Market size and urban hierarchy*

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Abstract

We investigate the importance of market size as a determinant for industrial location patterns. In order to focus on a broad range of sectors, including the service industries, both traded and non-traded goods are taken into consideration. In our model, traded goods industries always exhibit a 'home market effect' (HME), whereas the existence of such an effect for non-traded goods and services crucially hinges on the degree of product differentiation. High degrees of product differentiation generally support a HME, whereas a reverse HME may arise when products are sufficiently close substitutes.

Our results point to the existence of some market size dependent 'industrial urban' hierarchy: highly differentiated non-traded services are more sensitive to market size than manufacturing activities and traded services, which in turn are more sensitive to market size than closely substitutable non-traded services.

Keywords: reverse home market effect; traded goods; non-traded goods; service industries; urban hierarchy.

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1 Introduction

In recent years, spatial questions have attracted a great deal of attention, both from a theoretical and an applied point of view. In particular, there has been a significant increase in the number of contributions related to the so-called 'home market effect' (henceforth, HME; Krugman, 1980; Helpman and Krugman, 1985). The HME emphasizes the central role of market size as an important determinant of industry location and trade patterns in sectors characterized by some form of imperfect competition (Feenstra *et al.*, 2001; Head *et al.*, 2002). More precisely, the main finding of the HME literature is the existence of a *disproportionate causation from demand to supply*. Increases in local market size map into more than proportional increases in local industry size, thus suggesting that larger regions host a disproportionate share of the imperfectly competitive sectors and are net exporters of the goods they produce.

Although the HME literature has mainly focused on international trade, the idea that market size matters for determining the location patterns of industries within countries has also been put forward since long in the urban economics literature (see, e.g., Christaller, 1933; Berry, 1967; Henderson, 1988) and has become a major building block of 'new' economic geography (Krugman, 1991; Fujita *et al.*, 1999; Fujita and Thisse, 2002). There is indeed strong empirical support for such a relationship. As, e.g., recently shown for the North American case, "specialization varies to a substantial degree with a particular measure of market size – the concentration of population [...] even when we exclude rural areas and look only across urban areas, we find substantial variations in specialization based on market size" (Holmes and Stevens, 2004, p. 4). Thus, the temptation to apply models of HME to the analysis of sectoral location patterns and trade flows *within a regional urban system* is great. Yet, one major obstacle in doing so is that, in our opinion, models of HME offer only a fairly poor description of most service industries. This is because these models assume that all goods are always traded between distant locations, whereas a large fraction of consumer services remains *de facto* non-traded, despite the secular decline in transportation and communication costs (Daniels, 1993). The result being that the service industries still get the short end of the analysis, despite their uncontested and ever increasing role in shaping the modern national and international economic landscapes.

In this paper, we partly overcome this limitation by developping a HME model based on Ottaviano and Thisse (2004) that allows for non-traded goods as in Behrens (2004). We argue that the basic insights of the HME literature, namely that market size is an important determinant of geographical specialization patterns, carries through to this more general setting. Yet, we also show that non-traded goods may significantly alter the *qualitative properties* of the HME, which need not arise in sectors producing such goods even in the presence of plant-level increasing returns to scale, product differentiation, and trade costs. More precisely, we show that non-traded goods sectors may exhibit a *reverse* HME when varieties are sufficiently close substitutes: in that case, *larger regions host a less than proportionate share of the industry, turning the fundamental insights of the HME literature upside-down.* This illustrates forcefully that "for industries producing nontradable goods and services like retail, there is little specialization, while for tradable goods like manufactures, mining output, and agricultural products, there is a substantial amount of specialization across regions" (Holmes and Stevens, 2004, p. 3). Somewhat surprisingly, the home market effect may still arise (even in a particularily strong version!) when goods are non-traded, provided that varieties are sufficiently independent. This suggests the existence of a market size driven industrial hierarchy, in the sense that highly differentiated non-traded services (e.g. higher education) are likely to exhibit the strongest bias towards large urban areas, thus being more strongly agglomerated than manufacturing activities or traded services; which in turn are themselves more agglomerated than quite homogenous non-traded services (e.g. retail, basic health care). Note that such a hierarchical industry distribution is largely supported by empirical evidence, since higher-order services are spatially concentrated within large urban areas, whereas lower-order consumer services and manufacturing activities are more evenly spread across the space-economy (see, e.g., Daniels, 1993; Brülhart and Traeger, 2003; Holmes and Stevens, 2004; Combes and Overman, 2004).

The remainder of this paper is organized as follows. In Section 2, we briefly present some empirical evidence that supports the abovementionned idea of a market size driven industrial hierarchy. Section 3, develops the model as an extension of Ottaviano and Thisse (2004) and Behrens (2004). We derive the market equilibrium when (i) trade costs are sufficiently low, so that varieties are always traded across regions; and (ii) trade costs are prohibitive, so that varieties are always consumed locally only. Although such a clear-cut distinction is somewhat restrictive, it is helpful in uncovering some aspects of the HME that have gone largely unnoticed until now. Section 4 analyzes the spatial equilibrium when goods are traded across regions. This case serves as a benchmark against which we judge our findings of Section 5 when there is no trade. Previewing our *main result*, we show that the disproportionate causation from demand to supply that characterizes the HME may get dampened or even reversed in the absence of trade when varieties are sufficiently close substitutes. This suggests that local market size has a different impact on manufacturing and service sectors, thus highlighting the need to distinguish these sectors when analyzing the HME. Section 6 finally concludes and points towards future research directions.

2 A market size driven industrial hierarchy: some empirical facts

Recent work by Holmes and Stevens (2004) on US and canadian data offers a striking illustration of the existence of a market size driven industrial hierarchy in North America. We have summarized some of their main findings in Tables 1 to 3, which associate an 'urbanization-index' (that varies between −4 and 4) with a selection of the 2-digit NAICS sectors. Negative values of this index are associated with industries predominantly located in rural areas (Table 1), values close to zero are linked to "diffuse" industries that are quite evenly spread (Table 2), whereas positive values are associated with industries located predominantly in urban areas (Table 3).[1] Because the concept of 'urban-ness' used by these authors is clearly linked to considerations of population size (see Holmes and Stevens, 2004, pp. 19-20), Tables 1 to 3 depict in increasing order the correlation of industrial location with large local market size.

Insert Tables 1 to 3 here

In order to make our point most clearly, we have tried to classify the different sectors according to some of their fundamental economic characteristics. Due to the high level of sectoral aggregation, these classifications are of course subject to some arbitrariness. We nevertheless believe that the following highly regular pattern can be singled out.

First, the 'rural' sectors (Table 1) produce predominantly weakly differentiated traded goods under constant returns to scale. They include, as expected, agriculture and extractive industries, which are governed by considerations of comparative advantage and natural resources. It is also of interest to note that the US 'Manufacturing' and the canadian 'Education' sectors figure in this category. The latter is explained by the fact that the canadian data includes basic primary education, which is strongly spread

[1] We have dropped the two industries 'Unclassified establishments' and 'Auxiliaries (exec. corporate, subsidiary and regional mgt.)', since there are no canadian figures.

throughout the country (the US 'Education' sector, which mostly consists of higher university education, figures in the 'urban' category, thus already highlighting the importance of product differentiation). Second, the 'diffuse' sectors (Table 2) produce overwhelmingly non-traded weakly differentiated goods and services, e.g., retail, construction, basic health care and other non-public services. It is of interest to note that some of the production of such non-traded goods is *more than proportionally located in smaller markets*, thus pointing to the existence of a reverse HME. Finally, the 'urban' sectors (Table 3) produce almost exclusively traded and non-traded highly differentiated services, e.g., information, finance and higher eduction. These sectors display a classical HME, because they are *more than proportionally located in the larger markets.*

Although all sectors are highly aggregated at the 2-digit level, a finer disaggregation of the within-sector composition largely confirms the aforementionned pattern. Indeed, as pointed out by Holmes and Stevens (2004, p. 23): "[Finance, insurance] index of urbanization is 0.71, making it one of the most urbanized sectors. Within this sector are the narrow industries "Commodity Contracts Dealing" and "Commodity Exchanges" that are extremely concentrated in the largest cities with indices 3.04 and 3.90. But this sector also has industries such as "Consumer Lending" and "Commercial Banking" that are relatively spread out, having indices of 0.10 and 0.13. We conclude that within a broad industry there are narrow industries that provide retail-like services that are spread out and other industries that are tradable and specialized".

Overall, the empirical evidence by Holmes and Stevens (2004) points to the existence of the following *stylized* market size driven industrial hierarchy: (i) weakly differentiated non-traded services are more than proportionally located in smaller markets, thus exhibiting a reverse HME; (ii) manufacturing industries are more evenly spread, yet are on average located in larger markets, thus displaying a weak HME; whereas (iii) highly differentiated non-traded and traded services are overwhelmingly located in the large markets, thus exhibiting a strong HME. In what follows, we develop a model that provides a possible explanation for these empirical regularities.

3 The model

Consider an economy with two regions, labeled $r = H, F$. Variables associated with each region will be subscripted accordingly. There are two sectors of production: a modern sector M and a traditional sector T. The traditional sector produces a homogenous good under constant returns to scale and perfect competition, whereas the modern sector produces a continuum of varieties of a horizontally differentiated good under internal increasing returns to scale and monopolistic competition. There are two production factors in the economy, labor and capital. Denote by L the mass of workers and by K the mass of capitalists in the global economy. Each agent supplies inelastically either one unit of labor or one unit of capital, so that L and K also stand for the total mass of production factors.

The homogenous good is produced by using labor only. Without loss of generality, we normalize the constant unit input requirement in this sector to 1. Each variety of the modern sector is produced by a single firm, using both a fixed requirement f of capital and a constant marginal requirement m of labor. Clearly, such a technology exhibits increasing returns to scale because the average production cost is decreasing with respect to the volume of output. Labor is assumed to be perfectly mobile between sectors but immobile between regions, whereas capital is mobile between regions but specific to the modern sector. Because both f and K are exogenously given, the mass of firms (and, therefore, of varieties) in the global economy is tied down by the market-clearing condition for the specific factor. We let $N = K/f$ stand for the total mass of firms and denote by n_r the mass of firms established in region $r = H, F$.

In what follows, we assume that shipping the traditional good both within and between regions is costless. Hence, product prices in this sector are equalized across regions and equal to wages, which makes this good a suitable choice for the numéraire: $p^T = w^* = 1$, where w^* stands for the equilibrium wage, which is common to all sectors because of labor mobility. One unit of any variety of the modern good can be shipped at a cost of $\tau > 0$ units of the numéraire between the two regions, whereas shipping the variety within each region is costless. Such a trade cost specification is consistent with the well-documented fact that, because of the large size of modern transport infrastructure, the marginal transport cost is little sensitive to distance (Boyer, 1997). If we assume that the modern sector can also stand for the service industry, such a specification is even more meaningful because services are often traded via telecommunication technologies, which are characterized by even larger fixed and lower marginal costs.

Denote by $0 < \theta < 1$ the *exogenous* share of workers located in region H. In order to rule out the potential impact of comparative advantage à la Heckscher-Ohlin, we assume that θ also stands for the share of capitalists located in region H. Therefore, the relative factor endowments (the capital-labor ratios) are the same in the two regions. We further denote by $0 \leq \lambda \leq 1$

the *endogenous* share of mobile capital employed in region H. Because the mass of firms in each region is tied down by the mass of capital employed there, λ also stands for the share of firms located in region H. Capital market clearing then implies that

$$n_H = \lambda N \qquad \text{and} \qquad n_F = (1-\lambda)N.$$

All agents (capitalists and workers) have the same quasi-linear utility function with quadratic subutility. A typical agent established in region $r = H, F$ solves the following consumption problem:

$$\begin{cases} \max\limits_{q_r(v),\, v\in[0,N];\, Z} & \alpha \int_0^N q_r(v)\mathrm{d}v - \frac{\beta-\gamma}{2}\int_0^N [q_r(v)]^2 \mathrm{d}v - \frac{\gamma}{2}\left[\int_0^N q_r(v)\mathrm{d}v\right]^2 + T \\ \text{s.t.} & \int_0^N p_r(v)q_r(v)\mathrm{d}v + T = y_r + \overline{T} \end{cases}$$

where $\alpha > 0$, $\beta > \gamma > 0$ are given parameters, $p_r(v)$ is the consumer price of variety v of the modern good in region r, T is the consumption of the numéraire good, and y_r is the consumer's income which depends on whether she is a worker or a capitalist. Note that the quadratic utility encapsulates a preference for variety (*varietas delectat*) as long as $\beta > \gamma$: varieties become perfect substitutes when $\beta \to \gamma$, whereas they become independent when $\gamma \to 0$. Each consumer has an initial endowment $\overline{T} > 0$ of the numéraire, which is supposed to be sufficiently large for her consumption of this good to be strictly positive at the market outcome.

Let p_{rs} stand for the price a firm established in region r charges in region s. Assuming that all varieties are symmetric, so that firms only differ by the region they are established in, we can drop the variety index v in what follows. The individual demand in region s for a variety produced in region r can then be expressed as

$$q_{rs} = a - (b + cN)p_{rs} + cP_s \tag{1}$$

where a, b and c are positive coefficients, given by

$$a \equiv \frac{\alpha}{\beta + (N-1)\gamma} \qquad b \equiv \frac{1}{\beta + (N-1)\gamma} \qquad c \equiv \frac{\gamma}{(\beta-\gamma)[\beta + (N-1)\gamma]}$$

and where

$$P_r = n_r p_{rr} + n_s p_{sr} \tag{2}$$

is the aggregate price index of the modern sector in region $r = H, F$.

Expression (1) highlights that, for any given value of the price index, individual demands are decreasing at a constant rate $b + cN$ with respect to own price. Stated differently, firms' perceived demand functions are linear. This in turn implies that there is a *cut-off price* beyond which demands drop to zero, so that not all varieties of the modern good need to be interregionally traded. As pointed out by Neary (2003a,b), this is a desireable feature of linear demand systems because the occurence of trade is now endogenous to the model. In order for demands to be well specified for all prices, we rewrite them as follows (see Behrens, 2004, for further details):

$$q_{rs}^d = \left[a - (b + cN)p_{rs} + cP_s\right]^+, \tag{3}$$

where $[f]^+ \equiv \max\{0, f\}$ stands for the positive part of f.

In accord with empirical evidence, product markets are assumed to be segmented (Greenhut, 1981; Head and Mayer, 2000; Haskel and Wolf, 2001). This implies that modern firms are free to set their optimal price on each market independently. Denote by k_r the rental rate of capital in region $r = H, F$. A firm established in region r maximizes its profit given by

$$\pi_r = M_r(p_{rr} - m)q_{rr}^d + M_s(p_{rs} - m - \tau)q_{rs}^d - k_r f, \qquad r \neq s \tag{4}$$

where $M_H \equiv \theta(L + K)$ and $M_F \equiv (1 - \theta)(L + K)$ are the respective market sizes of the two regions.

Until now, the existence of a HME has only been investigated in the literature under the implicit assumption that the output of the modern sector is traded across all locations (Krugman, 1980; Helpman and Krugman, 1985; Head *et al.*, 2002; Behrens *et al.*, 2004). Albeit meaningful for most manufacturing goods industries, such a setting seems less suited to the analysis of how local market size and, therefore, the HME possibly influence the location decisions of consumer service firms, whose outputs remain largely non-traded despite the secular decrease in trade costs. In order to shed some light on this question, we investigate two different settings:

(i) HME *with interregional trade*: we assume that trade costs τ of the modern sector are sufficiently low, so that interregional demands q_{rs}^d remain strictly positive for all firm distributions λ. In this case, the output of the modern sector is always *traded across regions.*

(ii) HME *without interregional trade*: we assume that trade costs τ of the modern sector are sufficiently large, so that interregional demands q_{rs}^d are zero for all firm distributions λ. In this case, the output of the modern sector is *not traded across regions.*

We begin by deriving the price equilibrium under these two different sets of assumptions (the precise conditions for cases (i) and (ii) to hold will be established below). Since there is a continuum of firms, each firm is negligible to the market as a whole and therefore accurately neglects its impact on the price indices. Yet, the market as a whole has a non-negligible impact on each individual firm, which must hence take into account aggregate market conditions as given by P_r.

(i) *Price equilibrium with interregional trade*: Under the assumption of interregional trade for all firm distributions, straightforward maximization of (4) with respect to p_{rs} yields

$$p_{rs} = \frac{a + (b + cN)(m + \tau) + cP_s}{2(b + cN)}, \tag{5}$$

which may be viewed as a firm's reaction function to its local market conditions in region s, given by P_s. Plugging (5) into (2), we can solve for the (Nash) equilibrium prices, which are given by

$$p^*_{rr} = \frac{2[a + m(b + cN)] + cn_r\tau}{2(2b + cN)} \tag{6}$$

and

$$p^*_{sr} = p^*_{rr} + \frac{\tau}{2} \qquad r \neq s. \tag{7}$$

Clearly, export prices p^*_{sr} net of marginal production and transport costs are positive for all spatial distributions $0 \leq \lambda \leq 1$ if and only if

$$\tau < \tau_{\text{trade}} \equiv \frac{2(a - bm)}{2b + cN}, \tag{8}$$

thus implying that $m < a/b$ must hold.

(ii) *Price equilibrium without interregional trade*: Following the same approach as Behrens (2004), the profit maximizing prices in the absence of interregional trade may be expressed as

$$p_{rr} = \frac{a + (b + cN)m + cP_r}{2(b + cN)} \tag{9}$$

and

$$p_{rs} = \frac{a + cP_s}{b + cN} \qquad r \neq s, \tag{10}$$

which may be again viewed as a firm's reaction function to its local market conditions. Plugging (9) and (10) into (2), we can solve for the (Nash) equilibrium prices, which are now given by

$$p_{rr}^* = \frac{a + m(b + cn_r)}{2b + cn_r}. \tag{11}$$

Because there is no interregional trade by assumption, export and import prices p_{sr}^* are of no particular interest to us. Thus, we do not need to derive them explicitly. Is is readily verified that there is no interregional trade for all firm distributions $0 \leq \lambda \leq 1$ if and only if

$$\tau \geq \tau_{\text{notrade}} \equiv \frac{2(a - bm)}{2b}. \tag{12}$$

One can check that $\tau_{\text{trade}} < \tau_{\text{notrade}}$ for all parameter values of the model, thus revealing the existence of further patterns of interregional trade for intermediate values of τ. In what follows, we disregard these intermediate cases.

One can verify that the equilibrium prices in both case (i) and (ii) are decreasing functions with respect to the mass of local firms, therefore revealing the presence of a *direct competition effect* as emphasized in industrial organization. Clearly, such an effect does not directly arise in the Dixit-Stiglitz-Krugman framework, in which all price effects work indirectly through changes in the equilibrium wages only (Dixit and Stiglitz, 1977; Krugman, 1980; Helpman and Krugman, 1985). The equilibrium quantities are given by

$$q_{rr}^* = (b + cN)(p_{rr}^* - m) \tag{13}$$

and

$$q_{rs}^* = \begin{cases} (b + cN)(p_{rs}^* - m - \tau) & \text{if} \quad \tau < \tau_{\text{trade}} \\ 0 & \text{if} \quad \tau \geq \tau_{\text{notrade}} \end{cases} \quad r \neq s. \tag{14}$$

Free entry and exit of firms in the modern sector implies that the rental rate of capital absorbs all operating profits in region $r = H, F$. Thus, in equilibrium, the rental rate is given by

$$k_r^* = \frac{M_r(p_{rr}^* - m)q_{rr}^* + M_s(p_{rs}^* - m - \tau)q_{rs}^*}{f}. \tag{15}$$

The *market equilibrium*, associated with some given spatial distribution λ of capital, is characterized by the equilibrium prices (6), (7) and (15). Such an equilibrium is a short-run one, because we disregard capital mobility across regions. In the long-run, capitalists allocate their capital to the region offering them the highest *nominal* rate of return. In what follows, we assume that prices adjust instantaneously to clear all markets, whereas capital moves more slowly across regions in response to economic opportunities. To describe the 'migration process' of capital, we define the *rental rate differential* between regions H and F as follows:

$$\Delta k^*(\lambda) \equiv k_H^*(\lambda) - k_F^*(\lambda). \tag{16}$$

A positive value of Δk^* will induce the relocation of some capital from region F to region H, whereas capital moves in the opposite direction should Δk^* be negative.

A *spatial equilibrium* arises in the long-run at $\lambda^* = 0$ if $\Delta r^*(0) \leq 0$, or at $\lambda^* = 1$ if $\Delta r^*(1) \geq 0$, or at $0 < \lambda^* < 1$ if $\Delta r^*(\lambda^\star) = 0$. Stated differently, a spatial equilibrium is such that all mobile capital fetches the highest nominal rate of return in the global economy. Since the functions k_r^* are continuous with respect to λ, Proposition 1 of Ginsburgh *et al.* (1985) implies that a spatial equilibrium always exists. The two fully agglomerated equilibria are always *stable*, whenever they exist, whereas an interior equilibrium is stable if and only if the slope of the rental rate differential is negative in a neighborhood of the equilibrium.

4 HME when goods are traded

We first investigate the case in which condition (8) holds, i.e., trade costs are low enough to permit interregional trade for all firm distributions λ. The results derived in this section will serve as a benchmark against which to judge the outcome in the presence of non-traded goods. Using (13) and (14), the equilibrium rental rates of capital (15) when there is interregional trade may be rewritten as follows:

$$k_H^*(\lambda) = \frac{(b+cN)(K+L)}{f}\left[\theta(p_{HH}^* - m)^2 + (1-\theta)(p_{HF}^* - m - \tau)^2\right] \tag{17}$$

and

$$k_F^*(\lambda) = \frac{(b+cN)(K+L)}{f}\left[(1-\theta)(p_{FF}^* - m)^2 + \theta(p_{FH}^* - m - \tau)^2\right]. \tag{18}$$

Plugging the equilibrium prices (6) and (7) into (17) and (18), some straightforward calculations show that the capital rental rate differential can be expressed as follows:

$$\Delta k^*(\lambda) = \xi\tau\left[cN\tau\left(\frac{1}{2}-\lambda\right) + 2\left[2(a-bm)-\tau b\right]\left(\theta-\frac{1}{2}\right)\right], \tag{19}$$

where

$$\xi \equiv \frac{(b+cN)(K+L)}{2f(2b+cN)} > 0$$

is a constant independent of the trade costs τ and the expenditure distribution θ. It is readily verified that

$$\frac{\partial(\Delta k^*)}{\partial\theta} > 0 \qquad \text{and} \qquad \frac{\partial(\Delta k^*)}{\partial\lambda} < 0.$$

Following Ottaviano and Thisse (2004), the first effect will be referred to as the *market size effect*, whereas the second will be referred to as the *market crowding effect*. Everything else being equal, a larger share θ of demand in region H attracts more firms, because the joint presence of increasing returns to scale and trade costs makes firms locate in the large market to serve the larger fraction of demand locally (Krugman, 1980). Yet, a larger share λ of firms in region H exacerbates price competition there, thus making this region less attractive by decreasing profits. It is worth noting that the market crowding effect vanishes when varieties become independent (i.e. $c = 0$). In that case, the only force at work is the market size effect, which implies that *all firms producing independent goods choose to locate in the large region.* This provides a straightforward generalization of a well-established result in location theory (Beckmann and Thisse, 1986; see also Behrens *et al.*, 2004, for some related developments).

An interior equilibrium $0 < \lambda^* < 1$ arises when these two forces are balanced, i.e. when

$$cN\tau\left(\frac{1}{2}-\lambda\right) + 2\left[2(a-bm)-\tau b\right]\left(\theta-\frac{1}{2}\right) = 0.$$

Hence, the equilibrium industry distribution can be expressed as

$$\lambda^* = \frac{1}{2} + \frac{4(a-bm)-2\tau b}{cN\tau}\left(\theta-\frac{1}{2}\right). \tag{20}$$

Because Δk^* is linear in λ and because the coefficient associated with λ is negative, the interior equilibrium is always unique and stable whenever it exists. It is readily verified that, since condition (8) holds,

$$\lambda^* - \theta = \frac{4(a-bm)-\tau(2b+cN)}{cN\tau}\left(\theta-\frac{1}{2}\right) \gtreqless 0 \qquad \text{iff} \qquad \theta \gtreqless \frac{1}{2}. \tag{21}$$

Hence, the larger region hosts a more than proportionate share of the imperfectly competitive industry and, therefore, is a net exporter of the modern good (Helpman and Krugman, 1985).

Three characteristic *key results* stand out, which are summarized by propositions 1 to 3 below:

Proposition 1 (Home Market Effect) *In an economy with two regions and two sectors, the market equilibrium is such that a more than proportionate share of the modern sector locates in the region with the larger expenditure share.*

Expression (20) further reveals that $\partial\lambda^*/\partial c < 0$ and $\partial\lambda^*/\partial\tau < 0$. Stated differently, more product differentiation and lower trade costs exacerbate the HME, a result that has come to be known as the *magnification effect* (Head *et al.*, 2002; Behrens *et al.*, 2004):

Proposition 2 (Magnification Effect) *In an economy with two regions and two sectors, the home market effect is stronger the more differentiated the varieties are and the lower the transport costs are.*

Finally, one can ask under which conditions the whole mobile sector will agglomerate within a single region, say region H? Stated differently, when does a configuration similar to a core-periphery structure, i.e. $\lambda^* = 1$, emerge? Setting $\lambda^* = 1$ in expression (20), this will be the case if

$$\theta \geq \frac{1}{2} + \frac{cN\tau}{8(a - bm) - 4b\tau}. \tag{22}$$

For all θ satisfying (22), region H has sufficient attraction to be a *dominant market*. This is in accord with well-known results in location theory (see Weber, 1909; Witzgall, 1964). It is readily verified that the right-hand side of (22) is always less than unity when condition (8) is satisfied. Hence, the larger region can be a dominant market even if it does not host the whole expenditure of the economy. This result, which holds for a broad class of HME models (Head *et al.*, 2002), may be summarized as follows.

Proposition 3 (Dominant Market Effect) *Assume that* $\tau > 0$. *Then there exists* $\theta_{\text{sup}} < 1$ *(resp.* $\theta_{\text{inf}} > 0$*) such that for all* $\theta \geq \theta_{\text{sup}}$ *(resp. for all* $\theta \leq \theta_{\text{inf}}$*) the equilibrium is such that* $\lambda^* = 1$ *(resp.* $\lambda^* = 0$*).*

The following proof of Proposition 3 will help to illustrate under which conditions the dominant market effect, and also the HME, may fail to hold.

Proof. The rental rate of capital in region H can be expressed as follows:

$$\begin{aligned} k_H^*(\lambda) &= \frac{M_H\left[p_{HH}(\lambda,\tau)-m\right]q_{HH}(\lambda,\tau)+M_F\left[p_{HF}(\lambda,\tau)-m-\tau\right]q_{HF}(\lambda,\tau)}{f} \\ &= \frac{K+L}{f}\left[\theta\pi_{HH}(\lambda,\tau)+(1-\theta)\pi_{HF}(\lambda,\tau)\right] \end{aligned}$$

whereas that of region F is given by

$$\begin{aligned} k_F^*(\lambda) &= \frac{M_F\left[p_{FF}(\lambda,\tau)-m\right]q_{FF}(\lambda,\tau)+M_H\left[p_{FH}(\lambda,\tau)-m-\tau\right]q_{FH}(\lambda,\tau)}{f} \\ &= \frac{K+L}{f}\left[(1-\theta)\pi_{FF}(\lambda,\tau)+\theta\pi_{FH}(\lambda,\tau)\right]. \end{aligned}$$

Assume that $\theta = 1$ (the same argument applies with $\theta = 0$). We have

$$\begin{aligned} k_H^*(\lambda,\tau) &= \pi_{HH}(\lambda,\tau) = \frac{\theta(K+L)(b+cN)}{f}\left(p_{HH}^*-m\right)^2 \\ k_F^*(\lambda,\tau) &= \pi_{FH}(\lambda,\tau) = \frac{\theta(K+L)(b+cN)}{f}\left(p_{FH}^*-m\right)^2 \end{aligned}$$

Because $p_{FH}^* = p_{HH}^* + \tau/2$, $\pi_{HH}(\lambda,\tau) > \pi_{FH}(\lambda,\tau)$ for all λ when $\tau > 0$. This is because transport costs drive a wedge between local prices and import prices, whereas consumer preferences for varieties produced in regions H and F are a priori the same (no *regional product differentiation*). Hence, we have

$$\Delta k^*(1) = \pi_{HH}(\lambda,\tau) - \pi_{FH}(\lambda,\tau) > 0 \qquad \forall\lambda \in [0,1],$$

so that all mobile capital is employed in region H in equilibrium. The result then follows by continuity of Δk^* with respect to λ and θ. ■

The proof of Proposition 3 shows that the inequality $\pi_{HH}(\lambda,\tau) > \pi_{FH}(\lambda,\tau)$ is crucial in explaining the dominant market effect. Stated differently, transport costs must drive wedges between local and distant sales revenues of firms. Note that this will be automatically the case in the presence of trade costs when consumers value both local and foreign products a priori in the same way, but that this need no longer hold when consumers' preferences are biased in favor of varieties produced in some particular region. Proposition 3 thus provides a rationale for the findings of Head *et al.* (2002), who have shown that a reverse HME may arise in the model by Markusen and Venables (1988) because of *national product differentiation* (Armington, 1969). Indeed, in the presence of national product differentiation, $\pi_{HH}(\lambda,\tau) > \pi_{FH}(\lambda,\tau)$ need no longer hold, even with positive transport costs. For example, if varieties produced in region F have a lower elasticity of substitution with varieties produced in region H than varieties produced in region H have with each other, a firm established in region F can earn larger profits from its distant sales to region H than if it was directly located in region H.[2] In such a case, the dominant market effect and a HME need not arise.

5 Non-traded goods and reverse HME

As argued in the previous section, a reverse HME may arise in the presence of national product differentiation (Head and Ries, 2001; Head *et al.*, 2002). In what follows, we show that non-traded goods may also serve the purpose of explaining the absence of a HME, even in the presence of increasing returns to scale, imperfect competition and significant trade costs. Observe, indeed, that the fundamental trade-off between market size and price competition emphasized in the HME literature (Head *et al.*, 2002; Ottaviano and Thisse, 2004) also applies to industries whose output is not traded between distant regions. In that case, it is simply *local market size* and *local price competition* that matters in shaping location choices.

To investigate more closely the role of trade in the emergence of the HME, we focus on the special case in which there is no interregional trade in the modern sector. More precisely, we assume that condition (12) holds, so that modern firms never sell in the foreign market, no matter the value of λ. Although such a condition does not hold for most manufacturing industries, it is characteristic of many B-to-C service sectors, whose output would be so costly to trade that it remains de facto non-traded in equilibrium.[3] Plugging (9), (13) and (14) into (4), some straightforward calculations show that the equilibrium rental rate of capital in region r can be expressed as follows:

$$k_r^* = \frac{M_r(a - bm)^2(b + cN)}{f(2b + cn_r)^2} \qquad r = H, F. \tag{23}$$

[2] The existence of differences in price elasticities among local and foreign goods is strongly supported by empirical evidence (see Head and Ries, 2001; Brülhart and Trionfetti, 2002, for further references).

[3] Note that some goods are *non-traded* as an equilibrium result, whereas other goods may be *non-tradable* by assumption. In this paper, we focus on non-traded goods only. Stated differently, all goods are a priori tradable but some of them may not be traded in equilibrium.

Therefore, the capital rental rate differential is given by

$$\Delta k^*(\lambda) = \Gamma\left[\frac{\theta}{(2b + c\lambda N)^2} - \frac{1-\theta}{\big(2b + c(1-\lambda)N\big)^2}\right], \tag{24}$$

where

$$\Gamma \equiv \frac{(a - bm)^2(b + cN)(K + L)}{f} > 0$$

is a constant independent of the trade costs τ and the expenditure distribution θ. It is readily verified that

$$\frac{\partial(\Delta k^*)}{\partial\theta} > 0 \qquad \text{and} \qquad \frac{\partial(\Delta k^*)}{\partial\lambda} < 0,$$

thus showing that the market size effect and the market crowding effect still arise at the local level. Stated differently, even in the absence of interregional trade the same forces have an impact on the spatial distribution of the modern sector.

We now investigate more closely which of propositions 1 to 3 of Section 3 survive the extension to the non-traded case.

Proposition 4 (dominant market effect) *The dominant market effect arises even in the absence of interregional trade.*

Proof. Evaluating (24) at $\lambda^* = 0$ and $\lambda^* = 1$, it is readily verified that an interior equilibrium ($0 < \lambda^* < 1$) arises if and only if

$$0 < \frac{4b^2}{(2b + cN)^2 + 4b^2} \leq \theta \leq \frac{(2b + cN)^2}{(2b + cN)^2 + 4b^2} < 1. \tag{25}$$

Thus, we have found $\theta_{\text{inf}} > 0$ and $\theta_{\text{sup}} < 1$, which reveals the presence of the dominant market effect as defined by Proposition 3. ■

Proposition 4 shows that, by continuity, *there is always a HME in the vicinity of $\theta = 1$ (resp. $\theta = 0$), even when the output of the industry is not traded across regions.* Hence, a HME arises in non-traded goods industries, provided that the size of the local market is sufficiently large. Next, it is easy to show that

$$\frac{\partial\lambda^*}{\partial c} = -2b\frac{1 - 2\sqrt{\theta(1-\theta)}}{c^2N(2\theta - 1)} \gtreqless 0 \quad \Leftrightarrow \quad \theta \lesseqgtr \frac{1}{2}, \tag{26}$$

which reveals the presence of the magnification effect: less product differentiation increases the equilibrium industry share of the larger region.

Proposition 5 (magnification effect) *The magnification effect arises even in the absence of interregional trade.*

It remains to analyze whether the HME per se carries through to the no-trade setting. To solve for the equilibrium distribution λ^* of capital, we put (24) over a common denominator and equate the resulting expression to zero. Some standard calculations reveal that the resulting polynomial expression has always two real roots when $\theta \neq 1/2$. These roots are given by

$$\lambda^*_{\pm} = \frac{2b + \theta cN \pm (4b + cN)\sqrt{\theta(1-\theta)}}{cN(2\theta - 1)}. \qquad (27)$$

It is readily verified that

$$\lambda^*_+ > 1 \text{ when } \theta > \frac{1}{2} \qquad \text{and} \qquad \lambda^*_+ < 0 \text{ when } \theta < \frac{1}{2}$$

so that λ^*_+ can be ruled out as a possible equilibrium candidate. Because a spatial equilibrium always exists since Δk^* is a continuous function of λ, we have the following equilibria:

$$\lambda^* = \begin{cases} 1/2 & \text{if } \theta = \frac{1}{2} \\ \dfrac{2b + \theta cN - (4b + cN)\sqrt{\theta(1-\theta)}}{cN(2\theta - 1)} & \text{if } \theta \neq \frac{1}{2} \end{cases} \qquad (28)$$

Expression (28) reveals that the equilibrium share of the modern sector in region H is now a *non-linear function* of the expenditure share θ. This result comes as a surprise because in models without national product differentiation, this share is usually a *linear function* of θ (see Section 3; see also Head *et al.*, 2002; Behrens *et al.*, 2004). Straightforward calculations show that

$$\frac{\partial \lambda^*}{\partial \theta} = \frac{4b + cN}{4cN\theta(1-\theta) + 2cN\sqrt{\theta(1-\theta)}} > 0. \qquad (29)$$

Hence, as expected, the equilibrium industry share λ^* of region H is strictly increasing with respect to its expenditure share θ. Yet, such an increase is not sufficient for the industry to exhibit a HME, since even in a 'constant returns - comparative advantage' world of trade an increase in market size leads to an increase in locally produced supply (Dixit and Norman, 1981). What is needed is a *more than proportionate causation from demand to supply*, which would not be observed in the neo-classical model of trade. That the HME need no longer arise in non-traded goods industries when regions are sufficiently similar in terms of their expenditure distribution is shown by the following proposition.

Proposition 6 (Reverse HME) *In an economy with two regions and two sectors without interregional trade, there exists a threshold* $1/2 < \overline{\theta}(c) < 1$ *such that a reverse HME occurs for all* $\theta < \overline{\theta}(c)$*, whereas the industry exhibits a HME when* $\overline{\theta}(c) \leq \theta$*.*

Proof. From (25), we know that there exists some $\theta_{\text{sup}} < 1$ such that $\lambda^* = 1$ for all $\theta \geq \theta_{\text{sup}}$. Further, we know that $\lambda^* = 1/2$ when $\theta = 1/2$ and that λ^* is monotonically increasing with respect to θ. Straightforward calculations shows that

$$\frac{\partial^2 \lambda^*}{\partial \theta^2} \gtreqless 0 \qquad \text{if} \qquad \theta \gtreqless \frac{1}{2}.$$

Hence, λ^* is convex for $\theta > 1/2$ and concave for $\theta < 1/2$. By continuity of λ^* with respect to θ, only two cases may therefore arise: (i) either $\lambda^* > \theta$ for all $\theta > 1/2$; or (ii) there exists a single value $1/2 < \overline{\theta}(c) < 1$ such that $\lambda^*(\overline{\theta}(c)) = \overline{\theta}(c)$.

Solving the equation $\lambda^*(\overline{\theta}(c)) = \overline{\theta}(c)$ yields a unique solution in the interval $(1/2, 1)$, which is given by

$$\overline{\theta}(c) = \frac{1}{2} + \frac{\sqrt{c^2 N^2 - 16b^2}}{2cN} \tag{30}$$

provided that $c > 4b/N > 0$. It is readily verified that case (i) applies when $c \leq 4b/N$, thus showing that the model still exhibits a HME when products are sufficiently differentiated. When products are sufficiently bad substitutes, case (ii) applies and there exists a unique value of $\overline{\theta}$ for all values of c. This is because

$$\lim_{c \to \infty} \overline{\theta}(c) = 1 \tag{31}$$

and because $\overline{\theta}$ is increasing in c. Note, finally, that the condition $c \gtreqless 4b/N$ amounts to checking whether the derivative (29) is larger or smaller than one. The result then follows from convexity. ■

Proposition 6 shows that *interregional and international trade are neither necessary nor sufficient for a HME to arise.* Considerations of local market size and local price competition may suffice to trigger a process of regional specialization and the agglomeration of mobile industries.

Insert Figure 1 about here

Figure 1 illustrates the two different cases highlighted in the proof of Proposition 6. When products are sufficiently differentiated (i.e. case (i)), λ^*

lies always above the 45° line associated with the proportionate distribution $\lambda = \theta$. Hence, a HME arises even if the varieties are not interregionally traded. It is of interest to note that in this case *the HME may even be stronger than when the good is traded*, which stems from the convexity of λ^*. Not only do increases in expenditure share map into more than proportional increases in industry share, but they do so at an increasing rate. This suggests that *market size is a very important locational determinant for firms producing highly differentiated non-traded goods.*

As varieties become less differentiated, the price competition effect gets stronger, so that firms start to relax this competition by spreading themselves more equally across regions. Thus, λ^* shifts gradually down and we move along the arrow towards case (ii) in Figure 1. As can be seen from this figure and from (28), the larger region still hosts a larger share of the modern sector.[4] Yet, for $1/2 < \theta < \overline{\theta}(c)$, the more than proportionate part that characterizes the HME vanishes. Stated differently, provided the size of the two regions is not too different, the modern sector displays a *reverse home market effect* in that the larger region hosts a *less than proportionate share* of the imperfectly competitive industry.

6 Conclusions

We have shown that, despite increasing returns to scale, product differentiation, imperfect competition, and the absence of national product differentiation, some industries may exhibit a reverse home market effect when their output is not traded across regions and varieties are sufficiently close substitutes. This result is sufficient to show that the structure of interregional trade is of fundamental importance in explaining observed patterns of industrial location. In particular, great caution is needed when trying to assess the importance of market size for some service industries, since the locational determinants of these industries may be quite different from those of the manufacturing sector.

Our main result suggests that highly differentiated non-traded services are likely to exhibit a particularily strong bias towards large urban areas, thus being more agglomerated than manufacturing activities, which in turn are themselves more agglomerated than weakly differentiated non-traded services. This points to the existence of a market size driven industrial hierarchy in the spirit of Christaller (1933), in which the degree of product

[4]Such a result would also hold in a "constant returns - comparative advantage" world of trade (Dixit and Norman, 1981). Hence, this results seems to be extremely robust.

differentiation *and the fact of being tradable or not* play a fundamental role. Testing empirically for the existence of such a hierarchy could be one future extension of the present paper.

A final remark is in order. Recently, the existence of a HME has been increasingly considered as a discriminating hypothesis allowing to asses the relative importance of classical and new trade theory in explaining world trade (see, e.g., Davis and Weinstein, 2003; Head and Ries, 2001; Feenstra *et al.*, 2001; Behrens *et al.*, 2004). In particular, the absence of a HME is considered as confirming classical trade theory based on constant returns and comparative advantage. In this paper, we have shown that things are not that easy, since the absence of a HME does not imply that the underlying economic structure be characterized by comparative advantage and constant returns to scale. Therefore, the HME may be an inappropriate tool for discriminating between competing paradigms of international trade.

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Country	Description	Type	Employment share	Urbanization
CAN	Agriculture, Forestry	T/L/CA	0.009	-3.19
US	Crop, Livestock	T/L/CA	0.019	-2.67
US	Agriculture, Forestry	T/L/CA	0.001	-2.43
US	Mining	T/L/CA	0.002	-2.06
CAN	Mining, Oil, Gas	T/L/CA	0.012	-1.99
CAN	Crop, Livestock	T/L/CA	0.011	-1.94
CAN	Educational Serv.	N/L/SV	0.046	-1.27
CAN	Public Admin.	N/H/SV	0.039	-0.54
CAN	Health care, social assistance	N/L/SV	0.093	-0.51
US	Manufacturing	T/H/IR	0.100	-0.43
US	Utilities	T/L/IR	0.004	-0.39
US	Government	N/L/SV	0.138	-0.36
CAN	Transport., warehousing	N/L/SV	0.039	-0.34
CAN	Accomodation, food services	N/L/SV	0.084	-0.32

Table 1: Rural sectors in the US and Canada
(Source of data: Holmes and Stevens, 2004, Tables 10 and 13)

In Tables 1 to 3, sectors are classified into 'types' (1)/(2)/(3) as follows:

(1) T=traded, N=non-traded

(2) L=low differentiation, H=high differentiation

(3) CA=comparative advantage, IR=increasing returns, SV=service

Country	Description	Type	Employment share	Urbanization
CAN	Retail trade	N/L/SV	0.117	-0.22
US	Retail trade	N/L/SV	0.090	-0.22
CAN	Construction	N/L/IR	0.064	-0.21
US	Self-employed	N/H/SV	0.156	-0.21
US	Accomodation, food services	N/L/SV	0.060	-0.16
US	Health care, social assistance	N/L/SV	0.085	-0.05
CAN	Arts, Entertain.	N/H/SV	0.018	-0.03
CAN	Other non-public services	N/L/SV	0.041	-0.02
US	Construction	N/L/IR	0.040	0.00
CAN	Utilities	T/L/IR	0.005	0.16
US	Arts, Entertain.	N/H/SV	0.011	0.19
US	Other non-public services	N/L/SV	0.032	0.20
CAN	Manufacturing	T/H/IR	0.145	0.24

Table 2: Diffuse sectors in the US and Canada
(Source of data: Holmes and Stevens, 2004, Tables 10 and 13)

Country	Description	Type	Employment share	Urbanization
CAN	Real estate, rental	N/H/SV	0.025	0.40
US	Transp., warehousing	N/L/SV	0.023	0.57
US	Wholesale trade	N/H/SV	0.037	0.61
US	Real estate, rental	N/H/SV	0.012	0.65
US	Admin, remed. services	N/H/SV	0.053	0.69
US	Finance, insurance	T/H/SV	0.036	0.71
US	Educational Serv.	N/H/SV	0.015	0.72
CAN	Enterprise management	T/H/SV	0.016	0.75
CAN	Finance, insurance	T/H/SV	0.044	0.84
CAN	Admin, remed. services	N/H/SV	0.043	0.88
CAN	Wholesale trade	N/H/SV	0.061	0.89
US	Information	T/H/SV	0.021	0.91
CAN	Scientific and tech. services	T/H/SV	0.065	1.10
US	Enterprise management	T/H/SV	0.017	1.13
CAN	Information	T/H/SV	0.022	1.17
US	Scientific and tech. services	T/H/SV	0.041	1.17

Table 3: Urban sectors in the US and Canada
(Source of data: Holmes and Stevens, 2004, Tables 10 and 13)

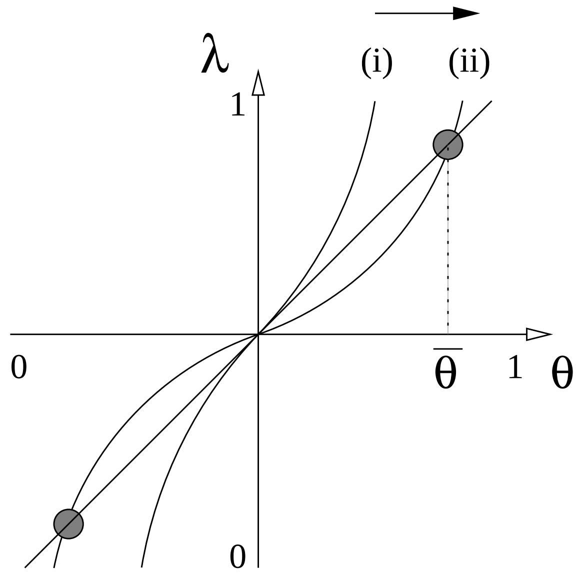

Figure 1: Existence of reverse HME