



Luiss Lab of European Economics

LLEE Working Document no.80

Does a Country-Specific Productivity Matter in Delocation Tendencies? A Footloose Capital Model Approach

Federica Orioli

May 2009

Outputs from LLEE research in progress, as well contributions from external scholars and draft reports based on LLEE conferences and lectures, are published under this series. Comments are welcome. Unless otherwise indicated, the views expressed are attributable only to the author(s), not to LLEE nor to any institutions of affiliation.

Does a Country-Specific Productivity Matter in Delocation Tendencies? A Footloose Capital Model Approach

Federica Orioli*

LLEE Working Document No.80

May 2009

Abstract

This paper presents a simple "core-periphery" model with footloose capital and heterogeneous firms in which it is assumed that the mean and the variance of the distribution functions of marginal production costs are country-specific. From the analysis it emerges that country-specific productivity is not innocuous and it matters in driving location decisions. In this case, in fact, the agglomeration forces and the direction of migration crucially depend on the level of trade costs.

JEL codes: F2, F12

Keywords: New Economic Geography, Firm Heterogeneity, Cross-Country Efficiency Gaps, Delocation Tendencies

*University of Rome "Luiss Guido Carli", Viale Romania n. 32, 00197 Roma, Italy. E-mail address: forioli@luiss.it. Phone: +393498533466.

1 Introduction

The fundamental contribution of the “New Economic Geography” (NEG) literature is to explicitly model "the self-reinforcing character of spatial concentration" (Fujita et al. 1999, p. 4). A look at almost any industry reveals geographic concentration. The possible explanations of why firms tend to cluster together are different and numerous. In the last two decades, economic theory has paid attention to the role of increasing returns to scale for explaining the uneven geographical distribution of economic activity. In particular Krugman (1991b) shows that the interaction of labour migration across regions with increasing returns and trade costs creates a tendency for firms and workers to cluster together as regions integrate.

One of the most convenient assumptions in NEG models is that of identical firms. However, recent empirical research has substantiated the existence of large and persistent differences in terms of size (Cabral and Mata, 2003), as well as in terms of productivity and trade behaviour (Bernard et al., 2003; Helpman et al., 2004).

In particular, Baldwin and Okubo (2006) develop a simple two-country foot-loose capital model (FC) with heterogeneous firms *à la* Melitz (2003). In that model the regions, North and South, are endowed with the same relative factor supplies, but endowment of labour and capital of North are proportionally larger than the South's. Two of key features of that paper are that every southern firm would gain from being the first to delocate from South to North and that no northern firm would gain from moving.

This paper extend the FC model of Baldwin and Okubo (2006). In particular, we assume that northern firms are more productive than southern ones. Since there exist significant efficiency gaps even across the most advanced industrial nations of the world, it seems to be an important issue to consider the case in which countries differ in their efficiency levels. Existing theoretical literature has provided a mixed picture on this issue. Montagna (2001) demonstrates that exposure to free trade will induce more low productivity firms to enter into the more efficient country; on the other hand, Jean (2002) shows that trade opening will improve the industry productivity in the more efficient country as well as in the less efficient one.

From our analysis it emerges that the assumption of country-specific productivity is not innocuous and it matters in driving location decisions. Namely, in these circumstances the agglomeration forces and the direction of migration crucially depend on the level of trade costs, contrary to Baldwin and Okubo (2006) seminal paper.

The remainder of the paper is organized as follows. Section 2 presents the basic FC model with country-specific productivity; Section 3 analyzes the delocation tendencies; finally Section 4 concludes.

2 The model

In the economy there are two countries, North and South, two sectors, two factors, labour and capital, and N firms, n in North country and n^* in South country.

The countries are assumed to be symmetric in terms of tastes and openness to trade, but the North is larger in a pure sense than the South and its firms are on the average more efficient than the southern ones.

Factors, physical capital K and labour L , are inelastically supplied in each region. Labour is inter-regionally immobile, while physical capital can move across countries but its reward is repatriated to its country of origin since capital owners are assumed to be inter-regionally immobile¹.

Since the region in which capital's income is spent may differ from the region in which it is employed it is necessary distinguish the share of world capital owned by northern residents, $s_K \equiv K/K^W$, from the share of world capital employed in the North, s_n .

The two sectors are: a perfectly competitive agriculture sector and a manufacturing sector that is characterized by monopolistic competition *à la* Dixit-Stiglitz (1977).

The agriculture sector A produces a homogeneous good under constant returns and employs only labour: more specifically it takes a_A unit of workers to produce one unit of the A sector good. Trade in sector A is frictionless: the agricultural good can be traded freely inter and intra regions without incurring in any transportation cost. Perfect competition in sector A forces marginal cost pricing, that is:

$$p_A^* = w^* a_A, \quad (1)$$

$$p_A = w a_A, \quad (2)$$

where p_A^* (p_A) is the price of agricultural good in South (North) country and w^* (w) is the wage prevailing in South (North) region. Costless trade in A equalizes northern to southern prices, and this, in turn, indirectly equalizes wage rates in both regions. Henceforth, we take A as numéraire and choose units of A such $a_A \equiv 1$. This implies that $p_A^* = w^* = p_A = w = 1$.

On the other hand, the manufacturing sector M employs labour and capital to produce output subject to increasing returns. In particular, the production of each variety requires a fixed input involving F units of capital K and a variable input a units of L per unit of output produced. All firms share the same fixed cost $F \equiv 1$, but they have different productivity levels indexed by a depending on the type of varieties produced². Since $F = K = 1$ then $s_n = (n + n^*)/N$, where $N \equiv (n + n^*)$. Finally, in sector M international trade is inhibited by iceberg trade costs. Specifically, it is costless to ship industrial goods to local

¹Note that this means physical capital can be separated from its owners.

²The cost function of a typical manufacturing firm in the FC model is non-homotetic: the fixed cost involves only capital and the variable cost involves only labour.

consumers, but to sell one unit in the other region an industrial firm must ship $\tau > 1$ units³. As usual, τ captures all the costs of selling to distant markets, not just transport costs, and $\tau - 1$ is the tariff-equivalent of these costs.

The preferences of the representative consumer are given by a two-tier utility function. The upper tier determines the consumer's division of expenditure between the homogeneous good and all differentiated industrial goods. The second tier dictates the consumer's preferences over the various differentiated industrial varieties. The specific function form is quasi-linear for the first tier and CES for the second. In symbols:

$$U = \mu \ln C_M + C_A, \quad (3)$$

$$C_M = \left(\int_{i \in N} c_i^{1-\frac{1}{\sigma}} di \right)^{1/(1-\frac{1}{\sigma})}, \quad (4)$$

where C_M and C_A denote consumption of the composite of all differentiated varieties of industrial goods and consumption of the homogeneous good, respectively; N represents the mass of available industrial goods of which n are produced in North and n^* are produced in South⁴. The set of varieties is predetermined by endowments since each variety requires a unit of capital and the world capital stock is assumed to be exogenously given. Goods are substitutes implying $0 < \frac{\sigma-1}{\sigma} < 1$ and where $\sigma > 1$ is the elasticity of substitution between any two industrial varieties. Finally, μ ($0 < \mu < 1 < \sigma$) measures the intensity of preference for differentiated goods and is the expenditure on all differentiated goods.

The aggregate price of this economy is:

$$P = \left(\int_{i \in N} p_i^{1-\sigma} di \right)^{\frac{1}{1-\sigma}} = \int_{i \in N} p_i^{1-\sigma} di = np_i^{1-\sigma} + n^* p_i^{*1-\sigma}, \quad (5)$$

where p and p^* are the local and export prices of every industrial firm, respectively.

Utility optimization yields a standard CES demand function for each industrial varieties, namely:

$$c_i = \frac{p_i^{-\sigma}}{P^{1-\sigma}} \mu. \quad (6)$$

Each industrial firm is atomistic and thus rationally ignores the impact of its price on the aggregate price. Moreover since varieties are differentiated no direct strategic interaction among firms arises. As a consequence the representative firm acts as if it is a monopolist facing a demand curve with a constant elasticity equal to σ . Given the standard formula for marginal revenue, this implies that

³The idea is that $\tau - 1$ units of the good "melt" in transit.

⁴In the M sector there is a discrete number of firms N and each variety of the differentiated good is produced by a single firm. Each firm is assumed to have a certain market power and can perfectly price discriminate across markets.

profit-maximizing consumer price is a constant mark-up of marginal cost. More specifically, the first-order conditions for a typical industrial firm's sales to its local market and its export market are:

$$p \left(1 - \frac{1}{\sigma}\right) = wa, \quad (7)$$

$$p^* \left(1 - \frac{1}{\sigma}\right) = w^* a \tau. \quad (8)$$

Substituting $w^* = w = 1$:

$$p_i = \frac{\sigma}{\sigma - 1} a, \quad (9)$$

$$p_i^* = \frac{\sigma}{\sigma - 1} \tau a. \quad (10)$$

The restriction $\sigma > 1$ ensures that p and p^* are always positive and finite. Dixit-Stiglitz monopolistic competition assumptions on market structure imply "mill pricing" is optimal and that operating profit earned by a typical market is:

$$\pi = \frac{pc}{\sigma}. \quad (11)$$

2.1 The distribution function of firm-level efficiency

Following Baldwin and Okubo (2006), we assume that each unit of labour in both countries is associated with a particular level of productive efficiency as measured by the unit labour requirement a^5 .

As in Helpman et al. (2004), the cumulative distribution of the marginal costs is assumed to be a Pareto:

$$G[a] = \frac{a^\beta}{a_0^\beta}, \quad 1 = a_0 \geq a \geq 0, \quad \beta \geq 1, \quad (12)$$

where a_0 is the scale parameter, denoting the highest marginal cost, and β is a shape parameter. Without loss of generality, we can normalize a_0 to unity.

The density function is:

$$f[a] = \frac{dG[a]}{da} = \beta \frac{a^{\beta-1}}{a_0^\beta}. \quad (13)$$

Differently from Baldwin and Okubo, we suppose that marginal costs are on average smaller and less dispersed in the North than in the South. In other words, we assume that the shape parameter β is country specific, that is β_N for North and β_S for South, where $\beta_N < \beta_S$. In this case the cumulative distribution and the density function are $G[a]_N$ and $f[a]_N$ for North and $G[a]_S$ and $f[a]_S$ for South.

⁵Recall that productivity differences may reflect cost differences as well as differences in consumer valuations of the good (see Melitz, 2003).

3 Delocation tendencies

Accordingly to (11), operating profit realised by a South-based firm is⁶:

$$\pi^* = \frac{1}{\sigma} (p_i c_i^* + p_i^* c_i) = \left(\frac{a}{1 - \frac{1}{\sigma}} \right)^{1-\sigma} \left(\frac{\mu^*}{P^{*1-\sigma}} + \frac{\tau^{1-\sigma} \mu}{P^{1-\sigma}} \right) \frac{1}{\sigma}. \quad (14)$$

Dividing and multiplying for the world expenditure on M-goods E^w (14) becomes:

$$\pi^* = \left(\frac{a}{1 - \frac{1}{\sigma}} \right)^{1-\sigma} \left(\frac{1 - s_E}{\int_{\in n} p_i^{*1-\sigma} di + \int_{\in n^*} p_i^{1-\sigma} di} + \frac{\tau^{1-\sigma} s_E}{\int_{\in n} p_i^{1-\sigma} di + \int_{\in n^*} p_i^{*1-\sigma} di} \right) \frac{E^w}{\sigma}, \quad (15)$$

where s_E is the northern share of E^w and $\tau^{1-\sigma} \equiv \varphi$ measures the "free-ness" of trade, where $0 < \varphi < 1$. That is, the free-ness of trade rises from $\varphi = 0$, with infinite trade costs, to $\varphi = 1$, with zero trade costs (see Baldwin et al. 2003, p. 20).

Using mill pricing and dividing and multiplying for K^w , operating profit can be written as function of productivity "a":

$$\pi^* [a] = a^{1-\sigma} \left[\frac{(1 - s_E)}{\Delta^*} + \frac{\varphi s_E}{\Delta} \right] \frac{E^w}{\sigma K^w}, \quad (16)$$

$$\pi [a] = a^{1-\sigma} \left[\frac{s_E}{\Delta} + \frac{\varphi(1 - s_E)}{\Delta^*} \right] \frac{E^w}{\sigma K^w}, \quad (17)$$

where:

$$\Delta = s_K \int_0^1 a^{1-\sigma} f[a]_N da + \varphi (1 - s_K) \int_0^1 a^{1-\sigma} f[a]_S da, \quad (18)$$

$$\Delta^* = \varphi s_K \int_0^1 a^{1-\sigma} f[a]_N da + (1 - s_K) \int_0^1 a^{1-\sigma} f[a]_S da. \quad (19)$$

Solving the integrals:

$$\int_0^1 a^{1-\sigma} f[a]_N da = \int_0^1 a^{1-\sigma} \beta_N \frac{a^{\beta_N - 1}}{a_0^{\beta_N}} da = \frac{\beta_N}{1 - \sigma + \beta_N} = \lambda_N, \quad (20)$$

$$\int_0^1 a^{1-\sigma} f[a]_S da = \int_0^1 a^{1-\sigma} \beta_S \frac{a^{\beta_S - 1}}{a_0^{\beta_S}} da = \frac{\beta_S}{1 - \sigma + \beta_S} = \lambda_S. \quad (21)$$

⁶ As in Baldwin and Okubo (2006), there are no fixed costs to establish a "beachhead" in a market, so all firms sell in both markets as long as trade costs are finite (Melitz, 2003, examines the case in which there are fixed entry costs).

In order for the price indexes to be positive it is necessary that η_N and $\eta_S > 0$ that is when $\sigma < 1 + \beta_N$ ⁷ Condition $\lambda_N > \lambda_S$ always holds because λ is increasing in σ ⁸.

Using (20) and (21), Δ and Δ^* can be written as:

$$\Delta = \lambda_N s_K + \lambda_S (1 - s_K) \varphi, \quad (22)$$

$$\Delta^* = \lambda_N \varphi s_K + \lambda_S (1 - s_K). \quad (23)$$

Since capital income is spent in the owner's region, capital moves in search of the highest nominal reward.

Starting as in Baldwin and Okubo (2006) from the initial situation where no firms have moved, the North's share of firm is exactly equal to the North's share of capital, so $s_n = s_k$. Capitals migrate from South to North if:

$$\pi [a] - \pi^* [a] = \left(a^{1-\sigma} \frac{E^W}{\sigma K^W} \right) \left\{ (1 - \varphi) \left[\frac{s_E}{\Delta} - \frac{(1 - s_E)}{\Delta^*} \right] \right\} > 0. \quad (24)$$

Using the symmetry of region's relative factor endowments $s = s_n = s_k > 1/2$ and substituting (22) and (23) to Δ and Δ^* , (24) becomes:

$$\begin{aligned} \pi [a] - \pi^* [a] &= \left[a^{1-\sigma} \frac{E^W}{\sigma K^W} (1 - \varphi) \right] \times \\ &\times \left\{ \frac{s^2 \varphi (\lambda_N - \lambda_S) + s (\lambda_S - \lambda_N) + s^2 (\lambda_N - \lambda_S) + \lambda_S \varphi (2s - 1)}{[\lambda_N s + \lambda_S \varphi (1 - s)] [\lambda_N s \varphi + \lambda_S (1 - s)]} \right\}. \end{aligned} \quad (25)$$

This expression is ≥ 0 if:

$$\varphi \geq \varphi_c = \frac{s (\lambda_N - \lambda_S) + s^2 (\lambda_S - \lambda_N)}{[s^2 (\lambda_N - \lambda_S) + \lambda_S (2s - 1)]}, \quad (26)$$

where:

$$0 < \varphi_c < 1. \quad (27)$$

The above result can be summarized in the following proposition.

PROPOSITION 1: *Country-specific productivity has impact on delocation tendencies. When the North is larger than South and its firms are more productive than southern ones then delocation for any atomistic southern firm is convenient only if trade is sufficiently costless that is when $\varphi > \varphi_c$, while migration from North to South arises if $\varphi < \varphi_c$. Finally, when $\varphi = \varphi_c$, the symmetric equilibrium is a possible spatial configuration.*

⁷In fact $\sigma < 1 + \beta_N$ implies $\sigma < 1 + \beta_S$.

⁸Note that $\frac{\delta \eta}{\delta \sigma} = -\beta (1 - \sigma + \beta)^{-2} (-\beta) > 0$.

We can distinguish two opposite effects: a size effect and a productivity effect. For a lower level of trade costs the first effect prevails and for southern firms to relocate in the largest market in order to take advantage of increasing returns is convenient; by contrast, if trade is sufficiently costly location of economic activity in the largest market becomes less attractive because competition among firms is stronger and to penetrate the more productive country will be more difficult.

4 Conclusions

In this work we develop a simple two-country FC model of Baldwin and Okubo (2006) with heterogeneous firms and country-specific productivity; in particular, we assume that North is larger in a pure sense than the South and its firms are on the average more efficient than the southern ones.

From our analysis it emerges that the assumption of country-specific productivity is not innocuous and it matters in driving location decisions. Namely, in these circumstances the agglomeration forces and the direction of migration crucially depend on the level of trade costs, contrary to Baldwin and Okubo (2006) seminal paper. In particular, delocation for any atomistic southern firm is convenient only if trade is sufficiently costless, while migration from North to South arises for a high level of trade costs.

References

- Amiti, M. and C. (2005), "Trade and Industrial Location with Heterogeneous Labour", *Journal of International Economics*, vol. 67, pp. 392-412.
- Baldwin, R. and R. Forslid (2000). "The Core-Periphery Model and Endogenous Growth: Stabilizing and Destabilizing Integration", *Economica*, vol. 67, pp. 307-324.
- Baldwin, R. et al. (2003). "Economic Geography and Public Policy", Princeton University Press, Princeton.
- Baldwin, R. and T. Okubo (2006). "Heterogeneous Firms, Agglomeration and Economic Geography: Spatial Selection and Sorting", *Journal of Economic Geography*, vol. 6, pp. 323-346.
- Bernard, A. B., B. Jensen and P. Schott (2003). "Falling Trade Costs, Heterogeneous Firms and Industry Dynamics", *CEPRDP*, 585, Centre for Economic Performance, LSE.
- Cabral, L. M. B. and J. Mata (2003). "On the Evolution of the Firm Size Distribution: Facts and Theory", *American Economic Review*, vol. 93, pp. 1075-1090.
- Chiswick, B. (1999). "Are Immigrants Favourably Self-Selected?", *American Economic Review*, vol. 89, pp. 181-185.
- Ciccone, A. (2002). "Agglomerations Effects in Europe", *European Economic Review*, vol. 46, pp. 213-227.

- Davis, D. (1998). "The Home Market Effect: Trade and Industrial Structure", *American Economic Review*, vol. 88, pp. 1264-1276.
- Dixit, A. K. and J. E. Stiglitz (1977). "Monopolistic Competition and Optimum Product Diversity", *American Economic Review*, vol. 67, pp. 297-308.
- Fujita, M., Krugman P. and A. Venables (1999). "The Spatial Economy: cities, Regions and International Trade", Cambridge (Mass.), MIT Press.
- Fujita, M. and J. F. Thisse (2002). "Economics of Agglomeration", Cambridge University Press, Cambridge.
- Hanson, G. and C. Xiang (2004). "The Home Market Effect and Bilateral Trade Patterns", *American Economic Review*, vol. 94, pp. 1108-1129.
- Head, K. and J. Ries (2001). "Increasing Returns versus National Product Differentiation", *American Economic Review*, vol. 91, pp. 858-876.
- Head, K., T. Mayer and J. Ries (2002). "On the Pervasiveness of the Home Market Effect", *Economica*, vol. 69, pp. 371-390.
- Helpman, E., M. Melitz and S. Yeaple (2004). "Export Versus FDI whit Heterogeneous Firms", *American Economic Review*, vol. 94, pp. 300-316 (317).
- Hopenhayn, H. (1992a). "Entry, Exit, and Firm Dynamics in Long Run Equilibrium", *Econometrica*, vol. 60, pp. 1127-1150.
- Hopenhayn, H. (1992b). "Exit, Selection and the Value of Firms", *Journal of Economic Dynamics and Control*", vol. 16, pp. 621-653.
- Jaffe A., M. Trajtenberg and R. Henderson (1993). "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations", *Quarterly Journal of Economics*, vol. 108, pp. 577-598.
- Jean, S. (2002). "International Trade and Firms' Heterogeneity Under Monopolistic Competition", *Open Economies Review*, vol. 13, pp. 291-311.
- Krugman, P. (1980). "Scale Economies, Product Differentiation and the Pattern of Trade", *American Economic Review*, vol. 70, pp. 950-959.
- Krugman, P. (1991a). "Geography and Trade", MIT press, Cambridge MA.
- Krugman, P. (1991b). "Increasing Returns and Economic Geography", *Journal of Political Economy*, vol. 99, pp. 483-499.
- Martin, P. and C.A. Rogers (1995). "Industrial Location and Public Infrastructure", *Journal of International Economics*, vol. 39, pp. 335-351.
- Melitz, M. (2003). "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, vol. 71, pp. 1695-1725.
- Melitz, M. and G. Ottaviano (2008). "Market Size, Trade and Productivity", *Review of Economic Studies*, vol. 75, pp. 295-316.
- Montagna, C. (2001). "Efficiency Gaps, Love of Variety and International Trade", *Economica*, vol. 68, pp. 27-44.
- Ottaviano G., J. F. Thisse and T. Tabuchi (2002). "Agglomeration and Trade Revisited", *International Economic Review*, vol. 43, pp. 409-436.
- Smithies, A. F. (1941). "Optimum Location in Spatial Competition", *Journal of Political Economy*, vol. 49, pp. 423-439.
- Tabuchi, T. and J. F. Thisse (2002). "Taste Heterogeneity, Labor Mobility and Economic Geography", *Journal of Development Economics*, vol. 69, pp. 155-177.

Venables, A. (1996). "Equilibrium Locations of Vertically Linked Industries", *International Economic Review*, vol. 37, pp. 341-359.

Weber, A. ((1909) 1928). "Theory of the Location Industry", translated by C. J. Friedrich, Chicago: University of Chicago Press.