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Location and Export Performance.

Theory and empirical evidence from food firms*

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Abstract

The impact of local environment on the international competitiveness of firms is a central issue for local policy makers. In this paper, we evaluate the nature and the magnitude of regional advantages explaining the export performance of firms by taking into account that the location choice of firms is not made randomly. We provide microeconomic foundations to the relationship between spatial externalities, firms location, and export performance. From French data on food industry, we show that (i) more local firms reduce the probability of exporting (as predicted by our model); (ii) the export sales of a firm increases with the number of exporters serving the same destination; (iii) the regional productivity cutoff for exporting is positively correlated with the minimum regional productivity.

Keywords: Exports; Heterogeneous firms; Spatial externalities; Food industry

JEL classification: F12; F14; R12; L66

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1 Introduction

Globalization of our economies and decentralization of public decision make local public authorities concerned with promoting export performance of firms set up in their jurisdictions. Trade liberalization creates incentives for subnational governments to play a more active role in enhancing trade by implementing regional export promotion agencies and networks of regional representation abroad, by improving transport infrastructure and regional human capital, or by reducing tax burden (for example). However, little attention has been paid to the impact of local economic environment on the international competitiveness of firms, while this question is a central issue for local policy makers since it may help policy makers to select their strategies to enhance the export performance of local firms.

Different reasons make difficult to evaluate the causal effect of regional specificities on export performance of firms. First, the firms are far from being evenly distributed within a country, and some severe regional disparities are to be observed because of spatial externalities, scale economies and lower transport costs (Krugman, 1991; Combes, Mayer and Thisse, 2012). Hence, the regional gap in export performance may only be due to the uneven spatial distribution of firms. A region hosting more firms is more likely to host more exporters. Second, regions are specialized in different industries that are more and less competitive on the international markets. As a consequence, a higher number of exporters or a higher export sales in a region can be explained by its industrial structure. Third, a larger region size increases average productivity via a selection process (competition is fiercer) and, in turn, higher productivity increases region size by attracting firms and workers from the other regions ([Behrens *et al.* , 2010]). In other words, the export performance differ significantly among regions within a same country because some regions attract the more productive firms within an industry. Because the most productive firms tend to agglomerate, the larger regions host firms having a higher probability of being exporters and, on average, higher level of exports. Indeed, recent trade literature shows that how the heterogeneity of firms in terms of productivity induces different export decisions and export sales (Melitz, 2003;). More precisely, empirical evidence shows that the probability of exporting and export sales of firms increase with their productivity and size. Hence, the more productive firms which have a higher probability of exporting are more likely to be located in the same region.

The objective of this paper is to understand to what extent the local environment of a firm is a determining factor in its performance to export by taking into the location choice of firms is not made randomly. To reach our goal, we first provide microeconomic foundations to the relationship between spatial externalities, firms location, and export performance. We develop a trade model with heterogeneous firm based on [Melitz, 2003] where the countries are divided

in regions that have specific export costs and specific productive environment. We consider that the productivity of firms depends not only on their own efficiency, but also on the regional advantage. In addition, we consider that the productivity of firms depends not only on their own efficiency, but also on the number of local firms through *technological externalities*. In presence of technological externalities, the region enjoying an increase in its comparative advantage force its firms with a low productivity to exit the market and attracts the more productive firms. In other words, the minimum productivity above which a firm can profitably export increases with the regional advantage via a tougher selection. We also consider the existence of *local export spillovers*, i.e. the presence of other exporters in the same region make the access to foreign markets easier ([Chevassus-Lozza & Galliano, 2003]). When they are spatially close, firms can share information on export, on foreign markets, or even share the transport costs.

We evaluate the nature and the magnitude of the impact of local externalities on export performance by using firm-level data on the French food industry. We select this sector for the following reasons. First, we can "easily" control for the factors explaining the spatial distribution of firms belonging to this industry. Indeed, the location of the food industry is strongly affected by the location of agricultural products processed by this industry (Bagoulla et al., 2010). The case of wine industry is particularly convincing. Second, we can identify the main agricultural products purchased by the agrifood firms at a very disaggregated level. Third, the food industry is characterized by a large number of firms which are more and less unequally distributed across the French regions. Our econometric study reveals that (i) more local firms reduce the probability of exporting (as predicted by our model); (ii) the export sales of a firm increases with the number of exporters serving the same destination; (iii) the regional productivity cutoff for exporting is positively correlated with the minimum regional productivity.

Related literature. The role of regions in promoting firms' internationalization does not seem to receive adequate attention from the literature in regional economics and in international economics. In his seminal paper [Melitz, 2003] develops a trade model with heterogeneous firms explaining the self selection of firms on the export market. Nevertheless in the Melitz's paper and its different extensions, the countries are considered as homogeneous and the location of firms within a country has no impact on its export performance. More recently, new economic geography literature has analyzed the relationship between heterogeneity of firms and regional inequalities (Behrens et al., 2013; Ottaviano, 2012); but it does not consider international trade. Though many recent papers studied the impact of international trade on the firms location ([Bagoulla et al. , 2010], [Behrens et al. , 2006], [Okubo et al. , 2010]) few is known on the reverse causality.

However, some empirical studies have tested whether local export spillovers are at work. For example, Aitken et al. (1997) [Aitken *et al.*, 1997] argue the presence of other exporters in the same region and industry in Mexico reduces the cost of access to foreign markets. Chevassus-Lozza and Galliano (2003) and Greenaway et al. (2004) find close results in the case of French and UK plants, respectively. In contrast, [Bernard & Jensen, 2004] show that, in the case of the United States, neighboring exporting firms have a negligible impact on the probability of exporting. For France, [Koenig, 2009] shows that export spillovers have significant positive effects on the decision to start to export but only when the spillover is defined at a destination country level. In addition, [Koenig *et al.*, 2010] find that the spillovers have a significant impact on the extensive margin but not on the intensive margin. Nevertheless these papers have few theoretical foundations.

The remain of the paper is organized as follows. In the next section we present our trade model with heterogeneous firms and regions where the productivity of firms depend also on local characteristics. In section 3, we present our data, our estimations, and our analysis. In section 4, we evaluate productivity cutoffs for each region. The last section concludes.

2 A model of trade with spatial externalities

We consider a country made up of R regions trading with J countries. When a region exports, the origin region is labeled r and the destination country j . Product markets are internationally segmented while they are not segmented within each country. In other words, each firm is able to set a price specific to the country in which its output is sold (Engel and Rogers 2001). In contrast, firms sell their varieties at the same price in the region belonging to their country. Labor is the only production factor. Individuals are endowed individually with one unit of labour and they can only consume and work in the region where they live. They are not mobile across regions but mobile within each region. Contrary to product markets, labor market is regionally segmented. Hence, wage rate is specific to each region and the mass of firms in a region depends on the mass of labor units supplied in the region.

In order to disentangle the various effects at work, we distinguish between the case where there is no spatial externality and where different types of spatial externality occur.

2.1 Preferences, technology, and exports

Consumer preferences in country j are given by a CES utility function over a continuum of varieties v , given by

$$U_j = \left[\int_{\Omega_j} q_{rj}(v)^{1-\varepsilon} dv \right]^{\frac{1}{1-\varepsilon}}$$

where Ω_j is the set of available goods in country j , $q_{rj}(v)$ is the demand of consumers living in country j for a variety v produced in region r and ε is the constant elasticity of substitution between varieties. The individual budget constraint is $\int_{\Omega_j} p_{rj}(v)q_{rj}(v)dv = w_k$ where w_k is the wage rate in region k belonging to country j and $p_{rj}(v)$ is the price of variety v produced in region r prevailing in country j . By maximizing U_j under the budget constraint and by summing for each individual, we obtain the total sales of variety v in country j for variety v produced in region r :

$$s_{rj}(v) \equiv E_j P_j^{\varepsilon-1} p_{rj}(v)^{1-\varepsilon} \quad (1)$$

where P_j is the consumer price index in country j (with $P_j^{1-\varepsilon} = \int_{\Omega_j} p(v)^{1-\varepsilon} dv$) and $E_j = \sum_{k \in j} w_k L_k$ represents the aggregate expenditure of country j .

The differentiated product is supplied by a continuum of firms. Each supplier produces a single variety ν under monopolistic competition and using only labor. Each variety is produced by a single producer. To serve a country, a firm located in region r incurs a fixed export cost (f_{rj}) and an "iceberg" variable export cost (τ_{rj}). These export costs are specific to the region where production occurs and to the destination. Hence, the access costs to foreign markets differ among firms with respect to their location within a country. They are specific to the destination because the costs of adaptation to foreign markets (e.g., establishing a distribution and servicing network, learning bureaucratic procedures, and adapting products for foreign markets) can vary among countries. The reasons explaining the interregional difference in access costs are assumed for the time being to be exogenous (the difference can be due to regional differences in the efficiency of intermediaries or to public intervention through subsidy/public infrastructure for example). These costs are all expressed in terms of labor.

With one unit of labor, a firm produces $A_r \varphi$ units of variety where φ is the efficiency of the firm (specific to the firm) and A_r is a region specific factor that expresses the advantage to be located in region r (quantity and quality of productive infrastructure, level of regional education, ...). Thus, the productivity of a firm is a combination of its own efficiency and the regional comparative advantage. The higher A_r , the lower the cost to produce a supplementary unit. The efficiency of one unit of labor is not the same from one region to another. When producing a firm also faces fixed production costs that are specific to the country in which it produces (f_i)

As a result, the total cost function for a firm producing in r and selling its production in $j \in [1; J]$ equals

$$c_{rj}(\varphi) = \frac{\tau_{rj} w_r}{A_r \varphi} q_{rj} + w_r f_{rj} \quad (2)$$

where w_r is the wage rate prevailing in region r . In the particular case where $j = i$, we have $\tau_{rj} = 1$ and $f_{ri} = f_i$. The total profit of a firm is defined as follows $\pi_r = \sum_j [s_{rj} - c_{rj}]$. In this context, the profit-maximising prices set by a firm located in region r and selling in country j

are given by:

$$p_{rj}(\varphi) = \frac{\varepsilon}{\varepsilon - 1} \frac{w_r \tau_{rj}}{\varphi A_r}. \quad (3)$$

As expected, the equilibrium price depends on a constant markup ($\varepsilon/(\varepsilon - 1)$) and the marginal cost which is affected by the characteristics of the firm (φ), of the region where production occurs (w_r, A_r, τ_{rj}), of the destination (τ_{rj}). Plugging this expression (3) into $\pi_r(\varphi)$, the profit function then simplifies to

$$\pi_r(\varphi) = \sum_j \left[\frac{s_{rj}(\varphi)}{\varepsilon} - f_{rj} w_r \right] \quad (4)$$

with

$$s_{rj}(\varphi) = E_j P_j^{\varepsilon-1} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{1-\varepsilon} (\tau_{rj} w_r)^{1-\varepsilon} \varphi^{\varepsilon-1} A_r^{\varepsilon-1} \quad (5)$$

Hence, the export sales of a firm depend positively on its efficiency φ and the regional advantage A_r . Notice that the marginal effect of A_r (resp., φ) on export sales increases with the efficiency of the firm (resp., A_r). In addition, we have $\partial^2 s_{rj} / \partial \varphi \partial A_r = (\varepsilon - 1)^2 s_{rj} / \varphi A_r > 0$. In words, *there is a strong complementarity between the efficiency of manufacturers and that of regions.*

2.2 Entry

We now determine the equilibrium mass of firms producing in each region. To enter the market, each producer must pay a sunk cost of f_e units of labor, but manufacturers do not know a priori their efficiency (φ). A manufacturer enters the market as long as the expected value of entry is higher than the enter sunk cost. As the efficiency of a firm remains constant over time, its optimal profit level is constant too, until a shock forces it to exit. Because of sunk cost, a certain level of efficiency is necessary to produce. A firm that draws an efficiency which is too low (so that it would not get a positive profit) exits the market without producing.

We get these two efficiency thresholds using the zero profit condition: $\pi_{rj}(\varphi_{rj}) = s_{rj}(\varphi_{rj}) - c_{rj}(\varphi_{rj}) = 0$ where φ_{rj} is the efficiency threshold to access market j from region r . In the particular case where $j = i$ we get the efficiency threshold to produce and to serve the domestic market, φ_r . An efficiency lower than φ_{rj} entails a negative profit on market j . Using (5), we get the general expression of the productivity threshold:

$$\varphi_{rj}^{\varepsilon-1} = \frac{\varepsilon \left(\frac{\varepsilon}{\varepsilon-1} \right)^{\varepsilon-1} f_{rj} w_r}{E_j P_j^{\varepsilon-1} (\tau_{rj} w_r)^{1-\varepsilon} A_r^{\varepsilon-1}}. \quad (6)$$

When $j = i$, 6 simplifies to:

$$\varphi_r^{\varepsilon-1} = \frac{\varepsilon \left(\frac{\varepsilon}{\varepsilon-1} \right)^{\varepsilon-1} f_i w_r}{E_i P_i^{\varepsilon-1} w_r^{1-\varepsilon} A_r^{\varepsilon-1}} \quad (7)$$

It appears that, *ceteris paribus*, the efficiency cutoff to enter the market in a region decreases with its advantage (A_r). Because profits are increasing with efficiency, only the firms that drew a φ above φ_r survive. The expected profit of the firms settled in region r is given by

$$\bar{\pi}_r = \sum_j \bar{\pi}_{rj}$$

With $\bar{\pi}_{rj}$, the average profit of firms exporting to j from r , it equals:

$$\bar{\pi}_{rj} = \int_{\varphi_{rj}}^{\infty} \pi_{rj}(\varphi) \mu_{rj}(\varphi) d\varphi \quad (8)$$

where $\mu_{rj}(\varphi)$ is the conditional distribution of the productivity only for productivities higher than the productivity threshold φ_{rj} . In other words, $\mu_{rj}(\varphi) = g(\varphi)/[1 - G(\varphi_{rj})]$ if $\varphi > \varphi_{rj}$ and 0 otherwise. A firm that draws a productivity lower than φ_r immediately exits the market without producing (since its expected revenue is not high enough to cover the fixed costs of production) and loses f_e . So a firm takes the risk to pay this sunk cost only if its expected profit after entering the market covers this cost.

Under free entry, at the equilibrium the expected profit is absorbed by the sunk cost so that

$$[1 - G(\varphi_r)] \bar{\pi}_r = w_r f_e \quad (9)$$

where $G(\varphi)$ is the cumulative distribution function of the productivity. Hence, $1 - G(\varphi_r)$ is the probability of entering with success. This equation allows us to calculate the number of firms set up in region r at the equilibrium and the price index, that is then replaced in 6. We assume that firms' efficiency follows a Pareto distribution on $[1; +\infty[$, we have $1 - G(\varphi_{rj}) = \varphi_{rj}^{-\gamma}$ where γ is the shape parameter of the Pareto distribution, which is a measure of the dispersion of the productivities in the economy. If γ is high, the distribution of the productivities is highly spread out.

By using the free entry condition (see Appendix A.1) and the labor market clearing (see Appendix A.2) we obtain the mass of firms and the mass of exporters in region r given by

$$M_r = \frac{L_r (\varepsilon - 1)}{\varepsilon \gamma \varphi_r^\gamma f_e} \quad \text{and} \quad M_{rj} = \frac{L_r (\varepsilon - 1)}{\varepsilon \gamma \varphi_{rj}^\gamma f_e} \quad (10)$$

where L_r is the quantity of labour in region r . By plugging (10) into the price index (see Appendix A.3) and replacing it in (6) we can express the efficiency threshold as follows:

$$\varphi_{rj} = K (f_{rj} w_r)^{\frac{1}{\varepsilon-1}} E_j^{\frac{-1}{\gamma}} \frac{\tau_{rj} w_r}{A_r} \Lambda_j \quad (11)$$

with

$$K \equiv \left[\frac{\varepsilon - 1}{f_e (\gamma - \varepsilon + 1)} \right]^{\frac{1}{\gamma}} \quad \text{and} \quad \Lambda_j \equiv \left[\sum_k L_k (w_k \tau_{kj})^{-\gamma} A_k^\gamma (f_{kj} w_k)^{\frac{-\gamma + \varepsilon - 1}{\varepsilon - 1}} \right]^{1/\gamma}$$

so that

$$M_{rj} = E_j \frac{\gamma - \varepsilon + 1}{\varepsilon \gamma} \frac{L_r (w_r \tau_{rj})^{-\gamma} A_r^\gamma (f_{rj} w_r)^{\frac{-\gamma}{\varepsilon - 1}}}{\Lambda_j^\gamma}$$

The impact of A_r on φ_{rj} and M_{rj} is ambiguous. On the one hand, a higher A_r decreases the prices set by the regional firms and in turn increases their profits (direct price effect). On the other hand, a rise in A_r decreases the price index (or Λ_j) inducing a lower demand and profit, *ceteris paribus*. The latter effect is a competition effect, known also as a market crowding effect (Baldwin et al., 2003). Formally, we have

$$\frac{d\varphi_{rj}}{dA_r} = \frac{\varphi_r}{A_r} \left[-1 + \frac{L_r (A_r)^\gamma (f_i w_r)^{\frac{-\gamma + \varepsilon - 1}{\varepsilon - 1}} w_r^{-\gamma}}{\Lambda_j^\gamma} \right] < 0$$

Hence, the efficiency cutoff to export decreases with A_r and the mass of exporters increases with A_r . However, there is no multiplier effect since the elasticity of the mass of exporters with respect to A_r decreases with A_r . In addition, the productivity cutoff ($A_r \varphi_{rj}$) above which a firm export depends positively on A_r . In this case, the market crowding effect dominates the direct price effect. In other words, *the average productivity of firms in a region increases with its locational advantage via a tougher selection even though the average efficiency decreases*.

By plugging (6) into (5) we get

$$s_{rj}(\varphi) = \varepsilon \left(\frac{\varphi}{\varphi_{rj}} \right)^{\varepsilon - 1} f_{rj} w_r \quad (12)$$

By plugging (11) into (12), the export sales of a firm located in region r become

$$s_{rj}(\varphi) = \varepsilon K^{1 - \varepsilon} E_j^{\frac{\varepsilon - 1}{\gamma}} \Lambda_j^{1 - \varepsilon} (\tau_{rj} w_r)^{1 - \varepsilon} A_r^{\varepsilon - 1} \varphi^{\varepsilon - 1}$$

with

$$\frac{ds_{rj}}{dA_r} = s_{rj} \frac{\varepsilon - 1}{A_r} \left[1 - \frac{L_r (A_r)^\gamma (f_i w_r)^{\frac{-\gamma + \varepsilon - 1}{\varepsilon - 1}} w_r^{-\gamma}}{\Lambda_j^\gamma} \right] > 0.$$

Similarly, the elasticity of the export sales with respect to A_r is positive but decreases with A_r . Hence, *a higher regional productivity (A_r) raises the number of exporting firms and the export sales of each exporter, but decreases the export sales conditional on exporting*. In contrast, a larger labor force in a region increases the mass of exporters and the productivity cutoff to export but decreases the export sales of each exporter. In other words, a larger regional labor market makes competition tougher.

In the particular case where $j = i$, (11) simplifies to

$$\varphi_r = K (f_i w_r)^{\frac{1}{\varepsilon - 1}} E_i^{\frac{-1}{\gamma}} w_r \Lambda_i A_r^{-1} \quad (13)$$

where the efficiency cutoff φ_r (resp., productivity cutoff $A_r \varphi_r$) above which a firm can profitably produce increases (resp., decreases) with A_r . In addition, we have

$$M_r = E_i \frac{\gamma - \varepsilon + 1}{\varepsilon \gamma} \frac{L_r w_r^{-\gamma} A_r^\gamma (f_i w_r)^{\frac{-\gamma}{\varepsilon - 1}}}{\Lambda_i^\gamma} \quad (14)$$

As a consequence, a region with a higher regional productivity attracts more firms and more exporters and boosts the average productivity by a tougher selection.

2.3 Spatial externalities

We now consider the existence of *Marshallian externalities* or technological externalities which aim at accounting for the benefits associated with the formation of a cluster. These benefits arise because of the development of new ideas based on face-to-face communications and on inter-firm mobility of workers and the existence of modern infrastructure. These externalities affect the firms belonging to the same geographical area while their impact on distant regions is negligible. We consider that Marshallian externalities increase the local productivity without to be precise on the origin of these externalities as in urban and regional economics (Fujita and Thisse, 2002). We study how the introduction of externalities modify our equilibrium configurations.

Local technological/productive externalities. When gathering, firms can gain in efficiency and produce with a higher productivity. This means that their marginal cost is reduced by a positive amount which is region-specific. In other words, we now consider that A_r depends positively on the mass of regional firms. Thus, the cost a firm faces to produce depends on the number of firms in its surrounding. We assume that:

$$A_r = \xi_r M_r^\delta \quad (15)$$

with $\xi_r > 0$ and $\delta > 0$. The higher δ , the lower the marginal cost of production for the firms located in region r . These economies benefit to all firms in this region. If more firms set up in region r , A_r raises and, in turn, the cut-off productivity decreases (equation 11). Each additional firm setting up in r reduces the marginal cost of production for all other firms. Contrary to the standard approach combining monopolistic competition and CES preferences, equilibrium prices are dependent from the number of local competitors.

By plugging (14) into (15), the comparative advantage is now expressed as follows.

$$A_r = \xi_r^{\frac{1}{1-\delta\gamma}} \left[E_i^{\frac{\gamma-\varepsilon+1}{\varepsilon\gamma}} \frac{L_r w_r^{-\gamma} (f_i w_r)^{\frac{-\gamma}{\varepsilon-1}}}{\sum_k L_k (w_k \tau_{ki})^{-\gamma} (f_{ki} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} A_k^\gamma} \right]^{\frac{\delta}{1-\delta\gamma}}$$

Inserting this expression in (13) gives the equilibrium efficiency threshold to produce in region r :

$$\varphi_r^* = \xi_r^{\frac{-1}{1-\delta\gamma}} \left[L_r^{-\delta} K_1 (f_i w_r)^{\frac{1}{\varepsilon-1}} E_i^{\frac{-1}{\gamma}} w_r \Lambda_i \right]^{\frac{1}{1-\gamma\delta}} \quad (16)$$

with $K_1 \equiv K \left(\frac{\varepsilon-1}{\varepsilon\gamma f_e} \right)^{-\delta}$ with

$$\varphi_r^* A_r = K (f_i w_r)^{\frac{1}{\varepsilon-1}} E_i^{-\frac{1}{\gamma}} w_r \left[\sum_k L_k (w_k \tau_{ki})^{-\gamma} \xi_r^\gamma M_k^{\delta\gamma} (f_{ki} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} \right]^{1/\gamma}.$$

so that the productivity cutoff increases with the mass of firms located in the same region. By using (14), the mass of firms is given by

$$M_r^* = E_i^{\frac{1}{1-\gamma\delta}} \left(\frac{\varepsilon\gamma}{\gamma - \varepsilon + 1} \right)^{\frac{1}{1-\gamma\delta}} L_r^{\frac{1}{1-\gamma\delta}} w_r^{\frac{-\gamma}{1-\gamma\delta}} \xi_r^{\frac{\gamma}{1-\gamma\delta}} (f_i w_r)^{\frac{-\gamma}{(\varepsilon-1)(1-\gamma\delta)}} \Lambda_i^{\frac{-\gamma}{1-\gamma\delta}}$$

where Λ_i includes the mass of firms in each region. In Appendix A.4, we can show that the equilibrium mass of firms which depends only on exogenous parameters and is given by

$$M_r^* = \frac{\varepsilon\gamma}{\gamma - \varepsilon + 1} \frac{E_i L_r w_r^{-\gamma} \xi_r^\gamma (f_i w_r)^{\frac{-\gamma}{(\varepsilon-1)}}}{\lambda_i} \quad (17)$$

where λ_i is given in Appendix A.4. In addition, the equilibrium exports sales are given by

$$s_{rj}(\varphi) = E_j^{\frac{\varepsilon-1}{\gamma}} \left(\frac{\varepsilon}{\varepsilon-1} \right)^{\frac{(\gamma-1)(\varepsilon-1)}{-\gamma}} \varepsilon K^{1-\varepsilon} \Lambda_j^{1-\varepsilon} (\tau_{rj} w_r)^{1-\varepsilon} \varphi^{\varepsilon-1} \xi_r^{\varepsilon-1} M_r^{\delta(\varepsilon-1)}$$

Some comments are in order. If $\delta = 0$, we fall back on the prediction obtained in Melitz (2003) and Arkolakis et al. (2012), except that the productivity of a firm differ across regions and is given by $\xi_r \varphi$. Under this configuration, the efficiency cutoff does not depend on the number of local firms. This is illustrated in Figure 1a. As in Arkolakis et al. (2012), a higher market size (E_i) or labor force always result in a decrease in the efficiency threshold.

Figures 1a and 1b

When $\delta > 0$, the determination of the equilibrium mass of firms and efficiency cutoff is more complex. Formally, we have a system of two equations ((13) and (10)) with two unknowns (φ_r and M_r). As illustrated in Figure 1b, the first equation represents the efficiency cutoff φ_r which depends negatively on M_r (with $\varphi_r \rightarrow \infty$ when $M_r \rightarrow 0$ and with $\varphi_r \rightarrow 0$ when $M_r \rightarrow \infty$) whereas the second one gives the mass of firms M_r which is negatively impacted by φ_r (with $M_r \rightarrow \infty$ when $\varphi_r \rightarrow 0$ and with $M_r \rightarrow 0$ when $\varphi_r \rightarrow \infty$). Thus, we have two curves giving two negative relationships between M_r and φ_r . We can show there exists a unique intersection point between the two curves when $M_r > 0$ regardless of the values taken by the parameters of the economy. However, if the intensity of spatial externalities is strong $\delta > 1/\gamma$, so that $1 - \gamma\delta > 0$, (17) is not an equilibrium and all firms concentrate in a single region in order to exploit spatial externalities. This is equivalent to the black-hole-condition in Krugman (1991) (for more details, see Fujita et al., 1999). Such an occurrence is more likely to occur when

γ increases, i.e. when the distribution of productivity gets more and more skewed towards low productivity firms. In what follows, we consider that the no-black-hole-condition holds ($\delta < 1/\gamma$).

When $1 - \gamma\delta > 0$, the spatial distribution of firms is related to the difference in the regional characteristics and the characteristics of the national economy. In the low-wage regions, the less productive firms are driven out of the market, resulting in the reduction in the number of firms in region r . This is expressed in Figure 1b. Assume a rise in the regional advantage (ξ_r) or a decrease in the regional wage rate (w_r) so that the curve φ_r decreases regardless of M_r (This new curve is illustrated by the dotted lines representing equation 11). Indeed, a lower w_r or higher ξ_r reduces the price of each variety produces in region r . This implies a decline in the price index (market crowding effect). As a result, there is a reallocation of demand from the firms located in the other regions to the local firms. This reallocation of market share forces the former firms to exit, especially the low productivity firms located in the region with a low regional advantage. In contrast, the latter firms enjoy higher sales and, in turn, higher profits for a given mass of firms so that the curve φ_r shifts downward. However $A_r\varphi_r$ increases so that the price index declines (market crowding effect is strengthened). Thus, a lower w_r or higher ξ_r may have an ambiguous impact on the revenue of the firm. For the firms with a low efficiency, the reduction in the own prices is low and can be lower than the fall in the price index. In other words, their profits can decline with lower wage costs and force them to exit the market. This impact depends on δ . The higher δ is, the tougher the positive response of the efficiency threshold (13) to a variation in market size or wage costs is. From (3), we know that the prices of the differentiated products decrease faster for firms that have a higher productivity when δ rises. So the consumers consume proportionnaly more of the goods produced by the most productive firms. All the firms are not impacted the same way when ξ_r increases. When δ is relatively high, the least productive firms are no more able to face the competition (market crowding effect). Their operating profits become low, so that they exit the market.

The effect of wage costs and the regional advantage on the productivity cutoff depends also on the value of γ . When γ gets higher the distribution of the firms efficiency becomes more concentrated on the lowest values of efficiency. There are proportionnaly more low efficiency firms. As a consequence, the competition among the most productive ones is relaxed when γ increases. When the wage costs decrease, the supplementary demand for more productive firm is higher when γ reaches higher values. In contrast, the demand for varieties produced by low efficiency firms decreases when γ increases. Thus, the decrease in price force the least productive firms to exit the market and the market share of the high efficiency firms becomes bigger.

Proposition 1 *In presence of technological externalities, the region enjoying an increase in its*

comparative advantage can force its firms with a low productivity to exit the market and attracts the more productive firms.

Export spillover. As explained in the introduction, the access to a foreign market may be easier for firms that have in their neighborhood other exporting firms. Indeed firms can share information on the destination market, transport costs, etc. As Feldman (1994) wrote "knowledge transverses corridors and streets more easily than continents and oceans", proximity with other exporting firms helps firms to share knowledge and costs for accessing foreign markets. This allows a decrease in the fixed costs or trade costs that firms face when exporting to this market. The existence of this export spillover has been empirically showed in numerous papers we described in the previous section. Thus we assume that the access costs to foreign markets incurred by a firm located in region r depend on the number of firms located in the very same region that export to this partner country. We have:

$$f_{rj} = f_j M_{rj}^{-\mu_0} \quad \text{and} \quad \tau_{rj} = \tau_j M_{rj}^{-\mu_1} \quad (18)$$

with $f_j, \tau_j > 0$ and $\mu_0, \mu_1 > 0$. The fixed export cost from region r to country j is composed of two distinct parts: $M_{rj}^{-\mu_0}$ that takes into account the export spillover through the number of firms that export to j in the same region and ξ_j a fixed part that is independent from the export spillover, this part is destination specific and do not depend an the region of origin. If there is no export spillover, then $\mu_0 = 0$ and $f_{rj} = f_j$. Under these assumptions, we have

$$s_{rj}(\varphi) = E_j^{\frac{\varepsilon-1}{\gamma}} \left(\frac{\varepsilon}{\varepsilon-1} \right)^{\frac{(\gamma-1)(\varepsilon-1)}{-\gamma}} \varepsilon K^{1-\varepsilon} \Lambda_j^{1-\varepsilon} (\tau_j w_r)^{1-\varepsilon} M_{rj}^{\mu_1(\varepsilon-1)} \xi_r^{\varepsilon-1} \varphi^{\varepsilon-1} M_r^{\delta(\varepsilon-1)}$$

We replace f_{rj} and A_r in equation 11 we get the equilibrium productivity threshold for exporting from r to country j :

$$A_r \varphi_{rj}^* = K (f_j w_r)^{\frac{1}{\varepsilon-1}} E_j^{\frac{-1}{\gamma}} \tau_j w_r \Lambda_j M_{rj}^{\frac{-\mu_0}{\varepsilon-1} - \mu_1} \quad (19)$$

Thus, the level of the productivity threshold to export to a country j from a country i varies from one region to another within the same country. Indeed as expressed in equation 19 it depends on some region specific characteristics. When the number of exporting firms located in region r increases, $A_r \varphi_{rj}^*$ decreases. By lowering the access costs to foreign markets, *a larger number of exporting firms induces a decline in the productivity cutoff for exporting and a rise in export sales.*

3 Empirical analysis

3.1 Estimation Strategy

Like in [Koenig, 2009] and [Koenig *et al.*, 2010], we model the individual export volume by adapting the traditional gravity equation at the firm level:

$$\text{EXP}_{irj} = \beta_0 + \beta_1 \text{TFP}_i + \beta_6 \text{SIZE}_i + \beta_2 \text{DIST}_j + \beta_3 \text{DEMAND}_j + \beta_7 \text{P-SPILL}_r + \beta_8 \text{E-SPILL}_{rj} + C + e_{irj}$$

with EXP_{irj} is the export sales of firm i located in area r and serving country j , TFP_i is the total factor productivity of firm i , SIZE_i is the number of workers employed by firm i (a high number of employees may show some internal economies of scale and lower costs of production); DIST_j is the distance between country j and France (this variable is used as a proxy of international trade costs)¹, DEMAND_j is the total demand of country j for the good; P-SPILL_r are the productive spillovers (or technological externalities) proxying by the total number of firms in area r ; and E-SPILL_{rj} are the local export spillovers. All these variables are expressed in log. We also consider a set of control variables (C) that we detail below and the error term e_{irj} is independently and normally distributed.

Estimating the impact of spatial externalities is a difficult task. Indeed, most exporters have positive exports to only a small number of destinations. Ideally, we would estimate a two-stage estimation procedure that uses an equation for selection into export markets in the first stage and an exports equation in the second stage, as in Helpman, Melitz and Rubinstein (2008) or Chevassus-Lozza, Gaigné and Le Mener (2013). However, as recognized by Crozet, Head and Mayer (2011), it is difficult to have a variable explaining the *decision to serve a country at the firm level* that is excludable from export sales equation. To control for the bias related the frequency of zeros in our data, we use a Tobit procedure with

$$\text{EXP}_{irj} = \begin{cases} \text{EXP}_{irj}^* & \text{if } \text{EXP}_{irj}^* > 0 \\ 0 & \text{if } \text{EXP}_{irj}^* \leq 0 \end{cases}$$

where EXP_{irj}^* is the latent response variable. By using a Tobit procedure, we can evaluate the conditional exports elasticities and the elasticities of the probability of exporting.

3.2 Data

We use data on food processing firms located in France. In 2009, France was the top agricultural producer in Europe (with a total of €61 billion) and the second largest European producer of agrifood goods, with a total of €125 billion. France is also the world's fourth largest exporter

¹This variable comes from the GeoDis dataset created by the CEPII. It is a geodesic distance.

of agrifood and agricultural products, with a total of €47.2 billion, which represents more than 6% of the world export market share.²

Our main data sources are the French Customs Register and the annual survey of firms (EAE) provided by the French National Institute of Statistics. Our database gathers information on more than 2700 firms (1800 exporters) of the Agrifood sector for year 2006 representing in value almost 60% in value of total French export of Agrifood goods. The French Customs Register provides information on export sales at the firm for each destination. The EAE is a compulsory survey of all firms located in France with more than 20 employees or with total sales of over €5 million. The EAE database gives a wide range of variables, including total sales, total export sales, value added, the number of employees, capital, investment, expenditures for intermediates and some accounting data as well as the main activity of the firm at the 4-digit industry level (NACE code) and its location (at the municipality level). We use this database to evaluate firms' productivity. We calculate the total factor productivity (TFP) for each firm using Olley and Pakes' methodology (1996).

For each firm, we determine its surrounding. We use a fine spatial disaggregation for our analysis. The spatial unit is the French "canton" (an administrative delineation similar to a US county; there are 3,572 *cantons* in France). We know from the EAE database in which *canton* a firm is located. We furthermore know the time of road transport to join two given *cantons*. The surrounding of a firm is then defined as all the *cantons* that can be reached on road in less than one hour from the *canton* where the firm is located. Thus the region defined as r in our previous sections is a *canton* and all the *cantons* reachable in one hour on road.

Knowing the main activity of the firm (i.e., its NACE 4-digit industry) and its location from the EAE survey, we can identify all exporting firms belonging to the same place and/or to the same 4-digit industry as well as all firms serving the same destination. We can construct two export spillover variables. First, we consider the total number of exporting firms located in the same *canton* and in the neighboring *cantons* that belongs to the same agrifood subsector. Note that this variable can also capture a negative effects related to a competition between exporters belonging to the same 4-digit industry. The second variable only takes into account the firms that export to the same destination country. It should be noted that this variable captures a pecuniary externality. Indeed, the trade costs to serve a country may be negatively impacted by the volume of bilateral trade, and in turn, the number of exporters serving this country, because of scale/density economies in transportation (the fixed costs in transport being really high ([Cristea *et al.* , 2010], [Gouel *et al.* , 2008])). These two specifications of export spillovers are tested separately.

²The food and agriculture industry generates around 13% of the value added of French industry as a whole and accounts for 1.7% of the French gross domestic product and 7.1% of French exports.

We also consider different control variables. Because the food industry processes intensively agricultural products and their transportation is costly, we have to account for the location of agricultural production which is not evenly spread on the French territory (grape is for example produced in some well defined area). If we do not control for this bias, the high exporting rate of firms in a region could be explained by a specialized agricultural production (the case of wine is particularly convincing). We have information on agricultural production for each *Département* (French administrative area; there are 96 of them in metropolitan France). We know the agricultural products processed by each 4-digit food industry (see Bagoulla et al., 2010 for more details). As a result, we can construct an index measuring the access to agricultural inputs which is specific to each 4-digit food industry and each *Département*. More precisely, we compute the share of agricultural production processed by each 4-digit food industry that is produced in each French département.

Last, we introduce two fixed effects. We consider a dummy for the 4-digit industry in which a firm is producing and a dummy for the *Région* where a firm is located. A *Région* is a French administrative area, there are 22 *Régions* in metropolitan France. *Régions* are composed of départements which are composed of cantons. We also test whether the location of the *Région* within France matters in the export performance. As shown in the trade literature, no landlocked regions and the proximity with the border of a foreign country make the trade with this country easier. We consider a dummy for the *Régions* which are not landlocked. In addition, a dummy variable *border* is integrated in our estimation, it equals to 1 if the firm is located in a French *Région* close to a foreign country. When we use these variables, we consider a dummy variable for a group of *Régions* (North, West, East, South).

3.3 Descriptive statistics

Informations on firms are summarized in Table 1. Our data reveals that, even in the same industry, firms are heterogeneous in terms of productivity. As expected, exporters are larger in size (number of employees) and exhibit higher productivity, confirming the results reported in [Bernard & Jensen, 1995] and [Bernard & Jensen, 1997]. They serve on average 10 countries and more than half of firms serve at least 6 countries. A large majority of firms are multi-products. More than 75% of firms export at least two varieties (at the 6- and 8-digit level). Even if they export mainly products belonging their 4-digit industry, a majority of firms export other types of products (at the 4-digit level, the median value is equal to 2) to more than eleven foreign countries. In its local surrounding, each firm has on average 50 exporting firms, this number reduces to 10 (resp., 5) when counting only the firms serving the same country (belonging to the same 4-digit industry).

Table 1 about here

Table 2 shows the great disparities existing between French *Régions* in terms of number of firms, firm's productivity, and firm's size. Regardless of the *Région*, exporters are larger and more productive than the other firms. The number of destination and the average exports by destination vary with respect to the *Région*. Considering the ratio of exporters in the total number of firms, this rate is of 68% at the national level. For some regions, close to a border, like Alsace, this percentage is almost equal to 100% when for other landlocked regions, it equals only 50%.

Table 2 about here

There also are large disparities within each *Région*. As shown in Table 3, the export sales by firm and by destination differ among firm located in the same *Région*. Similarly, the number of countries served by firm is unequally distributed between firms. In other words, firms are significantly heterogeneous within each *Région*.

Table 3 about here

3.4 Results

Table 4 reports the results associated with three estimations involving different proxies for export spillovers: (i) number of firms (column II); (iii) the number of exporters belonging to the same 4-digit industry (column III); and (ii) the number of firms serving the same countries (column II). In column I, we report the results of the estimation which does not include the spatial externalities.

Table 4 about here

We start by commenting on the effects of the control variables. As expected, the export sales increase with firm's productivity and firm's size (as in [Chevassus-Lozza *et al.*, 2012]). In accordance with gravity models, distance to foreign markets has a negative effect whereas the trade partner's GDP raises export sales. Additionally, it appears that local characteristics matter in export performance. A better access to their suppliers of agricultural products increases the export performance of firms. A location close to the sea and to a foreign country also boosts the export sales.

Table 5 about here

We now focus our analysis on the effects of spatial externalities. The elasticities of export performance to a change in spatial externalities are reported in Table 5. First, the number of firms set up in the same area plays a negative role on export performance at the firm level.

Remember that the rise in the number of local firms reduces the probability of exporting (the productivity cutoff increases) and favors the largest firms but increases the export sales of surviving firms.

Tables 6 and 7 about here

Concerning the impact of local export spillovers, they have a positive and significant impact on the export performance of firms. This effect is very strong when considering the firms exporting to the same destination country. An additional firm exporting to a given destination j increases the probability for a firm to serve this market and the value of its exports. However, it is difficult to determine if informational spillovers are work and density economies in transportation prevails. In addition, the number of firms serving a country is related to the distance to this country. It appears that the magnitude of the coefficient associated with distance declines when we introduce the number of exporters serving the same country. When we introduce the interaction term between the number of exporters and distance to the country (see Tables 6 and 7), the magnitude of the effect of export spillovers remains relatively high. More generally, we control for all effects specific to the destination and to the Région, our finding holds (see Table 8). This results are very important from a policy point of view, the experience sharing between neighboring firms may be a efficient lever to improve the export performance of the agrifood sector. Clusters or exporters clubs in which exporters may exchange information on their export strategie may help non exporting firms to access these foreign markets. Our result contrast with [Koenig, 2009] and [Koenig *et al.* , 2010] suggesting the presence of nearby exporters have a positive influence on the firm decision to start to export but has no significant impact on the exported volume.

Table 8 about here

The results reported in Table 6 show that the effect of spillovers varies according to the size of firms because the coefficient associated with the interaction terms between the number of exporters and the size of firms. We now explicitly consider the export performance of small enterprises (with a size inferior to 50 employees or to 100 employees). As shown in Table 9, the magnitude of export spillovers are lower for the small firms. In addition, the latter firms do not seem to benefit from the presence of large exporters set up in the same area. Hence, the large firms appear more able to absorb export spillovers.

Table 9 about here

3.5 Controlling for the selection

We have to account for the selection of firms into export markets. To do so, we need a selection variable. Remember that, according to our model, a firm exports if and only if $s_{rj}(\varphi) > \varepsilon w_r f_{rj}$ (see Section 2). Ideally, we would use the fixed export cost as the selection variable because it influences the decision to export but does not affect the level of exports. In our case, we do not find a selection variable. We determine a productivity cutoff for exporting (regardless of destination) that is specific for every French *Région*. We adopt the strategy developed in [Chevassus-Lozza & Latouche, 2011] where a productivity threshold to serve a country is determined for French agrifood firms. We apply the same estimation procedure that [Chevassus-Lozza & Latouche, 2011], but not for the destination market but for the origin market (French *Régions*).

A firm exports if and only if its export sales are enough $s_{rj}(\varphi) > \varepsilon w_r f_{rj}$ or, equivalently, its efficiency is high enough $\varphi \geq \varphi_{rj}^*$. According to our model, the probability that a firm has an efficiency above a given value is

$$\Pr(\varphi \geq \varphi_{rj}) = \left(\frac{\varphi_{rj}}{\varphi_r} \right)^{-\gamma_r} \quad (20)$$

where we consider that each *Région* has a specific distribution factor γ_r . We create a variable x_v which equals 1 if a firm v serves at least one country and 0 if it does not export:

$$\begin{cases} x_v = 1 & \text{if } \varphi > \underline{\varphi}_{rj} \\ x_v = 0 & \text{if } \varphi_f \leq \underline{\varphi}_{rj} \end{cases}.$$

As a result, $\Pr(x=1) = \Pr(\varphi \geq \min \varphi_{rj})$. Using 20 we get

$$\Pr(x_v = 1) = \left(\frac{\min \varphi_{rj}}{\varphi_r} \right)^{-\gamma_r}$$

so that the likelihood function of this probability is:

$$\ell = \prod_v \prod_r \left[\left(\frac{\min \varphi_{rj}}{\varphi_r} \right)^{-\hat{\gamma}_r} \right]^{x_v} \times \left[1 - \left(\frac{\min \varphi_{rj}}{\varphi_r} \right)^{-\hat{\gamma}_r} \right]^{1-x_v} \quad (21)$$

Our estimation of $\min \varphi_{rj}$ is performed by maximizing this likelihood function using 11. Notice that the productivity cutoff for exporting depends on the characteristics of partner country j and on the characteristics of the *Région* where firms are located. We consider *Région* fixed effects as well as 4-digit fixed effects.

The value of γ_r and φ_r (the minimum productivity in *Région* r) are calculated for each *Région* and are presented in Table 3. In Table 10, we report the coefficients associated with the maximum likelihood estimation. The result of the estimation of the productivity cutoff are presented in Table 3. We can see that almost all *Région* fixed effects are significant. That

shows that the location of a firm has an influence on export performance of firms. The *Régions* Ile-de-France (Région to which Paris belongs to) is chosen as the reference, all the coefficients for the other Régions are expressed as a comparison to Ile-de-France. We notice that except for two Régions all the coefficients are negative, showing that being in another Région than Ile de France make the access to foreign markets easier.

Table 10. Results - Maximum likelihood estimation

In Figure 2, we graph the link between φ_r (on the horizontal axis) and $\min \varphi_{rj}$ (on the vertical axis) that we estimated. We can see that these two variables are highly correlated. For example, the *Région* Ile-de-France has a high productivity cutoff to export has also a high minimum productivity. As a result, this region is not characterized by a high access cost to the foreign markets but by the agglomeration of highly productive firms in this *Région*. As shown in Section 2, with productive spillovers, the region with a locational advantage attracts the more productive firms.

Figure 2.

4 Summary

In this paper, we have shown that the local environment can play a significant role on the international competitiveness of firms. We have developed a framework which allows us to precise the relationships between the regional characteristics and export performance by taking account spatial externalities and the location process of firms with respect to their productivity. By using French data on food firms, we have evaluated the nature and the magnitude of regional advantages explaining the export performance of firms. Our results showed that (i) more local firms reduce the probability of exporting (as predicted by our model); (ii) the export sales of a firm increases with the number of exporters serving the same destination; (iii) the regional productivity cutoff for exporting is positively correlated with the minimum regional productivity.

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5 Appendix A. Details of calculations

1. Expected profit. The average profit of a firm exporting to j is:

$$\bar{\pi}_{rj} = \int_{\varphi_{rj}}^{\infty} \pi_{rj}(\varphi) \mu_{rj}(\varphi) d\varphi \quad (22)$$

By using () and (), we obtain

$$\begin{aligned} \bar{\pi}_{rj} &= \int_{\varphi_{rj}}^{\infty} (\varphi_{rj}^{1-\varepsilon} f_{rj} w_r \varphi^{\varepsilon-1} - f_{rj} w_r) \mu_{rj}(\varphi) d\varphi. \\ &= f_{rj} w_r \left[\varphi_{rj}^{1-\varepsilon} \int_{\varphi_{rj}}^{\infty} \varphi^{\varepsilon-1} \frac{g(\varphi)}{1-G(\varphi_{rj})} d\varphi - \int_{\varphi_{rj}}^{\infty} \frac{g(\varphi)}{1-G(\varphi_{rj})} d\varphi \right] \end{aligned}$$

Because we assume a Pareto distribution, i.e $[1 - G(\varphi)] = \varphi^{-\gamma}$ and $g(\varphi) = \gamma\varphi^{-\gamma-1}$, we can write

$$\bar{\pi}_{rj} = f_{rj} w_r \left[\frac{\varphi_{rj}^{1-\varepsilon+\gamma}}{\varphi_{rj}} \int_{\varphi_{rj}}^{\infty} \gamma \varphi^{-\gamma+\varepsilon-2} d\varphi - 1 \right] = f_{rj} w_r \left[\frac{\gamma \varphi_{rj}^{1-\varepsilon+\gamma}}{\gamma - \varepsilon + 1} \varphi_{rj}^{-1+\varepsilon-\gamma} - 1 \right]$$

After simplification, we get

$$\bar{\pi}_{rj} = \frac{\varepsilon - 1}{\gamma - \varepsilon + 1} f_{rj} w_r. \quad (23)$$

Therefore, the expected profit of a firm located in r can be expressed as follows:

$$\bar{\pi}_r = \sum_j \bar{\pi}_{rj} \frac{1 - G(\varphi_{rj})}{1 - G(\varphi_r)} = \sum_j \bar{\pi}_{rj} \varphi_{rj}^{-\gamma} \varphi_r^\gamma = \frac{\varepsilon - 1}{\gamma - \varepsilon + 1} w_r \varphi_r^\gamma \sum_j f_{rj} \varphi_{rj}^{-\gamma} \quad (24)$$

Therefore, (9) and (23) imply

$$\frac{\varepsilon - 1}{\gamma - \varepsilon + 1} \sum_j f_{rj} \varphi_{rj}^{-\gamma} = f_e.$$

2. Regional labour market clearing and the mass of firms. The expected number of employees per firm is equal to

$$\bar{l}_r = \sum_j \frac{1 - G(\varphi_{rj})}{1 - G(\varphi_r)} \bar{l}_{rj}$$

with

$$\bar{l}_{rj} = \int_{\varphi_{rj}}^{\infty} l_{rj}(\varphi) \mu_{rj}(\varphi) d\varphi.$$

The mass of units of labour used by a firm to serve country j is given by

$$\begin{aligned} l_{rj}(\varphi) &= \frac{\tau_r \tau_{ij}}{A_r \varphi} q_{rj}(\varphi) + f_{rj} \\ &= \frac{\tau_r \tau_{ij}}{A_r \varphi} E_j P_j^{\varepsilon-1} \left[\frac{\varepsilon}{\varepsilon - 1} \frac{w_r \tau_r \tau_{ij}}{\varphi_{rj} A_r} \right]^{-\varepsilon} + f_{rj} \\ &= E_j P_j^{\varepsilon-1} (\tau_r \tau_{ij})^{1-\varepsilon} \varphi^{\varepsilon-1} A_r^{\varepsilon-1} \left(w_r \frac{\varepsilon}{\varepsilon - 1} \right)^{-\varepsilon} + f_{rj}. \end{aligned} \quad (25)$$

Hence,

$$\begin{aligned}
\bar{l}_{rj} &= \int_{\varphi_{rj}}^{\infty} \left[E_j P_j^{\varepsilon-1} (\tau_r \tau_{ij})^{1-\varepsilon} \varphi^{\varepsilon-1} A_r^{\varepsilon-1} \left(w_r \frac{\varepsilon}{\varepsilon-1} \right)^{-\varepsilon} + f_{rj} \right] \mu_{rj}(\varphi) d\varphi \\
&= E_j P_j^{\varepsilon-1} \left(\frac{\tau_r \tau_{ij}}{A_r} \right)^{1-\varepsilon} \left(w_r \frac{\varepsilon}{\varepsilon-1} \right)^{-\varepsilon} \int_{\varphi_{rj}}^{\infty} \varphi^{\varepsilon-1} \mu_{rj}(\varphi) d\varphi + f_{rj} \int_{\varphi_{rj}}^{\infty} \mu_{irj}(\varphi) d\varphi \\
&= E_j P_j^{\varepsilon-1} \left(\frac{\tau_r \tau_{ij}}{A_r} \right)^{1-\varepsilon} \left(w_r \frac{\varepsilon}{\varepsilon-1} \right)^{-\varepsilon} \frac{\gamma}{\gamma - \varepsilon + 1} \varphi_{rj}^{\varepsilon-1} + f_{rj}
\end{aligned}$$

Because

$$\varphi_{rj}^{\varepsilon-1} = \frac{\varepsilon \left(\frac{\varepsilon}{\varepsilon-1} \right)^{\varepsilon-1} f_{rj} w_r}{E_j P_j^{\varepsilon-1} (\tau_r \tau_{ij} w_r)^{1-\varepsilon} A_r^{\varepsilon-1}}$$

we obtain

$$\bar{l}_{rj} = \frac{\gamma(\varepsilon-1) f_{rj}}{\gamma - \varepsilon + 1} + f_{rj} = f_{rj} \left[\frac{\varepsilon(\gamma-1) + 1}{\gamma - \varepsilon + 1} \right] \quad (26)$$

Therefore, the total demand of labour in r is:

$$L_r = \sum_j M_{rj} \bar{l}_{rj} + M_e f_e$$

where the number of firms producing in region r and serving country j in r given by

$$M_{rj} = \frac{1 - G(\varphi_{rj})}{1 - G(\varphi_r)} M_r = \varphi_{rj}^{-\gamma} \varphi_r^{\gamma} M_r \quad (27)$$

and

$$M_e = \varphi_r^{\gamma} M_r.$$

Hence,

$$L_r = \varphi_r^{\gamma} M_r f_{rj} \left[\frac{\varepsilon(\gamma-1) + 1}{\gamma - \varepsilon + 1} \right] \sum_j \varphi_{rj}^{-\gamma} f_{rj} + \varphi_r^{\gamma} M_r f_e$$

Using the free entry condition

$$\frac{\varepsilon-1}{\gamma - \varepsilon + 1} \sum_j f_{rj} \varphi_{rj}^{-\gamma} = f_e,$$

we get

$$L_r = \varphi_r^{\gamma} M_r f_{rj} \frac{\varepsilon(\gamma-1) + 1}{\varepsilon-1} f_e + \varphi_r^{\gamma} M_r f_e = \varphi_r^{\gamma} M_r f_e \frac{\varepsilon\gamma}{\varepsilon-1}$$

so that

$$M_r = \frac{L_r (\varepsilon-1)}{\varepsilon\gamma \varphi_r^{\gamma} f_e}. \quad (28)$$

3. Price index and productivity cutoffs

$$P_j^{1-\varepsilon} = \sum_k M_{kj} \int_{\varphi_{kj}}^{\infty} p_{kj}(\varphi)^{1-\varepsilon} \mu_{kj}(\varphi) d\varphi \quad (29)$$

where

$$M_{kj} = \varphi_{kj}^{-\gamma} \varphi_k^{\gamma} M_k \quad \text{and} \quad M_k = \frac{L_k (\varepsilon - 1)}{\varepsilon \gamma \varphi_k^{\gamma} f_e}.$$

Using those expressions and equilibrium prices () imply

$$\begin{aligned} P_j^{1-\varepsilon} &= \sum_k \frac{L_k (\varepsilon - 1)}{\varepsilon \gamma \varphi_{kj}^{\gamma} f_e} \left(\frac{\varepsilon}{\varepsilon - 1} \frac{w_k \tau_{kj}}{A_k} \right)^{1-\varepsilon} \int_{\varphi_{kj}}^{\infty} \varphi^{\varepsilon-1} \mu_{kj}(\varphi) d\varphi \\ &= \sum_k \frac{L_k (\varepsilon - 1)}{\varepsilon f_e} \left(\frac{\varepsilon}{\varepsilon - 1} \frac{w_k \tau_{kj}}{A_k} \right)^{1-\varepsilon} \int_{\varphi_{kj}}^{\infty} \varphi^{-\gamma+\varepsilon-2} d\varphi \\ &= \sum_k \frac{L_k (\varepsilon - 1)}{\varepsilon f_e} \left(\frac{\varepsilon}{\varepsilon - 1} \frac{w_k \tau_{kj}}{A_k} \right)^{1-\varepsilon} \frac{1}{\gamma - \varepsilon + 1} \varphi_{kj}^{-\gamma+\varepsilon-1} \end{aligned} \quad (30)$$

Because

$$\varphi_{kj}^{\varepsilon-1} = \frac{\varepsilon \left(\frac{\varepsilon}{\varepsilon-1} \tau_{kj} w_k \right)^{\varepsilon-1} f_{kj} w_k}{E_j P_j^{\varepsilon-1} A_k^{\varepsilon-1}}$$

we obtain

$$\varphi_{kj}^{-\gamma+\varepsilon-1} = \left(\frac{\varepsilon f_{kj} w_k}{E_j} \right)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} \left(\frac{\varepsilon}{\varepsilon-1} \frac{\tau_{kj} w_k}{A_k} \right)^{-\gamma+\varepsilon-1} P_j^{\gamma-(\varepsilon-1)}$$

so that ,

$$P_j^{-\gamma} = E_j^{\frac{\gamma-(\varepsilon-1)}{\varepsilon-1}} \varepsilon^{\frac{-\gamma}{\varepsilon-1}} \frac{\varepsilon - 1}{f_e [\gamma - (\varepsilon - 1)]} \left(\frac{\varepsilon}{\varepsilon - 1} \right)^{-\gamma} \sum_k A_k^{\gamma} L_k (w_k \tau_{kj})^{-\gamma} (f_{kj} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} \quad (31)$$

Using (6), we get

$$\begin{aligned} \varphi_{kj} &= \left(\frac{\varepsilon f_{kj} w_k}{E_j} \right)^{\frac{1}{\varepsilon-1}} \left(\frac{\varepsilon}{\varepsilon-1} \frac{\tau_{kj} w_k}{A_k} \right) P_j^{-1} \\ &= K (f_{rj} w_r)^{\frac{1}{\varepsilon-1}} E_j^{\frac{-1}{\gamma}} \tau_{rj} w_r A_r^{-1} \Lambda_j \end{aligned}$$

with

$$K \equiv \left[\frac{\varepsilon - 1}{f_e [\gamma - (\varepsilon - 1)]} \right]^{\frac{1}{\gamma}} \quad \text{and} \quad \Lambda_j \equiv \left[A_k^{\gamma} L_k (w_k \tau_{kj})^{-\gamma} (f_{kj} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} \right]^{\frac{1}{\gamma}}$$

so that

$$P_j^{\varepsilon-1} = E_j^{\frac{\gamma-(\varepsilon-1)}{-\gamma}} \left[\frac{\varepsilon}{\varepsilon-1} \right]^{\frac{\varepsilon-1}{\gamma}} \varepsilon K^{1-\varepsilon} \Lambda_j^{1-\varepsilon} \quad (32)$$

4. Equilibrium mass of firms with spatial externalities. The mass of of firms is given by

$$M_r^* = E_i^{\frac{1}{1-\gamma\delta}} \left(\frac{\varepsilon\gamma}{\gamma - \varepsilon + 1} \right)^{\frac{1}{1-\gamma\delta}} L_r^{\frac{1}{1-\gamma\delta}} w_r^{\frac{-\gamma}{1-\gamma\delta}} \xi_r^{\frac{\gamma}{1-\gamma\delta}} (f_i w_r)^{\frac{-\gamma}{(\varepsilon-1)(1-\gamma\delta)}} \Lambda_i^{\frac{-\gamma}{1-\gamma\delta}}$$

where

$$\Lambda_i \equiv \left[\sum_k L_k (w_k \tau_{ki})^{-\gamma} \xi_k^\gamma (f_{ki} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} M_k^{\delta\gamma} \right]^{1/\gamma}$$

so that the mass of firms in a region depends on the spatial distribution of firms.

Using the fixed point theorem,we obtain

$$M_r^* = \frac{\varepsilon\gamma}{\gamma - \varepsilon + 1} \frac{E_i}{\lambda_i} L_r w_r^{-\gamma} \xi_r^\gamma (f_i w_r)^{\frac{-\gamma}{\varepsilon-1}} \quad (33)$$

with

$$\lambda_i \equiv \left(\prod_{k' \neq k} \Upsilon_{k'} \right)^{\gamma\delta(1-\gamma\delta)} \sum_k \left[L_k (w_k \tau_{ki})^{-\gamma} \xi_k^\gamma (f_{ki} w_k)^{\frac{-\gamma+\varepsilon-1}{\varepsilon-1}} \left(\prod_{r' \neq k} \Upsilon_{r'} \right)^{-\gamma\delta} \right]$$

and

$$\Upsilon_{k'} \equiv L_{k'}^{\frac{1}{1-\gamma\delta}} w_{k'}^{\frac{-\gamma}{1-\gamma\delta}} \xi_{k'}^{\frac{\gamma}{1-\gamma\delta}} (f_i w_{k'})^{\frac{-\gamma}{(\varepsilon-1)(1-\gamma\delta)}}$$

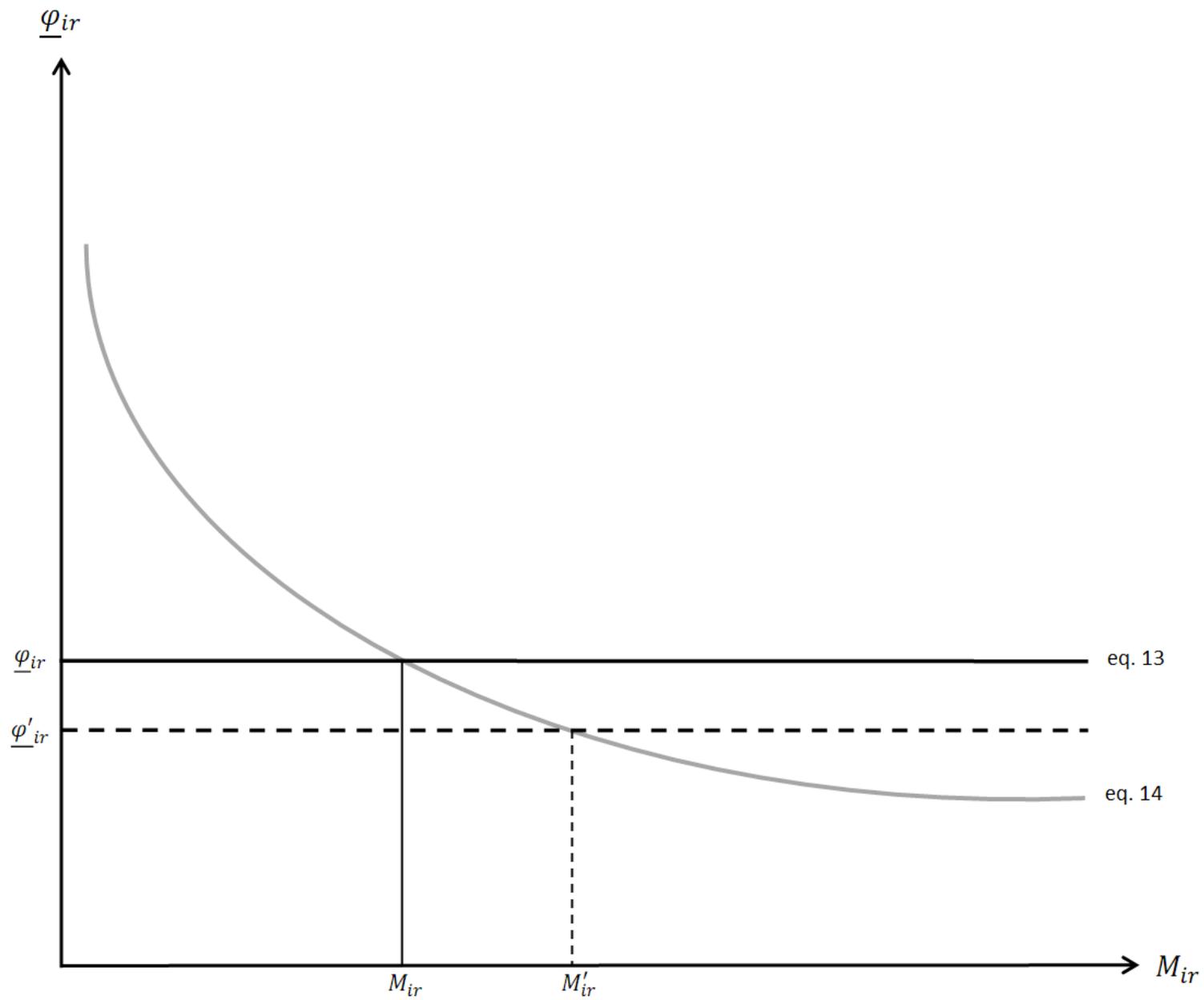


Figure 1a. : Evolution of the evolution threshold without externalities

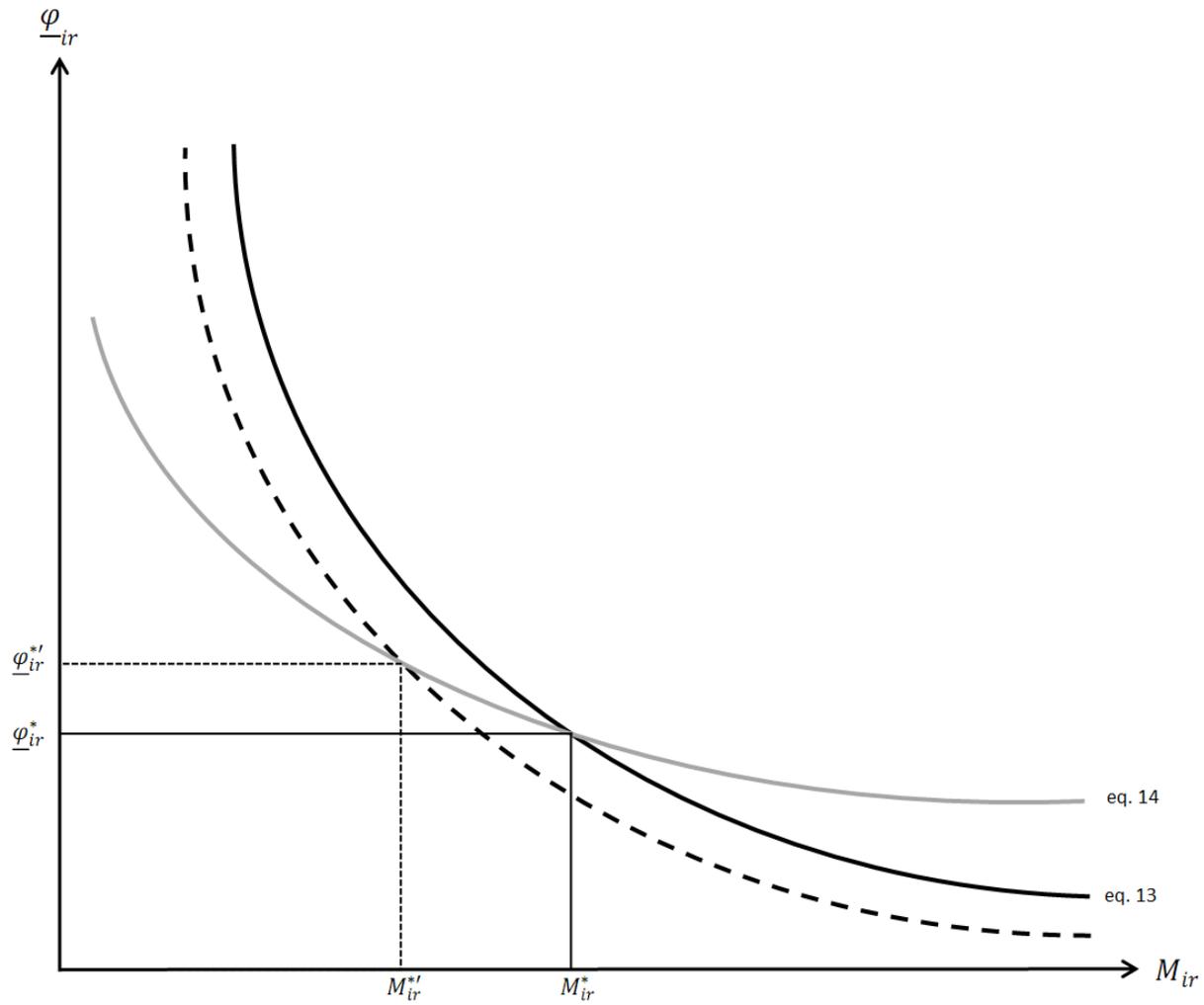


Figure 1b. : Evolution of the evolution threshold with productive/technological externalities

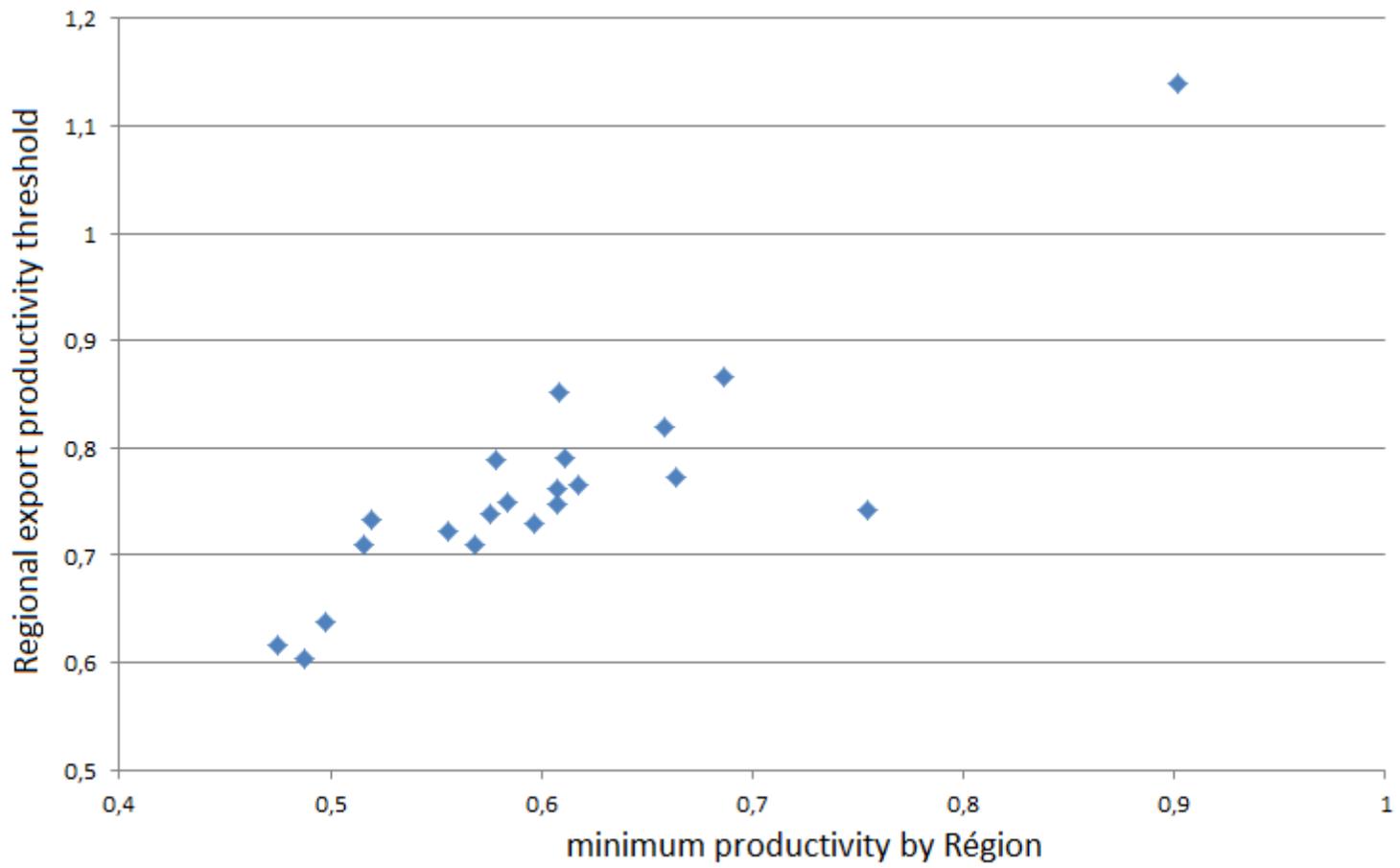


Figure 2. : link between minimum productivity and minimum regional export productivity

Table 1. Summary statistics

Variables	Average	St Dev	Q1	Q2	Q3	Min	Max
All firms							
<i>Size</i>	128.5	287.1	28	46	106	2	3878
<i>TFP</i>	1240	890	790	1030	1390	10	11050
Exporters							
<i>Size</i>	170.8	353	32	59	153.5	4	3878
<i>TFP</i>	1400	1020	880	1140	1560	10	11050
<i>Export Sales^a</i>	10676	41012	191.8	999.4	4762.7	1.07	623276
<i>Export Sales by destination</i>	1180.27	2047.57	204.94	485.92	1334.37	1.07	19815.83
<i>Nb of destination</i>	10.8	14.4	2	6	13	1	117
<i>#exported products(8-digit)</i>	10.40	14.20	2	6	12	1	176
<i>#exported products(6-digit)</i>	6.67	8.87	2	4	8	1	100
<i>#exported products(4-digit)</i>	4.07	4.91	1	2	5	1	61

a: In thousands of euros

Table 2. Summary statistics by Region

Regions	All firms			All exporters			Number of destination	Average Exports by destination	Number of products exported		
	#firms	Av. TFP	Av. Size	#firms	Av. TFP	Av. Size			8-digit	6-digit	4-digit
Ile-De-France	211	1.715448	279.028	153	1.975301	347.967	189	20574	749	346	144
Champagne-Ardenne	124	2.228426	95.5	90	2.391643	96.3556	162	14459	177	107	63
Picardie	55	1.316262	136.982	39	1.251328	107.513	94	2891	192	128	70
Haute-Normandie	56	1.307508	163.714	33	1.527945	220.576	145	2541	270	163	76
Centre	100	1.173778	109.84	70	1.211769	133.086	114	5950	338	193	87
Basse-Normandie	79	1.217219	148.342	52	1.298615	193.962	129	2781	373	172	70
Bourgogne	91	1.134669	108.725	63	1.190649	127.349	111	3873	334	166	80
Nord-Pas-De-Calais	155	1.226904	144.077	111	1.297519	175.342	164	12429	668	372	152
Lorraine	56	1.18693	89.1071	39	1.350676	111.231	68	4172	332	195	81
Alsace	117	1.263218	104.769	107	1.297315	109.664	125	5835	560	306	125
Franche-Comte	55	1.252544	74.0727	34	1.37696	83.8235	79	3062	147	68	37
Pays-De-La-Loire	235	1.119856	169.549	142	1.143667	189.725	114	7480	497	224	92
Bretagne	299	1.152042	179.746	193	1.240352	232.378	119	11643	757	333	123
Poitou-Charentes	112	1.185521	78.4643	68	1.316073	78.7941	165	10080	293	151	75
Aquitaine	171	1.065184	81.7836	109	1.160323	101.807	159	2619	586	278	106
Midi-Pyrenees	159	1.013934	82.4843	93	1.086694	109.226	115	3295	479	234	106
Limousin	38	1.07574	71.7105	19	1.111141	100.316	66	698	121	71	36
Rhone-Alpes	271	1.08194	105.185	181	1.186647	132.127	148	9374	629	307	129
Auvergne	92	1.080981	68.4239	54	1.09669	67.1481	82	996	280	184	88
Languedoc-Roussillon	94	1.052582	63.5532	62	1.160108	76.371	113	3469	375	226	101
Provence-Alpes-C.-D'A.	132	1.301451	79.0076	88	1.473916	93.2614	125	3399	505	272	106
Total	128.67	1.25	115.91	85.71	1.34	137.52	123.14	6267.62	412.48	214.10	92.71

Table 3. Summary statistics on firms by Region

Regions	Exports sales by firm and by destination				Nb of destination by firm				Minimum productivity	Cut-off productivity
	Mean	Q1	Q2	Q3	Mean	Q1	Q2	Q3		
Ile-De-France	1519.43	244.74	669.47	1736.69	14.80	2	7	17	0.69	0.87
Champagne-Ardenne	1123.83	111.91	315.40	1107.30	20.25	3	11	28	0.90	1.14
Picardie	864.62	73.65	302.93	1428.18	9.00	1	3	12	0.58	0.74
Haute-Normandie	725.11	84.94	257.15	1259.34	14.10	2	8	18	0.58	0.79
Centre	1077.86	156.16	333.41	1135.01	9.31	3	5	8	0.62	0.76
Basse-Normandie	532.11	98.03	258.05	730.39	11.50	2	8	16	0.66	0.77
Bourgogne	614.78	64.44	247.82	1201.61	9.73	2	5	15	0.57	0.71
Nord-Pas-De-Calais	1497.23	211.95	630.12	1407.64	13.28	1.5	4	21	0.60	0.73
Lorraine	1475.36	103.57	589.94	2114.43	5.37	2	3	6	0.49	0.60
Alsace	608.49	141.40	380.09	736.85	10.05	3	6	13	0.75	0.74
Franche-Comte	962.16	122.77	281.51	1340.39	7.20	2	3	10	0.58	0.75
Pays-De-La-Loire	788.40	91.51	335.72	635.15	7.38	2	4	10	0.52	0.73
Bretagne	824.37	203.71	450.57	1334.37	7.83	2	5	10	0.66	0.82
Poitou-Charentes	1302.73	109.30	422.42	1220.46	16.05	2	8	20	0.52	0.71
Aquitaine	377.50	81.17	188.91	468.36	9.25	2	4	10	0.61	0.76
Midi-Pyrenees	462.76	59.35	125.53	691.92	9.00	2	4	14	0.56	0.72
Limousin	252.50	17.51	51.17	277.03	10.07	2	7	18	0.61	0.85
Rhone-Alpes	887.05	143.00	452.31	1379.78	9.03	2	4	10	0.50	0.64
Auvergne	232.66	41.30	147.73	345.92	7.92	2	3	10	0.61	0.79
Languedoc-Roussillon	611.02	215.21	362.43	888.02	9.02	2	6	13	0.47	0.62
Provence-Alpes-C.-D'A.	421.48	91.56	272.71	432.84	10.48	2	8	14	0.61	0.75
Total	817.21	117.48	336.92	1041.51	10.51	2.07	5.52	13.95	0.76	0.60

Table 4. Results (dependent variable : export sales by destination)

Variables	I	II	III	IV
<i>TFP</i>	2.059*** (0.0680)	2.062*** (0.0680)	1.986*** (0.0693)	2.107*** (0.0671)
<i>Size</i>	2.125*** (0.0324)	2.127*** (0.0324)	2.134*** (0.0324)	2.138*** (0.0320)
<i>Distance_j</i>	-2.303*** (0.0321)	-2.303*** (0.0321)	-2.302*** (0.0321)	-0.424*** (0.0389)
<i>GDP_j</i>	1.653*** (0.0172)	1.653*** (0.0172)	1.652*** (0.0172)	0.222*** (0.0238)
<i>Border</i>	0.208*** (0.0770)	0.226*** (0.0776)	0.209*** (0.0777)	0.234*** (0.0764)
<i>Maritime</i>	0.187* (0.0986)	0.176* (0.0987)	0.167* (0.0988)	0.192** (0.0973)
<i>Agri. prod.</i>	15.93*** (1.492)	16.52*** (1.519)	15.44*** (1.534)	16.66*** (1.499)
<i># of local Firms</i>		-0.127** (0.0609)	-0.291*** (0.0676)	-0.142** (0.0600)
<i># of exporters/ 3-Digit</i>			0.252*** (0.0449)	
<i># of exporters_j</i>				3.521*** (0.0593)
<i>Regional dummy</i>	Yes	Yes	Yes	Yes
<i>4digit Dummy</i>	Yes	Yes	Yes	Yes

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Table 5. Elasticities of spatial externalities

Variables	II	III	IV
<i># of local Firms</i>			
<i>Proba</i>	-.0002995	-.0006886	-.0001956
<i>S_j (s_j>0)</i>	-.010891	-.0250248	-.0110346
<i># of exporters/ 3-Digit</i>			
<i>Proba</i>		.0005958	
<i>S_j (s_j>0)</i>		.0216502	
<i># of exporters_j</i>			
<i>Proba</i>			.0048451
<i>S_j (s_j>0)</i>			.273351

Table 6. Results (dependent variable : export sales by destination)

Variables	I	II	III
<i>TFP</i>	2.007*** (0.0693)	2.100*** (0.0673)	2.084*** (0.0668)
<i>Size</i>	1.842*** (0.0497)	2.400*** (0.106)	2.128*** (0.0318)
<i>Distance</i>	-2.301*** (0.0320)	-0.413*** (0.0392)	1.853*** (0.164)
<i>GDP</i>	1.652*** (0.0172)	0.217*** (0.0239)	0.196*** (0.0237)
<i>Border</i>	0.210*** (0.0776)	0.228*** (0.0765)	0.227*** (0.0761)
<i>Maritime</i>	0.200** (0.0987)	0.183* (0.0974)	0.182* (0.0968)
<i>Agri. prod.</i>	15.09*** (1.533)	16.65*** (1.501)	16.58*** (1.493)
<i># of local Firms</i>	-0.301*** (0.0674)	-0.142** (0.0601)	-0.142** (0.0598)
<i># of exporters/ 3-Digit</i>	-0.413*** (0.0984)		
<i># of exporters/ 3-Digit * Size</i>	0.157*** (0.0207)		
<i># of exportersj</i>		3.773*** (0.114)	6.771*** (0.237)
<i># of exportersj * Size</i>		-0.0504*** (0.0194)	
<i># of exportersj * Distance</i>			-0.402*** (0.0279)
<i>Regional dummy</i>	Yes	Yes	Yes
<i>4digit Dummy</i>	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7. Elasticities of spatial externalities

Variables	II	III	IV
<i># of local Firms</i>			
<i>Proba</i>	-0.0007122	-0.0001886	-0.0002211
<i>Sj (sj>0)</i>	-0.0259028	-0.0109334	-0.0112168
<i># of exporters/ 3-Digit</i>			
<i>Proba</i>	0.00053		
<i>Sj (sj>0)</i>	0.01949		
<i># of exportersj</i>			
<i>Proba</i>		0.00475	0.00529
<i>Sj (sj>0)</i>		0.27556	0.26837

Table 8. Results (dependent variable: export sales by destination)

Variables	II	III	IV
<i>TFP</i>	2.220*** (0.0620)	2.192*** (0.0625)	2.220*** (0.0620)
<i>Size</i>	2.038*** (0.0290)	2.041*** (0.0290)	2.038*** (0.0290)
<i>Agri. prod.</i>	23.68*** (1.598)	22.98*** (1.612)	23.68*** (1.598)
<i># of local Firms</i>	-0.138** (0.0646)	-0.240*** (0.0713)	-0.138** (0.0646)
<i># of exporters/ 3-Digit</i>		0.141*** (0.0415)	
<i># of exporters_j</i>			3.089*** (0.349)
<i>Destination dummy</i>	Yes	Yes	Yes
<i>Region dummy</i>	Yes	Yes	Yes
<i>4digit Dummy</i>	Yes	Yes	Yes

Table 9. Results (dependent variable : export sales of small firms Size<50 ou 100))

	<50		<100	
	I	II	I	II
<i>TFP</i>	3.939*** (0.0991)	3.941*** (0.0991)	3.938*** (0.0845)	3.940*** (0.0845)
<i>Size</i>	1.690*** (0.104)	1.694*** (0.104)	1.578*** (0.0661)	1.581*** (0.0661)
<i>Agri. prod.</i>	49.07*** (2.513)	48.94*** (2.504)	41.01*** (2.009)	40.57*** (1.991)
<i># of firms</i>	0.456** (0.189)	0.557*** (0.0992)	0.0312 (0.157)	0.269*** (0.0829)
<i># of large exporters</i>	0.105 (0.167)		0.247* (0.139)	
<i># of exportersj</i>		2.366*** (0.504)		2.632*** (0.477)
<i>Destination</i>	Yes	Yes	Yes	Yes
<i>Region dummy</i>	Yes	Yes	Yes	Yes
<i>3-digit Dummy</i>	Yes	Yes	Yes	Yes

Table 10. Maximum likelihood estimation results

Variables	
Constant	-0.0997 (0.0885)
French Région fixed effects	
<i>Ile de France</i>	0
Champagne Ardenne	0.376***(0.0477)
Picardie	-0.173***(0.0566)
Haute-Normandie	-0.0982(0.0757)
Centre	-0.109***(0.0501)
Basse-Normandie	-0.121***(0.0548)
Bourgogne	-0.199***(0.0496)
Nord Pas de Calais	-0.186***(0.0407)
Lorraine	-0.375***(0.0729)
Alsace	-0.143***(0.0340)
Franche Comté	-0.144***(0.0674)
Pays de la Loire	-0.0830***(0.0321)
Bretagne	-0.185***(0.0577)
Poitou Charentes	-0.113***(0.0419)
Aquitaine	-0.204***(0.0468)
Midi Pyrénées	-0.0357(0.0897)
Limousin	-0.301*** (0.0426)
Rhône Alpes	-0.0907*(0.0514)
Auvergne	-0.285***(0.0579)
Languedoc Roussillon	-0.118***(0.0496)
Provence Alpes Côtes d'Azur	0.376***(0.0477)
Subsector fixed effects	
	Yes
Observations	2,466
ll	-1448