Industry Reallocations in a Globalizing Economy*

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Abstract

We distill the main insights highlighted by recent trade models on firms' responses to globalisation. The primary aim is to assess the economic impact and the welfare implications of the resulting reallocation of resources across firms and countries. In so doing, we bring theory into life through the numerical implementation of a comprehensive theoretical framework calibrated on European data, which encompasses economic geography, firm heterogeneity, and firms' organizational choices. Our final purpose is to provide a comprehensive background for empirical investigations and to suggest new avenues for future theoretical research.

Keywords: international integration; resource reallocation; economic geography; firm heterogeneity; multinationals

JEL Classification: F12

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1 Introduction

'New trade theory' (henceforth, NTT) developed rapidly from the late 1970s on with the aim of explaining a phenomenon that could not adequately be dealt with in the standard perfectly competitive setting: a large share of world trade takes place between countries with relatively similar technologies and factor endowments (Grubel and Lloyd, 1975). Such trade is not driven by differences between countries (as Ricardian and Heckscher-Ohlin theories would predict) but rather, it seems, by their similarity. Various theoretical explanations have been put forward and all of them rely to varying degrees on imperfectly competitive market structures. The first main strand of NTT builds on seminal works by Spence (1976) and Dixit and Stiglitz (1977). It gives rise to a class of models characterized by monopolistic competition, firm-level scale economies, and differentiated products (Krugman, 1979, 1980; Lawrence and Spiller, 1983). In these models, each firm is assumed to produce a single variety in one location only, because of scale economies, and trade occurs because consumers in each locale value variety and purchase a fully diversified consumption bundle. The second main strand of NTT builds on oligopolistic competition to explain how firms' strategic interdependence may even generate trade in homogeneous goods between identical countries (Markusen, 1981; Brander, 1981; Brander and Krugman, 1983). Countries engage in intra-industry trade because, in the presence of trade costs, firms face a higher demand elasticity in their export market and 'dump' their product into that market.

One fundamental aspect distinguishing NTT from 'traditional' Ricardian and Heckscher-Ohlin theories is that *firms now become important players that have to make several strategic choices*. First, and foremost, firms face the key decision of *price-setting*. While the early literature has largely wrestled with this fundamental problem of market structure (see Helpman and Krugman, 1985), more recent extentions of NTT focus on firms that face two additional decisions: *where* to locate their production activity (the *locational choice* of economic geography) and *how* to serve foreign markets (the *organizational choice* of the multinational). The latest advances in NTT further enrich the already complex picture by allowing for *firm heterogeneity* and by introducing a new approach to the analysis of organizational choices based on contract theory.

Given the inherent richness of the above mentioned recent extensions, different models focus on different aspects to investigate the impacts of trade liberalization and the gains from trade. Our aim is to assess the current state-of-the-art of NTT by distilling its main insights on firms' responses to globalization and their implications for the reallocation of resources across firms and countries within a single unified framework. In particular, we will bring theory into life through the numerical implementation of a comprehensive theoretical framework calibrated on European data. Doing so should provide a comprehensive background for empirical investigations and future theoretical research.

The remainder of this chapter is organized into six sections, following an incremental approach. Section 2 briefly surveys the existing literature on NTT, 'new economic geography', multinational firms, and firm heterogeneity.[1] Section 3 then proposes a simple two-country partial equilibrium model that highlights the key features of NTT while bypassing most of its complexities. Both exports and foreign direct investment (henceforth, FDI) are considered. While this simple model is a useful pedagogical tool, it falls short of being an appealing framework in which to assess the economic impacts and the welfare implications of complex real world trade reforms, or on which to base empirical work. To overcome these limitations, Sections 4 and 5 extend the simple model of Section 3 by allowing for many countries, many firms, and endogenous firm heterogeneity. The result is a rich set of predictions on the effects of trade liberalization in terms of industry performance measures. Sections 4 and 5, however, do not consider multinationals. These are introduced in Section 6, which offers a first attempt at quantifying the impacts of trade reforms in the presence of heterogenous multinational firms.

In what follows, the main results of each section are summarized at its end. Overall, they highlight the fundamental roles of production costs ('cost-saving attraction'), market size ('market-seeking attraction'), and access to other markets ('accessibility'), and may be further summarized as follows:

1. Larger local markets are characterized by tougher competition, which generates richer product variety, higher productivity, lower prices, and higher welfare.

2. Technologically advanced regions are characterized by tougher competition. Again, this generates richer product variety, higher productivity, lower prices, and higher welfare.

3. When available technologies are similar across regions, trade liberalization leads to tougher competition in all markets. This generates richer product variety, higher productivity, lower prices, and higher welfare.

4. When available technologies differ across regions, trade liberalization generates tougher competition in all regions except when trade barriers are just above the threshold below which industry disappears from technologically backward regions. Thus, trade liberalization always improves welfare in advanced regions, yet may temporarily worsen welfare in backward regions until further reductions in trade costs make imports cheap enough.

[1] For the sake of conciseness, we do not review the literature on firms' organizational choices based on contract theory. See Helpman (2006) for a recent survey.

5. Regions with better overall access are characterized by tougher competition and, therefore, richer product variety, higher productivity, lower prices, and higher welfare. This occurs because those regions are better export bases (or 'hubs') and, therefore, attract firms.

6. Any change in the trade barriers between any pair of regions affects the other regions. In particular, preferential trade liberalization increases the average productivity of insiders, while it decreases the average productivity of outsiders. This maps into parallel changes in product variety, industry location, and welfare. The reason is that the liberalizing countries become better export bases: they gain better access to each other's market while maintaining the same ease of access to the third country's market. Average costs, prices, and markups move accordingly, falling for the insiders and rising for the outsiders.

7. All of the aforementioned effects are weaker in the presence of multinationals and when FDI constitutes the main mode to serve foreign markets. In the presence of FDI, small and centrally located countries stand to gain the most from a deepening trade integration. Furthermore, increasing liberalization of FDI yields larger gains than increasing trade liberalization.

Section 7 concludes by stressing the general message of the model: *trade liberalization induces a reallocation of resources from less to more productive firms ('selection'), from smaller to larger countries ('attraction') and from outsiders to insiders in preferential trade agreements ('accessibility').* This delivers long-run efficiency gains to liberalizing countries through selection among heterogeneous firms, which eventually leads to higher average productivity, lower average prices, larger average firm size, higher profits, richer product variety and lower markups. At the same time, it generates tensions between prospective short-run winners (e.g., more efficient firms, larger and more developed countries, larger and more developed regions within countries, insiders in preferential trade agreements) and prospective short-run losers (e.g., less efficient firms, smaller and less developed countries, smaller and less developed regions within countries, outsiders in preferential trade agreements).

2 Literature review

Several surveys of the various aspects of NTT already exist in the literature. For instance, 'new economic geography' is surveyed by Fujita et al (1999), Neary (2001) and Baldwin et al (2003); the theory of multinationals is surveyed by Markusen (2002) as well as Barba Navaretti and Venables (2004); and models dealing with firm heterogeneity and contracts are surveyed by Helpman (2006). Hence, rather than providing yet another survey, we prefer

3 A firm-based approach

This section develops a simple two-country partial-equilibrium model to illustrate the basic insights of NTT. The focus is on the effects that trade liberalization has on the locational and organizational choice of firms. Specifically, consider a world with two countries, labeled H and F. Their sizes, in terms of population, are $L^H \equiv e + E$ and $L^F \equiv e - E$, so $L^H - L^F = 2E > 0$ measures the size advantage of country H. The two countries also offer local firms different marginal costs of production, namely $c^H \equiv c - C$ and $c^F \equiv c + C$ respectively, so that $c^F - c^H = 2C > 0$ measures the cost advantage of H. For each plant, firms also have to incur a fixed set-up cost of production equal to f which, for simplicity, is assumed to be the same in both countries. Countries are separated by trade barriers with unit shipping costs $t > 0$.

3.1 Monopoly

As a first step, assume there is only one firm which has a constant marginal cost of production equal to c and faces the same linear demand in both countries. The individual inverse demand is given by:

$$p_{ij} = \alpha - \beta q_{ij}, \qquad \alpha, \beta > 0 \qquad i, j = H, F \tag{1}$$

where q_{ij} is the quantity demanded by an individual consumer in country j from the firm when it is established in country i, and p_{ij} is the corresponding delivered price. The common marginal cost component c may be set to zero without loss of generality as this amounts to rescaling α (see, e.g., Markusen, 2002).

3.1.1 A single plant

If the firm chooses to run a single plant only (i.e., it is an exporter), its profits are equal to

$$\pi_H^x = (e + E)(p_{HH} + C) q_{HH} + (e - E)(p_{HH} + C - t) q_{HF} - f$$

if the firm is located in H, and equal to

$$\pi_F^x = (e + E)(p_{FH} - C - t) q_{FH} + (e - E)(p_{FF} - C) q_{FF} - f$$

if it is located in F. To choose where to set up its single plant, the firm compares the maximum profits it can reap in the two countries. Such comparison gives:

$$\pi_H^x - \pi_F^x = \frac{2\alpha - t}{2\beta}(2eC + tE) \tag{2}$$

Since $t/2 < \alpha$ has to hold for the firm to be able to serve both countries irrespective of its location (which we henceforth assume to be the case), condition (2) shows that the profit is higher in country H. Accordingly, a monopolist would always be attracted to the country offering lower production costs and larger local demand. The strength of attraction depends, however, on the level of trade barriers t. In particular, (2) shows that lower trade barriers increase the importance of the cost advantage C ('cost-saving attraction') with respect to the size advantage E ('market-seeking attraction'). Eventually, when barriers vanish ($t = 0$), the firm's location is solely driven by cost advantage.

3.1.2 Two horizontal plants

We now allow the firm to choose the number of plants. In so doing, we introduce the traditional market-seeking trade-off between 'proximity' and 'concentration'. On the one hand, the firm may choose to run a single plant in one country while serving the other country through exports. On the other hand, it may choose to run two plants and serve each country locally.

If the firm chooses to set up two plants (i.e., to be a 'horizontal multinational'), it saves on trade costs by incurring an additional fixed cost. Its profits are then equal to:

$$\pi^m = (e + E)\,(p_{HH} + C)\,q_{HH} + (e - E)\,(p_{FF} - C)\,q_{FF} - 2f$$

Comparing these profits to the ones the firms obtains when running a single plant in the more profitable country H gives:

$$\pi^m - \pi^x_H = (e - E)\frac{t\alpha - C(2\alpha - t)}{2\beta} - f \tag{3}$$

When asymmetries are removed ($E = C = 0$), (3) boils down to $\pi^m - \pi^x_H = (t\alpha e)/(2\beta) - f$, which stresses the proximity-vs-concentration trade-off: high trade costs, low fixed costs and larger local markets promote the duplication of plants. The presence of asymmetries reduces the propensity to run two plants as they create an incentive to concentrate production in a single plant located in the country offering a larger market and lower marginal costs. The more so the lower trade barriers are.

3.1.3 A vertical supply chain

Consider now a different scenario in which the only final market is in country H ($E = e$) but country F offers lower marginal costs of production ($C < 0$). Production is assumed to entail two stages. First, intermediates are supplied at marginal costs c^H or c^F, depending on the country where their production takes place. Then, they are assembled and distributed in country H at a fixed cost f. The firm has two options. It may serve final demand in H from a local plant ('local sourcing') earning profits equal to:

$$\pi_H = 2e\,(p_{HH} + C)\,q_{HH} - f$$

Alternatively, it may produce intermediates in country F ('global sourcing') and ship them to H for assembly and distribution at a unit trade cost equal to t. This option generates profits equal to:

$$\pi^v = 2e\,(p_{FH} - C - t)\,q_{FH} - f$$

Hence, the profit difference between local and global sourcing evaluates to

$$\pi_H - \pi^v = \frac{2\alpha - t}{2\beta}(t - 2\,|C|)e \tag{4}$$

which shows that the propensity to fragment production across borders increases with the cost advantage of F. Moreover, provided that fragmentation is a viable option ($q_{FH} > 0$), (4) is an increasing function of t, i.e., freer trade promotes global sourcing.

3.2 Duopoly

The insights derived from the simple monopolistic setup can be enriched by introducing a second firm. In particular, with two firms two additional questions can be explored. First, under which conditions do firms choose the same location ('agglomeration')? Second, if they choose different locations, how do they sort between them ('sorting')?

Any interesting answer to the second question obviously requires that firms be different, i.e., that there is some firm heterogeneity. Hence, consider two firms, firm 1 with marginal cost $d - D$ and firm 2 with marginal cost $d + D$, so $2D > 0$ measures the cost advantage of firm 1. Each firm supplies one variety of a horizontally differentiated good and they interact in a two-stage game. First, they decide how many plants to run and where to locate; then, they choose how much to sell in the two national markets assuming market segmentation for simplicity.

There are a priori six different possible outcomes for the location/organization game:

1. 'agglomeration' with both firms running a single plant in the low-cost/large-size country H (outcome AH);

2. 'reverse agglomeration' with both firms running a single plant in the high-cost/small-size country F (outcome AF);

3. 'dispersion plus sorting' with both firms running a single plant, the low-cost firm 1 in the low-cost/large-size country H (oucome DH);

4. ‘dispersion plus reverse sorting’ with both firms running a single plant, the low-cost firm 1 in the high-cost/small-size country F (outcome DF);

5. ‘pure multinationals’ with both firms running two plants (outcome PM);

6. ‘mixed configurations’ with one firm running a single plant in the low-cost/large-size country H (outcome MH), or with one firm running a single plant in the high-cost/small-size country F (outcome MF).

We assume that individual inverse demand is an extended version of (1) and, due to firms' interactions, it needs to be specified under each possible outcome in both countries. For example, when firms run a single plant only and are agglomerated in H, the individual inverse demand facing firm 1 in country H is:

$$p_{1H}^{AH} = \alpha - \beta q_{1H}^{AH} - 2\sigma q_{2H}^{AH} \tag{5}$$

where p_{1H}^{AH} is the delivered price of firm 1 in country H under outcome AH, q_{1H}^{AH} and q_{2H}^{AH} are the corresponding quantities addressed to the two firms, and $\sigma < \beta/2$ measures the substitutability between varieties: the larger σ, the more similar varieties are.[2] Analogously

$$p_{1F}^{AH} = \alpha - \beta q_{1F}^{AH} - 2\sigma q_{2F}^{AH}$$

is the inverse demand facing firm 1 in country F. By symmetry, one can recover the inverse demands for both firms in all possible outcomes. As previously for c, the parameter d can be set to zero without loss of generality as this also amounts to rescaling α. For illustrative purposes, and to avoid a proliferation of sub-cases, let us assume that firms play a cooperative sub-game in the first stage and a non-cooperative sub-game in the second stage.[3] Put differently, they set quantities independently whereas they collude on location. Albeit admittedly particular, such setting allows for an easy illustration of the new insights that can be gauged in a duopoly setup.

The sequential game is solved backwards, that is, when choosing the number and location of their plants in the first stage, firms anticipate the result of quantity competition and the corresponding profits in the second stage. Specifically, in the second stage, firms choose their quantities simultaneously by maximizing their profits given the rival's choice and conditional on own and rival locations. For example, under outcome AH, firm 1 maximizes

$$\pi_1^{AH} = (e+E)\left(p_{1H}^{AH} + C + D\right) q_{1H}^{AH} + (e-E)\left(p_{1F}^{AH} + C + D - t\right) q_{1F}^{AH} - f,$$

whereas under outcome PM, firm 1 maximizes

$$\pi_1^{PM} = (e+E)\left(p_{1H}^{PM} + C + D\right) q_{1H}^{PM} + (e-E)\left(p_{1F}^{PM} - C + D\right) q_{1F}^{PM} - 2f.$$

[2]At the limit, varieties are perfect substitutes when $\sigma = \beta/2$, and they are independent when $\sigma = 0$.

[3]See, for example, Markusen (2002, Ch. 3) for an analysis of the non-cooperative case in both stages.

As was the case for inverse demands, the profits of both firms under all possible outcomes can be recovered by symmetry.

Due to market segmentation and constant marginal cost, firms' decisions in the two markets are independent. Accordingly, profit maximization for each firm in each market gives a reaction function in which the best-response quantity of the firm depends only on the quantity set by its rival in the same market. In the first stage, due to collusive behaviour, firms locate so as to maximize joint profit $\Pi \equiv \pi_1 + \pi_2$. In so doing, they compare the profits yielded by all the possible outcomes.

3.2.1 A single plant

A first comparison reveals that AH always dominates AF, whereas a second comparison shows that DH always dominates DF. In other words, there is neither reverse agglomeration nor reverse sorting in equilibrium, thus implying that there are only two candidate equilibrium outcomes when there are only single-plant firms: agglomeration in the low-cost/large-size country (AH) and sorting with the low-cost firm located in the low-cost/large-size country (DH).

In determining under which conditions one single-plant outcome prevails over the other, we focus on situations in which, when firms are not agglomerated, countries always engage in bilateral trade. This requires trade costs to be low enough, i.e. $t < t_{trade}$, with

$$t_{trade} \equiv \frac{\alpha(\beta - \sigma) - (D + C)(\sigma + \beta)}{\beta}.$$

For t_{trade} to be positive, $\alpha > (C + D)(\sigma + \beta)/(\beta - \sigma)$ must hold, which we assume from now on. Clearly, the larger the cost variance between countries (C) and between firms (D), the lower the trade barriers that allow for bilateral trade.

As a benchmark, consider a situation in which there are no differences between countries ($E = C = 0$) and between firms ($D = 0$). As already pointed out, there is only one type of agglomerated outcome, i.e. $\Pi^{AH} = \Pi^{AF} = \Pi^{A}$, and only one type of dispersed outcome, i.e. $\Pi^{DH} = \Pi^{DF} = \Pi^{D}$. This implies that the incentive for firms to disperse (i.e., $\Pi^{D} - \Pi^{A} \mid_{C=E=D=0}$) is equal to:

$$\Delta\Pi_{\text{comp}} = \frac{\beta^2 \sigma e t^2}{(\beta - \sigma)^2 (\beta + \sigma)^2} > 0$$

which, compared with the monopolistic equilibrium, shows that local competition is a dispersion force whose intensity falls as trade gets freer (lower t) and varieties become more differentiated (smaller σ).

Agglomeration. Consider now a situation in which countries differ only in terms of production costs ($E = 0$) and firms are identical ($D = 0$). Since sorting is not an issue here, there is only one type of dispersed outcome: $\Pi^{DH} = \Pi^{DF} = \pi^D$. In this situation, the differential profit is given by $\Pi^D - \Pi^{AH} \big|_{E=D=0} = \Delta\Pi_{\text{comp}} + \Delta\Pi_C$, where

$$\Delta\Pi_C = -\beta e C \frac{(\beta-\sigma)^2(2\alpha - t) - 4\sigma\beta C}{(\beta-\sigma)^2(\beta+\sigma)^2} < 0$$

which shows that international cost differences act as an agglomeration force (provided that $t < t_{trade}$). This force gets stronger as trade gets freer (lower t) and varieties become more differentiated (smaller σ). Thus, since lower trade costs and smaller product substitutability weaken the dispersion force of competition, whereas they strengthen the agglomeration force of international cost differences, trade liberalization and product differentiation foster agglomeration (Krugman, 1991; Ottaviano et al, 2002).

The next case has countries to differ only in terms of local market size ($C = 0$) with still identical firms ($D = 0$). Once more, sorting is not an issue, so $\Pi^{DH} = \Pi^{DF} = \Pi^D$. The profit differential can now be expressed as $\Pi^D - \Pi^{AH} \big|_{C=D=0} = \Delta\Pi_{\text{comp}} + \Delta\Pi_E$, where

$$\Delta\Pi_E = -\frac{\beta t(2\alpha - t)E}{2(\beta+\sigma)^2} < 0$$

which shows that international size differences act as an agglomeration force, whose intensity is magnified by lower trade costs (lower t) and more product differentiation (smaller σ). Note that, as trade barriers fall, the dispersion force of competition decreases at a rate of t^2, whereas the agglomeration force of size differences decreases at a rate of t. Since the former is faster than the latter, trade liberalization once more fosters agglomeration. The same holds true for product differentiation.

Sorting. Firm-specific cost differences can be introduced ($D > 0$) to see how they interact with international size and cost differences. When firm-specific cost differences are introduced together with country-specific cost differences ($E = 0$), the profit differential becomes $\Pi^{DH} - \Pi^{AH} = \Delta\Pi_{\text{comp}} + \Delta\pi_C + \Delta\pi_{CD}$ with

$$\Delta\Pi_{CD} = \frac{2\beta e C D}{(\beta-\sigma)^2} > 0 \tag{6}$$

which shows that sorting acts as a dispersion force when matched with country differences ($C > 0$). The more so, the larger the international differences (larger C) and the more differentiated the products (smaller σ). Note, however, that (6) is independent from trade barriers, so trade liberalization has no impact on the dispersion force due to sorting when countries differ in terms of production costs only.

The mirror case considers firm-specific differences together with international size differences ($C = 0$). In this case, the difference in profits is $\Pi^{DH} - \Pi^{AH} = \Delta\Pi_{\text{comp}} + \Delta\Pi_E + \Delta\Pi_{DE}$ with

$$\Delta\Pi_{DE} = \frac{\beta t D E}{(\beta-\sigma)^2} > 0$$

which shows again that sorting acts as a dispersion force, here amplified by wider country size differences (larger E), stronger product differentiation (smaller σ) and larger trade barriers (higher t).

3.2.2 Two horizontal plants.

Assume now that firms can run more than one plant and let us focus on the question of when firms produce locally in both countries. Since, as shown before, only the outcomes AH (i.e., 'agglomeration' with both firms running a single plant in the low-cost/large-size country H) and DH (i.e., 'dispersion plus sorting' with both firms running a single plant, the low-cost firm 1 in the low-cost/large-size country H) matter in the case where firms are exporters, we restrict ourselves to a brief comparision of these cases with the 'pure multinationals' case (outcome PM).[4]

As a benchmark, consider again the situation in which there are no differences between countries ($E = C = 0$) and between firms ($D = 0$). Firms' incentives to be multinational, $\Pi^m - \Pi^{AH} \mid_{C=E=D=0}$, evaluate to

$$\Delta\Pi^{mA}_{\text{comp}} = \frac{et(2\alpha - t)\beta}{2(\beta + \sigma)^2} - 2f,$$

whereas $\Pi^m - \Pi^{DH} \mid_{C=E=D=0}$ evaluates to

$$\Delta\Pi^{mD}_{\text{comp}} = \frac{1}{4}\beta t \left[\frac{e(4\alpha - t)}{(\beta + \sigma)^2} - \frac{et}{(\beta - \sigma)^2} \right] - 2f. \tag{7}$$

Both expressions highlight the proximity-vs-concentration trade-off discussed previously in the monopoly case: firms are never multinational when t is small enough, whereas they always run two plants when trade barriers are prohibitive. Moreover, since (7) is a decreasing function of σ, product differentiation favors horizontal FDI against export. The more so the higher trade barriers are.

When countries are allowed to differ, the results obtained under monopoly still hold: size and cost asymmetries again work against multinationals. Consider a situation in which countries differ only in terms of production costs ($E = 0$) and firms are identical ($D = 0$). In that case, we have $\Pi^m - \Pi^{AH} \mid_{E=D=0} = \Delta\Pi^{mA}_{\text{comp}} + \Delta\Pi^{mA}_{C}$, where

$$\Delta\Pi^{mA}_{C} = -\frac{Cm(2\alpha - t)\beta}{(\beta + \sigma)^2} < 0.$$

Analogously, we have $\Pi^m - \Pi^{D} \mid_{E=D=0} = \Delta\Pi^{mD}_{\text{comp}} + \Delta\Pi^{mD}_{C}$, where

$$\Delta\Pi^{mD}_{C} = -\frac{4C^2 e\beta^2\sigma}{(\beta - \sigma)^2(\beta + \sigma)^2} < 0.$$

[4] Comparing the outcomes with the mixed cases (outcomes MH and MF) yields complicated expressions that do not add much to our basic understanding. We hence omit them for the sake of brevity.

As in the monopoly case, production cost differences entice firms to operate a single plant in the low-cost country and, therefore, reduce the occurence of horizontal multinationals. When countries differ only in terms of local market size ($C = 0$) with still identical firms ($D = 0$), the profit differential is $\Pi^m - \Pi^{AH} \big|_{C=D=0} = \Delta\Pi^{mA}_{\text{comp}} + \Delta\Pi^{mA}_{E}$, where

$$\Delta\Pi^{mA}_{E} = -\frac{Et(2\alpha - t)\beta}{2(\beta + \sigma)^2} < 0.$$

One can further check that $\Pi^m - \Pi^{DH} \big|_{E=D=0} = \Delta\Pi^{mD}_{\text{comp}}$, thus showing that size differences do not matter for firms' choice between operating two plants or one plant each as dispersed exporters. Hence, overall size differences work (weakly) against multinationals as single plants firms are better able to exploit them.

Finally, we can again introduce firm-specific cost differences ($D > 0$) to see how they interact with international differences in costs and sizes in determining firms' organizational structure. When firm-specific cost differences are introduced together with country-specific cost differences ($E = 0$), the profit differential becomes $\Pi^m - \Pi^{AH} = \Delta\Pi^{mA}_{\text{comp}} + \Delta\Pi^{mA}_{C}$. Accordingly, firm-specific cost differences do not matter when firms choose between running a single plant under agglomeration or being multinational. This is due to the fact that both firms face the same competitive environment in all markets under the two regimes, which is independent of their cost difference. In the second case, $\Pi^m - \Pi^{DH} = \Delta\Pi^{mD}_{\text{comp}} + \Delta\Pi^{mD}_{C} + \Delta\Pi^{mD}_{CD}$ with

$$\Delta\Pi^{mD}_{CD} = -\frac{2CDe\beta}{(\beta - \sigma)^2} < 0$$

which shows that sorting across markets according to international cost differences acts as a force reducing the occurrence of multinationals.

The mirror case considers firm-specific differences together with international size differences ($C = 0$). In this case, the difference in profits is $\Pi^m - \Pi^{AH} = \Delta\Pi^{mA}_{\text{comp}} + \Delta\Pi^{mA}_{E}$, thus showing that firm-specific productivity differences do not interact with size differences in the organizational choice under agglomeration. The intuition is the same as in the previous case. Finally, one can check that $\Pi^m - \Pi^{DH} = \Delta\Pi^{mD}_{\text{comp}} + \Delta\Pi^{mD}_{E} + \Delta\Pi^{mD}_{DE}$, where

$$\Delta\Pi^{mD}_{DE} = -\frac{DE\beta t}{(\beta - \sigma)^2} < 0.$$

International size differences hence interact again with firm-level productivity differences to reduce the occurrence of multinationals.

3.3 Summary results

In this section we have developed a simple two-country partial equilibrium framwork to illustrate the main insights of NTT under monopoly and duopoly. The framework has allowed us to highlight the following key results in a two-country world:

Result 1 **Market-seeking and cost-saving attraction.** A single-plant monopolist produces in the country having a larger local market ('market-seeking attraction') and lower production costs ('cost-saving attraction'). Lower trade barriers increase the relative importance of cost saving with respect to market access for the plant location decision.

Result 2 **Proximity vs concentration**. Multinational activity through horizontal FDI is hampered by international asymmetries in market size and production costs, the more so the lower trade barriers are.

Result 3 **Global sourcing**. Multinational activity through vertical FDI is fostered by international asymmetries in production costs, the more so the lower trade barriers are.

Result 4 **Agglomeration**. Identical single-plant duopolists are attracted towards the country exhibiting a larger local market ('market-seeking attraction') and lower production costs ('cost-saving attraction'). The more so, the lower the trade barriers and the more differentiated the products.

Result 5 **Sorting**. Firm heterogeneity acts as a dispersion force as the more productive firm crowds its less productive rival out of the country with the larger market and the lower production costs. The more so the wider the international asymmetries, the stronger the product differentiation, and the higher the trade barriers.

Result 6 **Proximity vs concentration with sorting**. Multinational activity with firm heterogeneity supports the fact that international asymmetries in market size and production costs hamper horizontal FDI.

4 Industry reallocations

We have seen in the foregoing how the main insights of NTT, 'new economic geography', and multinational firms can be generated by a very simple model. While useful as a pedagogical tool, this model falls, however, short of being an appealing framework in which to assess the economic impacts and the welfare implications of complex real world trade reforms, or on which to base empirical work. To overcome such difficulties, the present section extends the simple set-up in the wake of Melitz and Ottaviano (2005). In particular, the extension allows for many countries, many firms, and endogenous firm-level heterogeneity. The extension also allows for a detailed welfare analysis of trade liberalization. The present section and the following Section 5 focus on single plant firms only. Multinationals are then introduced in Section 6.

The extended model integrates three main features that shape the attractiveness of a country to firms: locally available technologies and inputs ('cost-saving attraction'), the size of the local market for final products ('market-seeking attraction'), and the access to foreign customers ('accessibility'). Accordingly, the interactions among those three features determine the characteristics of local firms, and these in turn determine the welfare of the country. *Available* technologies and inputs determine the 'comparative advantage' of the country, whereas local market size and the access to foreign markets shape its 'competitive advantage' in terms of the technologies that are actually *adopted*. This happens through a selection process that sets a lower bound ('cutoff') on the productivity of firms able to operate locally. Most naturally, trade agreements affect accessibility and, therefore, the selection process.

To boost intuition, in presenting the analytical framework an incremental approach is again adopted. Specifically, the current section presents a two-country version of the framework that recovers the results derived in Section 3 when there are many firms. The next section then extends and calibrates the framework to a multi-country economy to highlight the role of accessibility and the associated impact of preferential trade policy.

4.1 Many firms

Consider two countries, labeled H and F as before, with respective sizes L^H and L^F. Without loss of generality, we assume that country H is larger ($L^H > L^F$). Entry and exit are free and there are a large number of potential entrants in each national market. The exposition focuses on country H. Expressions for country F can be derived by symmetry.

To allow for many differentiated suppliers, demand (5) is generalized as follows. For a generic firm i selling in country H inverse individual demand is given by

$$p_{iH} = \alpha - \gamma q_{iH} - \eta Q_H \tag{8}$$

where Q_H is total supply in market H. It is assumed that suppliers are so many that a single firm cannot affect Q_H. Formally, $Q_H = \int_0^{N^H} q_{iH} \mathrm{d}i$ where N^H is the mass of firms selling in H.[5]

As in the previous section, firms make their decisions sequentially. First, they choose where to locate; then, they produce. Differently from before, however, inter-firm cost differences are endogenized rather than assumed. In particular, after location, actual production requires the invention of a new product through R&D. This is a costly activity in so far as the invention of a new product requires a fixed cost f_E. R&D is also an uncertain activity that delivers a new horizontally differentiated variety with a random marginal cost of production c, drawn from some cumulative distribution G^H or G^F depending on the country firms choose to produce in. After the productivity draw, the R&D cost cannot be recouped,

[5]Note that, with respect to (5), demand has been simply reparametrized with $\gamma \equiv \beta - 2\sigma$ and $\eta \equiv 2\sigma$.

i.e., f_E is sunk. Consequently, in each country R&D generates a distribution of entrants across marginal costs.

To make the point as clear as possible, it is useful to adopt a specific parametrization even though most of the following results would hold for any continuous distribution. To fit reality, in equilibrium the chosen distribution will have to make large firms less frequent than small firms. This can be achieved by assuming that marginal costs are drawn from a Pareto distribution with upper cost bound c^H and shape parameter $k \geq 1$:

$$G^H(c) \equiv \left(\frac{c}{c^H}\right)^k, \ c \in [0, c^H]. \tag{9}$$

The shape parameter k captures the dispersion of cost draws. When $k = 1$, the cost distribution is uniform on $[0, c^H]$. As k increases, the relative number of high cost firms increases, and the cost distribution is more concentrated at these higher cost levels. As k goes to infinity, the distribution becomes degenerate at c^H. Given (9) the average cost of entrants (i.e., their expected cost) evaluates to $\overline{c}_E^H = c^H k/(k+1)$, with variance equal to $\overline{c}_E^H/[k(k+2)]$. Thus, the higher the cost bound c^H, the higher the mean and the variance of the cost distribution. This implies that an easy way to make country H offer better technological opportunities is to assume that $c^H < c^F$, so that entrants have a higher probability of getting good cost draws in country H than in country F.[6]

All entrants draw their costs simultaneously in the country they have chosen to produce in. This means that, after paying f_E, each firm gets to know its own marginal cost as well as the marginal costs of all other firms. It then decides whether to produce or not and, if yes, whether to export or not based on the profits it expects to make both at home and abroad. For an entrant in H with draw c, such profits are labeled $\pi_{HH}(c)$ and $\pi_{HF}(c)$ respectively, and they are conditional on the cost distribution of the entrants that eventually decide to produce. As in the previous section, exports face trade barriers t, which, for analytical convenience, are here redefined in the 'iceberg form' as $t \equiv (\tau - 1)c$, with $\tau > 1$. Only if $\pi_{HH}(c) > 0$ will the entrant produce for the local market and only if $\pi_{HF}(c) > 0$ will the entrant also export to the foreign country. Clearly, due to trade barriers, the second condition is more stringent. This generates a selection mechanism through which entrants end up in three cost categories defined by two threshold levels ('cutoffs'), c_D^H and c_X^H. High-cost entrants ($c > c_D^H$) decide not to produce at all and exit. Medium-cost entrants ($c_X^H < c < c_D^H$), serve only the domestic market; whereas low-cost entrants ($c < c_X^H$) also export to the foreign country F.

The domestic cutoff c_D^H and the export cutoff c_X^H are determined by the indifference conditions of marginal firms, that is, the firms that are just able to cover their marginal

[6] For example, one may think about the upper cost bound as being linked to fundamental societal characterstics like property rights protection and enforcement, as well as the institutional framework and the overall level of economic development.

costs for domestic and export sales, respectively:

$$\begin{aligned}\pi_{HH}(c_D^H) &= 0 \quad \Longleftrightarrow \quad p_{HH}(c_D^H) = c_D^H \\ \pi_{HF}(c_X^H) &= 0 \quad \Longleftrightarrow \quad p_{HF}(c_X^H) = \tau c_X^H\end{aligned} \tag{10}$$

Note that, in the same market, the marginal domestic seller and the marginal foreign exporter both make zero profit, which implies $c_D^H = \tau c_X^F$ and $c_D^F = \tau c_X^H$. In other words, because of trade barriers, in each country it is easier to survive as a domestic firm than as a foreign exporter.

Following Melitz and Ottaviano (2005), the optimal prices and output levels can be solely expressed as functions of the cutoffs:

$$\begin{aligned} p_{HH}(c) &= \frac{1}{2}\left(c_D^H + c\right) & q_{HH}(c) &= \frac{L^H}{2\gamma}\left(c_D^H - c\right) \\ p_{HF}(c) &= \frac{\tau}{2}(c_X^H + c) & q_{HF}(c) &= \frac{L^F}{2\gamma}\tau\left(c_X^H - c\right)\end{aligned} \tag{11}$$

which yields the following maximized profit levels:

$$\pi_{HH}(c) = \frac{L^H}{4\gamma}\left(c_D^H - c\right)^2 \qquad \pi_{HF}(c) = \frac{L^F}{4\gamma}\tau^2\left(c_X^H - c\right)^2 \tag{12}$$

4.2 Selection

Free entry of firms in country H implies zero expected profits in equilibrium. Stated differently, firms enter until their expected operating profits just cover the fixed R&D cost ('free entry condition'):

$$\int_0^{c_D^H} \pi_{HH}(c)\mathrm{d}G^H(c) + \int_0^{c_X^H} \pi_{HF}(c)\mathrm{d}G^H(c) = f_E.$$

Using the chosen parametrization (9) and the optimized profits (12), the free-entry condition can be explicitly rewritten as follows:

$$L^H\left(c_D^H\right)^{k+2} + L^F\rho\left(c_D^F\right)^{k+2} = \frac{2\gamma(k+1)(k+2)f_E}{\psi^H} \tag{13}$$

where we have used the relation $\tau c_X^H = c_D^F$. In (13), the expression $\rho \equiv \tau^{-k} \in (0,1)$ is an inverse measure of trade costs (i.e. the 'freeness' of trade) while $\psi^H \equiv \left(c^H\right)^{-k}$ is an index of 'average productivity' of the available technology ('absolute advantage').

The system formed by (13) and the analogous expression for country F can then be solved for the cutoffs in both countries as follows:

$$c_D^H = \left[\frac{2\gamma(k+1)(k+2)f_E}{1-\rho^2}\frac{1}{L^H}\left(\frac{1}{\psi^H} - \rho\frac{1}{\psi^F}\right)\right]^{\frac{1}{k+2}} \tag{14}$$

Bearing in mind (11) and (12), the parametrization (9) yields neat expressions for producer average performance measures such as average marginal cost $\bar{c}_D^H$, price $\bar{p}^H$, and markup $\bar{\mu}^H$:

$$\bar{c}_D^H = \frac{k}{k+1} c_D^H, \qquad \bar{p}^H = \frac{2k+1}{2(k+1)} c_D^H, \qquad \bar{\mu}^H = \frac{1}{2(k+1)} c_D^H \tag{15}$$

Note the distinction between the average cost of entrants $\bar{c}_E^H$ and the average cost of producers $\bar{c}_D^H$. As the cutoff c_D^H is lower than the upper bound c^H, on average producers are more productive than entrants. In other words, selection implies that on average adopted technologies are more productive than available technologies as part of the latter do not survive in equilibrium.

Selection also determines the number of firms that operate in country H. The number of sellers can be found by inverting (8) for the marginal domestic firm and imposing (10):

$$c_D^H = \frac{1}{\eta N^H + \gamma} \left(\gamma\alpha + \eta N^H \bar{p}^H \right) \tag{16}$$

Together with (15), (16) determines the number of firms selling in H:

$$N^H = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c_D^H}{c_D^H} \tag{17}$$

Thus, since firms sell differentiated products, a lower cutoff enriches product variety.

As to producers, note that the number of sellers N^H consists of both domestic producers and foreign exporters. Given a positive mass of entrants N_E^H in both countries, there are $N_D^H = G^H(c_D^H)N_E^H = \psi^H \left(c_D^H\right)^k N_E^H$ domestic producers and $N_X^F = G^F(c_X^F)N_E^F = \psi^F \left(c_X^F\right)^k N_E^F$ foreign exporters such that $N_D^H + N_X^F = N^H$. This condition can be solved together with its analogue for country F to obtain the number of entrants in each country. After using $\tau c_X^F = c_D^H$ and (17), the number of entrants evaluates to:

$$N_E^H = \frac{2(k+1)\gamma}{(1-\rho^2)\eta\psi^H} \left[\frac{\alpha - c_D^H}{\left(c_D^H\right)^{k+1}} - \rho \frac{\alpha - c_D^F}{\left(c_D^F\right)^{k+1}} \right] \tag{18}$$

and, given $N_D^H = \psi^H \left(c_D^H\right)^k N_E^H$, the corresponding number of producers:

$$N_D^H = \frac{2(k+1)\gamma}{(1-\rho^2)\eta} \left[\frac{\alpha - c_D^H}{c_D^H} - \rho \frac{\alpha - c_D^F}{c_D^F} \left(\frac{c_D^H}{c_D^F} \right)^k \right] \tag{19}$$

with analogous expressions holding for country F.

Expressions (14)-(19) shed light on the role of 'cost-saving attraction' and 'market-seeking attraction'. Increases in own market size (larger L^H) and improvements in own available technologies (larger ψ^H) reduce a country's cutoff (smaller c_D^H). This leads to richer product variety (larger N^H) as well as lower average production cost (smaller $\bar{c}^H$), lower average prices (smaller $\bar{p}^H$), and lower average markups (smaller $\bar{\mu}^H$). It also supports a larger number of domestic producers (larger N_D^H). Changes in the technologies available to the trading partner also affect the cutoff. In particular, technological progress in country F (larger ψ^F) increases the cutoff cost of country H. This leads to poorer product variety (smaller N^H) as well as higher average production cost (larger $\bar{c}^H$), higher average prices (larger $\bar{p}^H$), higher average markups (larger $\bar{\mu}^H$), and fewer domestic producers (smaller N_D^H). The partner's size is, on the contrary, irrelevant.

The foregoing expressions also shed some light on the impact of trade liberalization. When available technologies are the same ($\psi^H = \psi^F$), lower trade barriers (higher ρ) always reduce the cutoffs in both countries. This is also the case when available technologies differ ($\psi^H > \psi^F$) except when trade barriers are just above the threshold below which the industrial base of country F disappears. In such range, while the cutoff of the technologically advanced country still falls, it rises in the technologically backward one. The reason is that, as barriers fall in that range, domestic producers in F exit more rapidly than foreign exporters enter, which drives the local cutoff up.

4.3 Welfare

All the effects discussed so far have relevant welfare implications. To see this, note that with free entry aggregate profits vanish in equilibrium, so welfare in country H is given by consumer surplus only:

$$U^H = \frac{1}{2\eta}\left(\alpha - c_D^H\right)\left(\alpha - \frac{k+1}{k+2}c_D^H\right). \tag{20}$$

Expression (20) shows that welfare changes monotonically with the domestic cost cutoff, which captures the effects of both product variety and average price. Most naturally, welfare increases when the cutoff c_D^H decreases, as this leads to both richer product variety (higher N^H) and lower average price (lower $\bar{p}^H$).

When matched with (14), the relation between the domestic cutoff and welfare embedded in (20) allows one to conclude that welfare is higher in the country with stronger 'cost-saving' and 'attraction'. Moreover, whenever the available technologies do not differ between countries, trade liberalization has positive effects on welfare in both countries. The same holds true also when technologies differ, except when trade barriers are just above the threshold below which industry disappears from the technologically backward country. In this case, while the advanced country always gains, the backward country loses because more expensive imports slowly replace the rapidly vanishing local production. That happens until further trade liberalization makes imports cheap enough.

4.4 Summary results

This section has used a simple two-country multi-firm model to extend the main insights of the previous section to a workable framework allowing for endogenous firm heterogeneity. The model has generated the following results:

Result 7 **Market size and competition.** When available technologies are the same across countries, the larger national market is characterized by tougher competition. This supports richer product variety ('variety effect') as well as lower average production cost ('selection effect'), lower average prices and lower average markups ('pro-competitive effect'). Accordingly, welfare is higher in the larger country.

Result 8 **Technology and competition.** When market sizes are the same across countries, the technologically advanced country is characterized by tougher competition. Due to variety, selection and pro-competitive effects, welfare is higher in the technologically advanced country.

Result 9 **Trade liberalization and welfare.** When available technologies are the same across countries, trade liberalization generates tougher competition in both markets. Due to variety, selection and pro-competitive effects, trade liberalization improves welfare everywhere.

Result 10 **Technological differences.** When available technologies are not the same across countries, trade liberalization generates tougher competition in both countries except when trade barriers are just above the threshold below which industry disappears from the technologically backward region. Due to variety, selection and pro-competitive effects, liberalization improves welfare in the advanced region and worsens welfare in the backward region, until further trade liberalization makes imports cheap enough.

These results are summarized in Figures 1–5, which respectively depict the cutoffs, the numbers of sellers, entrants, and producers, as well as the levels of welfare in the two countries as functions of trade barriers.

[**Insert Figures 1–5 about here**]

Solid lines refer to country H, dashed lines to country F, and, when present, dotted lines to the whole economy. The figures reveal that, even though the backward region loses its industrial base as trade gets freer, welfare levels nonetheless converge since the location of producers becomes progressively immaterial for consumers.

5 Trade networks

So far, the analysis has been restricted to a pair of countries. This has allowed us to gain a rich set of insights on the intertwined impacts of attraction, firm heterogeneity, and trade liberalization on industry performance and welfare. However, focusing on two countries in isolation can be misleading. The reason is that the two-country set-up neglects the position of a country within the international trade network ('accessibility').

The aim of the present section is to stress the role of relative position and distances among countries. It shows that, absent accessibility differences, the insights of a multi-country set-up are a straightforward extension of those of the two-country one. New insights arise, instead, once countries are allowed to differ in terms of accessibility. This point is made theoretically in the case of three countries and then computationally through a numerical example calibrated on the EU.[7]

5.1 Three countries

While the model can easily deal with any number of countries and any spatial structure (see Section 5.2), considering three countries is enough to stress the role of accessibility. Accordingly, we add a third trading partner T to the two-country model presented in the foregoing. Again, the three countries differ in terms of cost-saving and market-seeking attractions. In particular, countries H and T are, respectively, the most and the least advanced ($\psi^H > \psi^F > \psi^T$) as well as the largest and the smallest ($L^H > L^F > L^T$). Countries also differ in terms of accessibility. In the case of country H, accessibility is determined by the 'freeness' of its trade with F and T: $\rho^{HF} = \left(\tau^{HF}\right)^{-k}$ and $\rho^{HT} = \left(\tau^{HT}\right)^{-k}$ respectively. For example, if $\rho^{HF} > \rho^{HT}$, country H is 'closer' to F than to T, meaning that shipments are cheaper, possibly because of smaller geographical distance, lower trade barriers or better transportation.

With three countries, the free entry condition (13) in H becomes:

$$L^H \left(c_D^H\right)^{k+2} + \rho^{HF} L^F \left(c_D^F\right)^{k+2} + \rho^{HT} L^T \left(c_D^T\right)^{k+2} = \frac{2\gamma(k+1)(k+2)f_E}{\psi^H}$$

with analogous expressions holding for F and T. This provides a system of three linear

[7] Behrens et al (2005) have shown that accessibility is an important aspect of multi-country trade networks that has to be controlled for in empirical work. They show, for example, that in order to test the 'home market effect' prediction of NTT, one has to filter accessibility differences out of the data.

equations in the three domestic cutoffs, which can be readily solved to yield:

$$c_D^H = \left[\frac{2\gamma(k+1)(k+2)f_E}{L^H} \frac{\left[1-\left(\rho^{FT}\right)^2\right]/\psi^H - \left(\rho^{HF}-\rho^{HT}\rho^{FT}\right)/\psi^F - \left(\rho^{HT}-\rho^{HF}\rho^{FT}\right)/\psi^T}{1+2\rho^{HF}\rho^{HT}\rho^{FT}-\left(\rho^{HF}\right)^2-\left(\rho^{HT}\right)^2-\left(\rho^{FT}\right)^2}\right]^{\frac{1}{k+2}} \tag{21}$$

The corresponding number of sellers N^H is still given by (17), while the number of entrants can be found by solving

$$\psi^H N_E^H + \rho^{HF}\psi^F N_E^F + \rho^{HT}\psi^T N_E^T = N^H$$

together with its analogous expressions for the other two countries. This gives the following number of entrants

$$N_E^H = \frac{\frac{\left[1-\left(\rho^{FT}\right)^2\right]N^H}{\left(c_D^H\right)^k} - \frac{\left(\rho^{HF}-\rho^{HT}\rho^{FT}\right)N^F}{\left(c_D^F\right)^k} - \frac{\left(\rho^{HT}-\rho^{HF}\rho^{FT}\right)N^T}{\left(c_D^T\right)^k}}{\psi^H\left[1+2\rho^{HF}\rho^{HT}\rho^{FT}-\left(\rho^{HF}\right)^2-\left(\rho^{HT}\right)^2-\left(\rho^{FT}\right)^2\right]} \tag{22}$$

with associated number of producers $N_D^H = \psi^H \left(c_D^H\right)^k N_E^H$.

Expressions (21) and (22) are, unfortunately, quite cumbersome. They are just reported here because, once extended to additional countries, they provide the framework for the EU example developed later. Before that, however, to get some general insight on the role of accessibility, it is useful to consider two particular 'pure' cases: (i) attraction without accessibility, and (ii) accessibility without attraction.

5.1.1 Attraction without accessibility

Consider a situation in which all countries have the same bilateral trade barriers ($\rho^{HF} = \rho^{HT} = \rho^{FT} = \rho$). In this case, accessibility due to relative trade barriers does not matter and countries differ only in terms of attraction. The corresponding cutoff for country H is

$$c_D^H = \left[\frac{2\gamma(k+1)(k+2)f_E}{L^H}\frac{(1+\rho)/\psi^H - \rho\left(1/\psi^F+1/\psi^T\right)}{(2\rho+1)(1-\rho)}\right]^{\frac{1}{k+2}}$$

with the associated number of sellers given by (17), the number of entrants given by:

$$N_E^H = \frac{(1+\rho)N^H/\left(c_D^H\right)^k - \rho\left[N^F/\left(c_D^F\right)^k + N^T/\left(c_D^T\right)^k\right]}{\psi^H(2\rho+1)(1-\rho)}$$

and the number of producers given by:

$$N_D^H = \frac{1}{(1+2\rho)(1-\rho)}\left\{(1+\rho)N^H - \rho\left[N^F\left(\frac{c_D^H}{c_D^F}\right)^k + N^T\left(\frac{c_D^H}{c_D^T}\right)^k\right]\right\}$$

These expressions are the natural counterparts of (14), (18), and (19) respectively and behave accordingly. As trade gets freer, the geography of production changes with the most backward country losing industry to the other two countries until no local producer can profitably operate anymore. Further liberalization makes the second most backward country lose industry to the advanced one. However, even though backward regions lose their industrial bases as trade gets freer, welfare levels nonetheless converge since the location of producers becomes progressively immaterial.

5.1.2 Accessibility without attraction

Consider a situation in which all countries have the same available technologies ($\psi^H = \psi^F = \psi^T = \psi$) and the same sizes ($L^H = L^F = L^T = L$). In this case, neither ex-ante cost saving due to relative productivities nor attraction due to relative market sizes matter and countries differ only in terms of accessibility. Simplifying (21), the associated cutoff for country H becomes:

$$c_D^H = \left[\frac{2\gamma(k+1)(k+2)f_E}{L\psi} \frac{\left(1-\rho^{FT}\right)\left(1+\rho^{FT}-\rho^{HF}-\rho^{HT}\right)}{1+2\rho^{HF}\rho^{HT}\rho^{FT}-\left(\rho^{HF}\right)^2-\left(\rho^{HT}\right)^2-\left(\rho^{FT}\right)^2} \right]^{\frac{1}{k+2}} \tag{23}$$

with the corresponding number of sellers given again by (17). Removing international differences in attraction does not simplify much the numbers of entrants, which is readily obtained from (22) by imposing $\psi^H = \psi$ in the denominator. The same holds true for the number of producers: $N_D^H = \psi \left(c_D^H\right)^k N_E^H$.

In expression (23), international differences in cutoffs stem from the accessibility measure $\left(1-\rho^{FT}\right)\left(1+\rho^{FT}-\rho^{HF}-\rho^{HT}\right)$. In particular, (23) reveals that the country with the best access to all other markets has the lowest cutoff. This occurs because this country is the best export base (or 'hub'). Moreover, since access is reciprocal, it is the most exposed to competition from abroad and, therefore, requires firms to be more productive to survive ('competition'). The fact that ρ^{FT} enters the expression of the cutoff of country H shows that any change in the bilateral trade freeness between any two countries is not irrelevant to the third one. This has important implications in terms of preferential trade agreements. To see that as clearly as possible, consider three countries of equal attraction with initially symmetric trade barriers ($\rho^{HF} = \rho^{HT} = \rho^{FT} = \rho$). Accordingly, by (23), the initial cutoffs are identical and equal to:

$$c_D = \left[\frac{2\gamma(k+1)(k+2)f_E}{L\psi} \frac{1}{1+2\rho} \right]^{\frac{1}{k+2}} \tag{24}$$

Introduce now a preferential trade agreement between H and F such that $\rho^{HF} = \rho' > \rho = \rho^{FT} = \rho^{HT}$. The new trade regime affects the cutoffs of all country. Given (23), in the insider countries the new cutoffs are:

$$c_D^H = c_D^F = \left[\frac{2\gamma(k+1)(k+2)f_E}{L\psi}\frac{(1-\rho')(1-\rho)}{1+2\rho'\rho^2-2\rho^2-(\rho')^2}\right]^{\frac{1}{k+2}} \tag{25}$$

while in the outsider country the new cutoff becomes:

$$c_D^T = \left[\frac{2\gamma(k+1)(k+2)f_E}{L\psi}\frac{(1-\rho')\left[(1-\rho)+(\rho'-\rho)\right]}{1+2\rho'\rho^2-2\rho^2-(\rho')^2}\right]^{\frac{1}{k+2}} \tag{26}$$

By comparing (24), (25) and (26), it is easily verified that preferential liberalization reduces the cutoffs of the insiders whereas it increases the cutoff of the outsider. The reason is that the liberalizing countries become better export bases: they gain better access to each other's market while maintaining the same ease of access to the third country's market. Average costs, prices, and markups move accordingly, decreasing in the insiders and rising in the outsider. Welfare levels move in the opposite direction, rising for the insiders and falling in the outsider.

5.2 A numerical example

As the number of countries grows, the model continues to be analytically solvable but becomes unwieldy. The present section presents the results of a numerical investigation of a stylized economy calibrated on EU data in the wake of Del Gatto et al (2006).

5.2.1 Many countries and many sectors

The cutoff (21) can be readily generalized to the case of M countries and S sectors. In particular, let $\rho_s^{lh} \equiv \left(\tau_s^{lh}\right)^{-k_s} \in (0,1]$ measure the 'freeness' of trade for exports from l to h in sector s and $\psi_s^l = \left(c_{M,s}^l\right)^{-k_s}$ be an (inverse) index of absolute advantage of country l in sector s. Then, the equilibrium domestic cutoffs in sector s ($s = 1, 2, \ldots, S$) and country h ($h = 1, 2, \ldots, M$) equals:

$$c_s^{hh} = \left(\frac{2(k_s+1)(k_s+2)f_{E,s}\gamma_s}{|P_s|}\frac{\sum_{l=1}^M \left|C_s^{lh}\right|/\psi_s^l}{L^h}\right)^{\frac{1}{k_s+2}} \tag{27}$$

where $|P_s|$ is the determinant of the trade freeness matrix and $\left|C_s^{lh}\right|$ is the cofactor of its element ρ_s^{lh}. Cross-country differences in cutoffs arise from three sources: own country size (L^h), as well as a combination of market access and comparative advantage ($\sum_{l=1}^M \left|C_s^{lh}\right|/\psi_s^l$). Countries benefiting from a larger local market, a better distribution of productivity draws, and better market accessibility have lower cutoffs.

Under the Pareto assumption, the delivered cost of domestic firms $c\tau_s^{hh} \in [0, c_s^{hh}]$ and the delivered cost of exporters $c\tau_s^{lh} \in [0, c_s^{lh}]$ have identical distributions over this smaller support as given by $G_s^h(c) = \left(c/c_s^{hh}\right)^{k_s}$. The price distribution in country h of domestic firms producing in h, $p_s^{hh}(c)$, and exporters producing in l, $p_s^{lh}(c)$, are therefore also identical, which implies that the average price in country h and sector s equals:

$$\bar{p}_s^h = (2k_s + 1)\sqrt{\frac{\overline{\mu}_s^h \overline{c}_s^h}{2k_s}}. \tag{28}$$

where $\overline{\mu}_s^h = c_s^{hh}/(2k_s + 2)$ and $\overline{c}_s^h = k_s c_s^{hh}/(k_s + 1)$ respectively are the average markup and the average cost of firms selling to country h in sector s. Hence, a percentage change in the cutoff c_s^{hh} has the same percentage impact on both the average markup $\overline{\mu}_s^h$ ('pro-competitive effect') and the average cost $\overline{c}_s^h$ ('selection effect'). Together these effects imply the same percentage impact on the average price, being each responsible for half of the impact. Finally, since the average profit evaluates to $\overline{\pi}_s^h = f_{E,s}\left(c_s^{hh}\right)^{-k_s}/\psi_s^l$, a one percentage change in the cutoff c_s^{hh} causes a percentage change of $-k_s$ in the average profit. Unfortunately, as there is no obvious way to calibrate the preference parameters, the quantitative impact of counterfactual scenarios on the number of sellers ('variety effect') and thus on overall welfare cannot be evaluated. Nevertheless, the theoretical model implies that the indirect utility is negatively correlated with the average cost no matter what happens to product variety.

5.2.2 A gravity equation

The model yields a gravity equation for aggregate bilateral trade flows by aggregating export sales $r_s^{lh}(c)$ over all exporters from l to h (with cost $c \leq c_s^{lh}$). Specifically, the aggregate bilateral exports in sector s from l to h are given by:

$$\mathrm{EXP}_s^{lh} = \frac{1}{2\gamma_s\,(k_s + 2)} N_{E,s}^l \psi_s^l L^h \left(\rho_s^{hh}\right)^{-(k_s+2)/k_s} \left(c_s^{hh}\right)^{k_s+2} \rho_s^{lh}. \tag{29}$$

This is a gravity equation in so far as it determines bilateral exports as a (log-linear) function of bilateral trade barriers and country characteristics. In particular, it reflects the combined effects of country size, technology (comparative advantage), and geography (accessibility) on both the extensive (number of traded goods) and intensive (amount traded per good) margins of trade flows. It highlights how a lower cutoff c_s^{ll} in country l dampens exports by making it harder for potential exporters in other countries to break into that market. Also note the role of the internal freeness of trade ρ_s^{hh}, which has a negative impact on international trade flows.

5.2.3 Calibration and simulation

Our model can be used to shed light on the effects of trade liberalization in two stages: calibration and simulation. At the calibration stage, Del Gatto et al (2006) first use trade and geographical data for the year 2000 to recover the sectoral trade freeness $\rho_s^{lh} = \left(\tau_s^{lh}\right)^{-k_s}$ from the gravity equation (29). In particular they assume, as usual in the gravity literature, that $\rho_s^{lh} = \exp(\beta^h + \lambda\ Lang^{lh})\ (d^{lh})^{\delta_s}$ if $l \neq h$, and $\rho_s^{lh} = (d^{lh})^{\delta_s}$ if $l = h$, where d^{lh} is distance between counties l and h, β^h is a coefficient capturing the fall in trade due to crossing country h border, and $Lang^{lh}$ is a dummy variable that takes value one if l and h share a common language. This allows them to obtain the trade freeness matrix P_s and to compute its determinant and co-factors that appear in equation (27).

They then use a database on manufacturing firms belonging to 11 EU countries (Belgium, Germany, Denmark, Spain, Finland, France, Great Britain, Italy, Netherlands, Portugal, and Sweden) and 18 manufacturing sectors to estimate individual total factor productivities (TFP) for the year 2000. From such productivities, they recover two additional elements of equation (27): the shape parameter of the underlying Pareto distribution (k_s) and the M endogenous domestic cut-offs (c_s^{hh}) by sector. Using the computed values of P_s, k_s and c_s^{hh} together with data on population L^h, they finally solve (27) to obtain the index of absolute advantage ψ_s^l up to a sector specific constant (related to $f_{E,s}$ and γ_s).

In the simulation stage, they run a counterfactual analysis on the calibrated model. In particular, they simulate the changes in productivity due to changes in trade costs by recomputing c_s^{hh} for alternative trade freeness matrices P_s. Two scenarios are considered: one in which international trade costs are prohibitive ($\rho_s^{lh} = 0$ for $l \neq h$), and one in which international trade costs (τ_s^{lh} for $l \neq h$) are reduced by 5 per cent. They find, on the one hand, that in the year 2000 an increase of trade barriers to prohibitive levels would have caused an average productivity loss of roughly 13 per cent, associated with a 16 per cent average increase in both prices and markups, as well as a fall of 23 per cent in average profits. On the other hand, a 5 per cent reduction in trade costs, would have raised average productivity by roughly 2 per cent, leading to a 2 per cent average decreases in both prices and markups, as well as a 5 per cent increase in average profits. These estimates reveal that the Darwinian selection of the best firms is an important effect of trade liberalization.[8]

5.2.4 Integration scenarios

In order to give a flavor of how the model reacts to different integration scenarios, we extend the analysis of Del Gatto et al (2006) further by simulating the following counterfactuals:

1. **'Multilateral trade liberalization 1'**. We start by simulating a 2 per cent decrease of international trade costs for all the 11 countries in their sample. This allows us to

[8] Del Gatto et al (2006) have shown that these results are fairly robust to alternative measures of productivity and trade costs. Indeed, the robustness checks overall suggest that, if anything, those numbers may actually underestimate the overall selection effects.

show how productivity changes induced by market integration relate to accessibility and attraction.

2. **'Preferential trade agreement'**. We simulate a 2 per cent decrease of international trade costs for the five (Belgium, Germany, France, Italy, and the Netherlands) out of the six founding EU countries only.[9] This should provide some assessment of how a preferential trade agreement affects selection.

3. **'Multilateral trade liberalization 2'**. We consider a 5 per cent drop of international trade costs for all countries with respect to a pre-existing preferential trade agreement among founding members. This analysis will allow us to show how the impact of a multilateral trade liberalization changes if some asymmetric trade agreement is already in place.

4. **'United Europe'**. By estimating the gravity equation (29), Del Gatto et al (2006) are able to recover one crucial component of trade costs: the border effects. These border effects measure the decrease of trade flows due to the crossing of an international border and represent a substantial portion of international trade costs (roughly 24 per cent). In order to shed light on the potential gains stemming from further behind-the-border integration ('harmonization') within the EU, we simulate what would happen to productivity if such border impediments were eliminated.

5. **'Partially United Europe'**. We eliminate border effect for the five founding EU countries in our sample only. This should again provide some useful insights on preferential trade agreements.

In order to provide results comparable with those of the FDI extension in Section 6, we do not consider here (unlike in Del Gatto et al, 2006) the 'Petroleum and Coal' industry for which few FDI data exists. Furthermore, to ensure a better comparability with previous studies, we have re-scaled the k_s to an average of 3.6 across sectors, as in the calibration of Bernard et al (2003). This latter change should, as shown in Del Gatto et al (2006), translate into higher productivity changes in response to a given trade cost reduction.

Tables 1 and 2 show the results of our simulations by country and by industry, respectively. The results for the first integration scenario ('Multilateral trade liberalization') is shown in column 3 of Table 1. Gains are defined as the average (across sectors) percentage increase of $1/c_s^{hh}$ which, under the Pareto assumption, corresponds to a proportional change in average industry-country productivity. The average productivity gain for the 11 countries is 2.67 per cent, but there is a lot of cross country variation with gains ranging

[9]The sixth EU founding member (Luxembourg) is missing in the data by Del Gatto et al. (2006).

Table 1: Productivity gains by country (exporters only)

Scenario		"Mult TL 1"	"Pref TA"	"Mult TL 2"	"United EU"	"Part Unit EU"
Country initials	Country	% gain	% gain	% gain	% gain	% gain
BE	Belgium	4.63	1.15	2.86	14.03	7.93
DE	Germany	8.59	2.66	10.21	11.45	7.16
DK	Denmark	4.64	-0.32	3.62	16.96	-4.76
ES	Spain	2.86	-0.03	2.83	14.48	-0.33
FI	Finland	1.88	-0.05	1.83	12.89	-0.63
FR	France	3.55	0.26	3.87	29.92	5.06
GB	Great Britain	0.21	-0.03	0.18	8.91	-0.33
IT	Italy	0.90	0.09	0.99	6.11	2.66
NL	Netherlands	1.50	0.47	2.08	9.27	1.91
PT	Portugal	0.13	-0.15	0.11	1.39	-1.03
SE	Sweden	0.50	-0.08	0.43	8.14	-0.98
Average		2.67	0.36	2.64	12.14	1.51

Table 2: Productivity gains by industry (exporters only)

Scenario	"Mult TL 1"	"Pref TA"	"Mult TL 2"	"United EU"	"Part Unit EU"
Industry	% gain	% gain	% gain	% gain	% gain
Food beverages and tobacco	0.82	0.17	1.01	8.40	0.61
Textiles	3.41	0.19	3.59	1.92	3.06
Wearing apparel except footwear	7.06	0.78	1.92	10.24	0.76
Leather products and footwear	19.05	0.79	14.57	39.32	0.83
Wood products except furniture	0.74	0.26	1.07	16.39	2.55
Paper products	1.39	0.19	2.06	11.79	-1.05
Printing and Publishing	0.65	0.15	0.82	5.04	1.04
Chemicals	1.19	0.21	1.43	14.66	1.81
Rubber and plastic	1.49	0.59	2.80	15.52	1.08
Other non-metallic mineral products	1.52	0.25	1.81	5.44	0.15
Metallic products	0.72	0.29	1.08	15.05	2.79
Fabricated metal products	1.02	0.37	1.57	7.07	0.89
Machinery except electrical	1.48	0.47	2.33	8.27	0.60
Electric machinery	1.28	0.29	1.65	10.91	-1.03
Professional and scientific equipment	2.21	0.25	2.36	12.58	-0.47
Transport equipment	1.37	0.32	1.81	10.06	1.29
Other manufacturing	2.79	0.58	5.11	7.93	0.72
Average	2.83	0.36	2.76	11.80	0.92
Correlation with δ_s	0.13	0.21	0.28	0.21	0.41

from 8.59 per cent for Germany to 0.13 per cent for Portugal. In accordance with the simplified versions of the model presented in the previous sections, these gains are positively correlated with international accessibility, as measured by $\bar{\rho}_s^h = \sum_l \hat{\rho}_s^{lh}/(M-1)$ for $l \neq h$ (the partial correlation being equal to 0.26), and with absolute advantage ψ_s^l, which we can identify up to a scale factor (the partial correlation being equal to -0.11).

Under the second scenario ('Preferential trade agreement') in column 4, it is easily verified that only the 5 countries that decrease trade barriers among each other experience positive gains, although these are smaller than in the multilateral case. Other countries see their productivity decrease because some of the exporting firms outside the preferential trade agreement are replaced by firms within the 5 country group (that can now reach final consumers more easily, i.e., there is trade diversion) and thus some of their export profits are lost. Profitability in those markets goes down and, to restore the equilibrium free entry condition, fewer firms choose to pay the sunk cost of entry. As a result, the cost cutoff increases and productivity decreases.

The third scenario ('Multilateral trade liberalization 2') in column 5 of Table 1 features a general 5 per cent trade cost reduction in a world where a preferential trade agreement among the 5 founding EU members is already in place. Comparing columns 3 and 5 reveals that Germany, France, Italy and the Netherlands gain more from a multilateral decrease in trade costs when they are already part of a preferential trade agreement. By contrast, other countries gain systematically less.

The fourth scenario ('United Europe') in column 6 simulates the impact of the elimination of destination-specific border effects (β^h) that represent a large share of international trade frictions (roughly 24 per cent). As one can see, average productivity gains for the EU are large (12.14 per cent). Overall, this simulation suggests that there are substantial potential gains from further behind-the-border integration in the EU. Again, country specific gains vary considerably depending on the underlying absolute advantage and accessibility changes. Interestingly, countries with the largest border effects are, conditionally on their technology, those who gain the least. The correlation between (the negative valued) β^h and productivity gains is 0.16. The reason is that trade costs decrease asymmetrically across countries and that those countries who open themselves the most see the profitability of indigenous firms fall substantially.

The fifth and final experiment ('Partially United Europe') in column 7 of Table 1 analyzes a particular case of preferential trade agreement, namely the elimination of border effects only for trade flows within the 5 founding EU members. As in the case of a simple preferential trade agreement, countries inside (outside) the agreement experience productivity gains (losses).

Table 2 provides sectoral figures for the various experiments. The magnitude of the sectoral gains is essentially driven by the degree of industry openness to trade, as measured by the distance elasticity parameter δ_s from the gravity equation. The more open the industry is to trade (lower δ_s), the higher are the gains from a given percentage fall in trade costs. The correlation between the sectoral gains and the δ_s is provided in the last row of Table 2. As one can see, sectoral gains are all positive except for three industries ('Paper products', 'Electric machinery' and 'Professional and scientific equipment') in the 'Partially United Europe' case. These negative values come from the fact that countries outside the preferential trade agreement are extremely productive in those sectors and a trade diversion effect is thus at work. Finally, note that average gains across sectors do not perfectly match those across countries for two reasons. The first is that one industry ('Leather products and footwear') is missing for Denmark. The other is that, especially for large trade cost reductions, like in the United Europe and the Partially United Europe experiments, some industry-country couples cease to exist because the reduction in trade costs is strong enough to make the free entry condition infeasible in such low profits markets.

Table 3: Specialization and economic fundamentals

	Fundamentals		Countries' specialization										
Industry	δ_s	k_s	BE	DE	DK	ES	FI	FR	GB	IT	NL	PT	SE
Food beverages and tobacco	-1.74	3.44	1.08	1.02	1.22	1.11	0.70	1.30	0.98	0.72	1.10	1.24	0.62
Textiles	-1.05	3.86	1.47	0.44	0.47	1.10	0.41	0.74	0.88	1.92	0.51	2.80	0.29
Wearing apparel except footwear	-1.35	3.10	0.47	0.26	0.37	1.60	0.51	0.77	0.76	1.84	0.18	4.58	0.13
Leather products and footwear	-1.11	4.03	0.21	0.22	0.22	1.87	0.45	0.63	0.37	2.35	0.18	3.82	0.10
Wood products except furniture	-2.02	4.22	0.70	0.80	1.13	1.33	2.17	0.77	0.69	1.23	0.59	1.93	1.68
Paper products	-1.43	3.38	1.01	0.87	0.83	0.90	3.54	1.01	1.04	0.87	1.03	0.55	2.44
Printing and Publishing	-2.46	3.42	0.99	0.85	1.46	0.92	1.18	1.05	1.53	0.67	1.64	0.60	1.17
Chemicals	-1.38	3.11	2.02	1.14	1.03	0.87	0.71	0.98	1.04	0.81	1.29	0.49	0.91
Rubber and plastic	-1.63	4.08	0.82	1.10	0.99	0.89	0.86	1.13	1.26	0.83	0.71	0.56	0.69
Other non-metallic mineral products	-1.76	3.70	1.13	0.85	1.03	1.46	0.79	0.79	0.75	1.36	0.68	1.32	0.50
Metallic products	-1.45	3.79	2.00	1.07	0.65	0.87	1.17	1.00	0.96	0.99	0.83	0.40	1.37
Fabricated metal products	-1.72	4.21	0.94	1.00	1.01	1.03	0.84	1.07	0.94	1.09	1.01	0.55	1.02
Machinery except electrical	-1.49	4.03	0.63	1.34	1.46	0.64	1.31	0.80	0.89	1.05	0.88	0.26	1.23
Electric machinery	-1.12	3.32	0.90	1.16	0.93	0.59	1.68	0.96	1.11	0.87	1.13	0.76	1.31
Professional and scientific equipment	-1.51	3.17	0.49	1.42	1.16	0.50	0.66	1.16	1.12	0.77	0.53	0.26	1.08
Transport equipment	-1.46	3.54	1.01	1.32	0.41	1.04	0.55	1.06	1.11	0.59	0.69	0.38	1.36
Other manufacturing	-1.72	3.66	0.82	0.65	1.36	1.33	0.78	0.99	0.90	1.09	2.51	1.16	1.09

One might wonder to what extent our results can be embedded into a more complex scenario that includes, for example, other OECD countries or big emerging economies like China and India. Unfortunately, we lack sufficient productivity data to add other countries to our experiment. Nevertheless, a simple analysis of countries' specialization, coupled with information on other economic fundamentals like the sectoral elasticity of trade with respect to distance (δ_s) and the sectoral dispersion of productivity (k_s), provides some useful insights. The lower the trade costs in a sector (low absolute value of δ_s), the stronger the impact of trade integration.[10] Furthermore, the lower the sectoral productivity dispersion (high k_s), the higher the perceived effect of trade integration. This is because all what matters in equation (27) is the freeness of trade $\rho_s^{lh} = \left(\tau_s^{lh}\right)^{-k_s}$, and because k_s magnifies a reduction in τ_s^{lh}. Therefore, if a country is highly specialized in a particular good for which the absolute value of δ_s is small, whereas k_s is large, then opening-up of trade with a very productive competitor may be devastating.

Table 3 summarizes all the sectoral δ_s and k_s, together with a simple country-sector specific Balassa index of specialization (based on total hours worked by employees).[11] This index takes values above (below) one when a country is (is not) specialized in a given industry. As one can notice, Italy is, for example, highly specialized in the 'Textile and Leather products' and 'Footwear' industries which are both characterized by a low δ_s and high k_s. It thus does not come as a surprise that Italy is complaining so much about the increasing competition from China and India in those industries.

[10] See Melitz and Ottaviano (2005) for a proof of this result.

[11] Data on total hours worked by employees in any country-sector pair comes from the Groningen Growth and Development Centre (GGDC) databases. The k_s reported in Table 3 are those used in the simulations. Compared to Del Gatto et al. (2006), they have been re-scaled to an average of 3.6 across sectors.

5.3 Summary results

When bilateral trade barriers are the same for all countries, the analysis of a multi-country set-up reduces to that of a two-country set-up and confirms the four insights derived in the previous section. However, when bilateral trade barriers differ across country pairs, several new results stand out:

Result 11 **Accessibility and productivity.** Countries with better access to other markets have higher average productivity. This occurs because such countries are better export bases (or 'hubs') and thus attract firms, which supports richer product variety ('variety effect') as well as lower average production cost ('selection effect'), lower average prices and lower average markups ('pro-competitive effect'). Accordingly, welfare is higher in countries with better accessibility.

Result 12 **Third country effects.** In principle, any change in the bilateral trade freeness between any pair of countries is not irrelevant to the other countries. In particular, preferential trade liberalization increases the average productivity of insiders whereas it decreases the average productivity of outsiders. This maps into parallel changes in product variety, industrial activity, and welfare. The reason is that the liberalizing countries become better export bases: they gain better access to each other's market while maintaining the same ease of access to the third countries' markets. Average costs, prices, and markups move accordingly, decreasing for the insiders and rising for the outsiders. Product variety and welfare move in the opposite direction.

6 Multinationals

The model presented in Sections 4 and 5 maintains the simplifying assumption that all firms run a single plant only. Yet, it is well known that FDI has grown more rapidly than trade in recent decades as the main mode to serve foreign markets (Barba Navaretti and Venables, 2004). We now integrate this fact into the analysis by presenting an extension of our model to the case in which firms may choose to become horizontal multinationals.

6.1 Extended model

The basic set-up is identical to that presented in the multi-country model and each multinational firm is assumed to behave like a local firm in each national market it serves. As the same firm may serve some markets by (horizontal) FDI and others by exports, for simplicity we assume that exports may only originate from the country where the firm has its headquarters. In other words, foreign plants are not used by firms as export bases. This is clearly a restrictive assumption but relaxing it gives rise to formidable complications that we have not explored further in detail until now.

Consider a firm headquartered in country i (from where it exports to all the markets in which it does no FDI), with marginal cost c. If this firm choses to be a multinational, with local foreign production plants in a subset $\mathcal{S}$ of countries (excluding its home country i), its maximized operating profit is given by

$$\pi_i^m(c) = \sum_{l \in \mathcal{S} \cup \{i\}} \frac{L^l (\tau^{ll})^2}{4\gamma} \left[c_D^l - c\right]^2 + \sum_{j \notin \mathcal{S},\, j \neq i} \frac{L^j (\tau^{ij})^2}{4\gamma} \left[\frac{c_D^j \tau^{jj}}{\tau^{ij}} - c\right]^2 .$$

The first part of this expression stands for the operating profit earned in all markets that are served locally (including its home market i), whereas the second part stands for the operating profit earned in all markets that are served through exports originating in the home country i.

A multinational firm incurs a sunk entry cost f_E for its first plant, which corresponds as before to the cost of getting a technology draw. It then faces an additional fixed cost cf_M^{ij} for setting-up foreign operations in country j when it is headquartered in country i. Note that in our specification the fixed set-up costs for foreign plants are: (i) proportional to the firm's marginal cost, thus implying that more productive firms also have lower costs for establishing affiliates in foreign markets; and (ii) specific to each country pair. The first feature, namely that more productive firms predominantly serve foreign markets through FDI, has been repeatedly highlighted in the empirical literature (Carr et al., 1998; Helpman et al., 2004; Del Gatto et al., 2006). The second feature captures the fact that if we interpret the fixed costs for FDI broadly as including all the costs of setting-up and running a business in a foreign country, aspects like cultural ties, linguistic ties, and business culture are included in these costs and, therefore, explain why they vary across country pairs.

Firms' arbitrage between exports and FDI implies that both options must be equally profitable in equilibrium. Equating the profit difference across FDI and exports, for serving market j from country i, to zero yields

$$\frac{L^j (\tau^{jj})^2}{4\gamma} \left[c_D^j - c\right]^2 - \frac{L^j (\tau^{ij})^2}{4\gamma} \left[\frac{c_D^j \tau^{jj}}{\tau^{ij}} - c\right]^2 - cf_M^{ij} = 0, \tag{30}$$

which allows us to retrieve the corresponding cut-off level for FDI:[12]

$$c_M^{ij} = \frac{2c_D^j \tau^{jj}}{\tau^{ij} + \tau^{jj}} - \frac{4f_M^{ij}\gamma}{L^j \left[(\tau^{ij})^2 - (\tau^{jj})^2\right]}. \tag{31}$$

Unfortunately, we have no information on the fixed costs f_M^{ij} in the data. Yet, we can retrieve them from the no-arbitrage condition (30) provided that we know the cut-offs c_M^{ij}.

[12] The second root of the quadratic equations is equal to 0.

To get a rough idea on multinationals' productivity edge over exporters, we estimate it from a database that combines information on productivity (value added per worker) and export status of all firms with at least 20 employees.[13] The overall productivity advantage of multinationals over exporters is 29.7 per cent. This gap shrinks to 15 per cent when corrections for capital intensity and sectoral dummies are included, which matches exactly the (comparable) figure that Helpman et al. (2004) find for the US.

Unfortunately, our data does not allow us to break-down the productivity advantage by destination country, as required to determine the cutoffs c_M^{ij} and the fixed costs f_M^{ij}. Nevertheless, data on foreign-owned firms serving the French market (inward French FDI) reveals that the productivity required to enter the French market as a multinational is increasing with distance.[14] Considering only the top 17 investor countries (Germany, Austria, Belgium, Canada, Denmark, Spain, US, Finland, Great Britain, Ireland, Italy, Japan, Luxembourg, Norway, Netherlands, Sweden, and Switzerland), which represent more than 90% of foreign-owned firms, we obtain a positive and significant correlation between productivity and distance (the correlation being 0.24). In the light of our model, this result suggests that the fixed cost f_M^{ij} is increasing with distance between i and j at a rate which might be even stronger than that of the trade elasticity.[15]

Lacking more precise information on multinationals' productivity advantage over exporters, we thus use a 30% gap as our benchmark. Let us hence define the initial cut-off values for FDI as follows:

$$c_M^{ij} \equiv \frac{c_X^{ij}}{1.3} = \frac{c_D^j \tau^{jj}}{1.3\, \tau^{ij}}. \tag{32}$$

Since $0 < c_M^{ij} < c_X^{ij} < c_D^j$, the most productive firms in country i will serve all foreign markets via FDI; the next productive firms will serve some markets by FDI and others via exports; whereas less productive firms will export only to a subset of markets, and the least productive firms eventually do not export at all and only sell in the domestic market. This ranking of FDI, exports, and domestic operations as a function of productivity is consistent with empirical evidence and previous theoretical work (Helpman et al, 2004).

Having obtained initial values for the cut-offs c_M^{ij}, the fixed cost f_M^{ij} for FDI can be retrieved from (30) as follows:

$$f_M^{ij} = \frac{L^j (\tau^{jj})^2}{4\gamma c_M^{ij}} \left[c_D^j - c_M^{ij}\right]^2 - \frac{L^j (\tau^{ij})^2}{4\gamma c_M^{ij}} \left[\frac{c_D^j \tau^{jj}}{\tau^{ij}} - c_M^{ij}\right]^2. \tag{33}$$

[13] Productivity information is provided by the French National Institute of Statistics (INSEE), whereas information about the multinational status is provided by the French Treasury and Economic Policy Directorate (DGTPE).

[14] Data on inward French FDI is provided by the French National Institute of Statistics (INSEE).

[15] Interestingly, Carr et al (2001) provide evidence that aggregate foreign subsidiaries' sales are negatively related to distance. This result is coherent with the existence of a positive relationship between the costs of doing FDI and distance.

Using these values, the generalized free entry condition in country i, that takes into account multinational operations, is such that

$$\frac{L^i(\tau^{ii})^2}{4\gamma}\int_0^{c_D^i}\left[c_D^i - c\right]^2 \mathrm{d}G^i(c) + \sum_{j\neq i}\frac{L^j(\tau^{ij})^2}{4\gamma}\int_{c_M^{ij}}^{c_X^{ij}}\left[c_X^{ij} - c\right]^2 \mathrm{d}G^i(c)$$
$$+\sum_{j\neq i}\frac{L^j(\tau^{jj})^2}{4\gamma}\int_0^{c_M^{ij}}\left[c_D^j - c\right]^2 \mathrm{d}G^i(c) = f_E + \sum_{j\neq i}\int_0^{c_M^{ij}} c f_M^{ij} \mathrm{d}G^i(c), \qquad (34)$$

where the left-hand side of the equality is the expected operating profit and where the right-hand side consists in the sunk entry cost plus the expected fixed costs for serving foreign markets by FDI. These latter costs depend on the number of foreign subsidiaries the firm is likely to establish abroad and the countries it choses to operate in. Note that, although it is possible to derive closed-form solutions for the free entry conditions (34), these are unfortunately no longer 'homogenous' to the power $k+2$ in the cutoffs as in Melitz and Ottaviano (2005). Therefore, we cannot solve them analytically for the cutoffs c_D^j as we did in the previous sections with exporters only (see, e.g., (13)). Yet, we can readily simulate and calibrate the model numerically using the same data as in Section 4 and the same Pareto parametrization for the productivity distribution.

6.2 A numerical example

In what follows, we again evaluate several integration scenarios for a sample of 11 European countries. The numerical procedure we use unfolds as follows. First, using τ^{ij}, L^j, and the initial values of c_D^j, as obtained from our data set, we compute the implied FDI cut-offs (32) assuming a 30 per cent productivity edge. Second, we retrieve the implied values of f_M^{ij} from (33), which then allows us to compute the upper bounds c^i of the supports of the productivity distributions G^i in all countries with the help of the zero-expected profits condition (34). Third, using the values of these bounds we then simulate changes in trade costs τ^{ij} and fixed costs f_M^{ij} for FDI and recompute the implied changes in the cut-offs c_D^j from the system of equations given by (34), using the FDI cutoffs (31).[16]

In what follows, we simulate the following four counterfactuals:

1. **'Multilateral trade liberalization'**. As in Section 4, we start by replicating the 2 per cent decrease of international trade costs for all the 11 countries in the sample. This allows us to show how productivity changes induced by market integration relate to accessibility and attraction in the presence of endogenous multinationals.

[16] Since (34) depends on the whole distribution of the domestic cut-offs, the numerical procedure involves solving a system of 11 non-linear equations in the 11 unknowns c_D^j. The procedure is implemented using Mathematica and the files and the data are available from the authors upon request.

2. **‘Preferential trade agreement’**. We simulate again a 2 per cent decrease of international trade costs for the five (Belgium, Germany, France, Italy, and the Netherlands) out of the six founding EU countries only.

3. **‘Multilateral FDI liberalization’**. We consider a 2 per cent drop of fixed costs f_M^{ij} for FDI across all countries. Although most trade models in general interpret economic integration as a decrease in trade costs, another interpretation is a reduction of fixed set-up costs by liberalizing capital flows and entry.

4. **‘Preferential FDI agreement’**. We simulate a 2 per cent decrease of fixed costs f_M^{ij} for FDI for the five (Belgium, Germany, France, Italy, and the Netherlands) out of the six founding EU countries only.

Tables 4 and 5 summarize the percentage changes in productivity by countries and industries due to the different integration scenarios in an analogous way to Tables 1 and 2 in Section 4.

Table 4: Productivity gains by country (with multinational firms)

Integration scenario		“Mult trade liber”	“Pref trade agree”	“Mult FDI liber”	“Pref FDI agree”
Country initials	Country	% gain	% gain	% gain	% gain
BE	Belgium	6.95	4.88	11.04	4.47
DE	Germany	0.16	0.06	0.27	0.10
DK	Denmark	3.40	-0.08	5.61	-0.12
ES	Spain	0.02	0.00	0.03	0.00
FI	Finland	0.18	0.00	0.22	0.00
FR	France	0.03	0.00	0.04	0.00
GB	Great Britain	0.01	0.00	0.02	0.00
IT	Italy	0.01	0.00	0.02	0.00
NL	Netherlands	1.29	0.44	1.91	0.66
PT	Portugal	0.42	0.00	0.89	0.00
SE	Sweden	0.04	0.00	0.07	0.00
Average		1.14	0.48	1.83	0.47

The first integration scenario (‘Multilateral trade liberalization’) is shown in column 3 of Table 4. Gains are defined, as previously, as an average (across sectors) percentage increase of $1/c_D^j$ which, under the Pareto assumption, corresponds to a proportional change in average industry-country productivity. The average productivity gain for the 11 countries is 1.14 per cent, which is significantly smaller than the corresponding number in the ‘pure exporter’ case of Section 4 (2.67 per cent). Again, there is a lot of cross country variation with gains ranging from approximately 6.95 per cent for Belgium to almost zero for Italy. As expected, it is the small and centrally located countries (Belgium, Denmark, Netherlands) that experience by far the highest productivity gains. The reason being that these countries are predominantly served by exports since they are both small and easily accessible, so that they are the most affected by a reduction in trade barriers. On the contrary, large and/or more remote countries (Italy, Spain, Great Britain) are the least affected by changes in trade barriers since FDI is the dominant mode to serve their markets.

Table 5: Productivity gains by industry (with multinational firms)

Integration scenario	"Mult trade liber"	"Pref trade agree"	"Mult FDI liber"	"Pref FDI agree"
Industry	% gain	% gain	% gain	% gain
Food beverages and tobacco	1.43	0.52	2.18	0.73
Textiles	1.05	0.17	1.03	0.13
Wearing apparel except footwear	0.33	0.10	0.62	0.15
Leather products and footwear	2.62	0.43	3.42	0.31
Wood products except furniture	2.33	2.72	6.86	1.80
Paper products	1.14	0.24	2.05	0.30
Printing and Publishing	0.69	0.48	1.07	0.70
Chemicals	1.13	0.42	1.86	0.62
Rubber and plastic	0.91	0.45	0.84	0.38
Other non-metallic mineral products	1.27	0.16	1.62	0.18
Metallic products	0.80	0.48	0.78	0.44
Fabricated metal products	0.69	0.40	0.60	0.32
Machinery except electrical	0.65	0.24	0.61	0.19
Electric machinery	1.20	0.55	1.62	0.64
Professional and scientific equipment	1.54	0.16	4.00	0.24
Transport equipment	0.73	0.33	0.91	0.36
Other manufacturing	0.80	0.37	1.02	0.43
Average	1.14	0.48	1.83	0.47

Under the second scenario ('Preferential trade agreement') in column 4 of Table 4, it is easily verified that only the 5 countries that decrease trade barriers among each other experience positive gains, although these are smaller than in the multilateral case and than when there are only exporters. Other countries see their productivity decrease because some of the exporting firms outside the preferential trade agreement are replaced by firms within the 5 country group (that can now reach final consumers more easily) and thus some of their export profits are lost. Profitability in those markets goes down and to restore the equilibrium free entry condition fewer firms choose to pay the sunk cost of entry. As a result, the cost cutoff goes up and productivity decreases. Again, small and centrally located countries within the PTA (Belgium, Netherlands) see their productivity increase by the largest amount.

The third scenario ('Multilateral FDI liberalization') features a general 2 per cent reduction in fixed costs for FDI. This captures the idea that trade integration may take many other forms than decreases in trade costs. Whereas the latter have been most relevant for the 'first wave of integration' in the EU during the 1950s-60s, the former have been most relevant for the 'second wave of integration' during the 1980s-90s, where the deepening of the Single Market mainly took the form of mutual recognition and harmonization of standards, of regulations, as well as the removal of administrative hassels and red-tape (Baldwin and Wyplosz, 2004). All of these changes can be naturally interpreted as reductions in fixed costs for operating in a foreign country. As can be seen from column 5 of Table 4, the productivity gains are systematically higher for all countries under multilateral FDI liberalization than under multilateral trade liberalization. Stated differently, making FDI less costly yields higher productivity gains than reducing trade barriers. The country-specific patterns in terms of the distribution of the gains remain the same as before, with small and centrally located countries (Belgium, Denmark, Netherlands) experiencing the highest productivity gains, whereas large and/or more remote countries (Italy, Spain, Great Britain) reaping the smallest gains. Finally, the fourth scenario ('Preferential FDI agreement') summarized in column 6 of Table 4, yields similar results to those in column 4 ('Preferential trade agreement'). We hence do not comment on these any further here.

Table 5 provides sectoral figures for the various integration scenarios with multinational firms. A straightforward comparision of columns 2-5 shows that the relative ranking of the different integration scenarios is similar to the one described in the above: FDI liberalization yields higher productivity gains than trade liberalization, and multilateral liberalization is better than preferential agreements. Again, there is a lot of cross-industry variation in productivity gains, ranging from a low 0.33 per cent for 'Wearing apparel except footwear', to a high 2.62 per cent for 'Leather products and footwear'.

6.3 Summary results

Allowing for endogenous multinationals in models with firm heterogeneity generates new insights with respect to the model with single-plant firms only. Although our model is highly stylized and constitutes only a first attempt at integrating multinationals into a heterogenous firms framework, we have shown the following results:

Result 13 **Reduced gains from trade liberalization.** With horizontal multinationals, multilateral trade liberalization increases productivity in all countries. Yet, multilateral trade liberalization yields lower productivity gains than when only exporters are active. The magnitude of the gains is naturally increasing in the trade/FDI ratio, thus implying that small and accessible countries experience the highest increase in productivity due to a decrease in trade costs.

Result 14 **Harmful exclusion.** Preferential trade agreements and preferential FDI agreements both increase productivity in insiders and decreases it in outsiders. Hence, even in the presence of horizontal multinationals preferential agreements continue to hurt outsiders and to benefit insiders.

Result 15 **FDI liberalization.** Multilateral FDI liberalization raises productivity in all countries by a larger amount that multilateral trade liberalization. This suggests that the removal of non-tariff barriers, as currently targeted by EU policies, may yield higher efficiency pay-offs than the removal of tariff barriers.

Average costs, prices and markups as well as product variety and welfare change accordingly, as previously examined in sections 3 and 4.

7 Conclusion

What are the predictions of NTT on the effects of globalization on firms and countries? With this question in mind we have proposed a comprehensive theoretical framework to assess the economic impact and the welfare implications of the associated reallocation of resources across firms and countries. The proposed framework has merged the insights of NTT and 'new economic geography' with more recent developments on firm heterogeneity and the selection effects of trade liberalization.

The general result is that trade liberalization induces a reallocation of resources from less to more productive firms ('selection'), from smaller to larger regions ('attraction') and from outsiders to insiders in preferential trade agreements ('accessibility'). This delivers long-run efficiency gains to liberalizing countries as tougher selection leads to higher average productivity, lower average prices, larger average firm size, higher profits, richer product variety, and lower markups. At the same time, it generates tensions between short-run winners and short-run losers by putting pressure on small remote backward countries and, within countries, on small remote backward regions as well as on low-productivity firms and workers. Reallocations and the resulting tensions are somewhat less pronounced, yet still present, in the presence of horizontal multinationals.

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