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Trade Liberalization, Outsourcing, and Firm Productivity

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Abstract
Empirical evidence suggests that trade liberalization increases firm productivity. This paper offers a novel explanation for this finding. I develop a simple general equilibrium model of trade in which trade liberalization leads to outsourcing as firms focus on their core competencies in response to tougher competition. Since firms are the better at performing tasks the closer they are to their core competencies, this outsourcing increases firm productivity. Moreover, I also investigate the links between various technological parameters and outsourcing. In particular, I analyze how technological progress, changes in fixed costs, and changes in internal governance costs affect firms' integration decisions.

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1 Introduction

Evaluating the gains from trade liberalization has always been a key concern of international economics. Recently, many empirical studies have focused on the productivity effects of trade liberalization (e.g. Pavcnik 2002, Topalova 2004, Trefler 2004).[1] Their results suggest that there are important trade-induced improvements in overall productivity, either through gains in average firm productivity ('firm productivity effect') or through the reallocation of market share from less to more productive firms ('reallocation effect').

While the recent theoretical literature has mainly concentrated on understanding the reallocation effect (e.g. Melitz 2003, Bernard et al. 2003, Melitz and Ottaviano 2005), my focus is on the firm productivity effect. In the context of a simple general equilibrium model of trade, I show that trade liberalization leads to outsourcing as firms focus on their core competencies in response to tougher competition. Since firms are the better at performing tasks the closer they are to their core competencies, this outsourcing then increases firm productivity. Besides establishing this result, I also investigate the links between various technological parameters and outsourcing. In particular, I analyze how technological progress, changes in fixed costs, and changes in internal governance costs affect firms' integration decisions.

To the best of my knowledge, this paper is the first attempt to theoretically link trade-induced gains in firm and industry productivity to a vertical focusing on core competencies. Other papers have mainly emphasized increasing returns to scale (e.g. Krugman 1979), learning by exporting (e.g. Clerides, Lach, and Tybout 1998), competition-induced innovation (e.g. Aghion et al. 2005), or a horizontal focusing on core competencies by multi-product firms (e.g. Eckel and Neary, 2005; Bernard, Redding, and Schott, 2006; Nocke and Yeaple, 2006) as potential sources of the firm productivity effect. Only McLaren (2000) also

[1] See Tybout (2002) for a survey of the earlier literature.

studies the productivity gains of trade-induced vertical disintegration. Both the source of the productivity gains as well as the link between trade-liberalization and outsourcing are very different in his model, however.

Apart from proposing a new mechanism which helps understanding trade-induced increases in firm productivity, this paper is also interesting from a modelling perspective. In particular, I solve for the range of vertically related production tasks performed within the boundaries of each firm, thus allowing me to study continuous changes in the degree of vertical integration. Previous work has usually considered two discreet 'upstream' and 'downstream' production facilities, which could either merge into a fully integrated firm or stay entirely disintegrated (e.g. Grossman and Helpman 2002).

The remainder of the paper is structured as follows. The next section sets up the model and introduces the concepts 'value chain' and 'core competencies'. Section 3 derives the outsourcing decisions of firms, while section 4 solves for the general equilibrium. Section 5 is concerned with the comparative statics, establishing the key results. A final section concludes.

2 The basic setup

The model is a generalization of Krugman's (1979) monopolistic competition model of trade, the key difference being that the production process of a given variety is now divided between vertically related firms. The basic setup of Krugman (1979) is chosen because it features a competition effect generating a reduction in mark-ups following trade liberalization. As will become clear, this reduction in mark-ups is necessary for trade liberalization to affect vertical integration in this model.

2.1 Demand

Consider thus an economy producing and consuming $i = 1, ..., n_y$ final goods, where n_y is endogenous. There are L consumers who are endowed with one unit of labor each. Consumers have 'love of variety'-preferences

$$U = \sum_{i=1}^{n_y} v(x_i), \quad v'(x_i) > 0, \quad v''(x_i) < 0 \tag{1}$$

where $v(x_i)$ is the utility derived from consuming x units of final good i. They maximize this utility subject to their budget constraint

$$\omega = \sum_{i=1}^{n_y} p_i x_i \tag{2}$$

where ω is the wage rate and p_i is the price paid for good i. As can be seen from the first order condition of the consumer's maximization problem, the resulting demand has elasticity

$$\varepsilon(x_i) \equiv -\frac{v'(x_i)}{x_i v''(x_i)} \tag{3}$$

To introduce a competition effect into the model, assume that $\varepsilon'(x_i) < 0$. As is easy to verify, this is equivalent to assuming that demand is less convex than in the constant elasticity case (e.g. linear). Assume also that $\varepsilon(\infty) > 1$ and $\varepsilon(0) > \frac{1+\gamma}{\gamma}$, γ a positive and constant cost parameter to be defined below. As will be discussed later, these parameter restrictions are necessary to guarantee the existence of a monopolistic competition equilibrium.

2.2 Value chain

Consider now the production process of the final goods. The production of each of these goods requires the sequential performance of a number of tasks. Early tasks are concerned with obtaining raw materials which are then refined successively in later production stages. The set of these tasks is represented by a line of length

v which I call the value chain. To produce the final good, all tasks $z \in [0, v]$ have to be performed sequentially. If only tasks $z \in [0, w_1]$, $0 < w_1 < v$, are performed, a preliminary good w_1 is obtained. This preliminary good w_1 can then be transformed into a more downstream preliminary good w_2, $0 < w_1 < w_2 < v$, by performing the additional tasks $z \in [w_1, w_2]$ and so on. One unit of each task is required to produce one unit of the final good. Similarly, one unit of the relevant subset of tasks is required to produce one unit of a preliminary good. The value chains of all final goods are assumed to be independent of each other. The preliminary goods are always specific to the production process of a particular final good and are of no use outside their value chains.[2]

2.3 Final good producers vs. preliminary good producers

There are a large number of potential firms whose role is to perform these production tasks. Each of these firms owns the trademark rights of a different final good, giving the firm the exclusive right to perform the final task v in the value chain of this final good.[3] All other tasks $z \in [0, v)$ can be performed by all firms without restrictions. Firms can choose between producing their own final product (i.e. becoming final good producers) or performing tasks outsourced by other firms (i.e. becoming preliminary good producers). As final good producers, they transform a preliminary good into the final good they own the trademark rights to. As preliminary good producers, they transform a preliminary good into a more downstream one. As will become clear, free entry drives profits down to zero for both types of producers, so that firms are indifferent between both options in equilibrium.

[2] A similar representation of the production process has been used by Dixit and Grossman (1982).

[3] This final task can be thought of as turning a relatively generic product into a particular brand.

2.4 Costs and core competencies

Firms are symmetric in all other aspects of the production technology. To start operating, they have to incur a fixed cost f which is measured in terms of labor. This fixed cost is associated with acquiring a core competency k in a value chain. The role of this core competency is reflected in the structure of variable costs. The labor requirement of performing one unit of each task in the range $[w_1, w_2]$ in this value chain is given by

$$l(w_1, w_2) = \frac{1}{2} \int_{w_1}^{w_2} c(|k - z|)\, dz \tag{4}$$

where $c'(.) > 0$, so that firms get the worse at performing a given task the further away it is from their core competency.[4] Firms can only acquire one core competency so that a core competency is the defining feature of a firm. Firms can choose, however, which core competency to acquire and which value chain to invest in.

2.5 Outsourcing contracts and the vertical division of labor

The vertical division of labor in each value chain is determined in the following bargaining game. There are two stages, a contracting stage and a production stage, and both stages are divided into a sequence of substages.

2.5.1 Contracting stage

Consider first the contracting stage. In the first substage, the final good producer enters, chooses a core competency, and incurs the associated fixed costs. Then she decides whether to perform all tasks $z \in [0, v]$ required to produce the final good in-house, or to tender a take-it-or-leave-it outsourcing contract, offering to purchase y_{n_s} units of preliminary good w_{n_s} at price p_{n_s}, where y_{n_s}, w_{n_s}, and p_{n_s}

[4] Notice that this is the labor requirement of transforming one unit of preliminary good w_1 into one unit of preliminary good w_2.

are choice variables.[5] If she decides to perform all tasks in-house, the contracting stage ends. If she decides to tender an outsourcing contract and this outsourcing contract is not accepted by any firm, she either performs all tasks in-house or exits. If, on the other hand, she decides to tender an outsourcing contract and this outsourcing contract is signed by a preliminary good producer, the second substage begins. This second substage is essentially a repetition of the first substage. First, the preliminary good producer enters, chooses a core competency, and incurs the associated fixed costs. Then she decides whether to perform all tasks $z \in [0, w_{n_s}]$ required to produce preliminary good w_{n_s} in-house, or to tender another take-it-or-leave-it outsourcing contract, offering to purchase y_{n_s-1} units of the more upstream preliminary good w_{n_s-1} at price p_{n_s-1}, where y_{n_s-1}, w_{n_s-1}, and p_{n_s-1} are again choice variables. If she decides to perform all tasks in-house, the contracting stage ends. If she decides to tender an outsourcing contract and this outsourcing contract is not accepted by any firm, she is forced to produce the agreed upon quantity of preliminary good w_{n_s} in-house. If, on the other hand, she decides to tender an outsourcing contract and this outsourcing contract is signed by another preliminary good producer, the third substage begins. This process continues until in some substage a preliminary good producer decides to perform all remaining tasks in-house. In all substages, contracts are assumed to be complete and perfectly enforceable. Also, there is free entry of potential firms, so that outsourcing offers are going to be accepted as long as they imply non-negative profits.

2.5.2 Production stage

Consider now the production stage which follows after the contracting stage ends. The production stage is simply the execution of the production process as agreed upon in the contracting stage, taking into account the sequentiality of the pro-

[5] Notice that she can do so because she has the exclusive right to perform the final task v, and preliminary goods are specific to the production process of a particular final good.

duction process. Hence, the most upstream preliminary good producer produces the agreed upon quantity of the agreed upon preliminary product by sequentially performing the required tasks and sells it to the second most upstream preliminary good producer at the agreed upon price and so on until all tasks have been performed and the final good is produced.

3 Optimal organization of production

As will turn out, this game has a unique subgame perfect Nash equilibrium. In this equilibrium, the final good producer chooses her actions to maximize her profits subject to the actions she can expect to be chosen by the preliminary good producers after eliminating non-credible threats. As always, profit maximization implies cost minimization, and it is useful to consider both in turn. The solution to the cost minimization problem will be derived in the following subsection. The solution to the profit maximization problem will be discussed thereafter.

3.1 Cost minimization

To solve the cost minimization problem, I proceed in two steps. First, I take a social planner's perspective and derive the division of labor between firms which ensures that total production costs of the final good are minimized for a given level of output. Then, I turn to the decentralized case. As will become clear later, the decentralized equilibrium is easy to characterize in view of the solution to the social planner's problem, given the strong bargaining position of the final good producer in the bargaining game.

3.1.1 First step: Solving the social planner's problem

Consider thus a social planner who is in full control of the final good producer and all potential preliminary good producers. How many firms should participate in the production process of the final good, which core competencies should they acquire, and which tasks should each firm perform in order to minimize the total cost of producing y units of the final good? This problem will be solved in a number of steps.

Consider first an arbitrary number of firms with an arbitrary distribution of core competencies. To minimize total production costs, which firm should perform which set of tasks? Since the fixed costs have to be incurred irrespective of the organization of production, they are irrelevant for the solution to this problem. For total cost minimization, the aim should thus be to minimize the total unit labor requirement. Consider figure (1) which plots $\frac{1}{2}c\left(|k-z|\right)$ for an arbitrary number of firms and an arbitrary distribution of core competencies.[6] In this figure, the total unit labor requirement is represented by the total area under all triangles. As can be easily seen, this area is minimized if each firm performs the task which exactly matches its core competency plus all the tasks to both sides of this core competency until half-way between this firm's core competency and the neighboring firm's core competency.

Consider now the optimal distribution of core competencies. Elementary geometry reveals that the total area under all triangles is minimized if the firms' core competencies are distributed uniformly along the value chain. Hence, for total cost minimization each firm should be of the same vertical size and perform a symmetric range of tasks around its core competency.

Finally, consider the optimal vertical firm size conditional on a given level of output $s\left(y\right)$. Since all tasks $z\in[0,v]$ have to be performed to produce the final product, this is equivalent to considering the optimal number of firms in this value chain conditional on a given level of output $n_s\left(y\right)$, where $n_s\left(y\right)=\frac{v}{s(y)}$.[7] For given vertical and horizontal firm sizes s and y, each firm has a labor requirement of

[6] To keep the illustration simple, $c\left(.\right)$ is drawn as a linear function with $c\left(0\right)=0$ in this figure. All results carry over to the more general case, however.

[7] v is assumed to be sufficiently large relative to $s\left(y\right)$ so that the integer problem can be ignored.

$$l = f + \left[\int_0^{\frac{s}{2}} c(z)\,dz \right] y \tag{5}$$

as can be inferred easily from equation (1) and figure (1).[8] Defining $C\left(\frac{s}{2}\right) \equiv \int_0^{\frac{s}{2}} c(z)\,dz$ this can be written as

$$l = f + yC\left(\frac{s}{2}\right) \tag{6}$$

Notice that $C'(.) \equiv c(.)$ from the above definition of $C(.)$. Since there are $\frac{v}{s}$ firms involved in the production of the given final good, the total labor requirement is given by $\frac{v}{s}l$. Since labor is paid a wage rate ω, total production costs are

$$TC = \frac{\omega v}{s} f + \frac{\omega v}{s} yC\left(\frac{s}{2}\right) \tag{7}$$

Minimizing this expression with respect to s yields the first order condition

$$f = y\left[\frac{1}{2} sc\left(\frac{s}{2}\right) - C\left(\frac{s}{2}\right)\right] \tag{8}$$

which implicitly defines $s(y)$.[9] It is straightforward to show that this implies[10]

$$s'(y) < 0 \tag{9}$$

Hence, vertical and horizontal firm size are negatively related if total production costs are to be minimized. Underlying this result is a trade-off between fixed and variable total production costs. If output is large, variable costs become more important relative to fixed costs so that it is efficient to incur additional fixed costs and set up more firms which can then operate at a smaller vertical scale in order

[8] Notice that the above result that firms should be of the same vertical size and perform a symmetric range of tasks around their core competencies is incorporated in this expression.

[9] It can be easily checked that the second order condition for cost minimization is also satisfied.

[10] From equation (8) it follows that $s'(y) = -\frac{4f}{y^2 sc'\left(\frac{s}{2}\right)}$ which is negative since $c'\left(\frac{s}{2}\right) > 0$.

to achieve lower variable production costs. Given the optimal firm size $s(y)$, the optimal labor requirement of each firm $l(y)$ then follows straightforwardly from equation (6).

In summary, total production costs are thus minimized if each task is performed by only one firm, all firms are of size $s(y)$ and perform a symmetric range of tasks around their core competencies.

3.1.2 Second step: Solving for the decentralized equilibrium

Given the strong bargaining position of the final good producer in the bargaining game, the decentralized equilibrium is easy to characterize in view of this solution to the social planner's problem. In fact, the subgame perfect Nash equilibrium of the bargaining game exactly replicates the solution to the social planner's problem in terms of the number of vertically related firms, the location of their core competencies, and the range and quantity of tasks they perform. As for the equilibrium outsourcing contracts, they are such that all preliminary good producers make zero profits. In terms of the above notation, the final good producer thus performs y units of the final $s(y)$ tasks in-house and buys y units of preliminary product $v - s(y)$ at price $\omega [n_s(y) - 1] l(y)$ from a preliminary good producer. This preliminary good producer purchases y units of preliminary product $v - 2s(y)$ at price $\omega [n_s(y) - 2] l(y)$ from yet another preliminary good producer and so on. Finally, the second most upstream firm in the value chain purchases y units of preliminary product $v - [n_s(y) - 1] s(y) = s(y)$ at price $\omega [n_s(y) - (n_s(y) - 1)] l(y) = \omega l(y)$ from the most upstream firm. To verify that this is the subgame perfect Nash equilibrium of the bargaining game, proceed by backwards induction. Consider first the production stage. Given the assumption that contracts are complete and perfectly enforceable, firms cannot deviate in the production stage. Consider now the contracting stage. Notice first that in all substages no preliminary good producer has an incentive to deviate in any action since only the described actions are consistent with zero profits (binding participation constraints). Notice second that the final good producer does not have an incentive to deviate since the described actions allow her to produce y units of the final good at minimum possible costs. Hence, this is indeed a subgame perfect Nash equilibrium of the bargaining game. Clearly, it is also the only one.

Since all firms are assumed to be able to become final good producers for some final good, the above argument only goes through if the final good producer also makes zero profits in equilibrium. This will be ensured through monopolistic product market competition as will be laid out in a later section.

3.2 Profit maximization

Consider now the profit maximization problem of the final good producer. Given the equilibrium outsourcing contract, the final good producer's total cost function is given by

$$TC(y) = \frac{1}{2}\omega v y c\left(\frac{s(y)}{2}\right) \tag{10}$$

This is just the expression for the minimum possible total production cost as follows from equations (7) and (8). Some manipulation reveals that the final good producer's marginal costs are given by

$$MC(y) = \frac{1}{s(y)}\omega v C\left(\frac{s(y)}{2}\right) \tag{11}$$

Consider now the demand facing the final good producer. In a setting of monopolistic competition, each firm takes the consumers' marginal utility of income as constant. Therefore, the demand elasticity perceived by the firm is exactly as derived above from consumer choice (see equation (4)). As is well known, profit maximization implies that firms charge a mark-up $m(x)$ over marginal costs, where

$$m(x) = \frac{1}{\varepsilon(x) - 1} \tag{12}$$

Notice that $m'(x) > 0$ since $\varepsilon'(x) < 0$ and that $m(0) < \gamma$ since $\varepsilon(0) > \frac{1+\gamma}{\gamma}$. Of course, $y = Lx$ so that

$$\frac{p}{\omega} = \left[1 + m\left(\frac{y}{L}\right)\right] \frac{1}{s(y)} vC\left(\frac{s(y)}{2}\right) \tag{13}$$

This is one of the central equations of the analysis. It describes the pairs $\frac{p}{\omega}$ and y consistent with profit maximization (for this reason, the relationship will be referred to as PMX curve henceforth).

4 The zero profit equilibrium

4.1 The zero profit condition

The model is closed with a zero profit condition. As long as final good producers make positive profits, new varieties will be established increasing the competition facing each final good producer.[11] Final good producers' average costs are given by

$$AC(y) = \frac{1}{2}\omega vc\left(\frac{s(y)}{2}\right) \tag{14}$$

as follows straightforwardly from equation (10). The zero profit condition can thus be written as

$$\frac{p}{\omega} = \frac{1}{2}vc\left(\frac{s(y)}{2}\right) \tag{15}$$

[11] As indicated above, if final good producers make positive profits the optimal outsourcing contract needs to be altered to induce some firms to become suppliers of preliminary products. Basically, the price offered for each intermediate good would have to be increased until firms are indifferent between becoming a final good producer or a supplier of a preliminary good. The conclusions regarding the zero profit equilibrium are, of course, unaffected by this consideration.

This is the second central equation of the analysis. It describes the combinations of $\frac{p}{\omega}$ and y where final good producers make zero profits (for this reason, the relationship will be referred to as ZPC curve henceforth).

4.2 The ZPC curve as an indicator of labor productivity

Notice that the ZPC curve also captures inverse labor productivity. To see this, recall that each firm in the value chain contributes an equal number of tasks to the production of the final product. Hence, $\frac{y}{n_s(y)}$ units of output can be attributed to the work of a single firm and labor productivity is simply given by $\frac{y}{n_s(y)l(y)}$. Now remember that the ZPC curve is defined as $\frac{AC(y)}{\omega}$. From equation (7) it follows that

$$\frac{AC\left(y\right)}{\omega}=\frac{n_s\left(y\right)}{y}\left[f+yC\left(\frac{s\left(y\right)}{2}\right)\right] \tag{16}$$

which, together with equation (6), implies that

$$\frac{AC\left(y\right)}{\omega}=\frac{n_s\left(y\right)l\left(y\right)}{y} \tag{17}$$

This observation will be useful later on in the analysis.

4.3 Existence, stability and uniqueness

The PMX curve and the ZPC curve are two equations in the two unknowns $\frac{p}{\omega}$ and y. For an equilibrium to exist, the PMX curve and the ZPC curve must intersect. For an equilibrium to be stable, the ZPC curve must intersect the PMX curve from above, as depicted in figure (2). Then entry of final good producers will shift the demand curve to the left whenever y is to the right of the intersection and exit of final good producers will shift the demand curve to the right whenever y is to the left of the intersection. For an equilibrium to be unique, the ZPC curve must only intersect the PMX curve once.

Some more structure needs to be imposed on the model to ensure that an equilibrium exists, is stable and unique. A particularly useful restriction sufficient to guarantee existence, stability and uniqueness is to impose

$$\frac{c\left(\frac{s}{2}\right)}{2} \equiv (1+\gamma)\,\frac{C\left(\frac{s}{2}\right)}{s} \tag{18}$$

As can be seen from equations (11) and (14), this restriction ensures that average and marginal costs are proportional, the factor of proportionality being $(1+\gamma)$,

$$AC = (1+\gamma)\,MC \tag{19}$$

Since $s'(y) < 0$ and $c'\left(\frac{s}{2}\right) > 0$, average costs are decreasing in y. It is easy to show that marginal costs are also decreasing in y.[12] Of course, the marginal cost curve must be strictly below the average cost curve in that case. $m(0) < \gamma$ implies that the PMX curve will be strictly below the ZPC curve at $y = 0$. Since $m'(y) > 0$, the PMX curve will fall less than proportionately relative to the marginal cost curve as y increases.[13] If marginal costs and average costs are proportional, this implies that ZPC intersects PMX only once and from above.

Notice that the above restriction is equivalent to imposing

$$c(.) = \lambda\,(.)^{\gamma}, \quad \lambda > 0, \quad \gamma > 0 \tag{20}$$

Since (18) is an identity it can be differentiated so that

$$c'\left(\frac{s}{2}\right) = a\left(\frac{s}{2}\right) c\left(\frac{s}{2}\right) \tag{21}$$

where $a\left(\frac{s}{2}\right) \equiv \frac{\gamma}{\left(\frac{s}{2}\right)}$. This is a simple linear first-order differential equation with general solution

[12] $\frac{\partial MC}{\partial y} = \frac{\omega v s'(y)}{s^2}\left[\frac{1}{2} sc\left(\frac{s}{2}\right) - C\left(\frac{s}{2}\right)\right] = \frac{\omega v s'(y)}{s^2}\frac{f}{y} < 0$ since $s'(y) < 0$.

[13] In fact, if the mark-up increases in output at a sufficient speed, the PMX curve might even become upward sloping.

$$c\left(\frac{s}{2}\right) = \lambda\left(\frac{s}{2}\right)^{\gamma} \tag{22}$$

Since $c'(.) > 0$ was required, $\lambda > 0$, $\gamma > 0$. This restriction will be imposed henceforth.

4.4 Solving for the general equilibrium

The equilibrium values $\left(\frac{p}{\omega}\right)^*$ and y^* are thus determined by ZPC and PMX. The equilibrium vertical firm size s^* then follows from (8), equilibrium consumption per worker is given by $x^* = y^*/L$. Equilibrium employment per firm l^* is determined by (6), the equilibrium number of firms per value chain can be calculated from $n_s^* = v/s^*$. Given the symmetry of the preference structure, $x_i = x$ and $p_i = p$ for all i in equilibrium, so that the consumers' budget constraints simplify to $n_y px = w$. This equation then determines the number of goods n_y^*. Finally, the total number of firms is given by $n^* = n_s^* n_y^*$.

4.5 Comparative statics

With this framework at hand, one can analyze the effect of the exogenous variables L, v, f, λ and γ on the endogenous variables p/ω, s, y, x, l, n_s, n_y and n. This exercise is simplified considerably by the proportionality assumption (18). Since $AC = (1+\gamma)\,MC$ and, in equilibrium, $AC = \left[1 + m\left(\frac{y}{L}\right)\right] MC$ one obtains

$$m\left(\frac{y^*}{L}\right) = \gamma \tag{23}$$

For a given function $m(.)$, y is determined by L and γ only. Since $x^* = y/L$, x^* depends on γ only. Firm labor demand is given by (6). Imposing $c(.) = \lambda(.)^{\gamma}$ it is easy to show that

$$l^* = f\left(1 + \frac{1}{\gamma}\right) \tag{24}$$

Therefore, firm labor demand depends on f and γ only.

4.6 Trade liberalization

4.6.1 Focusing on core competencies

Consider first a move from autarky to free trade, which is equivalent to an increase in the labor force in this model. If two identical countries of the type outlined above move from autarky to free trade, the effect is simply a doubling of the labor force. Globalization is often referred to by the business press as forcing firms to focus on their core competencies which is exactly what the model predicts. The effect of trade liberalization on $\frac{p}{w}$, y and s is depicted in figure (3) which plots the PMX and ZPC schedules as well as $s(y)$ as defined by equation (8). As can be seen from equations (8), (13), and (15), an increase in the labor force shifts the PMX curve down while leaving the other curves unchanged. Trade liberalization thus leads to an increase in real wage and output but to a decrease in vertical firm size. In the model, the larger market toughens competition by increasing the demand elasticity facing the final good producers. Final good producers respond to this by reducing their mark-ups and increasing their outputs. These increased outputs make variable costs more important relative to fixed costs so that, in equilibrium, firms will downsize to achieve a more efficient vertical scale. Firms will concentrate on their core competencies, i.e. cover a smaller segment of the value chain, as they expand horizontally. Trade liberalization is thus associated with outsourcing in this framework. Since there are no trade costs in the model and countries are assumed to be symmetric, there is no explicit distinction between the home country and the foreign country. Whether outsourcing occurs domestically or internationally ('offshoring') is hence indeterminate in this model.

4.6.2 Productivity effect

Notice that trade liberalization leads to an increase in firm productivity, as the equilibrium point moves down the ZPC curve (recall that the ZPC curve also captures inverse labor productivity). Underlying this productivity effect is an increasing returns to scale effect and an outsourcing effect. This is depicted in figure (4). The increasing returns to scale effect is the productivity effect which would occur if vertical firm size was fixed. The outsourcing effect is the additional productivity effect brought about by the endogeneity of vertical firm size. Consider first the construction of the ZPC schedules in figure (4). Suppose that vertical firm size is fixed at an arbitrary level $\tilde{s}$.[14] Since $s(y)$ minimizes $TC(y)$ and hence also $AC(y)$ with respect to s, this $\tilde{s}$ is suboptimal unless $y = \widetilde{y}$, where $\widetilde{y}$ is implicitly defined by $\tilde{s} = s(\widetilde{y})$. Therefore, the average cost curve of the restricted model must be strictly above the average cost curve of the unrestricted model, unless $y = \widetilde{y}$ and both curves coincide. As the ZPC curves are proportional to the average cost curves, the ZPC curve of the restricted model must thus also be strictly above the ZPC curve of the unrestricted model unless $y = \widetilde{y}$, as drawn in figure (4). Suppose now that the initial equilibrium is at $y = \widetilde{y}$ and consider the impact of a trade liberalization. It is easy to show that the output response to the trade liberalization is larger in the unrestricted case than in the restricted case. This is because marginal costs are decreasing rather than constant in output in the unrestricted case. The increasing returns to scale effect is captured by the distance between A and B in figure (4), whereas the outsourcing effect is given by the distance between B and C. Hence, there is a genuine outsourcing effect in this model which goes beyond the traditional increasing returns to scale effect.

[14] Notice that the model then essentially reduces to Krugman (1979). As can be seen from equation (7), a final good producer then has a constant fixed cost $\frac{\omega v}{\widetilde{s}} f$ and a constant marginal cost $\frac{\omega v}{\widetilde{s}} C\left(\frac{\widetilde{s}}{2}\right)$, just as in Krugman (1979).

4.6.3 Other effects

The effects on the remaining endogenous variables are as follows. The number of varieties available to consumers increases, while consumption per worker per final good is unchanged. Due to the reduced vertical firm sizes, the number of firms within each value chain increases. Interestingly, the number of workers hired by each individual firm is unaffected so that firm scale only changes as measured by output. Therefore, the total number of firms operating in each country remains unchanged. Hence, despite a reduction in the number of varieties produced in each country, trade liberalization does not lead to net exit of domestic firms in this model.

4.6.4 Decreasing the length of the value chain/technological progress

Consider now a reduction in the length of the value chain. Since a shorter value chain implies that fewer tasks need to be performed to manufacture the final product, this change can be interpreted as reflecting technological progress. The effect of a change in v on $\left(\frac{p}{w}\right)^*$, y^* and s^* is depicted in figure (5). $\left(\frac{p}{w}\right)^*$ decreases by the same proportion as v but y^* and s^* are unchanged. As can be verified easily, x^*, l^* are also unchanged. n_y^* increases by the same proportion as v falls but n_s^* falls by the same proportion as v falls so that the total number of firms remains unchanged.

4.7 Changes in the cost structure

To analyze changes in the cost structure it is useful to express the ZPC curve and the PMX curve explicitly in terms of the cost parameters. Substituting restriction (20) into the first order condition (8) and rearranging yields

$$s(y) = 2\left[\frac{f(1+\gamma)}{y\gamma\lambda}\right]^{\frac{1}{1+\gamma}} \tag{25}$$

Using this result in equations (15) and (13) yields the following expressions for the ZPC- curve and the PMX curve, respectively,

$$\frac{p}{\omega} = \frac{v}{2} (\lambda)^{\frac{1}{1+\gamma}} \left[\frac{f(1+\gamma)}{y\gamma} \right]^{\frac{\gamma}{1+\gamma}} \tag{26}$$

$$\frac{p}{\omega} = \frac{v}{2} \left[1 + m \left(\frac{y}{L} \right) \right] \left[\frac{\lambda}{1+\gamma} \right]^{\frac{1}{1+\gamma}} \left[\frac{f}{y\gamma} \right]^{\frac{\gamma}{1+\gamma}} \tag{27}$$

4.7.1 Changes in fixed costs

The effect of an increase in fixed costs on the real wage as well as horizontal and vertical firm size is depicted in figure (6). As can be seen from equations (25-27), an increase in f shifts up the PMX curve and the ZPC curve by the same proportion and shifts down $s(y)$. Hence, the real wage falls, output per firm stays constant and firms get larger horizontally. The insourcing, of course, comes along with a fall in the number of firms per value chain, which is exactly what one would expect following an increase in fixed costs. Of course, this implies that each firm has to cover a longer segment of the value chain so that, on average, tasks are further away from the firms' core competencies causing higher aggregate variable costs. Consumption per final good remains unchanged, each firm hires more workers, the number of varieties falls and so does the total number of firms.

4.7.2 Changes in governance costs

Consider fist an increase in λ. As shown in figure (7) this decreases real wage and vertical firm size but leaves output per firm unaffected. Again, the decrease in vertical firm size is exactly what one would expect to happen in response to an increase in this component of internal governance costs. Consumption per final good is unaffected and so is the number of workers hired by each firm. The number of firms per value chain increases but the number of varieties decreases at the same proportion so that the total number of firms is unaffected.

Consider now an increase in γ. The effect on both the PMX- curve as well as the ZPC curve is ambiguous, so a graphical illustration as above is not very insightful. From equation (23) it is clear, however, that y^* increases, from equation (24) it follows that l^* falls. Since L is unchanged, x^* will increase with y^*. Differentiating (25) reveals that s^* falls and hence n_s^* rises. As expected, an increase in this component of internal governance costs hence triggers outsourcing to save on marginal costs. The effect on $\left(\frac{\omega}{p}\right)^*$, n_y^* and n^* is ambiguous.

5 Conclusion

In this paper, I developed a simple general equilibrium model of trade in which trade liberalization leads to outsourcing as firms focus on their core competencies in response to tougher competition. Since firms are the better at performing tasks the closer they are to their core competencies, this outsourcing increases firm productivity. Besides establishing this result, I also investigated the links between various technological parameters and outsourcing. In particular, I analyzed how technological progress, changes in fixed costs, and changes in internal governance costs affect firms' integration decisions.

Essentially, the model relates Adam Smith's famous proposition that the division of labor is limited by the extent of the market to the topic of vertical integration. The larger the market, the more important become variable costs relative to fixed costs in the model so that, in equilibrium, the production tasks are divided among a larger number of leaner vertically related firm.

So far, the focusing on core competencies is just a plausible channel through which trade liberalization may affect firm productivity. To substantiate the importance of that link, rigorous empirical research is now required. Given that trade-induced increases in firm productivity have been found in several empirical studies, this seems to be a promising project for future work in this area.

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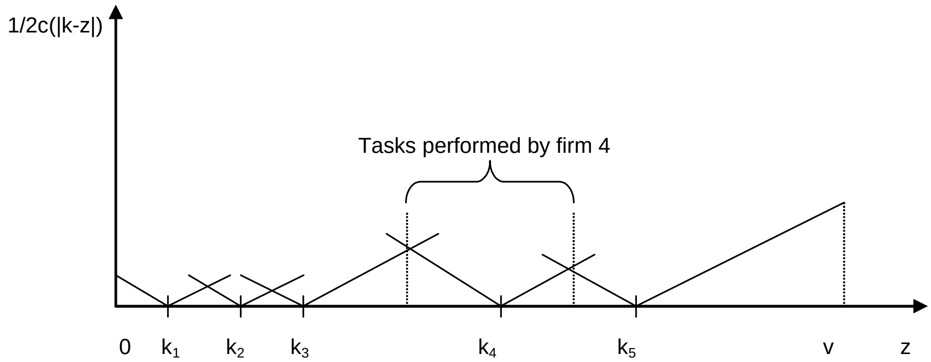

Figure 1: Vertical equilibrium

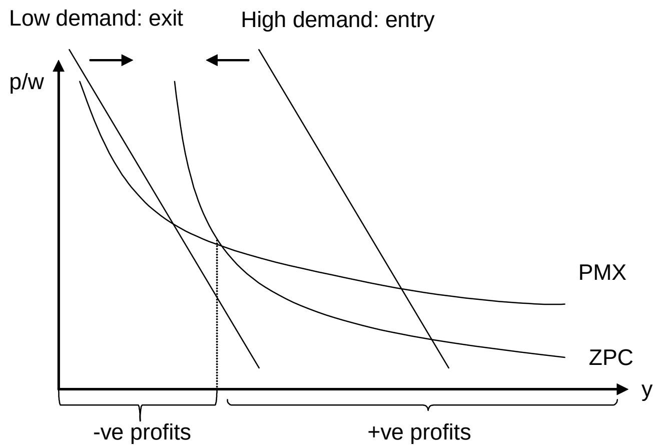

Figure 2: Horizontal equilibrium

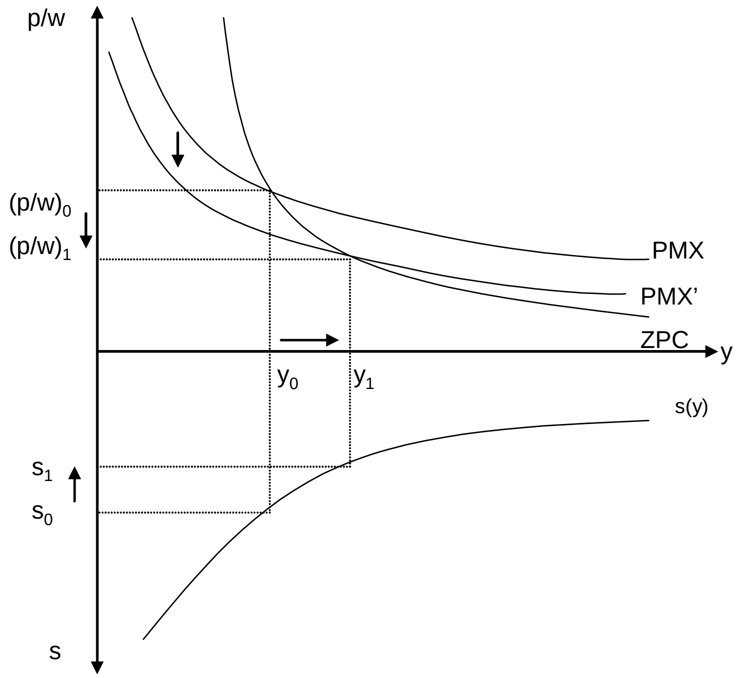

Figure 3: Trade liberalization

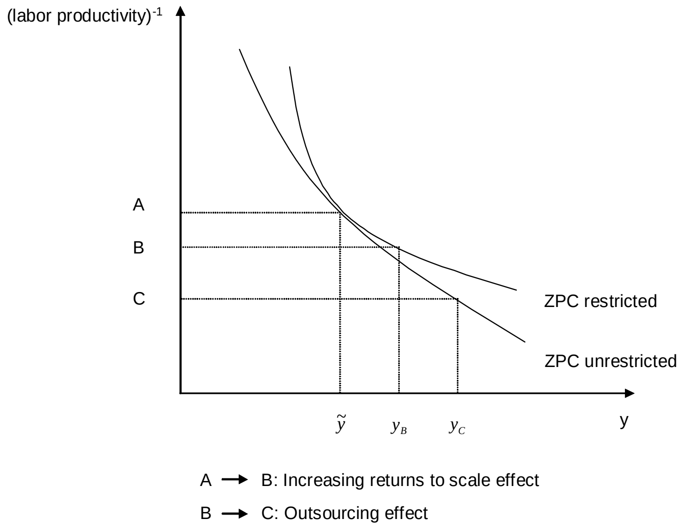

Figure 4: Decomposition of productivity effects

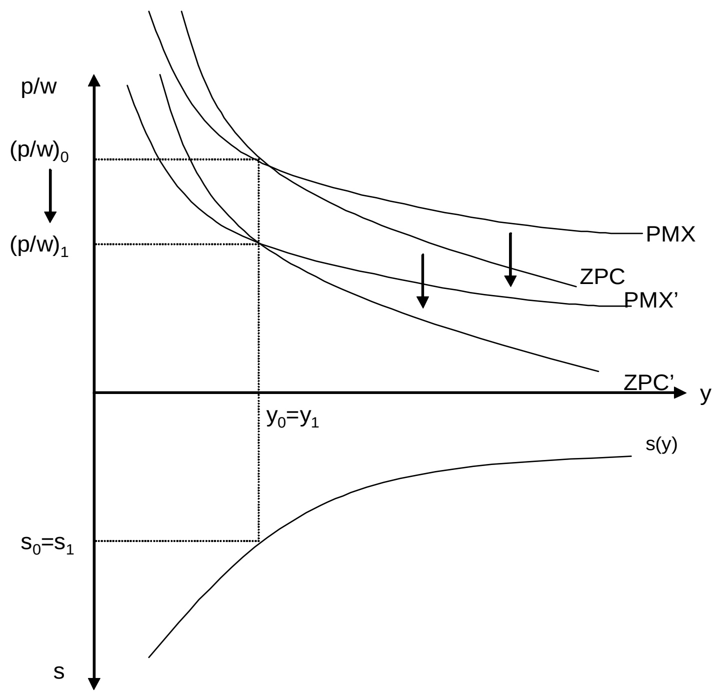

Figure 5: Technological progress

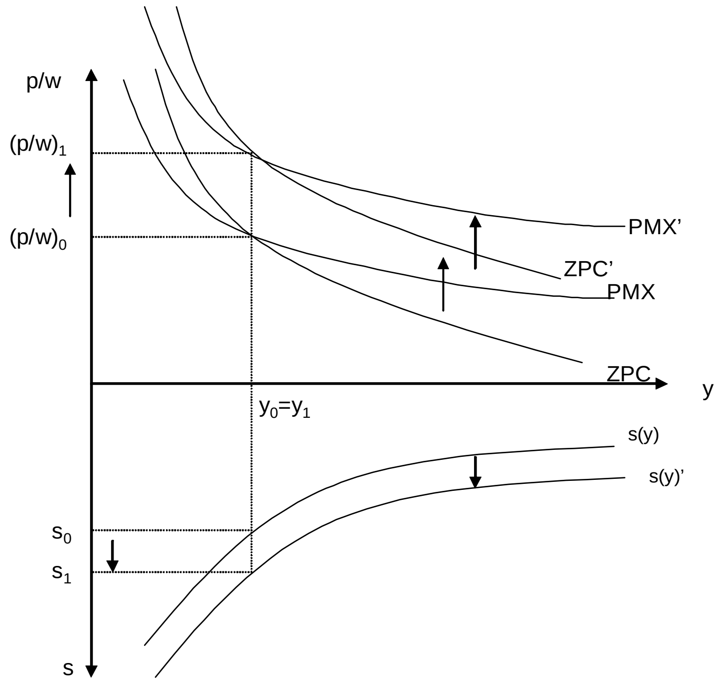

Figure 6: Increased fixed production cost

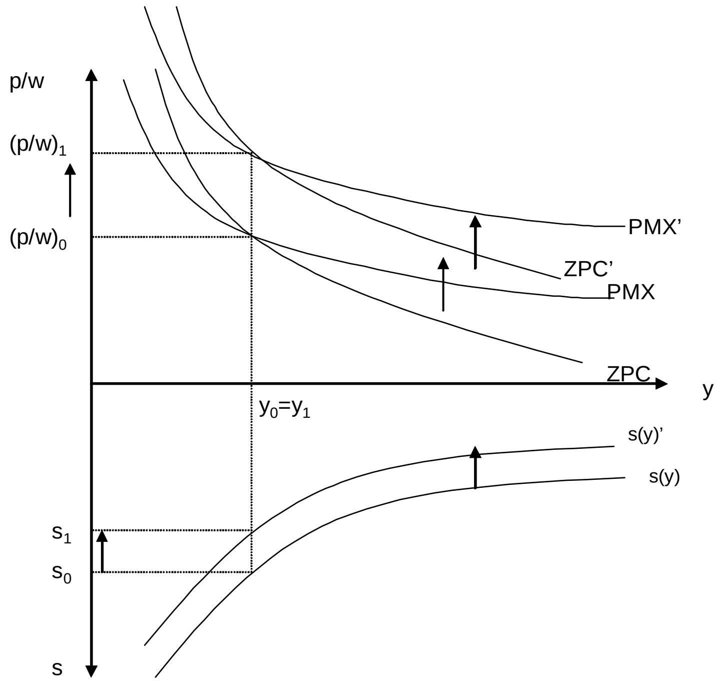

Figure 7: Increasing internal governance costs

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