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**Endogenous Market
Structures and International
Trade. I: Theory**

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Endogenous Market Structures and International Trade. I: Theory

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Abstract

With strategic interactions and endogenous entry in a market, opening up to trade creates gains under very general conditions. Under Dixit-Stiglitz preferences and Cournot (or Bertrand) competition, an expansion of the market size induces exit of domestic firms, lower prices and larger production of the surviving firms due to competition from more foreign firms, without resorting to selection effects à la Melitz. This holds also in a 2x2x2 Heckscher-Ohlin model with Cournot (or Bertrand) competition in a sector. I study heterogeneous preferences between countries as a source of trade: the country with a relative preference for the differentiated goods becomes a net importer of them facing radical business destruction. Finally, I extend the model to cost heterogeneity à la Melitz. In all cases, the elasticity of the number of firms to market size decreases with the substitutability between goods and reaches 1/2 under Cournot competition with homogenous goods.

Keywords

Gains from trade, Krugman model, Endogenous entry, Comparative advantage, Comparative preference

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In the traditional theories of trade, such as the neoclassical theory based on perfect competition and the Krugman theory based on monopolistic competition, the impact of trade and the gains from trade are associated with international specialization or with the consumption of new varieties of goods. These two approaches (integrated in Helpman and Krugman, 1985) neglect that trade usually affects the structure of markets, and in particular the degree of competition, the number of firms active in each country, the production level of each firm and the markups, with consequences for welfare as well. A separate line of research started by Brander (1981) and Markusen (1981) has shown that opening up to trade in imperfectly competitive markets generates price reductions, but the main implications of this endogenous market structures approach have not been investigated in a systematic way: not by chance, leading international trade economists (as Neary, 2010) talk about “two and a half theories of trade.”

In this work we first develop a rather general one-sector partial equilibrium model of endogenous market structures (EMSs) which includes Cournot and Bertrand competition with endogenous entry. We show that gains from trade emerge under general conditions and can be associated both with the increase in the number of goods consumed and with the reduction of their prices. We then focus on a microfounded demand based on the Dixit and Stiglitz (1977) preferences applied to trade in the models of Krugman (1980) and Melitz (2003) under monopolistic competition with respectively homogenous and heterogeneous firms (in both those models the markup is constant for all the firms and the number of firms was linearly increasing in the size of the market under free trade). We depart from monopolistic competition and examine Cournot and Bertrand competition. With competition in quantities an expansion of the market associated with trade increases less than proportionally the number of firms, because stronger competition reduces the markups and forces the firms to produce more to cover the fixed costs. For instance, in case of homogenous goods the elasticity of the number of firms with respect to the size of the market is $\beta = 0.5$: this means that doubling the size of a market increases the number of firms by about 40%,¹ expands their production and reduces their average cost and their markup, with relevant welfare gains even if there are zero gains from variety. When the substitutability between goods decreases the implied elasticity of the number of firms increases (but remains below unity), and trade creates gains both from the consumption of new varieties and from the reduction of their prices. Similar results emerge in case of competition in prices: expanding the market size attracts more firms (in this case approximately in a linear

¹If the relation between number of firms N and size of the market S is $\ln N = \beta \ln S$, a double size of the market attracts 2^β firms. The Krugman (1980) model with monopolistic competition implies $\beta = 1$.

way), which strengthens competition, reduces the prices and requires a larger production for each firm.

The model is then extended to a general equilibrium $2 \times 2 \times 2$ setup with identical preferences and different factor endowments between countries. A trading equilibrium without specialization induces factor price equalization and equal output and markups for all firms (under both price and quantity competition). Assuming EMSs in the capital-intensive sector and perfect competition in the labor intensive sector, the trading equilibrium induces intraindustry trade in the capital-intensive sector with positive net exports of the capital-abundant country. Our generalized $2 \times 2 \times 2$ model nests traditional models: when the fixed cost shrinks and substitutability between goods is increased for a given global population, the model converges asymptotically to the Heckscher-Ohlin model with a number of firms approaching infinity in the capital-intensive sector and a markup approaching zero; when substitutability between goods approaches infinity for given fixed cost and world population, the model converges to the Brander-Markusen model of competition in quantities extended to endogenous entry; and when the population expands for given fixed cost and degree of substitutability, the model converges to the Krugman model with monopolistic competition between an increasing number of firms in the capital intensive sector and the markup approaching the monopolistically competitive one. Assuming Cobb-Douglas production functions in both sectors we can fully solve the model in closed form and verify that the mentioned relation between total number of firms and size of the integrated market is robust to this extension.

We also consider the case of different homothetic preferences in the two countries, analyzing the realistic situation in which a country has stronger preferences for the goods of the imperfectly competitive and capital-intensive sector: in the extreme case of identical factor endowments (no technological comparative advantage), this country produces more capital-intensive goods in autarchy, but reduces their production under free trade and starts importing them. Therefore, we show that in the new case in which trade is driven by comparative preferences (rather than comparative advantage) the process of local business destruction can be much more drastic for one of the two countries.

We extend the model to take into account differences in productivities between firms as in the Melitz (2003) model. The latter is based on monopolistic competition and, under free trade, it preserves the linearity of the number of firms in the size of the market (because the average profit of the firms is invariant in market size). Introducing strategic interactions in the model with cost heterogeneity restores the role of trade in inducing local business destruction, larger production of each surviving firm and lower prices without resorting to the trade costs needed in the same Melitz model.

The paper is organized as follows. Section 1 reviews the literature on EMSs and trade. Section 2 introduces general models of international endogenous market structures and extends the Krugman model to Cournot and Bertrand competition. Section 3 develops a 2x2x2 model of trade that generalizes the neoclassical model with strategic interactions in one sector when countries have identical or different preferences. Section 4 extends our analysis to heterogeneous firms *à la* Melitz. Section 5 concludes.

1 Literature Review

The investigation of EMSs in international trade theory has a large number of precursors. Krugman (1979) augmented the monopolistic competition framework with markups depending on the number of firms under the assumption that substitutability depends on that number. The so-called reciprocal dumping model by Brander (1981) and Brander and Krugman (1983) and the general equilibrium duopolistic model by Markusen (1981) were the pathbreaking works in the analysis of strategic interactions in intra-industry trade, but they treated marginally the case of endogenous entry and they were based on Cournot competition with homogeneous goods. Helpman (1981) has introduced product differentiation in a 2x2x2 model, but through a spatial model of price competition rather different from the Krugman model. Helpman and Krugman (1985) have provided an introductory discussion of the general equilibrium model with Cournot competition and endogenous entry in one sector and they conjecture a “rationalizing effect” associated with business destruction in the integrated economy, but without developing further results. Lahiri and Ono (1995) and Shimomura (1998) have derived a more rigorous analysis of the 2x2x2 model with an imperfectly competitive sector, but once again only for homogeneous goods. Our theoretical contribution is to generalize some of the insights of this literature on the impact of trade and on the gains from trade in the presence of general forms of imperfect competition with product differentiation, and to develop a 2x2x2 model that nests the Heckscher-Ohlin model, the Helpman-Krugman theory and the Brander-Markusen approach.

The present work contributes also to the recent literature emphasizing the importance of EMSs in different general equilibrium fields such as growth theory (Peretto, 2003) or business cycle theory (Etro and Colciago, 2010). The common aspect of these works is the importance of the competition effect: markets that become larger because of growth, openness, aggregate shocks or policy shifts attract more firms, become more competitive and generate a reduction of markups with general equilibrium consequences on the production structure

and on welfare. Other works on EMS in partial equilibrium have been applied to trade issues and are related to the present work.² Horstmann and Markusen (1992) and Markusen and Stähler (2011) have analyzed EMSs under quantity competition but their focus has been on the entry of multinationals in foreign markets and on the role of trade policy. Stähler and Upmann (2008) have investigated EMSs in a game between two governments that can regulate entry. Finally Etro (2011) has studied optimal strategic trade policy for foreign markets with EMSs, while the companion paper Etro (2012b) has studied the optimal trade policy for a domestic market and an integrated market.

Our analysis is also related to the recent literature developed around the work of Melitz (2003), which introduces cost heterogeneity in the Krugman model with monopolistic competition (see also Bernard *et al.*, 2007, and Arkolakis, 2010). Under free trade, however, this extension is inconsequential: opening up to trade does not affect the average productivity of firms, the individual production and the prices and it increases proportionally the number (mass) of active (exporting) firms, exactly as in the Krugman model. The same occurs in a 2x2x2 extension of the model (Bernard *et al.*, 2007). Only when there are both heterogeneity in costs and trade barriers (such as transport costs and fixed export costs) the Melitz approach generates novel consequences: opening up to trade induces business destruction at the local level due to the competition from more efficient foreign firms, increases the average production of the exporters and reduces their prices. We show that a much simpler extension of the Krugman model with Cournot competition is able to replicate the same facts without the need of cost heterogeneity and trade costs: in our model opening up to trade induces business destruction at the local level because of competition from more (equally efficient) foreign firms, increases the average production of the exporters and reduces their prices. The last two effects are not due to increased productivity with constant markups as in the Melitz model, but to the stronger competition in the integrated market which requires lower markups and larger scale of production to cover the fixed costs. As we show, we can introduce cost heterogeneity (and trade barriers) in our model to replicate the other important results generated by the Melitz approach: the fact that only the most productive firms export and that production and profits increase with productivity. However, it appears remarkable that some of the key results of the Melitz model (local business destruction, larger production and lower prices of the exporters after opening up to trade) emerge under EMSs without recurring to cost heterogeneity or trade barriers.

Notice that the Melitz model has been already extended to strategic inter-

²See also Žigic (2012) and Cato and Matsumura (2012).

actions in a few early works. Early insights in this sense have been developed by Bernard *et al.* (2003), but the first extensions of a one-sector model to forms of strategic interactions are due to Eckel and Neary (2010),³ Long *et al.* (2011) and Eaton *et al.* (2012).⁴ However, none of these papers derives the above results within a 2x2x2 model and with both Bertrand and Cournot competition. Most important, Melitz and Ottaviano (2008) have obtained a related competition effect in a model of monopolistic competition where the direct demand of each firm is linearly decreasing in the price, linearly increasing in the average price of the other firms and negatively related to the number of firms (on the basis of a complex quadratic utility function). This induces markups that are reduced in larger markets with more productive firms on average. Our model shows that a similar competition effect emerges naturally within the original Krugman framework once we introduce strategic interactions.

Finally, a last contribution of the present work is the analysis of differences in preferences between countries, usually neglected in the trade literature. Even in the absence of technological comparative advantage (i.e.: identical factor endowments in the two countries) trade occurs and the country with a relative preference for the differentiated goods is a net importer of these goods and a net exporter of the perfectly competitive goods. Trade induced by comparative preferences preserves the competition effect: larger markets increase less than proportionally the number of firms, expand individual production and reduce markups.

2 A Partial Equilibrium Model

We start analyzing EMSs that belong to a general class of aggregative games introduced in Etro (2006). Consider a market with L identical consumers, so that opening up to frictionless trade with other identical countries is equivalent to an expansion of the number of consumers. Each firm $i = 1, \dots, N$ bears a fixed cost F and chooses a strategic variable x_i to maximize the profit function $\pi_i = L\Pi_i - F$, where Π_i is the gross profit per consumer, that depends on the strategies of all the firms. The following assumption summarizes its properties:

³Eckel and Neary (2010) consider a small number of multiproduct firms engaged in static Cournot competition over a continuum of goods and endogenize the range of goods produced by each firm and the same number of firms: trade affects the scale and scope of firms through a competition effect and a demand effect.

⁴Eaton *et al.* (2012) have simulated a model similar to our one-sector model with Bertrand competition, cost heterogeneity and endogenous entry, showing that it can explain how many and which firms do export in a better way than the monopolistic model.

A.1.: Gross profits per consumer are given by the function:

$$\Pi_i = \Pi [x_i, X_{-i}]$$

which is a) quasiconcave in x_i and decreasing in an aggregate statistic of the strategies of the other firms $X_{-i} = \sum_{j \neq i} h(x_j)$ for a positive and increasing function $h(x)$ with b) $\Pi_{11} < h'(x)\Pi_{12}$ and c) $\Pi_{11} + (N-1)h'(x)\Pi_{12} < 0$.

A.1.a) amounts to assume Π_1 unimodal with $\Pi_{11} < 0$ and $\Pi_2 < 0$, where we denote derivatives with subscripts, while we do not impose anything on the cross derivative, allowing for models with strategic substitutability ($\Pi_{12} < 0$) or complementarity ($\Pi_{12} > 0$). Assumptions A.1.b)–c) are standard to insure stability of the equilibrium. Examples include most of the common trade models with constant marginal costs. For instance, models of quantity competition with homogenous goods and inverse demand $p_i = p \left[\sum_{j=1}^N x_j \right]$ or models with product differentiation and inverse demand as $p_i = p \left[x_i + \sum_{j \neq i} h(x_j) \right]$ are all nested in our specification, where the strategies x_j can be interpreted as the amount of sales per consumer. Moreover, models of price competition characterized by a demand with constant expenditure, such as $D_i = g(p_i) / \sum_j g(p_j)$ (with g decreasing function) are nested as well after the change of variable $x_i = 1/p_i$, which allows one to interpret the strategy as the inverse of the price: examples include the Logit demand and isoelastic demand functions.

A general characterization of the Nash equilibrium with endogenous entry is straightforward. The first order condition for profit maximization $\Pi_1 [x_i, X_{-i}] = 0$ defines the reaction function of each firm i relative to the strategies of each rival, and entry occurs until net profits are zero. Therefore, a symmetric equilibrium is characterized by the following conditions:

$$\Pi_1 [x, (N-1)h(x)] = 0 \tag{1}$$

$$L\Pi [x, (N-1)h(x)] = F \tag{2}$$

One can easily verify that assumption A.1.b) makes sure that the Nash equilibrium is stable for a given number of firms and assumption A.2.c) makes sure that the equilibrium profit is decreasing in the number of firms so that an endogenous entry equilibrium exists.⁵ The system (1)–(2) provides the equilibrium

⁵One can verify that the slope of the reaction function is:

$$\frac{dx_i}{dx_j} = - \frac{h'(x_j)\Pi_{12} [x_i, X_{-i}]}{\Pi_{11} [x_i, X_{-i}]}$$

and the optimal adjustment of the strategy of firm i starting from an out-of-equilibrium strat-

strategy x and the number of firms n as functions of market size L . In this class of models, an expansion of the market size is equivalent to opening up to trade with other identical countries without trade frictions, therefore we will evaluate the impact of free trade in terms of the impact of an increase in L .⁶

Totally differentiating the equilibrium system, we have:

$$\frac{dx}{dL} = \frac{\Pi\Pi_{12}}{L\Pi_{11}\Pi_2} \quad \text{and} \quad \frac{dN}{dL} = \frac{-\Pi[\Pi_{11} + (N-1)h'(x)\Pi_{12}]}{L\Pi_{11}\Pi_2h(x)} \quad (3)$$

Our assumption A.1.c) implies that an expansion of the market increases always the number of firms and affects consumption of each good depending on the kind of strategic interaction. However, at this level of generality, we cannot draw conclusions about the impact of market integration on welfare. The reason is that the increase in the number of firms could be associated with more or less provision of each good and even with lower or higher prices for each good.⁷ Nevertheless, under an additional assumption on the microfoundation of the model we can derive unambiguous results on the welfare impact of a market expansion.

A.2.: The surplus of each consumer is an increasing function of the aggregate statistic $\sum_{j=1}^N h(x_j)$ as follows:

$$U = U \left[\sum_{j=1}^N h(x_j) \right] \quad (4)$$

This functional form is restrictive, but quite common in trade models. The typical example is the one of quasilinear preferences for homogenous goods.⁸ Also the Dixit-Stiglitz preferences satisfy A.2. with an isoelastic h function.

egy of firm j leads back to the symmetric equilibrium if this slope is in $[-1, 1]$. Assumption A.1.b) makes sure that, for a given number of firms, the slope of the reaction function of each firm is larger than -1 when evaluated at the Nash equilibrium. The derivative of the equilibrium profits with respect to the number of firms is:

$$\frac{d\Pi}{dN} = \frac{h(x)\Pi_2[\Pi_{11} - h'(x)\Pi_{12}]}{\Pi_{11} + (N-1)h'(x)\Pi_{12}}$$

where functions are evaluated at x satisfying (1). Assumption A.1.c) makes sure that profits decrease in N .

⁶Throughout all the paper we will consider the number of firms as a real variable. In this section we will not distinguish between domestic and foreign firms because a one factor model does not pin down the allocation of firms between countries.

⁷Examples of equilibrium prices increasing with the size of the market are provided under monopolistic competition by Zhelobodko *et al.* (2013) and under Bertrand competition by Etro (2012a) for microfounded models.

⁸Consider a quasilinear utility $U = u(C) + Y$ where $C = \sum_{j=1}^n x_j$ is total consumption

However, our functional form is more general and, for instance, does not even impose “love for variety”. Whether this holds or not depends on the elasticity of the $h(x)$ function: only if this is less than unitary the consumer surplus function implies love for variety.⁹ Finally, also models of price competition can satisfy this functional form as long as both profits and consumer surplus can be expressed as functions of the same price index: the typical case is the one of Dixit-Stiglitz preferences where direct demand and indirect utility depend on the usual price index.

Since we associate trade with an expansion of the market size that increases always the number of goods provided, there is no reason to expect that this is necessarily welfare improving. Nevertheless, we can prove that this is always the case:

GAINS FROM TRADE: Under EMSs subject to A.1.-2., opening up to free trade is always welfare improving.

PROOF. To verify this, notice that, since profits are zero under endogenous entry, total welfare per agent corresponds to the consumer surplus of the domestic agents (4). In a symmetric equilibrium this is $U[Nh(x)]$, where N and x satisfy the system (1)-(2) as functions of market size L . Deriving the welfare function with respect to L and using (3), we obtain:

$$\begin{aligned}\frac{dU}{dL} &= U'[Nh(x)] \left[h(x) \frac{dN}{dL} + Nh'(x) \frac{dx}{dL} \right] = \\ &= \frac{U'[Nh(x)] \Pi [h'(x)\Pi_{12} - \Pi_{11}]}{L\Pi_{11}\Pi_2}\end{aligned}$$

whose sign is always positive under A.1. – 2. $\square$

The gains from trade derive from two potential sources: the increase in the number of firms, which is welfare enhancing if preferences exhibit love for variety, and the impact on the strategy of each firm, which is ambiguous. The result above shows that, even if the welfare impact of an increase in the number of firms is not positive, the welfare impact of the change in strategy is positive and more than compensates the first (and if the latter is negative, there are larger gains

of a homogenous good and Y is a numeraire. A consumer with income I facing a price p generates an inverse demand $p = u'(C)$ which is decreasing under concave subutility. Total utility becomes $U = u(C) - u'(C)C + I$, which satisfies A.2. with a linear h function.

⁹Let us say that $U(N, x) = U(N, E/N)$ exhibits “love for variety” if $dU/dN > 0$. Under (4) we have:

$$\frac{dU}{dN} = U'[Nh(x)] [h(x) - h'(x)x]$$

which is positive if and only if $h'(x)x/h(x) \in (0, 1)$.

from variety). For instance, in the case of homogenous goods, which excludes any welfare gain from variety, the strengthening of competition leads to an expansion of the total production that benefits consumers. In the typical case of product differentiation, the gains from trade derive both from “gains from variety” associated with more goods provided and “gains from competition” associated with larger consumption and lower price for each good.

It is important to remark that the EMS analyzed here is generally inefficient because firms do not take into account two externalities in their entry choice: the reduction in the profits of the others (the so-called business stealing effect of Mankiw and Whinston, 1986) and the creation of a new variety (the consumer surplus effect). The first element tends to create excess entry and the second one too little entry,¹⁰ but in general this inefficiency leaves open the space for government interventions and, in particular, for trade policy. For instance, export subsidies are always optimal in this context (Etro, 2011), contrary to what happens when the market structure is exogenous, in which case export taxes can be optimal. The companion paper Etro (2012b) characterizes also optimal tariffs for the domestic market.

Our analysis has emphasized that opening up to trade with a country of the same size increases the total number of goods produced and consumed by each agent. However, we still cannot say whether this number increases more or less than proportionally, which is crucial to determine if the number of firms in each country can increase or decrease as a consequence of trade. To verify this we need additional conditions. We will adopt for the rest of the paper the usual assumption of the trade literature, that of CES preferences (Dixit and Stiglitz, 1977; Krugman, 1980):

A.3.: *The surplus of each consumer is given by:*

$$U = \left[\sum_{j=1}^N x_j^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} \quad (5)$$

where x_j is the consumption of good j .

The parameter $\theta > 1$ represents the elasticity of substitution between goods, with $\theta \rightarrow \infty$ in case of homogenous goods. Define p_j as the price of good j . Each consumer with unitary income maximizes utility (5) under a budget constraint

¹⁰See Etro (2012a) for a general characterization of the welfare properties of EMSs of this kind.

$\sum_{j=1}^N p_j x_j = 1$. The inverse and direct demand functions can be derived as:

$$p_i = \frac{x_i^{-\frac{1}{\theta}}}{\sum_{j=1}^N x_j^{\frac{\theta-1}{\theta}}} \quad \text{and} \quad D_i = \frac{p_i^{-\theta}}{\sum_{j=1}^N p_j^{1-\theta}} \quad (6)$$

Each good i is produced according to a linear production function in labor. Normalizing the wage to unity, the marginal cost of production is unitary as well and aggregate spending corresponds to total labor income, which is also our measure of the size of the economy. Therefore, the profit function of each firm can be expressed in terms of sales or prices as:

$$\pi_i = \left[\frac{x_i^{\frac{\theta-1}{\theta}}}{\sum_{j=1}^N x_j^{\frac{\theta-1}{\theta}}} - x_i \right] L - F = \frac{[p_i - 1] p_i^{-\theta} L}{\sum_{j=1}^N p_j^{1-\theta}} - F \quad (7)$$

In both cases, the profit function is nested in our general model.¹¹ In a symmetric equilibrium, each firm produces $X = xL$ and the utility of each agent is $U = xN^{\frac{\theta}{\theta-1}}$, which increases in the number of goods and in the consumption of the agent. The equilibrium price $p = 1/xN$ allows one to rewrite welfare also in the following way:

$$U = \frac{N^{\frac{1}{\theta-1}}}{p} \quad (8)$$

which emphasizes that gains from trade can derive either from an increase in the number of goods or from a reduction in the price level with a relative weight on the latter that is increasing in the substitutability between goods.

The Krugman (1980) model based on Dixit-Stiglitz monopolistic competition ignores the strategic interactions between firms: each firm chooses its own strategy as if there is an infinity of competitors in the market and any impact on the others is negligible. In such a case, the optimal price is the constant price $p = \theta/(\theta - 1)$ for any firm and the endogenous number of firms in a market of size L is:

$$N = \frac{L}{\theta F} \quad (9)$$

with individual production $X = F(\theta - 1)$. After opening up to trade, the price and the production of each firm remain the same as in the closed economy and

¹¹This is not immediate under price competition. However, consumer surplus can be expressed as an inverse function of the price index $P \equiv \left[\sum_{j=1}^N p_j^{1-\theta} \right]^{1/(1-\theta)}$. Therefore, after a transformation of variable $p = 1/x$, one can express both profits and consumer surplus as in our general specification with $h(x) = x^{\theta-1}$.

consumers reduce their consumption of each single variety, but utility increases because more goods are consumed.¹² If we define the elasticity of the number of firms with respect to the size of the market as $\beta \equiv (L/N)(dN/dL)$, the Dixit-Stiglitz-Krugman case of monopolistic competition implies $\beta = 1$: this means that doubling the size of a market doubles the number of firms.¹³

2.1 Competition in quantities

Let us first analyze Cournot competition between firms. For the sake of simplicity, let us start our investigation in the extreme case of homogenous goods ($\theta \rightarrow \infty$), in which the possibility of gains from variety is absent. The profits of firm i are:

$$\pi_i = \frac{x_i L}{\sum_{j=1}^N x_j} - x_i L - F$$

In a symmetric Cournot equilibrium the sales per consumer of each firm are $x = (N-1)/N^2$, which implies a price $p = N/(N-1)$. In a market of size L this generates profits $\pi = L/N^2 - F$ and entry occurs until the number of producers is:

$$N = \sqrt{\frac{L}{F}} \quad (10)$$

Taking logs, this implies:

$$\ln N = 0.5 (\ln L - \ln F)$$

which emphasizes the elasticity of the number of firms with respect to market size, $\beta = 0.5$. Therefore, doubling the size of a market increases the number of firms by about 40%: alternatively, to double the number of firms one needs a market size that is four times as large. The equilibrium price becomes:

$$p = \frac{1}{1 - \sqrt{\frac{F}{L}}} \quad (11)$$

the consumption level is $x = \sqrt{F/L} - F/L$ and the individual production of each firm is $X = \sqrt{LF} - F$, which is now an increasing function of the size of the market. Contrary to what happens under Dixit-Stiglitz monopolistic competition, where price and production per firm are independent from the market size,

¹²More formally, utility (8) becomes $U = (L/\theta F)^{1/(\theta-1)}(1 - 1/\theta)$.

¹³Notice that in case of homogenous goods ($\theta \rightarrow \infty$), the market structure becomes perfectly competitive with $p \rightarrow 1$ and an indeterminate number of firms, but the gains from trade disappear because there are no gains from variety.

now the price is decreasing in it and the production of each firm is increasing. This result is due to a competition effect associated with the positive impact of market size on the equilibrium number of firms: this strengthens competition and reduces the markup, which forces the firms to produce more to cover the fixed costs of entry. Moreover, the lower margin reduces the profitability of entry, inducing a less than proportional increase in the number of firms. Trade increases market concentration, but production becomes more efficient thanks to the reduction of the waste in fixed costs. More formally, utility becomes:

$$U = 1 - \sqrt{\frac{F}{L}}$$

which is the inverse of the price: all the gains from trade are gains from competition, that is from lower average costs of production translated into lower prices.

In case of imperfect substitutability between goods, product variety is beneficial and the impact of trade is more complex, but the competition effect is still present. In particular, the first order condition for the maximization of profits (7) can be solved for $x = (\theta - 1)(N - 1)/\theta N^2$, which generates the equilibrium price $p = \mu(\theta, N)$ where the markup is:

$$\mu(\theta, N) = \frac{\theta N}{(\theta - 1)(N - 1)} \quad (12)$$

In a market of size L profits are $\pi = (N + \theta - 1)L/\theta N^2 - F$. Endogenous entry leads to the following number of firms:

$$N = \sqrt{\left(1 - \frac{1}{\theta}\right) \frac{L}{F} + \left(\frac{L}{2\theta F}\right)^2} + \frac{L}{2\theta F} \quad (13)$$

which is clearly increasing in the size of the market in a way that depends on the degree of substitutability between goods. Finally, the equilibrium price can be derived as:

$$p = \left(\frac{\theta}{\theta - 1}\right) \left(1 - \frac{2\theta F}{L + \sqrt{L^2 + 4\theta(\theta - 1)FL}}\right)^{-1} \quad (14)$$

which is again decreasing in the size of the market. One can also verify that the production level of each firm is still positively related to market size. Using these equilibrium variables in (8) one could decompose the gains from trade into the gains from variety and the gains from lower prices.

The elasticity of the number of firms with respect to the size of the market β can be calculated as follows:

$$\beta = 1 - \frac{1}{2 + \frac{L}{2F(\theta-1)} + \sqrt{\frac{L^2}{4F^2(\theta-1)^2} + \frac{L}{F(\theta-1)}}} < 1 \quad (15)$$

When $\theta \rightarrow \infty$ we go back to the case of homogenous goods with $\beta \rightarrow 1/2$. Moreover, when $\theta \rightarrow 1$ this elasticity increases to $\beta \rightarrow 1$. Since $d\beta/d\theta < 0$, the elasticity goes down from 1 to 0.5 while θ increases from 1 to ∞ , a prediction that waits for empirical investigation. We can summarize our findings as follows:

IMPACT OF TRADE WITH COURNOT COMPETITION: Under EMSs subject to A.1.-3. and competition in quantities, increasing the size of the market reduces the prices, increases individual production and increases less than proportionally the number of firms, with an elasticity $\beta \in [0.5, 1)$ which is decreasing in the substitutability between goods; gains from trade derive from lower prices and more varieties.

2.2 Competition in prices

Let us consider Bertrand competition now. The first order condition for the maximization of profits (7) with respect to p_i can be solved for the symmetric equilibrium price $p = \mu(\theta, N)$ with markup:

$$\mu(\theta, N) = \frac{\theta(N-1) + 1}{(\theta-1)(N-1)} \quad (16)$$

Given market size L , net profits are $\pi = L/(\theta N - \theta + 1) - F$. Endogenous entry leads to the following number of producers:

$$N = 1 + \frac{L - F}{\theta F} \quad (17)$$

which is linear in the size of the market, as in the Dixit-Stiglitz case. The elasticity of the number of firms with respect to the size of the market is now $\beta = [1 + (\theta - 1)F/L]^{-1} < 1$, which is again decreasing in the substitutability between goods, but approximately unitary if the number of firms is large enough (for empirical purposes, $N - 1$ is linear in market size). This may suggest that Bertrand competition implies small deviations from the case of monopolistic competition. In reality, this is not exactly the case, because price competition is tough and an increase in the number of competitors rapidly erodes profit margins. The equilibrium price is indeed decreasing in market size:

$$p = \frac{\theta L}{(\theta - 1)(L - F)} \quad (18)$$

and the equilibrium production level is $X = F(\theta - 1)(L - F) / [L + (\theta - 1)F]$, which increases in size. Therefore, trade attracts more firms and the strengthening of competition between them reduces the markups and increases individual production exactly as before. Welfare can be calculated as:

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

where the first component is again the inverse of the price reflecting the gains from competition, and the second component represents the gains from variety, as from (8). Summing up, we have:

IMPACT OF TRADE WITH BERTRAND COMPETITION: Under EMSs subject to A.1.-3. and competition in prices, increasing the size of the market reduces the prices, and increases individual production and total number of firms (in a linear way); the gains from trade derive from lower prices and more varieties.

3 A General Equilibrium 2x2x2 Model

In this section we introduce the model of the previous section in a standard trade setup with two factors of production, two sectors and two countries. Capital and labor inputs are immobile and with endowments K and L for the home country and K^* and L^* for the foreign country. Define $L^W = L + L^*$ and $K^W = K + K^*$ as the world endowments. One sector is perfectly competitive and produces a homogenous good, and the other is characterized by product differentiation and EMSs with competition in prices or quantities and fixed entry costs as before.

As standard in the literature, we start assuming that the preferences are identical and homothetic in both countries over the homogeneous good Y and the differentiated goods, whose consumption index U is still given by (5). Accordingly, we assume:

$$V = U^\gamma Y^{1-\gamma} \quad (19)$$

where $\gamma \in (0, 1]$ represents the relative preference for the differentiated goods and is common to both countries as usual. This implies that each agent from both countries spends a fraction γ of income in the differentiated goods.

Technology is also identical in both countries, with a linearly homogenous production function for the homogenous good:

$$Y = F(K, L) \quad (20)$$

which is associated with a constant marginal cost $c_Y(w, r)$. Increasing returns characterize the production of the differentiated goods; in particular, let us assume that the production of each variety requires a fixed cost of η units of labor and takes place according to a linearly homogenous function:

$$X = g(k, l) \quad (21)$$

where k and l are the inputs used by a representative firm. The production function is associated with a constant marginal cost $c_X(w, r)$. The assumption that the fixed cost is in terms of labor simplifies the analysis, but we could have obtained similar results assuming that the fixed cost requires both labor and capital or is directly in terms of output.¹⁴

Let us define with X_i the total production of firm i and with p_i its price. The profit function can be expressed in terms of production levels or prices using the inverse and direct demands derived from (5) for an agent with unitary budget. Denoting with E total industry sales, that is aggregate spending in the imperfectly competitive sector, profits of firm i can be written as:

$$\pi_i = \frac{X_i^{\frac{\theta-1}{\theta}} E}{\sum_{j=1}^N X_j^{\frac{\theta-1}{\theta}}} - cX_i - F = \frac{[p_i - c] p_i^{-\theta} E}{\sum_{j=1}^N p_j^{1-\theta}} - F$$

The marginal cost is $c_X(w, r)$ and the fixed cost is $F = \eta w$. The same occurs in the foreign country, but the foreign wage w^* and rental rate r^* may be different, inducing different unit and fixed costs in both sectors. Total spending is a fraction γ of total labor and capital income in both countries:

$$E = \gamma(wL + w^*L^* + rK + r^*K^*) \quad (22)$$

Free trade guarantees price equalization for the homogenous good, which is assumed to be the numeraire, and guarantees that the law of one price holds also for the differentiated goods. However, in principle goods produced in different countries may be produced in different quantities and may have different prices.

3.1 Comparative advantage and trade

Let us consider an equilibrium of the world economy in which there is no specialization by any country in a sector.¹⁵ Given the factor prices in each country

¹⁴Lahiri and Ono (1995) adopt a fixed cost in both labor and capital input. Etro and Colciago (2010) adopt a fixed cost in labor input in a dynamic general equilibrium model with two inputs and endogenous market structures, and discuss alternative assumptions.

¹⁵The cone of diversification exists under the condition:

$$\frac{K}{L}, \frac{K^*}{L^*} \in \left(\frac{a_{KY}}{a_{LY}}, \frac{a_{KX}}{a_{LX} + \eta/X} \right)$$

(w, r) and (w^*, r^*) , by symmetry all domestic varieties are produced in quantity X and sold at the price p , and all the foreign varieties are produced in quantity X^* and sold at price p^* . The equilibrium market structure is characterized by free entry conditions in the two sectors:

$$c_Y(w, r) = 1 \quad c_Y(w^*, r^*) = 1 \quad (23)$$

$$X[p - c_X(w, r)] = \eta w \quad X^*[p^* - c_X(w^*, r^*)] = \eta w^* \quad (24)$$

Under competition in quantities, the first order equilibrium conditions of the domestic and foreign firms can be rearranged as follows:

$$\frac{(\theta-1)p}{\theta} - \frac{(\theta-1)Xp^2}{\theta E} = c_X(w, r) \quad \frac{(\theta-1)p^*}{\theta} - \frac{(\theta-1)X^*p^{*2}}{\theta E} = c_X(w^*, r^*) \quad (25)$$

For a given aggregate spending E , the six conditions (23)-(24)-(25) under competition in quantities can be solved for the six unknowns w , w^* , r , r^* , X and X^* with prices p and p^* that can be derived from the inverse demand functions.

Under competition in prices, the first order equilibrium conditions of the domestic and foreign firms can be rearranged as follows:

$$X = [p - c_X(w, r)] \left[\frac{\theta X}{p} + \frac{(\theta-1)X^2}{E} \right] \quad X^* = [p^* - c_X(w^*, r^*)] \left[\frac{\theta X^*}{p^*} + \frac{(\theta-1)X^{*2}}{E} \right] \quad (26)$$

The six conditions (23)-(24)-(26) under competition in prices can be solved for the six unknowns w , w^* , r , r^* , p and p^* with sales of the domestic firms X and sales of the foreign firms X^* that can be derived from the direct demand functions. The characterization of the equilibrium can be simplified extending a traditional result of neoclassical trade theory, factor price equalization, to the case of endogenous market structures (see the proof in the Appendix):¹⁶

FACTOR PRICE EQUALIZATION. Under EMSs in one sector and perfect competition in the other, a trading equilibrium with production of both countries in both sectors induces equal prices and outputs for all firms (under both price and quantity competition) and equal wages and interest rates in both countries.

where the labor (capital) requirements a_{LY} and a_{LX} (a_{KY} and a_{KX}) for for a unitary production are defined below.

¹⁶Helpman (1981) derived a similar result but with increasing returns at the industry level rather than at the firm level. His model of imperfect competition was based on the circular city model of spatial competition. Lahiri and Ono (1995) have obtained a similar result under Cournot competition with homogenous goods and under different technological conditions (see also Lawrence and Spiller, 1983, and Shimomura, 1998).

Factor price equalization ($w = w^*$ and $r = r^*$) implies that aggregate spending becomes simply $E = \gamma(wL^W + rK^W)$. Moreover, all goods are produced in the same quantity $X = X^*$ and all prices $p = p^*$ are given by a common markup on the common marginal cost $c_X(w, r)$. The markup $\mu(\theta, N)$ depends on the form of competition but is a function only of the elasticity of substitution and of the sum of the n domestic firms and n^* foreign firms $N = n + n^*$: it is given by (12) under competition in quantities and (16) under competition in prices.

The four market clearing conditions for the factor markets in both countries employ the *Shepherd Lemma* for which the labor and capital requirements for a unitary production in sector $j = X, Y$ are the same in both countries and given by $a_{Lj} = \partial c_j(w, r)/\partial w$ and $a_{Kj} = \partial c_j(w, r)/\partial r$. We will assume:

$$\frac{a_{KX}}{a_{LX} + \eta/X} > \frac{a_{KY}}{a_{LY}} \quad (27)$$

to make sure there are no factor intensity reversals in this framework. Substituting the capital and labor requirements and using (24), we can rewrite (27) as:

$$\frac{\frac{\partial c_X(w, r)}{\partial r}}{\frac{\partial c_X(w, r)}{\partial w} + \frac{p - c_X(w, r)}{w}} > \frac{\frac{\partial c_Y(w, r)}{\partial r}}{\frac{\partial c_Y(w, r)}{\partial w}}$$

Let us define with $\gamma_j(w, r)$ the elasticity of the marginal cost with respect to the wage w in sector $j = X, Y$, and with $\sigma_j(w, r)$ the elasticity of the marginal cost with respect to the interest rate r in sector $j = X, Y$. Rearranging the expression above, we have:

$$\frac{\sigma_X(w, r)}{\gamma_X(w, r) + \frac{p}{c_X(w, r)} - 1} > \frac{\sigma_Y(w, r)}{\gamma_Y(w, r)} \quad (28)$$

Finally, since constant marginal cost implies $\sigma_j(w, r) + \gamma_j(w, r) = 1$ for $j = X, Y$, we can use this and the mark up $\mu(\theta, N) = p/c_X(w, r)$ to rewrite (28) as an assumption on the mark up:

$$\mu(\theta, N) < \frac{\sigma_X(w, r)}{\sigma_Y(w, r)} \quad (29)$$

The mark up in the imperfectly competitive sector must be low enough to avoid factor intensity reversals.¹⁷

To close the model, the market clearing conditions for the integrated markets for goods can be combined in a single one by *Walras' Law*. Therefore, the system of eight equations:

$$c_Y(w, r) = 1 \quad (30)$$

¹⁷Notice that the right hand side of (29) is larger than one under the assumption that sector X is capital intensive. Clearly, under perfect competition this assumption is always satisfied.

$$X[p - c_X(w, r)] = \eta w \quad (31)$$

$$p = \mu(\theta, N)c_X(w, r) \quad (32)$$

$$a_{LY}Y + a_{LX}nX + \eta n = L \quad (33)$$

$$a_{LY}Y^* + a_{LX}(N - n)X + \eta(N - n) = L^* \quad (34)$$

$$a_{KY}Y + a_{KX}nX = K \quad (35)$$

$$a_{KY}Y^* + a_{KX}(N - n)X = K^* \quad (36)$$

$$p = \frac{\gamma}{1 - \gamma} \left(\frac{Y + Y^*}{NX} \right) \quad (37)$$

can be solved for the eight unknowns w , r , p , n , N , X , Y and Y^* . The amount of each input used in each sector of each country can be obtained residually. Notice that the equations (30)-(36) define the relative supply, that is an increasing relation between the relative price of the differentiated goods p and the ratio between total quantities $NX/(Y + Y^*)$: this is a weighted average of the autarchic relative supply curves for the two countries. The final equation (37) can be seen as defining the relative demand, that is a decreasing relation between p and the ratio between total quantities $NX/(Y + Y^*)$: this is the same as the autarchic relative demand because of the assumption of identical and homothetic preferences. The equilibrium defines the relative price and determines the pattern of trade.

A modified *Rybczynski theorem* implies that in autarchy the capital-abundant country produces more goods in the capital-intensive sector compared to the labor-abundant country, therefore the relative price of the capital-intensive goods is lower at home than abroad. After the countries open up to free trade, the relative price p converges to an intermediate level. Its reduction in the domestic country stimulates a larger domestic production of capital intensive differentiated goods and a lower consumption, therefore the country must export these goods and import the homogenous good. Accordingly, we can confirm the main result of neoclassical trade theory, the *Heckscher-Ohlin theorem*, in the presence of EMSs (see the Appendix for the proof):

TRADE DUE TO COMPARATIVE ADVANTAGE. Under EMSs in the capital-intensive sector, heterogenous factor endowments and identical homothetic preferences between two countries, a trading equilibrium without specialization induces intraindustry trade in the capital-intensive sector with positive net exports of the capital-abundant country.

Notice that, depending on the markup functions, the degree of substitutability between goods, and the size of the fixed costs relative to the size of the market, the model converges to traditional trade models:

- when the fixed cost shrinks (η is reduced toward zero) and substitutability between goods is increased (θ goes up indefinitely) for a given population L^W , the model converges asymptotically to the Heckscher-Ohlin model with an indefinite number of firms in the capital-intensive sector and markup:¹⁸

$$\mu(\infty, \infty) \rightarrow 1$$

so that both sectors are perfectly competitive in the limit, which suggests why the general model inherits some of the basic neoclassical properties on interindustry trade;

- when the population expands (L^W increases) for a given fixed cost η and a given degree of substitutability θ , the model converges to the Krugman model extended to general equilibrium as in Helpman and Krugman (1985), with monopolistic competition between an increasing number of firms in the capital intensive sector and markup:

$$\mu(\theta, \infty) \rightarrow \frac{\theta}{\theta - 1}$$

which suggests why the general model inherits some of the basic properties of the monopolistic competition models on intraindustry trade;

- when substitutability between goods θ approaches infinity for a given fixed cost η and a given population L^W , the model converges to the Brander-Markusen model under competition in quantities as extended to free entry and general equilibrium by Lahiri and Ono (1995), with markup:

$$\mu(\infty, N) \rightarrow \frac{N}{N - 1}$$

which suggests why the general model inherits some of the basic properties of the imperfectly competitive models in which trade increases competition.

¹⁸One can verify that the number of firms approaches infinity under Cournot competition and unity under Bertrand competition. Not by chance, the number is indeterminate under perfect competition.

Beyond these three particular cases, the general model presents simultaneously the three effects of trade: the impact of factor endowments on interindustry trade, the impact of product differentiation on intraindustry trade, and the impact of competition on markups. As a consequence, the general model also presents three sources of gains from trade: gains from comparative advantage related to factor endowments, gains from variety related to the increase in product differentiation and gains from competition related to the reduction of markups.

However, as usual, imperfect competition leads to inefficiency, which does not allow one to prove the universal existence of net gains from trade. In particular, the inefficiency of the EMS emphasized in the partial equilibrium model remains here as well, with a tendency toward excess entry in the imperfectly competitive sector (the frontier of the production possibilities is shifted inward with the exception of the point in which all inputs are used in the perfectly competitive sector). This opens the space for a new case for trade policy intervention (analyzed in the companion paper Etro, 2012b).

3.2 A Cobb-Douglas example

As an example, consider the case of Cobb-Douglas production functions:¹⁹

$$Y = K^{\alpha_Y} L^{1-\alpha_Y} \quad \text{and} \quad X = k^{\alpha_X} l^{1-\alpha_X} \quad \text{with} \quad \alpha_X > \alpha_Y \quad (38)$$

This generates marginal cost functions:

$$c_j(w, r) = \frac{w^{1-\alpha_j} r^{\alpha_j}}{\alpha_j^{\alpha_j} (1 - \alpha_j)^{1-\alpha_j}} \quad \text{for } j = Y, X$$

which allows one to solve explicitly for the entire equilibrium with closed form solutions depending on the form of competition.

To focus on the simplest case, let us assume competition in quantities with homogenous goods ($\theta \rightarrow \infty$), which implies the markup $\mu = N/(N-1)$. Notice that $\sigma_j(w, r) = \alpha_j$ for $j = X, Y$ therefore the assumption (29) corresponds to $\mu < \alpha_X/\alpha_Y$ or:

$$N > \frac{\alpha_X}{\alpha_X - \alpha_Y} \quad (39)$$

which will always be satisfied as long as the size of the economy (as measured by the world labor endowment) is large enough.

¹⁹Closed form solutions are also available with technologies with fixed coefficients.

The equilibrium number of firms can be derived in a closed form solution as follows (see the Appendix for the derivation):

$$N = \sqrt{\frac{\gamma L^W}{\eta [1 - \alpha_Y - \gamma(\alpha_X - \alpha_Y)]} + \Phi(\gamma)^2} - \Phi(\gamma) \quad (40)$$

$$\text{with } \Phi(\gamma) = \frac{\gamma \alpha_X}{2 [1 - \alpha_Y - \gamma(\alpha_X - \alpha_Y)]}$$

which allows one to derive residually all the other equilibrium variables. The total number of firms is independent from capital endowments, but increases less than proportionally with the world endowment of labor. This depends uniquely on the simplifying assumption that the fixed cost of production is entirely a labor cost. Had we assumed that the fixed cost of production was part in labor and part in capital, the total number of firms would have been a function of both world endowments. Had we assumed that it was in units of output, the number of firms would have been related to aggregate spending. What is relevant is that, in line with the partial equilibrium model of the previous section under quantity competition in homogenous goods, the total number of firms increases with the square root of the size of the market. As long as the size of the integrated market is large enough and the term Φ is relatively negligible, the elasticity β is still approximately 0.5 as in the basic model of the previous section with homogenous goods. Moreover, the number of firm is increasing in the relative preference for the capital-intensive goods γ and in the difference in capital-intensity between sectors $\alpha_X - \alpha_Y$.

What we found confirms that opening up to trade induces a reduction of the markup and business destruction in at least one country. The allocation of firms between countries depends, however, on their respective capital endowments. In particular, the number of domestic firms can be derived as (see the Appendix for the derivation):

$$n = \frac{(1 - \alpha_Y)KN}{K^W} + \frac{\alpha_Y K \left[\frac{(1 - \alpha_Y)N^2}{K^W} - \frac{\gamma L}{\eta K} \right]}{\gamma [(\alpha_X - \alpha_Y)(N - 1) - \alpha_Y]} \quad (41)$$

where the second denominator is positive under our assumption (39). First of all, notice that the number of domestic firms is exactly linearly increasing in the ratio between domestic and total capital. Second, since N^2 is approximately proportional to the world population L^W from (40), the second term is positive when the domestic capital-labor ratio K/L is large enough compared to the world capital-labor ratio K^W/L^W . Finally, notice that when the capital-labor ratios are not too different, the second term in (41) is relatively small, and the number of domestic firms is approximately linear in the total number of firms

N as given by (40). This implies that when the size of the world population increases also the number of the firms in each country increases less than proportionally, and the elasticity of the number of national firms with respect to market size is again approximately 0.5. In other words, the pattern of entry in the imperfectly competitive sector changes with the relative endowments of capital and labor of each country, but it depends on the size of the integrated economy in an analogous way to the world number of firms.

The general case of imperfect substitutability (θ finite but larger than unity) is more cumbersome but leads to analogous qualitative results. Under competition in quantities, which implies the markup (12), the elasticity of the number of firms with respect to the size of the market is higher and goes up from 1 to 0.5 while θ decreases toward its lower bound. In case of competition in prices, which implies the markup (16), we can explicitly derive the number of firms as:

$$N = \frac{\frac{\gamma L^W}{\eta} + (\theta - 1) [1 - \alpha_Y - \gamma (\alpha_X - \alpha_Y)]}{\theta [1 - \alpha_Y - \gamma (\alpha_X - \alpha_Y)] + \gamma \alpha_X} \quad (42)$$

which is now linearly increasing in the world population: as long as the size of the integrated market is large enough, the elasticity of the total number of firms with respect to the size β is still approximately 1 as in the basic model of the previous section and in the case of monopolistic competition.²⁰ Nevertheless, it is still true that markups are reduced with trade, even if the impact on prices is ambiguous because the marginal cost $c_X(w, r)$ is also affected by general equilibrium changes of the factor prices. These have also an impact on income, which affects the welfare gains from trade, whose general analysis is beyond the scope of this section.

3.3 Comparative preferences and trade

In this section we introduce heterogeneity in the preferences of the consumers of the two countries in the 2x2x2 model. Trade theory has been traditionally focused on the case of identical and homothetic preferences, which is crucial to isolate the role of (technological) comparative advantage as a source of trade. However, it is important to be aware of the implications of differences in preferences between countries. For this purpose, we retain homotheticity and assume

²⁰Notice that in case of monopolistic competition with markup $\mu = \theta/(\theta - 1)$, one can also derive the total number of firms as:

$$N = \frac{\gamma L^W}{\eta [\theta [1 - \alpha_Y - \gamma (\alpha_X - \alpha_Y)] + \gamma \alpha_X]}$$

that the utilities of the domestic and foreign countries are

$$V = U^\gamma Y^{1-\gamma} \quad \text{and} \quad V^* = U^{\gamma^*} Y^{1-\gamma^*} \quad \text{with } \gamma \geq \gamma^* \quad (43)$$

that is domestic consumers have a relative preference for the capital intensive good relative to the foreign consumers. This creates heterogeneity in the demand for the goods across countries. World demand of each good is now a weighted average of domestic aggregate spending $wL + rK$ and foreign one $wL^* + rK^*$, and in particular aggregate spending in the capital-intensive and imperfectly competitive sector (22) becomes:

$$E = \gamma(wL + rK) + \gamma^*(w^*L^* + r^*K^*) \quad (44)$$

As long as both countries produce both goods, factor price equalization still holds, and preference heterogeneity does not affect in any way the analysis of the relative supply of the integrated market as summarized by the system (30)-(36). However, the relative demand of the integrated market (37) changes as follows:

$$p = \frac{\gamma^* + \gamma\vartheta(w, r)}{1 - \gamma^* + (1 - \gamma)A(w, r)} \left(\frac{Y + Y^*}{NX} \right) \quad (45)$$

where:

$$\vartheta(w, r) \equiv \frac{wL + rK}{wL^* + rK^*}$$

Notice that p is increasing in $\vartheta(w, r)$, which is decreasing in the ratio w/r if $K/L > K^*/L^*$, therefore if the domestic country is capital-abundant, an increase of the wage-rental rate ratio reduces the relative willingness to pay for the capital-intensive goods and the other way around, which strengthens the *Stolper-Samuelson effect*. This new effect disappears only when the two countries have the same relative factor endowments and no comparative advantage.

To verify the consequence of heterogeneity in preferences, let us neutralize (technological) comparative advantage considering the extreme case in which factor endowments are indeed identical in the two countries, $L = L^*$ and $K = K^*$. In autarchy, the domestic country would consume more differentiated goods and sell them at a higher relative price (because relative demand is larger) compared to the other country, which implies a lower wage/interest rate ratio. Moreover, this would generate a larger number of varieties sold in the domestic country, and therefore a lower markup relative to the foreign country.

When the countries open up to trade, the relative price of the capital-intensive goods must decrease in the domestic country and increase in the foreign one, which induces even more domestic consumption of differentiated goods and

lower consumption by the foreign consumers. However, since factor endowments are identical, none of the countries has a comparative advantage in any sector. Facing the same relative price p they must produce exactly the same amounts of both goods: this implies that the domestic country reduces (increases) its production of the capital-intensive (labor-intensive) goods. Therefore, the domestic country becomes a net importer of capital-intensive goods and a net exporter of labor-intensive homogenous goods. More precisely, the value of the net domestic imports of capital-intensive goods (net domestic exports of labor-intensive goods) can be easily calculated as $Trade = (\gamma - \gamma^*)(wL + rK)/2$. We can summarize the results as follows (see the Appendix for the proof):

TRADE DUE TO COMPARATIVE PREFERENCES. Under EMSs in the capital-intensive sector, equal factor endowments and different homothetic preferences between two countries, a trading equilibrium without specialization induces intraindustry trade in the capital-intensive sector with positive net exports of the country with a relative preference for the labor-intensive good.

Under our Cobb-Douglas specification with Cournot competition and homogenous goods in the capital-intensive sector, we have:

$$N = \sqrt{\frac{2(\gamma + \gamma^*)L}{\eta[2(1 - \alpha_Y) - (\gamma + \gamma^*)(\alpha_X - \alpha_Y)]}} + \Phi\left(\frac{\gamma + \gamma^*}{2}\right)^2 - \Phi\left(\frac{\gamma + \gamma^*}{2}\right) \quad (46)$$

The total number of firms is always increasing and concave in the size of the market because of the usual competition effect. Given the absence of any comparative advantage, each country has $n = n^* = N/2$ firms. Then, the domestic country faces always a drastic process of business destruction: for both the competition effect and the new tendency to import the favorite (and cheaper) goods. On the other side, one can verify that the foreign country faces a reduction in the number of firms if the countries have similar preferences.²¹ When trade is driven by comparative preferences (rather than comparative advantage) the process of business destruction can be quite drastic. Nevertheless, both countries gain from trade because this improves their terms of trade: each country faces a reduction of the price of imports and an increase in the price of exports.

The mentioned mechanism persists in case of small differences in factor endowments: the capital abundant country may become a net importer of the

²¹Only if γ/γ^* is large enough, the foreign country may develop new firms producing differentiated goods after opening up to trade.

capital intensive differentiated goods as long as its consumers have a relative preference for these goods that is strong enough, and opening up to trade induces a drastic process of business destruction in the capital-abundant country in favour of the labor-abundant one. Incidentally, heterogenous preferences contribute to solve the Leontief (1953) paradox,²² and explain why some developing countries produce and export manufacturing goods that they do not consume or consume less than the destination countries. Beyond this, we can conclude that the concave relation between market size and number of firms due to the competition effect is robust to different versions of the general equilibrium model with multiple sectors and factor of production.

4 Heterogeneity between Firms à la Melitz

In this section we extend the analysis of EMSs to take into account cost heterogeneity between firms. Contrary to the Melitz (2003) model characterized by product differentiation with monopolistic competition (see also Melitz and Ottaviano, 2008), here we focus on the opposite case of homogenous goods ($\theta \rightarrow \theta$) with quantity competition. For simplicity, let us consider the simplest case in which any firm can adopt a standard technology with a constant marginal cost c ,²³ but m firms have a superior and firm-specific technology with marginal costs c/A_i , where $A_i > 1$ for the more efficient firms ($A_i = 1$ for any “marginal” firm adopting the standard technology). This assumption and the finite number of firms with higher productivity represent a departure from the assumption of Melitz (2003) for which firms produce different goods and draw their productivity parameters from a known distribution after entry takes place. However, most sectors appear characterized by a finite and small number of heterogenous incumbents and a competitive fringe of marginal firms adopting a common technology, especially when they produce a homogenous good. We do not impose any condition on the distribution of the productivity parameter across firms, except for an upperbound (defined below) on technological differences such that

²²See Vanek (1968) and Leamer (1980) on the Leontief Paradox. The analysis of the factor content of trade can go in any direction if preferences are different across countries. In particular, capital-abundant countries can be net importers of capital intensive goods if they like them relatively more. However, our analysis suggests an empirical avenue to test whether trade is due to comparative preference rather than comparative advantage. If the former is more important, we would expect a negative correlation between consumption rates of goods and export rates across different countries, but if the latter (comparative advantage) is more important, we would expect a positive correlation. We are not aware of any empirical investigation in this direction.

²³We have $c = w = 1$ in our partial equilibrium model or $c = c_X(w, r)$ in our general equilibrium model, with factor price equalization emerging under free trade (see the Appendix).

there is entry of some firms adopting the standard technology in both countries.

In the domestic market, each firm chooses the profit-maximizing output X_i to satisfy the first order condition:

$$p(X^W) + X_i p'(X^W) = \frac{c}{A_i}$$

where $X^W = \sum_{j=1}^N X_j$ is world output and $p(X^W) = E/X^W$ is the inverse demand described above with worldwide spending E (but most of what follows applies to general inverse demand functions for homogenous goods). An immediate consequence of the Cournot equilibrium is that, for given world production and market size, firms with higher productivity A_i choose a larger production, namely:

$$X_i = X^W - \frac{c(X^W)^2}{EA_i} \quad (47)$$

and obtain larger profits:

$$\pi_i = E \left(\frac{X_i}{X^W} \right)^2 - F$$

These results are in line with those of the Melitz (2003) model. However, in his case of monopolistic competition and differentiated goods, all firms choose the same markup and the price goes down with productivity. Here the markup is increasing in productivity ($p(X^W) - c/A_i$ grows with A_i) and the price is the same for all firms. Moreover, the price is also independent from the distribution of productivities of the efficient firms. To verify this, notice that, as long as there is entry of some firms adopting the standard technology, the zero profit condition must hold on them. Accordingly, their optimality and free entry conditions pin down their output X and the world output X^W :

$$X[p(X^W) - c] = F \quad \text{and} \quad p(X^W) + Xp'(X^W) = c$$

This implies that the productivities of the heterogenous firms and their associated production levels do not affect the total world production X^W and the output level of each firm adopting the standard technology X : these are the same as if all firms adopted the standard technology featuring homogenous costs.²⁴ However, cost heterogeneity differentiates production for the efficient firms, and their profits can be rearranged as follows:

$$\pi_i = F \left[\left(\frac{X_i}{X} \right)^2 - 1 \right] \quad (48)$$

²⁴This is a consequence of a Neutrality Theorem in Etro (2012b).

which is increasing in production and productivity. Of course, the presence of more efficient firms is going to reduce the total number of firms compared to the total number emerging under homogenous costs. The latter was concave in market size, and equal to $N = \sqrt{L/F}$ in our partial equilibrium framework. Let us define $\phi = (1/m) \sum_{j=1}^m A_j^{-1} \in (0, 1]$ as the average cost of the firms with non-standard technology relative to the others (an index of inverse productivity), which is unitary in case of homogenous costs and is reduced by any improvement in the technology of any firm. Then, summing (47) over all firms we obtain an expression for X^W . Since the latter must be the same as under homogenous costs, $X^W = L(1 - \sqrt{F/L})/c$, solving for the number of firms we obtain:²⁵

$$N = \sqrt{\frac{L}{F}} [1 - m(1 - \phi)] + m(1 - \phi)$$

As evident, with more firms adopting more efficient technologies (larger m and smaller ϕ), there is space for a smaller number of entrants. However, the number of firms is still a concave function of the size of the market. In a partial equilibrium context, this would be enough to conclude that cost heterogeneity does not change any of our results: an increase in the size of the market strengthens competition, reduces the price $p(X^W)$, increases the individual production of each firm and increases the number of firms less than proportionally.²⁶

²⁵This allows one to define an upperbound on technological differences to guarantee entry of at least one firm per country with the standard technology and therefore $N > m + 1$. Rearranging, this implies:

$$\phi + 1/m > \frac{\sqrt{L}}{\sqrt{L} - \sqrt{F}}$$

²⁶We can easily analyze the impact of trade barriers. Assume $c = 1$ and suppose that exports require an additional fixed cost F_X and a transport costs expressed as an iceberg cost $\tau > 1$ (τ units of good must be produced at home to sell one unit abroad). Markets are now segmented, with each firm choosing production for the domestic one and, if profitable, choosing exports for the foreign market. Aggregate spending and total production are E^F and X^F in a foreign country. The profits of the domestic firm i exporting X_i^F abroad are:

$$\pi_i^F = \left[p(X^F) - \frac{\tau}{A_i} \right] X_i^F - F_X = E^F \left(\frac{X_i^F}{X^F} \right)^2 - F_X$$

where the optimal exports are $X_i^F = X^F - \tau (X^F)^2 / E^F A_i$. Endogenous entry of the competitive fringe induces the total production $X^F = E^F - \sqrt{F E^F}$. Accordingly, firm i exports if:

$$A_i > \tau \frac{\sqrt{E^F} - \sqrt{F}}{\sqrt{E^F} - \sqrt{F_X}}$$

Trade barriers reduce the subset of firms engaged in trade, but do not affect total production for each country. Therefore, opening up to trade induces business destruction at the local level due to the entry of more productive foreign firms.

Introducing such a market as the capital-intensive sector of our general equilibrium 2x2x2 model is now straightforward (see the Appendix). The efficiency of the most productive firms reduces the input requirement needed to produce a given amount of capital-intensive goods, which ultimately affects the prices of factor inputs (the impact is similar to the impact of an innovation biased toward the capital-intensive technology). However, it is always the competitive fringe of firms adopting the standard technology that determines total world production of the capital-intensive good X^W and its relative price $p(X^W)$, therefore factor price equalization holds as before and the behavior of the economy resembles the one with homogenous costs.

5 Conclusion

When markets are characterized by strategic interactions and endogenous entry, opening up to trade decreases the price level and increases less than proportionally the global number of firms and the production of each firm, with a positive competition effect on welfare. The main results hold in a 2x2x2 general equilibrium extension nesting the neoclassical model and the Krugman model with strategic interactions. Important directions for further research concern the integration of trade costs in a general equilibrium environment (see Eaton *et al.*, 2012, for steps in this direction), the analysis of endogenous aspects of labor productivity (Leamer, 1999) and of factor mobility. Moreover, further investigations on trade policy within our model are needed.

In conclusion, our work supports the idea that an increase in the size of a market associated with trade integration leads to a less than proportional increase in the number of firms, exit of firms at the local level, lower markups and larger production for each surviving firm. This happens for reasons that depend on the new competitive pressure from foreign firms and have nothing to do (but could be consistent) with cost heterogeneity and barriers to trade as assumed by Melitz (2003). Empirical research discriminating between alternative explanations is needed.

Appendix. Details on the 2x2x2 model

FACTOR PRICE EQUALIZATION. Under EMSs in one sector and perfect competition in the other, a trading equilibrium with production of both countries in both sectors induces equal prices and outputs for all firms (under both price and quantity competition) and equal wages and interest rates in both countries.

PROOF. Consider competition in quantity first. From the inverse demand function we can obtain the price of a domestic variety as $p = E/X^{1/\theta}\Sigma$ and the price of a foreign variety as $p^* = E/X^{*1/\theta}\Sigma$ where $\Sigma = nX^{\frac{\theta-1}{\theta}} + n^*X^{*\frac{\theta-1}{\theta}}$ is an aggregate statistic of the output levels, n is the number of domestic firms and $n^* = N - n$ is the number of foreign firms. With this, we can rewrite the equilibrium equations as:

$$\begin{aligned} c_Y(w, r) = 1 \quad c_Y(w^*, r^*) = 1 \\ \frac{EX^{\frac{\theta-1}{\theta}}}{\Sigma} - c_X(w, r)X = \eta w \quad \frac{EX^{*\frac{\theta-1}{\theta}}}{\Sigma} - c_X(w^*, r^*)X^* = \eta w^* \\ \frac{(\theta-1)}{\theta\Sigma^2}EX^{-\frac{1}{\theta}}\left(\Sigma - X^{\frac{\theta-1}{\theta}}\right) = c_X(w, r) \quad \frac{(\theta-1)}{\theta\Sigma^2}EX^{*-\frac{1}{\theta}}\left(\Sigma - X^{*\frac{\theta-1}{\theta}}\right) = c_X(w^*, r^*) \end{aligned}$$

Given world expenditure E and given an aggregate statistic Σ , we have two specular systems of three equations respectively in (w, r, X) and in (w^*, r^*, X^*) . If the mapping of the two systems is univalent, then both countries will have the same factor prices, the same level of output and the same price of a firm in the imperfectly competitive sector.

Consider competition in prices now. From the direct demand function we can express the demand of a domestic variety as $X = Ep^{-\theta}/P$ and the demand of a foreign firm as $X^* = Ep^{*-\theta}/P$, where $P = np^{1-\theta} + n^*p^{*1-\theta}$ is a standard price statistic. With this, we can rewrite the equilibrium equations as:

$$\begin{aligned} c_Y(w, r) = 1 \quad c_Y(w^*, r^*) = 1 \\ \frac{Ep^{-\theta}[p - c_X(w, r)]}{P} = \eta w \quad \frac{Ep^{*-\theta}[p^* - c_X(w^*, r^*)]}{P} = \eta w^* \\ 1 = [p - c_X(w, r)] \left[\frac{\theta}{p} + \frac{(\theta-1)p^{-\theta}}{P} \right] \quad 1 = [p^* - c_X(w^*, r^*)] \left[\frac{\theta}{p^*} + \frac{(\theta-1)p^{*-\theta}}{P} \right] \end{aligned}$$

Given world expenditure E and the aggregate statistic P , we have two specular systems of three equations respectively in (w, r, p) and in (w^*, r^*, p^*) . If the mapping of the two systems is univalent, then both countries will have the same factor prices, the same price and the same output of each firm in the imperfectly competitive sector. $\square$

TRADE DUE TO COMPARATIVE ADVANTAGE. Under EMSs in the capital-intensive sector, heterogenous factor endowments and identical homothetic preferences between two countries, a trading equilibrium without specialization induces intraindustry trade in the capital-intensive sector with positive net exports of the capital-abundant country.

PROOF. Exploiting the common production of all firms X , one can solve the equilibrium conditions of the factor markets for n and n^* :

$$n = \frac{[K/L - a_{KY}/a_{LY}]L}{\left(\frac{a_{KX}}{a_{LX} + \eta/X} - \frac{a_{KY}}{a_{LY}}\right)(a_{LX}X + \eta)} \quad n^* = \frac{[K^*/L^* - a_{KY}/a_{LY}]L^*}{\left(\frac{a_{KX}}{a_{LX} + \eta/X} - \frac{a_{KY}}{a_{LY}}\right)(a_{LX}X + \eta)}$$

It follows that $n \geq n^*$ if and only if $K \geq K^* + (a_{KY}/a_{LY})(L - L^*)$. At the same time we can solve for Y and Y^* and derive the relative production in the two sectors:

$$\frac{nX}{Y} = \frac{\left(\frac{K}{L} - \frac{a_{KY}}{a_{LY}}\right) a_{LY}}{\left(\frac{a_{KX}}{a_{LX} + \eta/X} - \frac{K}{L}\right) (a_{LX} + \eta/X)} \quad \frac{n^*X}{Y^*} = \frac{\left(\frac{K^*}{L^*} - \frac{a_{KY}}{a_{LY}}\right) a_{LY}}{\left(\frac{a_{KX}}{a_{LX} + \eta/X} - \frac{K^*}{L^*}\right) (a_{LX} + \eta/X)}$$

Under the assumption (27), we immediately obtain that:

$$\frac{nX}{Y} \geq \frac{n^*X}{Y^*} \text{ iff } \frac{K}{L} \geq \frac{K^*}{L^*}$$

Since both countries consume goods in the same proportions because of the identical and homothetic preferences, and in particular the market clearing conditions for the goods' markets provide:

$$\frac{(n + n^*)X}{Y + Y^*} = \frac{\gamma}{(1 - \gamma)p}$$

we must have that the country which is relatively abundant of capital produces relatively more differentiated good than it consumes, and therefore exports them. $\square$

COBB-DOUGLAS EXAMPLE. To derive the equilibrium number of firms under Cournot competition and homogenous goods in a closed form solution, let us notice that $a_{Lj} = (1 - \alpha_j) c_j(w, r)/w$ and $a_{Kj} = \alpha_j c_j(w, r)/r$. From (30) and (32) we have:

$$a_{LY} = \frac{1 - \alpha_Y}{w} \quad \text{and} \quad a_{LX} = \frac{(1 - \alpha_X)p(N - 1)}{wN}$$

Substituting all these expressions into (33) and (34) we have:

$$\frac{1 - \alpha_Y}{w} Y + \frac{(1 - \alpha_X)p n X}{w\mu} + \eta n = L \quad \text{and} \quad \frac{1 - \alpha_Y}{w} Y^* + \frac{(1 - \alpha_X)p n^* X}{w\mu} + \eta n^* = L^*$$

From (30) and (31) we have $Xp/N = \eta w$. Using this and (37) after summing the two relations above member by member, we obtain a quadratic expression for N :

$$\left[\frac{(1 - \alpha_Y)(1 - \gamma)}{\gamma} + (1 - \alpha_X) \right] \eta N^2 + \eta \alpha_X N = L^W$$

This can be solved for the equilibrium number of firms in the text.

To derive the number of domestic firms, let us replace the previous conditions and the following:

$$a_{KY} = \frac{\alpha_Y}{r} \quad \text{and} \quad a_{KX} = \frac{\alpha_X p(N - 1)}{rN}$$

in (35) and (36). Summing member by member, one can obtain an expression for w/r . From (33) and the previous conditions one can isolate Y . Replacing all in (35) allows one to express the number of domestic firms as in the text. The number of

firms in case of imperfect substitutability and Bertrand competition can be derived in the same way adopting the appropriate markup in the derivation. $\square$

TRADE DUE TO COMPARATIVE PREFERENCE. Under EMSs in the capital-intensive sector, equal factor endowments and different homothetic preferences between two countries, a trading equilibrium without specialization induces intraindustry trade in the capital-intensive sector with positive net exports of the country with a relative preference for the labor-intensive good.

PROOF. As in the model with identical preference, under the assumption (27), the supply conditions imply:

$$\frac{nX}{Y} = \frac{n^*X}{Y^*} \quad \text{since} \quad \frac{K}{L} = \frac{K^*}{L^*}$$

However, countries consume goods in the different proportions because of the homothetic but different preferences, and the market clearing conditions for the world goods' markets provide:

$$\frac{(n + n^*)X}{Y + Y^*} = \frac{\gamma^* + \gamma\vartheta(w, r)}{[1 - \gamma^* + (1 - \gamma)A(w, r)]p}$$

Denoting with C_X and C_X^* aggregate spending in the capital-intensive goods by the domestic and foreign agents and with C_Y and C_Y^* aggregate spending in the labor-intensive goods, market clearing implies:

$$\frac{C_X + C_X^*}{C_Y + C_Y^*} = \frac{\gamma^* + \gamma\vartheta(w, r)}{[1 - \gamma^* + (1 - \gamma)A(w, r)]p}$$

However, optimal spending in each country implies:

$$\frac{C_X}{C_Y} \geq \frac{C_X^*}{C_Y^*} \quad \text{iff} \quad \frac{\gamma^*}{(1 - \gamma^*)p} \geq \frac{\gamma}{(1 - \gamma)p}$$

Comparing this with the previous condition shows that the country with a relative preference for the capital-intensive goods consumes more of them, and therefore imports them. $\square$

COST HETEROGENEITY. Let us introduce cost heterogeneity in the imperfectly competitive sector of the 2x2x2 model. Any firm can adopt the standard technology with a constant marginal cost $c_X(w, r)$, but m firms have a superior and firm-specific technology based on production functions $X_i = A_i g(k_i, l_i)$, where $A_i > 1$ are the productivity parameters. This generates the marginal costs $c_X(w, r)/A_i$, with $A_i >$

1. In the domestic market, given the factor prices (w, r) , each firm chooses the profit-maximizing output X_i to satisfy the first order condition:

$$p(X^W) + X_i p'(X^W) = \frac{c_X(w, r)}{A_i} \quad (49)$$

where $X^W = \sum_{j=1}^N X_j$ is world output and $p(X^W) = E/X^W$ is the inverse demand. This implies profits $\pi_i = -p'(X^W) X_i^2 - \eta w$. The optimality and free entry conditions for the marginal firms pin down their output X and the world output X^W :

$$X [p(X^W) - c_X(w, r)] = \eta w \quad \text{and} \quad p(X^W) + X p'(X^W) = c_X(w, r) \quad (50)$$

Notice that in the absence of trade costs, the world market is perfectly integrated, demand depends on world aggregate spending E and total production from both countries X^W determines a unique price. The competitive sector remains characterized by marginal cost pricing:

$$c_Y(w, r) = 1 \quad (51)$$

The foreign country is characterized by the same conditions as above except for the fact that different wages and interest rates may entail different marginal and fixed costs:

$$\begin{aligned} p(X^W) + X_i p'(X^W) &= \frac{c_X(w^*, r^*)}{A_i} \\ X^* [p(X^W) - c_X(w, r)] &= \eta w^* \quad \text{and} \quad p(X^W) + X^* p'(X^W) = c_X(w^*, r^*) \\ c_Y(w^*, r^*) &= 1 \end{aligned}$$

The independence of the equilibrium price $p(X^W)$ and the individual output of the marginal entrants from cost heterogeneity is again crucial. It insures that the proof of factor price equalization goes through as in the model with homogenous costs: given a world production X^W both countries must have the same $w = w^*$, $r = r^*$ and $X = X^*$ for the marginal firms adopting the standard technology.

Since we introduced cost heterogeneity, however, the labor and capital requirements for unitary production are now smaller for the most efficient firms. In particular, a unit of differentiated good i produced by a firm with productivity A_i requires a_{LX}/A_i units of labor and a_{KX}/A_i units of capital. Therefore, market clearing in the domestic labor and capital market requires:

$$a_{LY}Y + a_{LX}\mathbf{X} + \eta n = L \quad \text{and} \quad a_{KY}Y + a_{KX}\mathbf{X} = K \quad (52)$$

where

$$\mathbf{X} = \sum_{j=1}^n \left(\frac{X_j}{A_j} \right)$$

and the coefficients a_{LY} , a_{LX} , a_{KY} and a_{KX} are exactly the same as before. Here $a_{LX}X$ is the amount of labor employed by the domestic firms in the imperfectly competitive sector: more efficient firms require less labor for each unit produced but they also produce more endogenously. Notice that X corresponds to the production that firms with standard technology would have obtained employing the same amount of inputs.

Analogous conditions hold for the foreign country:

$$a_{LY}Y^* + a_{LX}\mathbf{X}^* + \eta(N - n) = L^* \quad \text{and} \quad a_{KY}Y^* + a_{KX}\mathbf{X}^* = K^* \quad (53)$$

with

$$\mathbf{X}^* = \sum_{j=n+1}^N \left(\frac{X_j}{A_j} \right)$$

The equilibrium is closed by the relative demand equation. Under identical and homothetic preferences, the presence of profits for the owners of the efficient firms does not affect the relative allocation of world income between sectors, therefore the relative demand equation reads as before:

$$p(X^W) = \frac{\gamma}{1 - \gamma} \left(\frac{Y + Y^*}{X^W} \right) \quad (54)$$

Accordingly, the equilibrium is fully characterized by a system of $8 + m$ equations (49)-(50)-(51)-(52)-(53)-(54) in the following unknowns: w , r , n , N , X , X_i for $i = 1, 2, \dots, m$, X^W , Y and Y^* . The efficiency of the most productive firms reduces the input requirement needed to produce a given amount of differentiated goods, which ultimately affects the allocation of the inputs and their prices. However, it is always the competitive fringe of firms adopting the standard technology that determines total world production of the capital-intensive good X^W and its relative price $p(X^W)$, therefore the behavior of the economy resembles the one with homogenous costs. Similar results apply in case of imperfect substitutability (see Bernard *et al.*, 2007, for an analysis of free trade in the simpler case of monopolistic competition): free trade guarantees that factor price equalization holds, all the active firms are exporters and, under Cournot or Bertrand competition, opening up to trade strengthens competition.²⁷□

²⁷A more realistic description of trade, which is beyond the scope of this paper, should incorporate transport costs and export costs to account for an endogenous set of exporters. However, in this case the markets of the different countries would be segmented: domestic firms and the most productive foreign exporters would be active at home and foreign firms and the most productive domestic firms would be active in the foreign market. This excludes factor price equalization, induces differences in aggregate spending in the two countries and leads to different EMSs. While a characterization of such an equilibrium is cumbersome and beyond the scope of this paper, the usual competition effect is going to emerge in each one of the two segmented markets.

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