The importance of the asymmetry in trade costs in defining the spatial distribution of the economic activity*

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Abstract: The author studies the relevance of trade costs in determining the economic landscape. The Linear Footloose Capital Model is extended in order to consider asymmetric trade costs. Key insights arise. Firstly, when the own-price effect is low and product differentiation is high, the impact of the market size on the spatial distribution of firms is strong. Secondly, the region with a relevant and well protected market attracts firms. This paper presents a background in which it is plausible to disentangle analytically the effects of absolute and relative trade costs and to reach the equilibrium of the spatial distribution of firms.

Keywords: Trade costs; Spatial distribution; Economic geography.

JEL Code: F12, F21, R12.

* The author would like to thank an anonymous referee very much for valuable comments.

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1 Introduction

It is a fact that economic activity is distributed around the world in an unequal fashion. No matter to which geographical scale one refers, whether one observes neighborhoods, cities, nations, continents or the globe, there exists any type of economic agglomeration. One example of economic concentration at the global scale is given in Fujita and Mori (2005). The authors well note that, in two decades, the NAFTA, the EU (15 countries) and East Asia increased their shares in the world GDP by more than 10 percentage points. In 2000 these economic blocs altogether ended up to concentrate 83% of the world GDP.

Many factors may explain the formation of different kinds of spatial concentration. To some extent, it is logical that a heterogeneous space may partially result in uneven economic development. Differences in natural resources, such as climate, land, harbors, mines, etc., mainly explain why some kinds of economic activities are concentrated in some particular regions. Nevertheless, such differences in the natural environment, which have been called *first nature,* are not the only responsible for the outcome of uneven economic landscape. As it has been pointed out by Ottaviano and Thisse (2004):

> "… first nature play an important role in explaining economic history and especially the early stage of economic development……….human kind has tried to soften the constraints of first nature, thus generating a spatial distribution of economic activities that, in many cases, is largely independent from natural advantage…

In fact, there are cumulative processes that are driven by different actions, affecting the economic geography. What it has been called *second nature,* explains the presence of many clusters of economic activities; those that would be difficult to understand by only taking into account natural advantages. *Second nature* emerges as the outcome of human beings' actions that aims to improve upon the first nature (Ottaviano and Thisse (2004)).

The New Economic Geography (henceforth, NEG) aims to explain the imbalances of economic activity by mainly focusing on the study of *second nature*. The NEG is a general equilibrium framework, which introduces microfoundations to the agglomeration and dispersion mechanisms. Since its beginnings, -Fujita (1988), Krugman, (1991), and Venable (1996)-, the branch has grown pretty well. To date, several surveys review the NEG.[1] Particularly, Fujita and Mori (2005) make an interesting distinction between models of first and second generation within the NEG. Models of the first generation rely mainly on the monopolistic framework of Dixit-Stiglitz and consider trade costs *a la* iceberg. From the standpoint of the economic modeling, this combination of tools makes the analysis of the economic geography technically manageable.[2] The second generation extends the branch and makes some interesting refinements. Particularly, Ottaviano *et al.* (2002) follow other modeling strategy. By considering an alternative functional form of preferences and additive trade costs, they present a model that overcomes some undesirable features of models within the first generation.[3] Such a framework is a based-model of a set of linear models, which are described in Baldwin *et al*. (2003) and feature the same desirable advantages of the based-model. Among the advantages, the new frameworks characterize for being more parameterized than those of based on Dixit-Stiglitz background. This distinction improves the analysis of comparative statics within the linear models, since it allows disentangling different effects of exogenous events on the endogenous variables. Linear models also introduce the pro-competitive effect. This incorporation, which reflects a realistic feature of world trade, enhances the analysis by considering another plausible source that tends to promote dispersion of the economic activity. Moreover, as trade costs are modeled additively, this strategy prevent to assume that any change in the price of the differentiated good will drive to a proportional change in its trade cost; an implication that is implicit within the concept of iceberg trade costs.[4]

[1] Some of these surveys are Ottaviano and Puga (1998), Fujita and Krugman (2004), Ottaviano and Thisse (2004 and 2005), Fujita and Mori (2005) and Gáname and Granato (2008).

[2] Fujita, Krugman and Venable (1999) nicely explain the modeling tricks of the first generation models (pp. 6-9). Baldwin et al. (2003) introduce an appendix that they have called "All that you wanted to know about Dixit-Stiglitz but you were afraid to ask".

[3] For an exposition of the problems within the Dixit-Stiglitz framework and iceberg trade costs, see Ottaviano (2001), Ottaviano et al. (2002), Baldwin, et al. (2003) and Fujita and Mori (2005).

[4] For an exhaustive exposition of the advantages of linear models see also Ottaviano (2001), Ottaviano et al. (2002), Baldwin, et al. (2003).

The NEG branch states at the scene trade costs as playing a relevant role in affecting the spatial distribution of the economic activity. In a world where firms compete imperfectly and economies of scales are present, trade costs are crucial in defining the economic landscape. Indeed, when economic players face positive trade costs, the question "*where to locate*" becomes relevant; in an integrated world without trade costs, this issue would be immaterial. The NEG models introduce trade costs as one parameter that characterizes any type of trade barriers (i.e. transport costs, different instruments of trade policies such as tariffs and the bundle of non tariff barriers, impediments in communication or cultural barriers, etc.). Generally, for a methodological matter, they are considered to be equal between regions; though, among the first generation of NEG, some tractable models allow to introduce analytically the asymmetry in trade costs.[5] Such a consideration becomes relevant in understanding, for instance, how differences in regions' trade policies may affect the spatial distribution of economic activity between them. This paper aims to extend the Linear Footloose Capital Model presented by Baldwin, *et al.* (2003), which belongs to the second generation of NEG models, by allowing regions to differ in terms of trade costs. Interestingly, by considering such an extension, the model takes into account the fact that, in general, when imperfect competitive firms export, they face different trade costs from those that are faced by their foreign competitors when they export to the local market.

The introduction of asymmetry in trade costs brings to the theoretical analysis a new flavor of a fact in international trade. Recently, Kee, Nicita and Olarreaga, (2009) have well documented for a sample of countries, that they face different impediments to trade. The authors have handed measures of trade restrictiveness that account for different instruments of trade policies. Interestingly, all trade restrictiveness indicators presented in Kee, Nicita and Olarreaga (2009) vary across countries. Among such indicators, the Market Access Overall Trade Restrictiveness measure– MA OTRI –accounts for trade barriers faced by each country's exporters when they sell in other partner countries.[6] Particularly, authors find a negative correlation between MA OTRI and the log of Gross Domestic Product, suggesting that richer countries face lower trade restriction on their exports than those of faced by poor countries. According to their estimations, poor countries would impose and face more restrictive trade policies. Hence, the extended framework presented in this paper enhances the theoretical study of the spatial distribution of the economic activity by incorporating a fact (i.e. asymmetric trade costs) without paying any cost in terms of model tractability. Moreover, this incorporation is made by taking into account as a based-model, the Linear Footloose Capital Model, which features all the advantages above mentioned of linear models. By considering such a framework one can distinguish formally how market characteristics and the relative measure of trade protection interact in affecting the concentration and dispersion forces, which define the spatial distribution of firms. This distinction is not possible within the models that deal with asymmetric trade costs and are based on the Dixit-Stiglitz model with iceberg trade costs since they feature a problem of identification.

The paper is structured as follows. Section II describes briefly the based-theoretical model and introduces the equations that are modified when trade costs are asymmetric. Section III shows the short run results, which comprise the equilibrium prices and the rental rates of capital that emerge when firms are unable to move. Section IV presents the long run equilibria of the spatial distribution of firms. Finally, section V presents some concluding remarks.

2 Theoretical Framework

The assumptions and the structure of the background presented in this section are those mainly considered in the Linear Footloose Capital Model, which has been developed by Baldwin, *et al.* (2003).[7] The Linear Footloose Capital Model is based on two settings

5 As it is well known in the literature, since the NEG aims to focus on "second nature", from a methodological point of view, NEG models control for first nature. The NEG starts by taking into account a homogeneous space, where regions are identically in all respects; then a temporary shock is introduced in order to study the forces that may change the initial economic distribution and may generate agglomeration of the economic activities (see Ottaviano and Thisse, 2005a). Nonetheless, extended models incorporate some kinds of asymmetries in regions, such as differences in market share and trade costs. Among the first generation, for instance, the Core-Periphery model lacks tractability; the analysis of the impact of asymmetric trade costs may be done through numerical simulations. The Footloose Capital Model (Baldwin et al. 2003) has the advantage of being fully tractable; hence, it is easy to incorporate such discrepancy in trade costs.

6 Other Indices provided in Kee, Nicita and Olarreaga (2009) are Trade Restrictiveness Index (TRI) and Overall Trade Restrictiveness Index (OTRI). The MA OTRI summaries the impact of trade policies applied by partner countries on each country's exports. In calculating such an impact, the authors ask for the uniform tariff that, if imposed by all trading partners on export of a particular country instead of their current structure of protection, would leave exports of this country at their current level.

7 The Linear Footloose Capital model is introduced in chapter 5 of Baldwin, et al. (2003).

previously introduced in Ottaviano *et al.* (2002) and Ottaviano (2001). The extended framework introduced in this paper only differs from the original model in allowing regions to have different trade costs.

The setting considers two regions, the domestic and foreign economies. Each economy is endowed with two factors, capital and labor, which are employed in two productive sectors, the traditional and the industrial ones. Capital factor is specific to the industrial sector. Domestic and foreign regions are endowed with K and K^* units of capital respectively. Services of capital can be used in any regions; owners of capital offer capital services in the region that rewards the highest nominal rental rate. By assumption, profits are repatriated to the region of bird, where owners live.[8] Labor is mobile between sectors but immobile across the economies. Particularly, L and L^* denote labor endowments of domestic and foreign economies.[9] It is assumed that regions have similar tastes and technologies.

In each economy, sectors produce different type of goods, which are sold in different market structures. The industrial sector is composed by a large number of firms, which compete monopolistically and produce differentiated goods under increasing returns to scale. A monopolistic firm has a negligible influence on the market, but the market affects firm's decision. A single domestic firm presents the following non-homothetic cost function:

$$TC = \pi F + a_m w x_i \tag{1}$$

where π is the reward of capital, F denotes units of capital input, a_m is the labor-output coefficient, x_i is the output of good i and w is the wage. Industrial goods are traded between regions facing trade costs. The model extends the based Linear Footloose Capital model by taking into account the asymmetry in costs, which means that If any domestic firm wants to sell its variety abroad, it faces a foreign trade cost denoted by τ^*; while if a single foreign firm wants to introduce its differentiated good in the domestic market, it faces a positive trade cost equal to τ. In a broad definition, trade costs may comprise not only transportation but also any kind of commercial barriers that can be set in each economy, as well as cultural and communicational barriers that limit trade. As it is assumed in Ottaviano et al. (2002), trade costs are in terms of the numeraire good.

The traditional sector produces a homogeneous good under constant returns to scale. This good is chosen to be the *numeraire*. As it was mentioned above, the traditional sector produces the homogeneous good only using labor, with an input-output coefficient equals to 1 ($a_A = 1$). The market is perfectly competitive and the homogeneous good is traded between regions without frictions. As a consequence, equilibrium wages at the domestic and foreign regions are equal to 1.

The domestic region is populated by M individuals while foreign population equals to M^*. Individuals of both economies have identical preferences though they may be owners of different endowments. The typical consumer maximizes the following quasi-linear quadratic utility function:

$$U = c_A + \alpha \int_{i=0}^{N} c_i d_i - \frac{\beta - \delta}{2} \int_{i=0}^{N} c_i^2 d_i - \frac{\delta}{2} \left[\int_{i=0}^{N} c_i \right]^2; \quad \alpha > 0 \quad and \quad 0 < \delta < \beta \tag{2}$$

where c_i is the consumption of variety i and c_A is the consumption of the homogeneous good. Differentiated goods enter symmetrically in equation (2). Unlike CES utility function, which has been commonly used in models of the first generation; the quasi-linear quadratic utility is more parameterized; it takes into account, through its different parameters, several characteristics of individuals´ preferences.[10] Firstly, in equation (2) parameter α measures the intensity of preferences for differentiated goods. Secondly, δ represents the degree of substitutability between varieties, with high values of δ denoting that they are closer substitute. Thirdly, $\beta > \delta$ expresses the *love for varieties* assumption, which implies that individuals are biased towards a dispersed consumption

[8] The assumption that only services of capital but not its owners can migrate from one region to the other, prevents the model from featuring circular causality, Though circular causality would enrich the model, it also would make the model less tractable.

[9] This section describes mainly the domestic economy. Expressions for the foreign economy are similar and will be denoted by (*). Equations of the foreign economy will be presented when it were convenient.

[10] As it is pointed out by Ottaviano (2001), the asymmetric characteristic of the quasi-linear quadratic utility allows to differentiate between own and cross price effects.

of differentiated goods. Finally, in equation (2), $N = n + n^*$ accounts for the total number of differentiated goods, for which n - goods are produced domestically and n^* -goods are produced abroad.

With a quasi-linear quadratic utility function, the optimal demand function of a variety i, c_i, is independent of the level of income:

$$c_i = a + c\int_{j=0}^{N} p_j d_j - (b + cN)p_i \tag{3}$$

As expression (3) shows, each single firm faces a downward-sloping demand function, where $a \equiv \alpha/[\beta + (N-1)\delta]$, $b \equiv 1/[\beta + (N-1)\delta]$ and $c \equiv \delta/(\beta-\delta)[\beta + (N-1)\delta]$. Parameter c captures each cross-price effect and is positively related with parameter δ; high values of *c* account for a low degree of product differentiation among varieties.[11] Interestingly, the demand of variety i, falls when its own price rises, not only in absolute term (own-price effect given by *b*) but also in relatively terms.[12]

Considering equation (3), one can distinguish between the demands that a particular domestic firm faces at the domestic and foreign markets, as well as those demands that a foreign firm faces at its local market and abroad. Particularly, a domestic firm faces the following demand functions:[13]

$$c_i = a + cP - (b + cN)p_i \tag{4}$$

$$\bar{c}_i = a + cP^* - (b + cN)\bar{p}_i \tag{5}$$

where c_i is de demand function of a domestic variety i that is sold at the domestic market; $\bar{c}_i$ is demand function of a variety i, which is produced in the domestic economy but is sold in the foreign market. $\bar{p}_i$ is the price of a domestic variety that prevails in the domestic market and $\bar{p}_i$ denotes the price of such a variety, which is charged in the foreign market. $P = np_i + n^*\bar{p}_i^*$ and $P^* = n\bar{p}_i + n^* p_i^*$ stand for index prices prevailing in domestic and foreign regions.[14]

Similarly, in the domestic and foreign markets, a representative foreign firm faces the following demand functions:

$$c_i^* = a + cP^* - (b + cN)p_i^* \tag{6}$$

$$\bar{c}_i^* = a + cP - (b + cN)\bar{p}_i^* \tag{7}$$

where c_i^* denotes the demand function of a foreign variety i in the foreign market while $\bar{c}_i^*$ stands for the demand function of a foreign variety i that is sold in the domestic market. p_i^* represents the price of a foreign variety that consumers face in the foreign market and $\bar{p}_i^*$ is the price of a foreign variety that domestic consumers face in the local market.

In each economy, a typical individual spends all its income, which is denoted by E and E^* respectively. Particularly, the optimal consumption choice for the numeraire good in the domestic region is $c_A = E - \int_{i=0}^{N} c_i p_i d_i$.

For the domestic economy, the indirect utility function takes the following form:

$$V(p,E) = \frac{a^2N}{2b} - a\int_{i=0}^{N} p_i d_i - \frac{c}{2}\left[\int_{i=0}^{N} p_i d_i\right]^2 + \frac{(b+cN)}{2}\int_{i=0}^{N} p_i^2 d_i + E \tag{8}$$

As it is known, the indirect utility depends on prices and the income. The consumer surplus that a typical individual derives from the consumption of differentiated goods is given by:[15]

$$S(p) = \frac{a^2N}{2b} - a\int_{i=0}^{N} p_i d_i - \frac{c}{2}\left[\int_{i=0}^{N} p_i d_i\right]^2 + \frac{(b+cN)}{2}\int_{i=0}^{N} p_i^2 d_i \tag{9}$$

[11] The sum of all cross-price effects equals cN.

[12] The differential price effect is given by $-cN\left(p_i - \frac{P}{N}\right)$; $\frac{P}{N}$ is the average price that prevails at home; a similar expression holds for the foreign economy.

[13] Equations (4) to (7) are derived by taking into account assumption of symmetry among differentiated goods.

[14] As the total number of firms, N, remains fixed (see normalization issue), P and P^* can be considered as index prices that prevails in the domestic and foreign economies respectively.

[15] Similar expressions for the indirect utility and the consumer surplus hold in the foreign economy.

Turning to the production side, each domestic firm presents the following operating profit function:

$$\Pi_i = \left(p_i - a_m\right)c_i\left(M\right) + \left(\overline{p}_i - \tau^* - a_m\right)\overline{c}_i\left(M^*\right) \tag{10}$$

As equation (10) shows, operating profits depend on mark ups. Since the framework assumes that any firm segments markets, in general mark ups are different and depend on trade costs, τ and τ^*. Also, demand parameters as well as the size of each market, which is related to the population of regions M and M^*, affect profits. A domestic firm will set prices that maximize its operating profit.

Similarly, the operating profit function of a foreign firm is given by:

$$\Pi_i^* = \left(p_i^* - a_m\right)c_i^*\left(M^*\right) + \left(\overline{p}_i^* - \tau - a_m\right)\overline{c}_i^*\left(M\right) \tag{11}$$

As it was mentioned above, a domestic manufacturing firm employs the same technology as a foreign firm; hence the labor-output coefficients are equal; that is $a_m = a_m^*$.

Finally, capital market clearing implies that the number of firms that are located at the domestic economy equal to:

$$n = \frac{K}{F} \tag{12}$$

Similarly, the number of foreign firms located at the foreign economy is:

$$n^* = \frac{K^*}{F^*} \tag{13}$$

Therefore, the total number of firms equals to $N = \frac{K + K^*}{F}$.[16] To clarify the presentation of equations, appropriate normalization is made. Particularly, one can choose $N=1$, which implies that the share of monopolistic firms that are located in the domestic region is given by $s_n = \frac{n}{N} = n$ and $s_n = (1 - s_{n^*})$, where and stands for the share of firms located at the foreign region.

3 Short run equilibria

In this section, equilibrium prices of differentiated goods and rental rates of capital are derived by considering as given the spatial distribution of capital. The based-model -the Linear Footloose Capital Model with symmetric trade costs- introduces an interesting interaction within manufacturing sector. Monopolistic firms act as they were an insignificant supplier. A typical firm that maximizes operating profits neglects its impact on the market but is aware that the market as a whole has a nonnegligible impact on its behavior. This interaction introduces the interdependence between the price choices; such interaction results in equilibrium prices that depend on market characteristics.[17] In the present model, as trade costs that firms face when they sell their differentiated product at the market where they are not "locals" may differ, the level of equilibrium prices will be affected by the asymmetry of trade costs. As it is shown below, trade costs interact with the number of competitors in affecting equilibrium prices.

The profit maximization problem for local and foreign firms, gives the equilibrium prices of differentiated goods. Each local and foreign firm maximizes its profits, which are represented by equation (10) and (11) respectively, assuming that its price choice does not impact on both price indices, P and P^*. Due to the interaction process and the symmetric assumption, prices are equals and become a function of P and P^*. Moreover, they must satisfy definition of price indices. Therefore, the equilibrium prices prevailing at the domestic and foreign markets are given respectively by:

$$p_i = \frac{2\left[a + a_m\left(b + cN\right)\right] + cn^*\tau}{2\left(2b + cN\right)} \quad \text{and} \quad \overline{p}_i^* = p_i + \frac{\tau}{2} \tag{14}$$

[16] In this background, it is not introduce any asymmetry among monopolistic firms in terms of requirements of capital and labor; since $F = F^*$.

[17] As Ottaviano et al. (2002) remark, this kind of market interaction, which is not present in the Dixit and Stiglitz monopolistic competition framework, makes firms do not follow a simple mark up rule.

$$p_i^* = \frac{2\left[a + a_m\left(b + cN\right)\right] + cn\tau^*}{2\left(2b + cN\right)} \quad \text{and} \quad \bar{p}_i = p_i^* + \frac{\tau^*}{2} \tag{15}$$

Equilibrium prices of differentiated goods are positively affected by the degree of desirability of varieties with respect to the homogeneous good (parameter a). Also, they are affected by domestic and foreign trade costs, τ and τ^* respectively. As equation (14) shows, domestic firms may charge higher prices when domestic trade costs are high. The distribution of firms across regions affects the level of prices; for instance a fierce competition at home, which implies a low number of firm in the foreign market, $n^*=N-n$, prevents local firms to charge high domestic prices. The strength of the trade cost effect on equilibrium prices depends on the degree of product differentiation. The closer substitute are differentiated goods (parameter c is high), the higher the impact of trade cost on equilibrium prices. However, equilibrium prices are directly related with the degree of product differentiation; the higher the level of product differentiation -denoted by a low c- the higher the equilibrium prices. Finally, as can be noticed from (14) and (15), firms absorb part of trade costs when they sell in the other market where they are not locals.

The rental rent earned by capital owners is obtained by evaluating operating benefits at equilibrium prices:

$$\pi = \left(b + cN\right)\left[\left(p_i\left(\tau\right) - a_m\right)^2 M + \left(\bar{p}_i\left(\tau^*\right) - \tau^* - a_m\right)^2 M^*\right] \Big/ F \tag{16}$$

where π is the rental rate that a unit of capital rewards when is employed by a domestic firm. As it is mentioned above, as the equilibrium prices depend on the number of local competitors, the rental rate earned at the local market is lower when local firms faces a fierce competition at the local market. Domestic and foreign trade costs, τ and τ^* , as well as market characteristics affect rental rates. Similarly, the capital used for a foreign firm rewards:

$$\pi^* = \left(b + cN\right)\left[\left(p_i^*\left(\tau^*\right) - a_m\right)^2 M^* + \left(\bar{p}_i^*\left(\tau\right) - \tau - a_m\right)^2 M\right] \Big/ F \tag{17}$$

4 Long run equilibria

The short run equilibra of good prices and capital rewards were derived by taking into account as given the spatial distribution of capital. In general, rewards of capital services may differ between regions. In the long run, as services of capital can be supplied in any region, capital owners will have the incentive to relocate them in the region that pays the highest nominal reward. Capital owners only look at nominal profits since, by assumption, though capital services are inter-regional mobile, owners are not allowed to migrate; hence they spend their income in the region where they live.[18] As in Baldwin *et al.* (2003), the transition to the long run equilibrium is characterized by the following equation of migration:

$$\dot{s}_n = \left(\pi - \pi^*\right)\left(1 - s_n\right)s_n \tag{18}$$

where $\dot{s}_n = \partial s_n / \partial t$ and t denotes time. Expression (18) is an *ad hoc* equation, which describes capital owners' decisions about capital services relocation and introduces the dynamics in the model.[19] This equation can take any sign during the process of adjustment, but the long run equilibrium is achieved when there are not incentives to move capital services from one region to the other, that is when $\dot{s}_n = 0$. This situation may arise when:

$$\begin{aligned} &\pi = \pi^* \text{ and } 0 < s_n < 1 \\ &\pi > \pi^* \text{ and } s_n = 1 \\ &\pi < \pi^* \text{ and } s_n = 0 \end{aligned} \tag{19}$$

[18] IAs it was mentioned above, this assumption simplifies the analysis, since as capital owners cannot migrate to the region where the cost of living is lower, the model breaks with circular causality. In some of the NEG models, circular causality emerges by two channels. Firstly, when some productive factors migrate from one region to the other, they shift their expenditure to the host region; such expenditure shifting leads to a new relocation of productive factors that favors the region that has enlarged its domestic market and generates a production shifting. Secondly, the production shifting makes the host region more attractive since the cost of living in such region is now low. The cost of living effect leads to a new migration of productive factors. Though circular causality enhances the study, it also makes the analytical tool less tractable

[19] NEG models use the ad hoc migration to introduce dynamics in a simple and manageable fashion. As Fujita, Krugman and Venable (1999) have remarked, the study of economic geography deals with dynamic stories; modeling such dynamics explicitly by considering that firms and consumers take intertemporal decisions based on rational expectation would make more difficult the treatment of the topic. See Fujita, Krugman and Venable (1999) and box 2-1 in Baldwin et al. (2003) for a discussion about the use of this equation.

Expression (19) shows two sorts of equilibria, and interior solution and two core-periphery equilibria. The interior solution requires that the nominal rental rate differential equals zero (i.e.$(\pi - \pi^*) = 0$). The core-periphery equilibria are $s_n = 1$ or $s_n = 0$.

PROPOSITION 1: Assume that domestic and foreign trade conditions holds.[20] When capital owners decide to supply their capital services in the region that pays the highest nominal reward, owners will relocate their capital services from one region to the other until both regions reward the same nominal rental rate and the incentive to move them vanish; that is when $\pi = \pi^*$. Hence, by equating rental rates (equations (16) and (17)), an interior solution of the spatial distribution of firms emerges and equals to:

$$s_n = \frac{1}{2} + \frac{2(a - a_m b)}{c\tau^*}\left[\frac{\lambda s_E - (1 - s_E)}{\lambda^2 s_E + (1 - s_E)}\right] - \frac{b}{c}\left[\frac{\lambda^2 s_E - (1 - s_E)}{\lambda^2 s_E + (1 - s_E)}\right] \quad (20)$$

where $s_E = \frac{M}{M^W}$ is the size of the domestic market and $(1 - s_E) = \frac{M^*}{M^W}$ that of the foreign market; M^W is the total population of the world and $\lambda = \frac{\tau}{\tau^*}$ denotes, in relative terms, the level of protection of domestic economy.

Proposition 1 shows a positive relationship between the equilibrium share of domestic firms and its market size, $\partial s_n / \partial s_E > 0$. This relationship describes the tendency of firms to locate where the market is relevant.[21] The impact of the market size on such a distribution depends on market characteristics. *Ceteris paribus*, when the own-price effect (measured by b) is low, the impact of market size is strong. Interestingly, product differentiation also affects the strength of market size in affecting the equilibrium firm distribution; a high degree of product differentiation, given by a low level of parameter c, increases the impact of market size on the spatial distribution of firms.

In Equation (20) the *Home Market Effect* is present (henceforth, HME);[22] which means that a small exogenous change of the market share leads to a more than proportional relocation of firms to the enlarged market; i.e. $\partial s_n / \partial s_E > 1$.[23] As it is well known, the HME is defined by the strength of two opposite forces, the agglomeration and the dispersion forces. In this background, the agglomeration force is represented by the market access advantage of being at the larger market. A relevant market attracts firms since it allows them to sell the differentiated product to a larger number of consumers. The dispersion force is depicted by the market crowding disadvantage. A crowded market implies that a large number of firms are located in one region; firms tend to avoid such a competition by relocating in the region that hosts fewer competitors.

To understand how these two forces operate, one can follow the strategy presented in Ottaviano (2001), and disentangles algebraically the market access advantage and market crowding disadvantage when asymmetric trade cost are considered. As expression (19) shows, an interior solution of the spatial distribution of firms requires that the differential of rental rates equals to zero. In the adjusting process, the gap of profits can take positive or negative values. The sign of rental rate differential depends on the balance of the two forces, which are described by the following expression:

$$\begin{aligned} \operatorname{sgn}(\pi - \pi^*) = \operatorname{sgn}&\left[\left(\kappa s_E - \frac{1}{2}\right)\left(4(a - a_m b) - 2b\tau^*\right) - s_E \lambda (\lambda - 1) b\tau^*\right] \\ &- \left[2c\tau^*\left(s_n - \frac{1}{2}\right)\left(1 - s_E(1 - \lambda^2)\right)\right] \end{aligned} \quad (21)$$

where κ (λ) is a monotonic function.[24] On the one hand, in expression (21), the first term inside the first brackets depends on the spatial distribution of population and depicts the *"pure"* market access advantage of being in the larger market when trade barriers are asymmetric. As long as $s_E > 1/2$ and $\kappa \geq 1$, this term affects positively the rental rate differential. As it can be noted, the strength of this force is defined by the absolute level of foreign protection. When τ^* is high, the relative weight of the domestic

[20] Domestic and foreign trade conditions allow for intra-industry trade. These terms implies that those prices -net of trade costs-, which are set by firms that sell on the distant markets, are positive. Annex A shows such a conditions.

[21] For $\partial s_n / \partial s_E$ to be positive, a sufficient condition is that the domestic trade condition be satisfied; that is $2(a - a_m b - b\tau)/c \geq \tau \geq 0$.

[22] Krugman (1980).

[23] Sufficient conditions for the home market effect to operate are $(a - a_m b - b\tau) \geq c$ and $\lambda \geq 1$.

[24] $\kappa = \frac{\lambda + 1}{2}$.

market access advantage is low. The reason why is that high levels of foreign absolute trade costs make the foreign market more attractive, since firms located at this region can charge higher prices (i.e. $p_i^*(\tau^*)$ and $\partial p_i^* / \partial \tau^* > 0$). The second term also depends on the spatial distribution of consumers, s_E ; it shows the fact that the market access effect is relevant when absolute domestic trade costs do not differ so much from foreign trade costs. The sum of these terms characterizes the total effect of market access; its relative weight increases with the level of the relative domestic protection. On the other hand, the terms inside the second brackets in (21) depend on the spatial distribution of firms s_n; it reflects the disadvantage of the region that hosts the larger number of firms. The *"pure"* crowding market effect affects negatively the differential rental rate; its strength is defined by market characteristics as well as the absolute foreign trade cost.[25] High level of product differentiation weakens the level of competition between firms and, therefore, the disadvantage of being in region with a relevant number of firms. Similarly, when foreign trade costs are low, the pure market effect becomes less relevant. The total market crowding effect, denoted by the second square brackets in expression (21), depends also on the relative domestic trade cost. The more protective the domestic region, the less the importance of the market crowding disadvantage. The intuition is that, when the domestic region protects relatively more local manufacturing sector, local firms can charge a higher domestic price, which has a positive effect on their operating profits. The impact of the relative level of protection on the market crowding effect is higher when the market size is large; i.e. when the domestic region is important in terms of population.

PROPOSITION 2 (outcome of Baldwin *et al.* (2003)): Assume that domestic and foreign trade conditions holds; If domestic trade costs are equal to foreign trade costs, that is $\lambda = 1$, the interior solution of the spatial distribution of firms equals to:

$$s_n = \frac{1}{2} + \frac{2(a - a_m b) - b\tau}{c\tau}\left(s_E - \frac{1}{2}\right) \tag{22}$$

Baldwin *et al.* (2003) present this analytical result. In this case, market characteristics, reflected by parameters *b* and *c,* affect the agglomeration and dispersion forces similarly as they do when $\lambda \neq 1$.[26] In equation (22), only absolute trade costs impact on the spatial distribution of firms. The strength of market size becomes relevant in defining the spatial distribution of firms when trade costs are lower. When trade costs are low enough; all firms may end up in one region if market sizes are asymmetric.

Finally, when $\lambda \cong 0$, the spatial distribution of firms is independent of market sizes. In this case, firms tend to agglomerate at the foreign market, since they can obtain higher nominal rewards, when $\tau^* > 0$. However, a plausible interior solution emerges when the domestic economy does not protect the manufacturing sector, $\tau = 0$. Market characteristics play an interesting role. The higher the own-price effect, the lower the operating profit earned in the foreign region. Foreign operating profits also are affected negatively by the degree of substitutability; when varieties are closer substitutes, the services of capital reward in the foreign region a lower rental rate.[27]

5 Concluding Remarks

Trade costs play an important role in defining the economic landscape; they make the question *where to locate* becomes critical for economic agents. Frequently, agents' actions generate a spatial distribution of the economic activity that, in many cases, is far away of being balanced. The New Economic Geography is the branch that aims to explain the imbalances of economic activity by mainly focusing on the analysis of such actions.

The first generation of NEG models has studied how asymmetric trade costs may affect the spatial distribution of economic activity. The main insight that comes from this literature is that regions with a relevant and relatively well protective market attract

[25] For the market crowding disadvantage, the "pure" terminology refers to the term insides the second brackets, which does not depend on the market size, . In general, the distinction between the pure and total effects serves to compare the market access and market crowding effects with those that are obtained when trade cost are equals. The pure effects are similar to the ones obtained when trade costs are symmetric. See Annex A.

[26] Annex B presents the market access and market crowding effects algebraically for the particular case of $\lambda = 1$.

[27] Annex C presents the spatial distribution of firm in case of $\lambda \cong 0$.

mobile factors. The intuition is that they provide better access to world markets. One shortcoming of such frameworks is that many of them lack for an analytical solution of the spatial distribution of economic activity; this problem persists when one introduces an asymmetry in trade costs. The present paper studies how differences in trade protection may alter the economic space by considering an alternative modeling strategy. The Linear Footloose Capital Model (Baldwin, *et al.* (2003)), which belongs to the second generation of NEG models, is extended by allowing regions to differ in terms of trade costs.

In the extended model, market characteristics affect the spatial distribution of firms in a similar fashion as they do in the based-model. Particularly, when the own-price effect is low, the impact of market size on the spatial distribution of firms is strong. Product differentiation also affects the strength of market size; a high degree of product differentiation increases the relevance of market size in defining the spatial distribution of firms. Hence, in both cases, firms tend to agglomerate where the market is bigger.

Several key insights arise when one distinguishes between the absolute value of trade costs and the relative level of trade protection. On the one hand, the relative weight of the domestic market access advantage diminishes as the level of *absolute* foreign protection increases, but it increases when the level of the *relative* domestic protection rises. On the other hand, the market crowding disadvantage becomes relevant for high level of *absolute* foreign protection but it is less important when the relative level of domestic protection increases. The intuition is that, when the domestic region protects relatively well the local manufacturing sector, firms increase their operating profits. The impact of the relative level of protection on the market crowding effect is higher when the market size is large. As it is well known, the market access advantage tends to agglomerate the economic activity while the market crowding disadvantage tends to disperse it. Both, the centripetal and centrifugal forces, define the economic landscape.

These results are in line with the insights that come from the first generation of NEG models. Hence, as Ottaviano *et al.* (2002) have argued the main results of the NEG branch do not depend on the specific modeling strategy. The main contribution of models within the second generation is that they go beyond the limits of the Dixit-Stiglitz based-models. Particularly, the linear models have the nicely features of being fully tractable; moreover they shed light on comparative statics analyses. The model presented in this paper goes in this direction; it allows to disentangle analytically the effects of absolute and relative trade costs and to reach an analytical result of the spatial distribution of firms when trade costs are asymmetric.

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ANNEX A

When asymmetric trade costs are taken into account, the following conditions must hold to allow for intra-industry trade:

$$\left(\bar{p}_i^*(\tau) - \tau - a_m\right) \geq 0 \qquad \text{(A1)}$$

$$\left(\bar{p}_i(\tau^*) - \tau^* - a_m\right) \geq 0 \qquad \text{(A2)}$$

Expressions (A1) and (A2) imply that:

$$\tau_{trade} \equiv \frac{2(a - a_m b)}{2b + cn} \qquad \text{(A3)}$$

$$\tau^*_{trade} \equiv \frac{2(a - a_m b)}{2b + cn^*} \qquad \text{(A4)}$$

ANNEX B

When trade costs are equals, $\lambda = 1$, as presented by Baldwin et al. (2003), market access advantages and the market crowding disadvantage are given by the following expression:

$$\operatorname{sgn}(\pi - \pi^*) = \operatorname{sgn}\tau\left[\left(4(a - a_m b) - 2b\tau\right)\left(s_E - \frac{1}{2}\right) - 2c\tau\left(s_n - \frac{1}{2}\right)\right] \qquad \text{(B1)}$$

The first term represents the market access advantage of being in the larger market, while the second term shows the market crowding disadvantage.

ANNEX C

When $\lambda \cong 0$, the spatial distribution of firms is given by the following expression:

$$s_n = -\left[\frac{2(a - a_m b) - b\tau^*}{c\tau^*}\right] + \frac{1}{2} \qquad \text{(C1)}$$