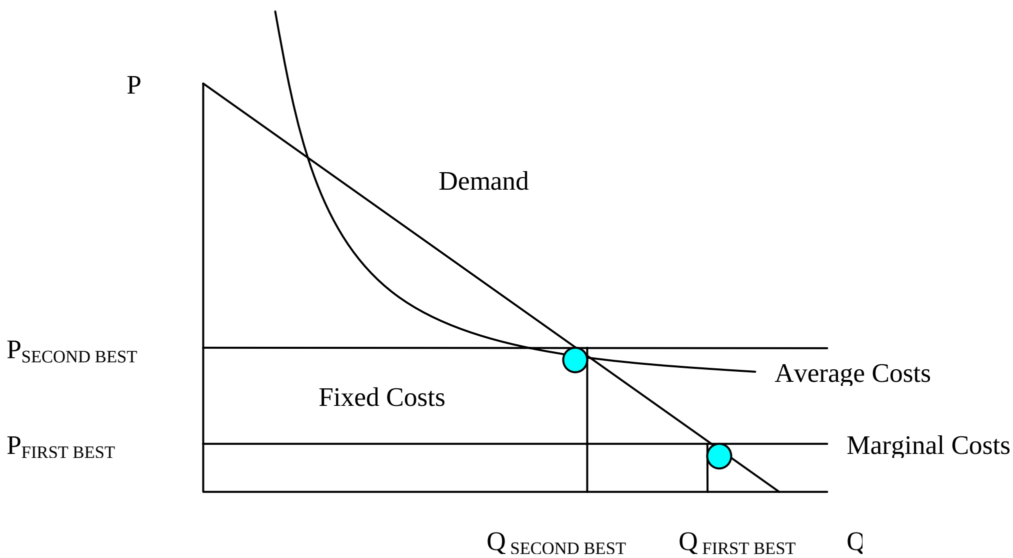
$$Q_{FB} = \frac{a-d}{b}$$

If there are fixed costs in the relevant range of production, then the first best allocation will also be the one obtained when price equals marginal costs, as pointed by Hotelling (1938) and Dupuit (1952). This case is shown in figure 1.

Figure 1

First and Second Best Allocations in the Model Developed

Taken from Braeutigam (1989) p. 1300



However, in this case firms will have loses, so the producers will have to be reimbursed their fixed costs if they are to produce at price equal to marginal cost. Such reimbursement may not be feasible because of fiscal and/or political reasons. So a second best allocation would be to fix price equal to average cost, as pointed out by Perry (1984) and Braeutigam (1989). In this case, the second best prices and quantities obtained would be:

$$a - bQ = \frac{c}{Q} + d$$

$$bQ^2 - (a-d)Q + c = 0$$

$$Q_{SB} = \frac{(a-d) \pm \sqrt{(a-d)^2 - 4bc}}{2b}$$

$$p_{SB} = \frac{a + d - \sqrt{(a-d)^2 - 4bc}}{2}$$

The second best quantities will be identical to the natural market structure quantities if $(a-d) = 2\sqrt{bc}$. But this is the case of natural monopoly. Else, the second best quantities will be higher than the quantities of the natural oligopoly equilibrium, even if all market structures yield zero economic rents[5]. Note also that monopoly with price equal to average cost is the Bertrand equilibrium, and this means that in this context, the Bertrand equilibrium is a second best equilibrium, since it is Pareto dominated by the price equal to marginal cost allocation.

IV. REGULATION

As noted above, a perfect competition market would not require any regulation at all, since prices would be set equal to the marginal costs. But with the existence of fixed costs, markets alone would not generate an efficient allocation, so there would be room for regulation. In order to make this clearer, define the regulatory margin *RM* as the natural market price shown in

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5

$$Q_{SB} = \frac{(a-d) + \sqrt{(a-d)^2 - 4bc}}{2b}$$

$$Q = \frac{(a-d) - \sqrt{bc}}{b}$$

$$\frac{(a-d) + \sqrt{(a-d)^2 - 4bc}}{2b} \quad ? \quad \frac{(a-d) - \sqrt{bc}}{b}$$

$$4(a-d)\sqrt{bc} \quad ? \quad 8bc$$

$$(a-d) \quad \geq \quad 2\sqrt{bc}$$

$$Q_{SB} \geq Q$$

equation (6) minus the price desired by the regulator. The price desired by the regulator may be –for example- the first best price –equal to marginal cost- or the second best price –equal to average cost-, depending on the constraints that it faces.

A. Analysis with a Continuum of Firms

The analysis of regulation with a continuum of firms will be divided between first best and second best pricing.

1. Regulation with First Best Pricing

If the regulator is able to set the price equal to the marginal cost, the regulatory margin with first best pricing *RMFB* could be described as:

$$RMFB = d + \sqrt{cb} - d$$
$$RMFB = \sqrt{cb} \quad (8)$$

This means the regulatory margin with first best pricing will be higher the higher are the fixed costs and the higher is the demand slope, and will be zero if the fixed cost is zero (c = 0), or if the price is given (b = 0). This also means that the regulatory margin does not depend on the marginal cost d and the demand intercept a. The regulatory margin with first best pricing as a share of the first best price *RMFB** can be written as:

$$RMFB^* = \frac{\sqrt{cb}}{d} \quad (9)$$

Note that *RMFB** will tend to infinity when the marginal costs tend to zero. Note also that achieving the first best price would not only require subsidies. It would also reduce the number of firms to one if the level of subsidies is to be minimized. Thus, if there is monopolistic competition, achieving a first best equilibrium will be optimal only if the welfare gains ΔW

$$\Delta W = b\left[\frac{a-d}{b} - \frac{a-d-\sqrt{cb}}{b}\right]$$

$$\Delta W = \sqrt{cb}$$

more than compensate the welfare loss due to the loss of varieties, and the costs of regulation – including the resources used to regulate and the inefficiencies of the regulatory process.

2. Regulation with Second Best Pricing

The second best prices will be equal to average costs, so

$$p^* = \frac{a+d-\sqrt{(a-d)^2-4bc}}{2}$$

As before, these second best prices will be identical to the natural market equilibrium prices if $(a-d) = 2\sqrt{cb}$. But this is the case of natural monopoly. This means that there is no need to regulate a natural monopoly with second best pricing when there is a continuum of firms. If $(a-d) > 2\sqrt{cb}$, the second best prices will be lower than the prices of the natural market equilibrium, even if all market structures yield zero economic rents, so there will be room for regulation in this case.

Defining the regulatory margin with second best pricing *RMSB* as:

$$RMSB = \frac{d-a+2\sqrt{cb}+\sqrt{(a-d)^2-4bc}}{2} \qquad (10)$$

Note that *RMSB* will be equal to zero if there are no fixed costs (c = 0), of if the market price is given (b = 0).

Defining the regulatory margin with second best pricing as a percentage of the second best price *RMSB** as:

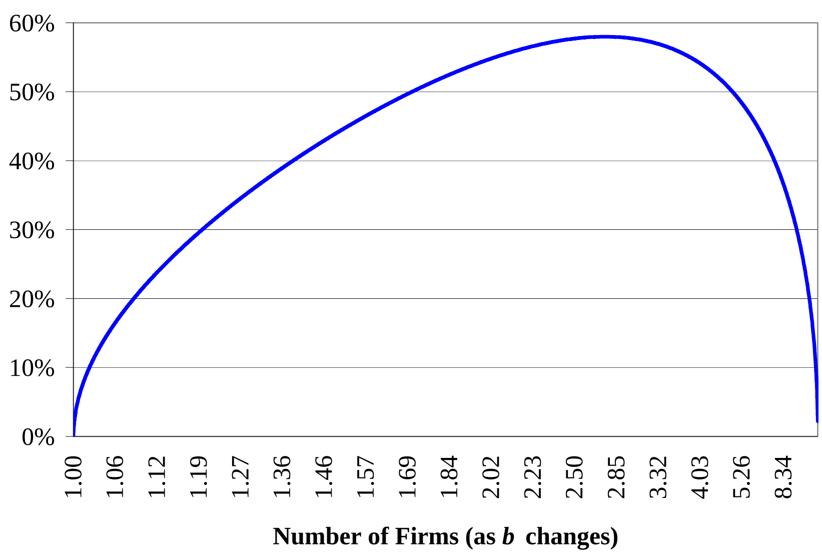
$$RMSB^* = \frac{p - p^*}{p^*} = \frac{d - a + 2\sqrt{cb} + \sqrt{(a-d)^2 - 4bc}}{a + d - \sqrt{(a-d)^2 - 4bc}} \qquad (11)$$

This expression is non-linear in the number of firms. If $n = 1$ (for example because $(a - d) = 2\sqrt{cb}$), $RMSB^* = 0$. If n tends to infinity (for example because c or b tend to zero) $RMSB^* = 0$. But if $1 < n < \infty$, $RMSB^* > 0$. Thus, although firms have zero profits, in general there will be room for optimal regulation since one firm is more efficient than several firms due to increasing returns to scale. To see this graphically, a simulation is presented in figure 2.

Figure 2

Regulatory Margin as a percentage of the Second Best Price

***a* = 100, *c* = 100, *d* = 20**



Note that given the parameters used for the simulation, with one firm there is no need for regulation, while with more than one firm, the natural market price can be above the second best price by up to 58%. This means that regulation can improve the allocation of resources even if the firms in the market have zero profits. Note also that in this particular case the highest room for regulation (the highest *RMSB**) occurs when there are more than two firms, and that beyond a given number of firms, the scope for market regulation is fairly small.

As with first best price regulation, second best price regulation implies leaving only one firm in the market. Thus, if there is monopolistic competition, achieving a second best equilibrium will be optimal only if the efficiency gains more than compensate the welfare loss due to the loss of varieties, and the costs of regulation –including the resources used to regulate and the inefficiencies of the regulatory process.

B. Analysis with a Discrete Number of Firms

The previous analysis assumed that there was a continuum of firms in the market. If there are a discrete number of firms, the analysis changes. Remember that with a discrete number of firms, the market existence conditions can be expressed as:

$$n^* \geq 1$$
$$a - d \geq 2\sqrt{cb}$$

When there are a discrete number of firms, it is possible for the existing firms to make economic profits, as long as a new firm cannot enter the market with non-negative profits. The price with a discrete number of firms is given by equation (2), that is:

$$p = \frac{a + nd}{1 + n}$$

The difference between the price charged with a discrete number of firms and the zero profit price charged when there is a continuum number of firms, which will be labelled here as the regulatory margin induced by economic profits *RMPR,* is:

$$RMPR = \frac{a - d - (1 + n)\sqrt{cb}}{1 + n}$$

Such regulatory margin induced by profits, as a percentage of the free entry and exit price, can be expressed as *RMPR**

$$RMPR^* = \frac{a - d - (1+n)\sqrt{cb}}{(1+n)\left(d + \sqrt{cb}\right)}$$

The behaviour of *RMPR** resembles that of a seesaw, and can be seen in the simulation presented in figure 3.

Figure 3

Profit Seesaw: Regulatory Margin Induced by Profits when there is a Discrete Number of Firms, as a Percentage of the Market Price with a Continuum of Firms

***a* = 100, *c* = 100; *d* = 20**

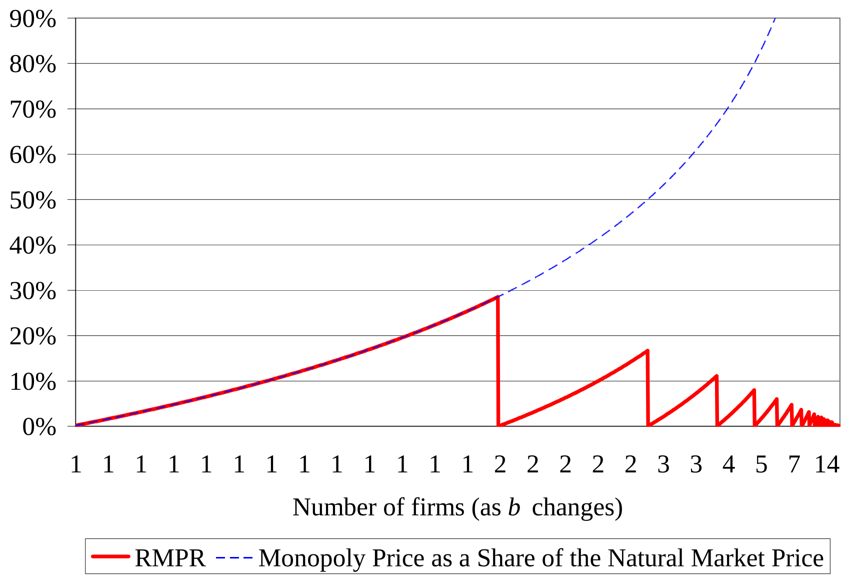


Figure 3 shows that if the market size is expected to increase through decreases in the demand slope *b*, avoiding the use of licences -or any other policy that prevents the entry of firms- may be a powerful tool to reduce the need for regulation, while allowing for a more efficient allocation of resources. Similar results can be obtained if market size increases through an increase in *a*, or if cost structures fall through a fall in *c* and/or *d,* because all of these changes in parameters lead to a higher equilibrium -and in this case discrete- number of firms, as can be deduced from equation (3).

The doted line in figure 3 represents the *RMPR** as *b* falls, with one firm and complete entry barriers. Every vertical line represents the entry of an additional firm. Thus, the *RMPR** as *b* falls -with more firms and complete entry barriers- can be found as the projection of the positive –but non vertical- slope corresponding to the desired number of firms

The regulatory margin with first best pricing and a discrete number of firms $RMFB_D$ will be

$$RMFB_D = \frac{a-d}{(n+1)} \tag{12}$$

This means that the regulatory margin will be higher the higher the intersection of the demand curve with the price axis *a*, and the lower the marginal costs and the number of firms.

The $RMFB_D$ as a percentage of the first best price $RMFB_D$* will be

$$RMFB_D^* = \frac{a-d}{(n+1)d}$$

The $RMFB_D$ is equal to the sum of *RMFB* plus *RMPR*. This shows two possible sources for regulation: the exploitation of economies of scale (captured by *RMFB*), and economic rents (captured by *RMPR*). Note that the regulatory margin from exploiting economies of scale as in *RMFB* will be larger than the regulatory margin generated by economic profits if

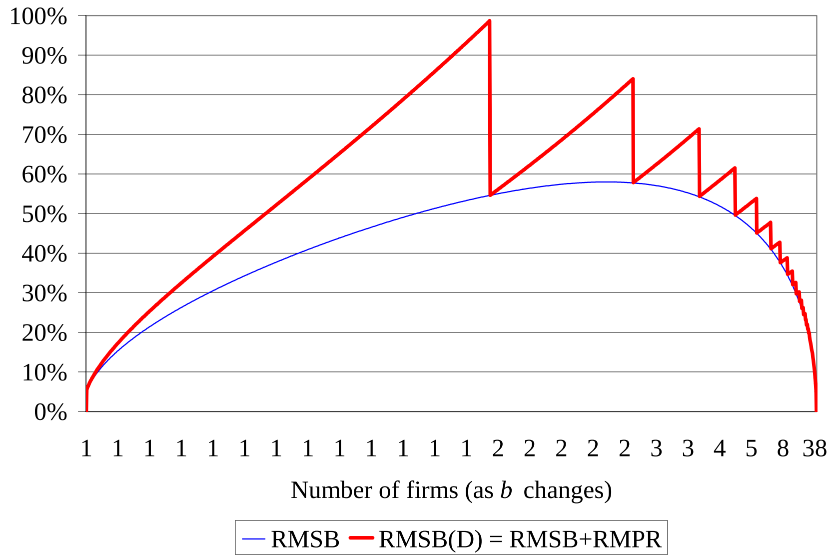
$$\frac{a-d-2\sqrt{cb}}{2\sqrt{cb}} < n \tag{13}$$

The regulatory margin with second best pricing and a discrete number of firms $RMSB_D$ is equal to the sum of *RMSB* plus *RMPR*. These margins are shown in the simulation presented in figure 4.

Figure 4

Composition of the Second Best Regulatory Margin with a Discrete Number of Firms, as a percentage of the Second Best Price

***a* = 100, *c* = 100, *d* = 20**



Note that in the case of the simulation at hand, the gross of the regulatory margin is given by the exploitation of economies of scale, rather than by the economic rents, especially when there are two or more firms. This suggests that in terms of the need for regulation, with free entry and exit the exploitation of economies of scale can be more relevant than the existence of economic rents, as occurs with first best regulation when equation (13) is fulfilled. Note also that the scope for market regulation is fairly small beyond a given number of firms. The analysis presented so far also means that with a discrete number of firms there is no need to regulate a natural monopoly that has no profits, since the regulatory margin is zero.

The simulation of figure 4 also shows that with monopoly, the margin of regulation can shift from cero, to the highest level of all. This means that if markets are expected to expand and/or costs are expected to decrease, regulation may be important, especially if the number of firms that enter freely to the market is small.

A summary of the regulatory results developed so far can be seen in table 2

Table 2

Summary of the Regulatory Results

	Regulation Reference Price	
	Marginal Cost First Best	Average Cost Second Best
Continuum	$\sqrt{cb}$	$\dfrac{d-a+2\sqrt{cb}+\sqrt{(a-d)^2-4bc}}{2}$
Profit Margin[6]	$\dfrac{a-d-(1+n)\sqrt{cb}}{1+n}$	$\dfrac{a-d-(1+n)\sqrt{cb}}{1+n}$
Discrete[7]	$\dfrac{a-d}{(n+1)}$	$\dfrac{(1-n)(a-d)+(1+n)\sqrt{(a-d)^2-4bc}}{2(1+n)}$

V. RESEARCH AND DEVELOPMENT AND FOREIGN DIRECT INVESTMENT

In order to evaluate the effects of R&D and FDI, consider the impacts in the case of a continuum of firms[8]. In terms of welfare, reducing costs through higher R&D or through greater FDI will lead to lower fixed costs and/or to lower marginal costs, that should lead to lower prices, as shown in equation (6). Ceteris paribus, falls in prices will lead to greater quantities and as shown in equation (7), this will generate higher welfare.

If R&D and/or FDI lower fixed costs and increase marginal costs or vice versa, it would be required to identify which effects dominate on the price. Taking the total differential on the price equation (6):

$$\delta p=\delta d+\frac{1}{2}\sqrt{\frac{c}{b}}\delta b+\frac{1}{2}\sqrt{\frac{b}{c}}\delta c$$

6 The profit margin appers only when a discrete number of firms is considered.

7 The regulatory margins with a discrete number of firms are equal to the margins with a continuum of firms (scale economies effect) and the profit margins.

8 With a continuum of firms all impacts are generated by the economies of scales effect, while with a discrete number of firms the impacts are generated by the economies of scale effect and the economic rents effect.

Setting the change in *b* equal to zero, there will be a welfare gain if the marginal costs fall and the fixed costs increase, if

$$\delta d > \frac{1}{2}\sqrt{\frac{b}{c}}\delta c$$

Setting the change in *b* equal to zero, there will be a welfare gain if the marginal costs increase and the fixed costs decrease, if

$$\delta d < \frac{1}{2}\sqrt{\frac{b}{c}}\delta c$$

If the overall impact of R&D and FDI is an increase in the number of firms as in equation (3), then they would lead to another source of welfare improvements if product differentiation and a taste for variety are introduced in the model.

Reductions in the fixed costs will reduce the absolute regulatory margin as shown in equation (8). This means that if R&D and FDI reduce –but do not remove- *c*, they would be imperfect substitutes of regulation, independently of what happens to the marginal costs. Furthermore, if R&D and FDI remove *c*, they will be perfect substitutes of regulation.

With regard to the interaction between of R&D and FDI, with the regulator setting first best prices, and totally differentiating (9):

$$\delta RMFB^* = \frac{1}{2d}\sqrt{\frac{c}{b}}\delta b + \frac{1}{2d}\sqrt{\frac{b}{c}}\delta c - \frac{\sqrt{cb}}{d^2}\delta d$$

Thus, R&D and FDI that increase fixed costs and/or reduce marginal costs, increase even more the need for regulation. This means that in this case R&D and FDI are complements to regulation.

Also, with second best regulation, changes in cost structures through R&D and FDI will have non linear effects on the regulatory margin and thus, they may be complements or imperfect substitutes of market regulation.

If a discrete number of firms are considered, then note that R&D and FDI that lower marginal costs increase the need for regulation with first best pricing, for a given number of firms as shown in equation (12). But a lower *d* also increases the number of firms, reducing the need for regulation every time a new firm enters the market. Note also that the fixed costs no longer have a direct impact on the price margin as shown in equation (12). However, changes in fixed costs will have an indirect impact through changes in the discrete number of firms. This means that changes in the fixed and marginal costs will have non-linear impacts on the need for regulation, that is, that changes in costs structures can be either complements or imperfect substitutes to the need for market regulation.

VI. INTERNATIONAL TRADE OF GOODS AND SERVICES AND INTERNATIONAL MIGRATION

In order to study the impacts of international trade and migration, consider once more the model with a continuum of firms. The welfare effects of having freer trade can be understood in this model as having a larger market perceived by producers, even though the domestic demand remains unchanged. The impact of having producers perceiving a greater market demand can be understood in terms of a higher *a* and/or a lower *b*. With homogeneous goods, a higher *a* would not affect prices and with a constant domestic demand, national welfare would not change. But a higher *a* would imply more firms participating in the domestic market (national and foreign) and -with product differentiation and a taste for variety- higher welfare.

With a lower *b* perceived by the firms (because of the combined domestic and foreign demands), output per firm will increase. To see this, consider equation (5):

$$\frac{\partial q_i}{\partial b} = -\frac{\sqrt{cb}}{2b^2} < 0$$

Thus, with a lower *b* the equilibrium price will be lower because of exploitation of economies of scales, and national welfare –measured in terms of the unchanged domestic demand-, will be higher. Note that if this is the case, the number of firms participating in the market (domestic and foreign) will also increase, as in equation (1).

All of the above means that a country that expects increases in market size –for example from regional trade agreements and/or multilateral trade negotiations- should avoid licensing monopolies and/or oligopolies, or at least do so for the shortest possible period of time. As with R&D and FDI, increases in market size with differentiated products could be another source of welfare improvement, if consumers appreciate variety.

However and as demonstrated in Appendix 1, the number of firms operating in the market with free trade will be lower than the sum of the number of firms operating under autarky because

$$\frac{a-d}{\sqrt{c}} \geq \frac{\sqrt{b_A b_B}}{\sqrt{b_A}+\sqrt{b_B}-\sqrt{(b_A+b_B)}}$$

The larger scale of operation per remaining firm, and the disappearance of some firms could explain –but not justify- some resistance to trade liberalization, even if it is welfare improving.

In terms of the optimal number of firms with free trade, setting price equal to marginal costs will lead to the optimal level of consumption. But the greater the number of firms operating under such scheme, the larger the reimbursements for fixed costs. Thus, in the first best scenario and with homogeneous goods, the optimal price equals the marginal cost, and the optimal number of firms is one. This means that even with free trade, if goods are homogeneous, optimal regulation could still be welfare improving as long as *b* does not tend to zero -as in equations (8), (9), (10) and (11)- and as long as those welfare improvements are higher than the regulation costs –including the cost of resources used to regulate and the inefficiencies of the regulatory process. If goods are not homogeneous, there would be a trade off between having a more efficient allocation, and benefiting from having more varieties, while avoiding the regulation costs mentioned above.

Thus, freer international trade increases welfare by promoting more efficiency and allowing for more varieties, but in general, it does not eliminate the need for regulation. Even with free trade, regulation could improve national and international welfare by forcing one producer to provide the world at average cost, maximizing the gains from economies of scale. As before, if regulating is costly, ensuring that no policies -such as licences- prevent the entry of firms is a powerful tool to reduce the need for regulation, while ensuring a more efficient allocation of resources. Note also from equation (9) that if R&D and FDI increase the fixed costs and decrease the marginal costs, opening up to freer trade may compensate –at least in part- the impact on the increased need for market regulation caused by the changes in cost structures.

Migration analysis can be introduced in the model by thinking in terms of the movement of consumers, and in this sense, the framework presented in this paper replicates most insights developed in Krugman (1979) with love of variety preferences, and Vallejo (2005) with ideal variety preferences. Consider two countries *A* and *B* that are identical and that have a market in terms of the basic framework developed in this paper. Suppose now that these two countries allow free movement of consumers between them, and that those shifts are captured through the parameter *b*. Prices and welfare would be identical, and there would be no incentive for migration since $p_A = d + \sqrt{cb_A} = p_B = d + \sqrt{cb_B}$. However, this equilibrium would be unstable since the movement of one consumer to the other country –for example of a consumer from *A* to *B*- would imply that welfare would be higher in the receiving country because $p_A = d + \sqrt{cb_A} > p_B = d + \sqrt{cb_B}$. Thus, there would be incentives for all consumers to move from the source country to the receiving country. In the end, all consumers would end up in the receiving country and would have higher welfare because of a lower *b* and a lower *p*.

In terms of GNP, with migration –for example from *A* to *B*- all consumers from both countries would be better off than before. However, GDP would fall in the source country. If some consumers could not migrate to the receiving country, the consumers left in the source country would be worse off (because of a higher *b* in equation (6)), and that could lead to political barriers to the exit of consumers in the source country.

Besides, if both countries have the same size but different technologies, the country with the best technologies –for example *A*- would have the lowest prices and the highest welfare (because of lower *c* and/or *d* in equation (6)), and would receive all migrants since $p_A = d + \sqrt{cb_A} < p_B = d + \sqrt{cb_B}$. However, if one country (*A*) has a better technology than the other, but the other (*B*) has a sufficiently larger market to more than compensate the technological advantage and to have lower autarky prices ($p_A = d + \sqrt{cb_A} > p_B = d + \sqrt{cb_B}$) and higher welfare, free migration could lead all consumers to the technologically disadvantaged nation. In this case, the model would suggest that there could be sub-optimal migration flows because world welfare would not be maximized.

In terms of the impacts of migration on regulatory margins, the analysis is similar to that of international trade of goods and services, discussed earlier.

With a discrete number of firms, an increase in *a* due to an inflow of consumers, does not affect the price and with a given domestic demand, does not affect welfare either. However a lower *b* due to international migration with a constant domestic demand has an indirect impact on the need for regulation through the changes in the number of firms. As *b* falls and the number of firms increases (in a discrete way), the need for regulation is reduced (freer migration is an imperfect substitute to regulation) but such effect is non linear, as shown in figure 3.

VII. CONCLUSIONS

This paper has developed a general and simplified framework based on two simple equations - one for a linear demand and the other for a cost structure with increasing returns to scale-, in which a wide range of natural market structures –such as monopoly, Cournot oligopoly, Bertrand oligopoly, monopolistic competition and perfect competition- can be analyzed in terms of only four underlying parameters.

The model has been used to study the effects of regulation, R&D, FDI, and international trade of goods, services and factors. It has been shown that in natural market structures there is usually room for regulation. With a discrete number of firms, the model has shown that profits of the firms and the regulatory margins can be graphed by a “saw”. The use of a discrete number of firms has also suggested that the exploitation of economies of scale can be more relevant as an argument for market regulation, than the existence of economic rents.

It has also been shown that R&D and FDI can improve welfare providing they reduce cost structures or fulfil certain conditions. Greater international trade of goods and services has also been shown to enhance welfare. With homogenous products, welfare gains are generated by the exploitation of economies of scale at home and abroad. However, with international trade some firms are likely to disappear. International migration has been shown to increase Gross National Income, and to decrease Gross Domestic Product in the source country, leading to potential barriers to the exit of consumers. It has also been shown that with technological differences among countries, there may be sub-optimal migration flows. In this sense, the model has allowed to replicate results obtained by other authors in the context of much more elaborated frameworks.

The model has explained that R&D, FDI, international trade of goods and services and international migration, can improve welfare with product differentiation and a taste for variety, when they induce a larger number of equilibrium firms (national and foreign). The model has also shown that R&D, FDI, international trade of goods and services and international migration, can be either complements or imperfect substitutes to market regulation. It has also been shown that if markets are expected to grow –for example as a result of trade liberalization- or technologies are expected to change –for example because of R&D and/or FDI-, avoiding policies that prevent the entry of firms –such as licences- can reduce the need for regulation while promoting a more efficient resource allocation.

VIII. BIBLIOGRAPHY

Baumol, W. J. (1977). "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry.," A.E.R., 67, 809-22.

Berg, S. B. and Tschirhart ,J. (1988). Natural Monopoly Regulation. Cambridge U.P.

Braeutigam, R. (1989). "Optimal policies for natural monopolies," in Schmalensee, R. and Willig, R. (eds.) Handbook of Industrial Organization, Elsevier Science Publishers.

Cournot, A. A. (1838) Researches into Mathematical Principles of the Theory of Wealth, Trad Irving Fisher. New York and London, Macmillan, 1927.

Chamberlin, E. H. (1937). “Monopolistic or Imperfect Competition?” Q.J.E., Vol. 51, No. 4., 557-580.

Chamberlin, E. H. (1956). “The Theory of Monopolistic Competition,” Cambridge: Harvard University Press.

Demsetz, H. (1968). “Why regulate Utilities?”J.L.E., 11, 55-65.

Dixit, A. and Stiglitz, J. (1977). “Monopolistic Competition and Optimum Product Diversity,” A.E.R., 67, 297-308.

Dupuit, J. (1952). “On the measurement of the Utility of Public Works,” International Economic Papers , 2, 83-102.

Ely, R.T. (1937). Outlines of Economics. New York: Macmillan.

Frank, C. R. (1965). “Entry in a Cournot Market,” The Review of Economic Studies, Vol. 32, No. 3, 245-250.

Glaeser M. G. (1927). Outlines of Public Utility Outcomes.

Hotelling, H. (1938). “The General Welfare in Relation to Problems of Taxation ando g Railway and Utility Rates,” Econometrita, 6, 242-69.

Jevons (1871) “The Theory of Political Economy” New York; Kelly and Millman 1957.

Clark, J. M. (1923). The Economics of Overhead Costs. University of Chicago Press.

Clark J. M. (1939). The Social Control of Business. New York: McGraw-Hill.

Kahn, A. E. (1971). The Economics of Regulation: Principles and Institutions, Vol. I and Vol. II. New York: Wiley.

Krugman, P. (1979) Increasing Returns, Monopolistic Competition and International Trade" Journal of International Economics 9, 469-479.

Mankiw, N. Gregory (2001) "Principles of Economics" Second Edition, Harcourt, 332-333.

Marshall, A. (1920) "Principles of Economics", Londres, MacMillan.

Menger, C (1871) "Principles of Economics" Glencoe, Illinois, Free Press 1950.

Novshek, W. (1980). "Cournot Equilibrium with Free Entry,"The Review of Economic Studies, Vol. 47, No. 3, pp. 473-486.

Perry, M. (1984) "Scale Economies, Imperfect Competiton and Public Policy" The Journal of Industrial Economics, Vol 32 No. 3 313-333.

Pigou A. C. (1913) "Railway Rates and Joint Costs: Comment," Q.J.E., 27,535-8.

Ruffin, R. J. (1971). "Cournot Oligopoly and Competitive Behaviour," Vol. 38, No. 4., 493-502.

Seade, J. (1980). "On the Effects of Entry," Econometrica, Vol. 48, No. 2, 479-490.

Sharkey, W. W. (1982). The Theory of Natural Monopoly. Cambridge U. P.

Taussig F. W. (1913). "Railways Rates and Joint Costs Once More," Q.J.E., 27, 378-384.

Von Weizsacker, C. C. (1980) "A Welfare Analysis to Entry" The Bell Journal of Economis, Vol 11, No. 2, 399-420.

Vallejo, H. (2005) "A Model of International Trade with Horizontal Product Differentiation and Free Entry and Exit of Firms", Universidad de los Andes, Documento CEDE 2005-62

Walras, L. (1874) "Elements of Pure Economics" Homewood, Ill. Richard D Irwin (1954).

APPENDIX 1

ENTRY AND EXIT OF FIRMS WITH INTERNATIONAL TRADE[9]

With international trade, the number of firms operating in a market will increase. However, some firms will disappear since the final number of firms operating with free trade will be lower than the sum of the firms operating in autarky.

In order to demonstrate that this is the case, note that the slope of the demand with free trade b_{FT} can be determined by adding horizontally the domestic demand (with sub-index *A*) and the external demand (with sub-index *B*), and is equal to:

$$b_{FT} = \frac{b_A b_B}{(b_A + b_B)}$$

The number of firms in autarky and with free trade will be

$$n_A = \frac{(a-d)}{\sqrt{cb_A}} - 1$$

$$n_B = \frac{(a-d)}{\sqrt{cb_B}} - 1$$

$$n_A + n_B = \frac{(a-d)}{\sqrt{c}}\left[\frac{\sqrt{b_A} + \sqrt{b_B}}{\sqrt{b_A b_B}}\right] - 2$$

$$n_{FT} = \frac{(a-d)\sqrt{b_A + b_B}}{\sqrt{c}\sqrt{b_A b_B}} - 1$$

Some of the original firms will disappear, as has been explained by Krugman (1979) with love of variety preferences, and by Vallejo (2005) with ideal variety preferences, if the following condition is met

$$\frac{(a-d)}{\sqrt{c}} > \frac{\sqrt{b_A b_B}}{\sqrt{b_A} + \sqrt{b_B} - \sqrt{b_A + b_B}}$$

9 I am endebted to Pietro Bonaldi for his contribution to this demostration.

Assuming that there is at least one firm in each country, from the market existence conditions for one firm we know that

$$a - d \geq 2\sqrt{cb_A}$$
$$a - d \geq 2\sqrt{cb_B}$$
$$\frac{a-d}{\sqrt{c}} \geq \sqrt{b_A} + \sqrt{b_B}$$

Note that for

$$\sqrt{b_A} + \sqrt{b_B} \geq \frac{\sqrt{b_A b_B}}{\sqrt{b_A} + \sqrt{b_B} - \sqrt{(b_A + b_B)}}$$

the following condition must be met

$$\left(\sqrt{b_A} + \sqrt{b_B}\right)^2 - \left(\sqrt{b_A} + \sqrt{b_B}\right)\left(\sqrt{(b_A + b_B)}\right) \geq \sqrt{b_A b_B}$$
$$b_A + \sqrt{b_A b_B} + b_B \geq \left(\sqrt{b_A} + \sqrt{b_B}\right)\left(\sqrt{(b_A + b_B)}\right)$$
$$b_A^2 + b_B^2 + 3b_A b_B + 2(b_A + b_B)\sqrt{b_A b_B} \geq b_A^2 + b_B^2 + 2b_A b_B + 2(b_A + b_B)\sqrt{b_A b_B}$$
$$b_A b_B \geq 0$$

Since $b_A \geq$ and $b_B \geq 0$, this implies that

$$\frac{a-d}{\sqrt{c}} \geq \frac{\sqrt{b_A b_B}}{\sqrt{b_A} + \sqrt{b_B} - \sqrt{(b_A + b_B)}}$$

Thus, if both countries have at least one firm each, this will be sufficient (but not necessary) to demonstrate that with free trade, although the total number of firms operating in the market (national and foreign) will increase in both countries, some firms will disappear.