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Productivity and firm selection: intra- vs international trade

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Abstract

Recent theoretical models predict gains from international trade coming from intra-industry reallocations, due to a firm selection effect. In this paper we answer two related questions. First, what is the magnitude of this selection effect, and how does it compare to that of intra-national trade ? Second, would the removal of 'behind-the-border' trade frictions between integrated EU countries lead to large productivity gains? To answer these questions, we extend and calibrate the Melitz and Ottaviano (2007) model on productivity and trade data for European economies in 2000, and simulate counterfactual trade liberalization scenarios. We consider 11 EU countries and a total of 31 economies, including 21 French regions. Our first result is that, in the French case, international trade has a sizeable impact on aggregate productivity, but smaller than that of intra-national trade. Second, substantial productivity gains (around 20%) can be expected from 'behind-the-border' integration. In both experiments, we predict the corresponding variations in average prices, markups, quantities and profits. We show that the model fits sales and exports data reasonably well, and we perform a number of robustness checks. We also suggest some explanations for the substantial cross-economy and cross-industry variations in our estimates of productivity gains, highlighting the importance of accessibility and competitiveness.

Keywords: European integration, intra-national trade, firm-level data, firm selection, gains from trade, total factor productivity.

JEL classification: F12, R13

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1 Introduction

In recent decades, as tariff barriers have been generally and steadily falling worldwide, non-tariff barriers (NTBs) have become a crucial concern for international organizations due to their potentially harmful effects on trade and development. NTBs consist of all barriers to trade that are not tariffs and include all interferences with international trade that distort the free flow of goods and services. As such they include, for example, import quotas and voluntary export restraints (VERs) but also export subsidies. To NTBs belong 'behind-the-border' trade barriers (BTBs) stemming from domestic regulations that cover government procurement, product standards, inward foreign investment, competition law, labor standards, and environmental norms. These barriers are the main concern within free trade areas such as NAFTA and the EU. Indeed, mixed feelings about the success of the Single Market Program (SMP) are largely motivated by the persistence of BTBs that seem to disproportionately hamper the internationalization of firms, especially small and medium-sized enterprises.

The aim of the present paper is to quantify the additional gains from trade that would accrue to EU countries from the dismantlement of their BTBs beyond what the SMP has already achieved in terms of other NTBs. Our focus is on the effects of NTBs on productivity and markups as these played centre stage in the recommendations and forecasts of the European Commission when the SMP was launched in 1993. Prime examples are the *White Paper on Completing the Internal Market* (European Commission, 1985), and the *Cecchini Report* (Cecchini et al., 1988).[1] While the analysis is carried out for the EU, its implications are of broader interest as BTBs strain trade relations of both developed and developing countries (see, e.g., European Commission, 2006; Hoekman, Mattoo and English, 2002).

The specific channel we investigate is the one highlighted by the recent literature on firm heterogeneity (Bernard et al., 2003;Melitz, 2003), according to which trade liberalization has a positive impact on aggregate productivity through the survival of the most productive firms and the death of the least productive ones. The reason is a combination of import competition, which is harmful to all firms, and export market access, which benefits only firms that are productive enough to afford the additional costs of internationalization. This selection mechanism finds empirical support in firm-level analyses (Clerides, Lach and Tybout, 1998; Bernard and Jensen, 1999; Aw, Chung and Roberts, 2000; Tybout, 2003) and is consistent with the aggregate evidence provided in Alcalá and Ciccone (2004).

To evaluate the gains from removing BTBs, we calibrate the theoretical model of trade with heterogenous firms by Melitz and Ottaviano (2007). This model has two important advantages over those of Melitz (2003) and Chaney (2006). First, it predicts that larger markets are associated with lower markups and prices, bigger firms, and less productivity dispersion. These findings are more consistent with cross-regional evidence in the US retail, concrete and cement industry (Campbell and Hopenhayn, 2002, Syverson 2004 a,b) than those of the former models.[2] Second, the Melitz-Ottaviano model is easier to calibrate, as it does not require data on the fixed costs of exporting, which are notoriously difficult to obtain.

Our calibrated simulation builds on Del Gatto, Mion and Ottaviano (2006), who investigate

[1] This initial emphasis has hardly been matched by ex post evaluation. Exceptions are Notaro (2002) and Bernard and Leroy (2003). The Commission's 1996 Single Market Review did not address productivity gains.

[2] The difference between the present and the aforementioned papers comes from an important difference in modelling choices. The Melitz-Ottaviano model uses a linear demand system with a non-constant elasticity of substitution. Optimal markups are not constant, and more productive firms set higher markups. An increase in market size intensifies competition and increases the elasticities of substitution, which in turn changes the distribution of performance variables.

how trade integration affects productivity levels through firm selection, using individual panel data across 11 EU countries. We enrich their dataset by breaking up one country (France) into a collection of 21 regional (NUTS2) economies trading with EU partners and with one another.[3] This extension has three advantages. First, focusing on France allows us to study the effect of intra-national vs. international trade in a large European country. To the best of our knowledge, this delivers the first analysis of firm selection on comparable individual panel data across sub-national economies. Second, French data allow us to assess the relevance of BTBs by estimating the effects that regional borders have on intra-national trade flows and comparing them with international border effects. Last, firm level data on French firms can be used to quantify the impact of BTBs on their performance variables.

In particular, we use the structurally estimated model to explore three scenarios. The first scenario is used to validate our calibrations with respect to Del Gatto, Mion and Ottaviano (2006). In particular, we assess the productivity losses that would be associated with international autarky ('costs of non-Europe').[4] In the enriched dataset we find that with prohibitive international barriers, average country productivity in 2000 would have dropped by roughly 11.6 percent in our 11 countries, compared to the 12.7 percent found by Del Gatto, Mion and Ottaviano (2006). The second scenario is designed to assess the relative magnitude of the gains from international vs intra-national trade in terms of average productivity. To do so, we perform an exercise analogous to the former one, by simulating average productivity levels for France when allowing for inter- but not intra-national trade ('costs of non-France'). We find that non-France causes a 25% productivity loss for an average French region, which is much larger than its 8% loss from non-Europe. This reveals the overwhelming importance of the domestic market for the firms of a relatively large country such as France.

The third and last scenario is used to assess the hypothetical productivity increase that would stem from the removal of BTBs among EU countries. To do that, we set the 'thickness' of borders between EU countries at the same level as those between French regions ('United Europe'). This removes all international trade frictions that come from the crossing of a border, irrespective of the distance between trading partners. When the thickness of borders is measured by the 'border effects' of theoretically-grounded gravity equations, 'United Europe' corresponds to a 34% decrease in average trade costs and leads to a 20% increase in average productivity. This productivity gain can be mapped into a 13.14% decrease in prices and markups and a 22.57% and a 12.96% decrease in average profits and quantities, respectively. The productivity gain for the average French region is roughly 9%. These numbers reveal the existence of substantial gains from removing of BTBs within the EU.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 derives its equilibrium properties and designs the simulation strategy. Section 4 describes the dataset. In Section 5 we estimate some parameters of the model. Section 6 describes the calibration procedure, shows the goodness of fit of the model and simulates our three alternative integration scenarios. In Section 7 we explore the robustness of our results to a variety of alternative productivity and trade freeness estimations. Finally, Section 8 concludes.

[3]France is composed of 22 administrative regions. However, due to data availability, we must exclude one region (Corsica) from the analysis. Hence, we study 21 regional and 10 national economies.

[4]This expression 'cost of non-Europe' was coined in the Cecchini report, to refer to the economic cost of not completing the common market.

2 The model

Consider a system of economies, indexed $l = 1, ..., M$, endowed with labor and capital that are immobile between countries. In each economy l, L^l identical workers supply labor, one unit each inelastically. Workers own capital and each of them holds a balanced portfolio, so they are only interested in expected returns.

2.1 Demand

The focus is on a subgroup of M sectors that are active in all economies and take factor returns as given. The product of each of these sectors $s = 1, ..., S$ is horizontally differentiated in a continuum of varieties indexed by $i \in \Omega_s$. Not all existing varieties are necessarily demanded and $\widetilde{\Omega}_s^l \subset \Omega_s^l$ denotes the subset of varieties actually consumed by the residents of economy l. Individual inverse demand for $i \in \widetilde{\Omega}_s^l$ is given by

$$p_s^l(i) = \alpha_s - \gamma_s d_s^l(i) - \eta_s D_s^l, \tag{1}$$

where $p_s^l(i)$ and $d_s^l(i)$ are price and quantity demanded of variety i, while $D_s^l = \int_{i \in \Omega_s} d_s^l(i) di$ is total consumption of all varieties in sector s. The parameters $\alpha_s > 0$ and $\eta_s > 0$ measure the degree of product differentiation between good s and the other goods in the economy: a larger α_s and a smaller η_s shift out the inverse demand schedule. The parameter $\gamma_s > 0$ measures, instead, the degree of product differentiation between the varieties of good s: a larger γ_s makes the inverse demand steeper.

The market demand for each variety $i \in \widetilde{\Omega}_s^l$ can be obtained by inverting (1):

$$q_s^l(i) \equiv L^l d_s^l(i) = \frac{\alpha_s L^l}{\eta_s N_s^l + \gamma_s} - \frac{L^l}{\gamma_s} p_s^l(i) + \frac{\eta_s N_s^l}{\eta_s N_s^l + \gamma_s} \frac{L^l}{\gamma_s} \bar{p}_s^l, \ \forall i \in \widetilde{\Omega}_s^l, \tag{2}$$

where L^l is the total number of resident consumers in economy l, N_s^l is the measure of consumed varieties in $\widetilde{\Omega}_s^l$ and $\bar{p}_s^l = \left(1/N_s^l\right) \int_{i \in \widetilde{\Omega}_s^l} p_s^l(i) di$ is their average price. Since $\widetilde{\Omega}_s^l$ is the subset of varieties that are actually consumed, it is the largest subset of Ω_s^l that satisfies

$$p_s^l(i) \leq \frac{1}{\eta_s N_s^l + \gamma_s} \left(\gamma_s \alpha_s + \eta_s N_s^l \bar{p}_s^l \right) \equiv p_s^l. \tag{3}$$

so that $\bar{p}_s^l \leq \alpha_s$ with strict inequality in the presence of price heterogeneity. For a given level of product differentiation γ_s, a lower average price $\bar{p}_s^l$ or a larger number of competing varieties N_s^l raises the price elasticity of demand and decreases the price bound p_s^l due to a tougher competitive environment.

2.2 Supply

The N_s^l varieties of good s consumed by the residents of economy l may be supplied both by domestic firms and by exporters located in other economies. In all sectors market structure is monopolistic competition and each variety is supplied by one and only one firm. All firms face a Cobb-Douglas production technology that transforms labor, capital (and intermediate inputs) into final output under constant returns to scale. Within sectors the Cobb-Douglas factor shares are the same for all firms in all economies. Factor prices and total factor productivities vary instead between economies. The latter also vary between firms within sectors and economies.

Within sectors and economies, firm heterogeneity is introduced by modelling entry as a research and development process with uncertain outcome. In particular, each entrant has to invent its own

variety and a corresponding production process by making an irreversible investment f_s^l in terms of labor, capital and intermediate inputs. A prospective entrant knows for certain that it will invent a new variety and that it will produce using a Cobb-Douglas technology with given factor shares. It does not know, however, its total factor productivity and thus nor its marginal cost of production c as these are randomly determined only after f_s^l has been sunk. Uncertainty is modelled as a draw from a common and known distribution $G_s^l(c)$, with support $[0, c_{A,s}^l]$, which varies across sectors and economies. The upper bound of the support $c_{A,s}^l$ is exogenously assigned, which allows us to introduce (probabilistic) 'comparative advantage' stemming from factor endowment and technological differences between economies that affect the distribution of firm-level cost draws. For example, if $\left(c_{A,s}^l/c_{A,r}^l\right) < \left(c_{A,s}^h/c_{A,r}^h\right)$, economies l and h are said to have comparative advantages in sectors s and r respectively. Relative to entrants in h (l), entrants in l (h) have a 'better chance' of getting lower cost draws in sector s than in sector r.

National markets are segmented. Nevertheless, firms can produce in one market and sell in another by incurring a per-unit trade cost. The overall cost of a delivered unit with cost c from economy h to economy l is $\tau_s^{hl}c$ with $\tau_s^{hl} > 1$, where $(\tau_s^{hl} - 1)c$ is the frictional trade cost. We interpret such a cost in a wide sense as resulting from all impediments to trade. For this reason, even within an economy, trade may not be costless and we allow for $\tau_s^{ll} \geq 1$.

Since the entry cost f_s^l is sunk, only entrants that can cover their marginal cost survive and produce. All other entrants exit without even starting production. Survivors maximize their profits facing the demand function (2). Given the continuum of competitors, a firm takes the average price level $\bar{p}_s^l$ and number of firm N_s^l as given. Let $p_s^{lh}(c)$ and $q_s^{lh}(c)$ denote the levels of the profit-maximizing price and quantity *delivered* for a firm in sector s producing in economy l with cost c and selling to economy h. Since we assume that markets are segmented by economy and production faces constant returns to scale, firms independently maximize the profits earned from sales to each economy. Let $\pi_s^{lh}(c)$ denote the maximized value of these profits. Then, the profit maximizing prices and output levels must satisfy: $\pi_s^{lh}(c) = \left[p_s^{lh}(c) - \tau_s^{lh}c\right] q_s^{lh}(c)$ and $q_s^{lh}(c) = \left(L^h/\gamma_s\right)\left[p_s^{lh}(c) - \tau_s^{lh}c\right]$. Only firms earning non-negative profits in a market will choose to serve that market. This implies a number of similar cost cutoff rules for firms selling to the various markets. Let c_s^{lh} denote the upper bound cost inclusive of trade costs ('delivered cost') for firms producing in economy l and selling to economy h. Recalling (3), this (endogenous) cost cutoff must then satisfy:

$$c_s^{lh} = \sup\left\{\tau_s^{lh}c : \pi_s^{lh}(c) > 0\right\} = p_s^h \tag{4}$$

which implies that $c_s^{lh} = c_s^{kh} = c_s^h$ for all $l, k = 1, ..., M$. Note that, for given p_s^h, higher trade barriers from l to h make it harder for exporters from l to break even relative to their competitors from k as the former need better cost draws than the latter in order to break even. The cost cutoffs summarize all the effects of market conditions that are relevant for firm performance. In particular, the optimal prices and output levels can be written as:

$$p_s^{lh}(c) = \frac{1}{2}(c_s^h + \tau_s^{lh}c), \quad q_s^{lh}(c) = \frac{L^h}{2\gamma_s}\left(c_s^h - \tau_s^{lh}c\right) \tag{5}$$

which yield the following maximized operating profit levels:

$$\pi_s^{lh}(c) = \frac{L^h}{4\gamma_s}\left(c_s^h - \tau_s^{lh}c\right)^2. \tag{6}$$

with markup:

$$\mu_s^{lh}(c) = \frac{1}{2}\left(c_s^h - \tau_s^{hl}c\right) \tag{7}$$

Firms choose a production location prior to entry and sink the corresponding entry cost f_s^l. Free entry of firms in economy l then implies zero expected profits in equilibrium:

$$\sum_{h=1}^{M}\left[\int_0^{c_s^h/\tau_s^{lh}}\pi_s^{lh}(c)dG_s^l(c)\right]=f_s^l. \tag{8}$$

The M cost cutoffs can be calculated by substituting (6) into (8) and solving the resulting system of M equations for $l=1,...,M$. The number of sellers to each country can be found by substituting (4) into (3) and solving the M resulting equations individually:

$$N_s^h=\frac{2\gamma_s}{\eta_s}\frac{\alpha_s-c_s^h}{c_s^h-\bar{c}_s^h}, \tag{9}$$

where $\bar{c}_s^h=\sum_{l=1}^{M}\left\{\left[\int_0^{c_s^{lh}}\tau_s^{lh}cdG_s^l(c)\right]/G_s^l(c_s^{lh})\right\}$ is the average delivered cost of sellers.

3 Equilibrium

All the results derived in the previous section hold for any distribution of cost draws $G_s^l(c)$. However, to implement the model empirically, we must use a specific parametrization for the distribution, whose empirical relevance will then be tested. In particular, we assume that in sector s and economy l productivity draws follow a Pareto distribution with shape parameter $k_s\geq 1$, which implies a distribution of cost draws c given by

$$G_s^l(c)=\left(\frac{c}{c_{A,s}^l}\right)^{k_s},\ c\in[0,c_{A,s}^l]. \tag{10}$$

The shape parameter k_s indexes the dispersion of cost draws in sector s; it is the same in all economies. When $k_s=1$, the cost distribution is uniform on $[0,c_{A,s}^l]$. As k_s increases, the relative number of high cost firms increases, and the cost distribution is more concentrated at higher cost levels. As k_s goes to infinity, the distribution becomes degenerate at $c_{A,s}^l$. Any truncation of the cost distribution from above at $c_s^h/\tau_s^{lh}<c_{A,s}^l$ retains the same distribution function and shape parameter k_s. The productivity distribution of firms producing in l and selling to h is therefore also Pareto with shape k_s, and the truncated cost distribution is given by $G_s^{lh}(c)=\left[c/(c_s^{lh}/\tau_s^{lh})\right]^{k_s},\ c\in[0,c_s^{lh}/\tau_s^{lh}]$.

3.1 Cutoffs

Let $\rho_s^{lh}\equiv\left(\tau_s^{lh}\right)^{-k_s}\in(0,1]$ measure the 'freeness' of trade for exports from l to h, which allows us to define the following trade freeness matrix for sector s:

$$P_s\equiv\begin{pmatrix}\rho_s^{11}&\rho_s^{12}&\cdots&\rho_s^{1M}\\ \rho_s^{21}&\rho_s^{22}&\cdots&\rho_s^{2M}\\ \vdots&\vdots&\ddots&\vdots\\ \rho_s^{M1}&\rho_s^{M2}&\cdots&\rho_s^{MM}\end{pmatrix}.$$

Given our parametrization, the free entry condition (8) in economy l can be rewritten as:

$$\sum_{h=1}^{M}\rho_s^{lh}L^h\left(c_s^h\right)^{k_s+2}=\frac{2\gamma_s(k_s+1)(k_s+2)f_s^l}{\psi_s^l}\qquad l=1,...,M, \tag{11}$$

where $\psi_s^l = \left(c_{A,s}^l\right)^{-k_s}$ is an index of absolute advantage in sector s. This yields a system of M equations that can be solved for the M equilibrium domestic cutoffs in sector s using Cramer's rule:

$$c_s^h = \left(\frac{2(k_s+1)(k_s+2)\gamma_s}{|P_s|} \frac{\sum_{l=1}^{M} \left|C_s^{lh}\right| / (\psi_s^l / f_s^l)}{L^h} \right)^{\frac{1}{k_s+2}} \qquad h = 1, ..., M, \tag{12}$$

where $|P_s|$ is the determinant of the trade freeness matrix and $\left|C_s^{lh}\right|$ is the cofactor of its ρ_s^{lh} element. Cross-economy differences in cutoffs arise from four sources: own economy size (L^h), as well as a combination of market accessibility, entry barriers and comparative advantage ($\sum_{l=1}^{M} \left|C_s^{lh}\right| / (\psi_s^l / f_s^l)$). Economies benefiting from a larger local market, a better distribution of productivity draws, lower barriers to entry and better market accessibility have lower cutoffs.[5]

3.2 Performance Variables

Under the Pareto assumption, average performance variables for sellers in country h can be expressed as functions of the domestic cutoffs (12). In particular, average (delivered) costs, prices, quantities, markups and operating profits evaluate to:

$$\begin{aligned}
\overline{c}_s^h &= \tfrac{k_s}{k_s+1} c_s^h \\
\bar{p}_s^h &= \tfrac{2k_s+1}{2(k_s+1)} c_s^h \\
\overline{q}_s^h &= (k_s+2) \tfrac{\sum_{l=1}^{M} \left|C_s^{lh}\right| / \left(\psi_s^l / f_s^l\right)}{|P_s|} \left(c_s^h\right)^{-(k_s+1)} \\
\overline{\mu}_s^h &= \tfrac{1}{2(k_s+1)} c_s^h \\
\overline{\pi}_s^h &= \tfrac{\sum_{l=1}^{M} \left|C_s^{lh}\right| / \left(\psi_s^l / f_s^l\right)}{|P_s|} \left(c_s^h\right)^{-k_s}
\end{aligned} \tag{13}$$

These results point out that smaller cutoffs generate smaller average costs, prices and markups. In particular, a percentage change in the cutoff c_s^h has the same percentage impact on both the average markup $\overline{\mu}_s^h$ ('pro-competitive effect') and the average cost $\overline{c}_s^h$ ('selection effect'). Through these channels, a percentage change in the cutoff translates into an identical percentage change in the average price. Each channel is responsible for half of the impact since (13) implies $\bar{p}_s^h = (2k_s+1)\sqrt{\overline{\mu}_s^h \overline{c}_s^h / 2k_s}$.

As for average profits and quantities the question is slightly more complicated. The endogenous cutoffs c_s^h are a function, among other things, of trade freeness. At the same time trade freeness enters in the equations determining $\overline{\pi}_s^h$ and $\overline{q}_s^h$ directly via the cofactors C_s^{lh} and the determinant $|P_s|$. Therefore, when simulating counterfactual trade costs changes (as we do later on) we have to take into account both the direct and indirect (via c_s^h) effect of changes in trade freeness to determine the new average profits and quantities. On the one hand, a better accessibility decreases c_s^h pushing towards an increase of both average profits and quantities in (13). Intuitively, this comes from the fact that in a tougher competitive environment resources are reallocated towards large and more productive firms that make more profits and sales. However, a better accessibility also turns into a direct decrease of the term $\frac{\sum_{l=1}^{M} \left|C_s^{lh}\right|}{|P_s|}$ in (13). Intuitively, this second effect is related to the equilibrium adjustment in the number of local sellers. As we show later on in equation (14), the number of sellers is in fact monotonically decreasing with c_s^h. Therefore in a tougher competitive environment the number of varieties sold locally increase pushing quantities and profits down. Which one of the two effects dominates is a priori indeterminate.

[5] Melitz and Ottaviano (2007) show that in each country welfare is a decreasing function of the domestic cost cutoff.

3.3 Number of Firms

Turning to the number of firms, the mass of sellers N_s^h is obtained from (9) after substituting the value of $\overline{c}_s^h$ in (13):

$$N_s^h = \frac{2\gamma_s(k_s+1)}{\eta_s}\frac{\alpha_s - c_s^h}{c_s^h} \tag{14}$$

Sellers consist of domestic producers and foreign exporters. Accordingly, given a positive mass of entrants $N_{E,s}^l$ in all countries, N_s^h equals $\sum_{l=1}^M G_s^l(c_s^h/\tau_s^{lh})N_{E,s}^l$. By (4) and (10), this equality provides a system of M linear equations

$$\sum_{l=1}^{M} \rho_s^{lh}\psi_s^l N_{E,s}^l = \frac{N_s^h}{(c_s^h)^{k_s}}.$$

that can be solved for the number of entrants in the M countries using Cramer's rule:

$$N_{E,s}^l = \frac{2\,(k_s+1)\,\gamma_s}{\eta_s\,|P_s|\,\psi_s^l}\sum_{h=1}^{M}\frac{(\alpha_s - c_s^h)\,|C_s^{lh}|}{(c_s^h)^{k_s+1}} \tag{15}$$

Given $N_{E,s}^l$ entrants in country l, $N_{E,s}^l G_s^l(c_s^l/\tau_s^{ll})$ firms survive and produce for the local market. Among them, $N_{E,s}^l G_s^l(c_s^h/\tau_s^{lh})$ export to country h. Thus, the measure of producers located in country l is:

$$N_{P,s}^l = \psi_s^l N_{E,s}^l \rho_s^{ll}\left(c_s^l\right)^{k_s} \tag{16}$$

3.4 Trade Flows

The model yields a gravity equation for aggregate bilateral trade flows. In sector s an exporter from l to h with cost c generates f.o.b. export sales $r_s^{lh}(c) = p_s^{lh}(c)q_s^{lh}(c)$. Aggregating over all exporters from l to h (with cost $c \leq c_s^h/\tau_s^{lh}$) yields the aggregate bilateral exports in sector s from l to h. Expressions (4) and (5) then imply aggregate bilateral exports equal to:

$$EXP_s^{lh} = \frac{1}{2\gamma_s\,(k_s+2)}N_{E,s}^l\psi_s^l L^h\left(c_s^h\right)^{k_s+2}\rho_s^{lh}. \tag{17}$$

which is a gravity equation in so far as it determines bilateral exports as a (log-linear) function of bilateral trade barriers and economy characteristics. In particular, it reflects the combined effects of market size, probabilistic comparative advantage, and geography on both the extensive (number of traded goods) and intensive (amount traded per good) margins of trade flows.[6] It shows that a lower cutoff c_s^h dampens exports by making it harder for potential exporters to break into the market.

3.5 From Theory to Simulation

The model developed so far can be calibrated and simulated to address the questions raised in the introduction. In so doing, we proceed in three stages. We start with structurally estimating the model. We then calibrate its parameters on the results of the estimation and we validate the calibration. Finally, we use the calibrated model to investigate the effects of different integration scenarios.

[6]See Eaton and Kortum (2002), Helpman, Melitz and Rubinstein (2004), and Chaney (2006) for similar results derived from different models.

We consider 11 EU countries. One of them, France, is divided into the 21 NUTS2 regions. This gives 31 units of analysis ('economies'). In the structural estimation stage, we first use geographical and trade data for the year 2000 to recover the trade freeness matrix P_s from the gravity equations (17). We compute the determinant and the co-factors of P appearing in equation (12). The bilateral trade freeness parameters ρ_s^{lh} for French regions are reconstructed from aggregate (*country-level*) figures, based on the assumption that the elasticity of trade with respect to distance is invariant to the type (international vs intra-national) of trade. In Section 7 we provide some evidence on the robustness of our results to that hypothesis. Second, we combine the database on manufacturing firms belonging to 11 EU countries used by Del Gatto, Mion and Ottaviano (2006) with more detailed data on French firms to estimate firm-level total factor productivities (TFP) for the year 2000. From such productivities we recover two additional elements of equation (12): the shape parameter of the underlying Pareto distributions (k_s) and the MxS endogenous domestic cutoffs (c_s^h) of our economy-sector pairs. Finally, using the computed values of P_s, k_s and c_s^h together with data on population L^h, we solve (11) to obtain the index of absolute advantage and entry barriers ψ_s^l/f_s^l (up to a sector-specific constant related to the unobservable γ_s).

At the validation stage, we compare our model's predictions with actual data on the distribution of productivity and sales in the population of manufacturing firms. Our model fits reasonably well the data on the share and size advantage of exporters, and the size distribution of manufacturing firms. In relative terms our fit is also comparable to that of Bernard et al. (2003). Interestingly, as noted by Eaton et al. (2004), the French and US manufacturing sector are quite similar in a number of respects, and in particular export intensity. This allows us to further compare our model's predictions to US data when these are more reliable than their French counterparts.

Finally, at the simulation stage, we run a counterfactual analysis on the calibrated model. In particular, we simulate the changes in productivity induced by different trade costs by recomputing c_s^h for alternative freeness matrices P_s. Three scenarios are considered. In the first one, international trade costs are set to be prohibitive ($\rho_s^{lh} = 0$ for $l \neq h$ and l and h belonging to two different countries). This provides us with an assessment of the 'costs of non-Europe' and allows us to replicate the results of Del Gatto, Mion and Ottaviano (2006) in a world in which France is now divided into 21 sub-national economies (NUTS2). The second experiment ('costs of non-France') features a world where intra-national French trade costs are prohibitive, but French regions can still trade with other EU countries ($\rho_s^{lh} = 0$ for l and h being two different French regions). Lastly, in the third scenario ('United Europe') international trade frictions not related to distance (captured by border effects) are eliminated. This experiment roughly corresponds to a 34% decrease of international trade costs (τ_s^{lh}), and sheds some light on gains from further behind-the-border integration in the EU.

4 Data

In our empirical analysis we take advantage of different datasets. For *country-level* productivity estimations we extensively use the Amadeus database provided by the Bureau van Dijk. This dataset gives (harmonized) yearly balance-sheet information on the biggest 250,000 European firms for the period 1994-2003. To the best of our knowledge, it is the only dataset that provides comparable individual figures for a relatively large group of economies. In particular, Amadeus provides information on value added, fixed assets (capital), sales, and the cost of materials (intermediates consumption) in thousands of euros, as well as on the number of employees. We focus on manufacturing firms in western Europe for the year 2000. We chose that year because of the quality of the data and the fact that no major economic change took place. We consider only those economies for which a reasonable data coverage exists. We eliminate missing values and extreme observations,

defined as having either a capital/employees or value added/employees ratio which is out of the range identified by the 1st and the 99th percentile. This leaves us with a sample of 22,120 firms across 11 countries as listed in Table 1.[7]

Table 1: Data coverage across countries for the year 2000: Amadeus only.

Economy initials	Economy	Frequency	Percent
BE	Belgium	1557	7.04
DE	Germany	385	1.74
DK	Denmark	309	1.40
ES	Spain	2730	12.34
FI	Finland	529	2.39
FR	France	3956	17.88
GB	Great Britain	4514	20.41
IT	Italy	5735	25.93
NL	Netherlands	861	3.89
PT	Portugal	156	0.71
SE	Sweden	1388	6.27
Total		22120	100

As one can see in the table, data coverage for Germany, which is the biggest EU economy, is rather poor. This is the reason why we complement our Amadeus data with information coming from the MIP (Mannheim Innovation Panel) database on German firms provided by the Zentrum für Europäische Wirtschaftsforschung (ZEW). The MIP database has relatively smaller firms than Amadeus. However, the productivity of German firms in the two samples is not very different and both samples reveal that Germany is the most productive economy. The MIP contains information on value added, employment and input consumption. The capital variable is reconstructed by using the book value of capital in 1998, adding investments at the end of the period and applying the relevant deflators. After eliminating missing as well as extreme observations, the MIP database provides us with roughly 700 additional firms. Although our results are virtually the same when we use the Amadeus data only, the actual sample we rely on for *country-level* productivity estimations contains those additional firms. Descriptive statistics of the main variables in the combined Amadeus-MIP database are given in Table 2.

Table 2: Descriptive statistics of the country-level dataset (Amadeus and MIP).

Variable	N. firms	Mean	St. dev.	Min	Max
Sales	22801	146008.9	1739573	2	162000000
Value added	22801	47083.5	511309	18	44500000
Capital	22801	72865.69	937859.3	8	89100000
Intermed. consumpt.	22801	57920.58	428622.7	1	26900000
Employees	22801	667.84	6027.05	1	449594

Note: All variables except Employees are in thousands of euros.

In order to recover sub-national French productivity figures, we use the EAE (Enquete An-

[7]Sample statistics indicate that observations are missing at random within each country suggesting that there is no sample representativeness issue.

nuelle Entreprises) database provided by the SESSI (Service des Etudes et Statistiques Industrielles, French Ministry of Industry) and the SCEES (Service Central des Enquêtes et Etudes Statistiques, French Ministry of Agriculture and Fisheries), under the authorization of the French Conseil National de l'Information Statistique (CNIS). This database provides detailed information on the balance sheets and location of all firms with more than 20 employees, as well as on a stratified sample of those with less than 20 employees. After eliminating missing as well as extreme observations, the EAE database provides us with 23,203 additional firms for the year 2000. Descriptive statistics of the main variables of the EAE dataset used in the analysis are provided in Table 3.

Table 3: Descriptive statistics of the French dataset (EAE).

Variable	N. Firms	Mean	St. dev.	Min	Max
Sales	23203	29904.14	304830.6	83	29900000
Value added	23203	8078.472	65215.5	40	5303471
Capital	23203	10333.84	108842.4	0.15	13000000
Intermed. consumpt.	23203	12716.59	195236.4	0	19900000
Employees	23203	137.2749	498.4147	1	27966

Note: All variables except Employees are in thousands of euros.

As a benchmark, we estimate firm-level productivity in the year 2000 by means of simple OLS regressions. In Section 7 we further extend our analysis by implementing the Levinsohn and Petrin (2003) estimation method.

Turning to the industry disaggregation, we work with a 17-sector breakdown of manufacturing activities that excludes the 'Petroleum and Coal' industry for both data availability and confidentiality reasons.[8] The loss in terms of firms is modest (53 for the EAE, and 129 for the Amadeus+MIP) and we checked that this omission does not significantly alter our results. The actual industry disaggregation used is detailed in Table 4.

The core data we use to compute trade costs are provided by the Centre d'Etude Prospectives et d'Informations Internationales (CEPII). The dataset, used in Mayer and Zignago (2005), comprises trade and production figures in an ISIC 3-digit classification that is consistent across a large set of countries over the 1976-2001 period.[9] To estimate the freeness of trade ρ_s^{lh} from the gravity equation (17), we complement trade and production data with geographical variables such as bilateral distances (that we have elaborated using a GIS software, as CEPII data do not include distances between French regions), and common language indicators (provided by CEPII).

To recover the bilateral trade costs for our 31 economies (10 countries plus 21 NUTS2 French regions) in 2000, we use international trade flows between 15 European countries (our 11 countries plus Austria, Greece, Ireland and Norway) in the years 1999-2001. We use a larger number of countries and a longer time span to obtain more accurate measures. With the coefficients estimated in our gravity equations, and in particular that of distance, we can then compute trade costs for French regions by simply imposing that the same distance decay effect applies to intra-national trade.

Table 5 shows descriptive statistics of the trade and geographical variables we will use in the gravity equation. The data are organized by flows and the number of observations (11,475) is given

[8]There are in fact only 53 French firms in the EAE database that belong to this sector and they are distributed in just a few regions. We decided to drop this sector in order to prevent firms' identification and to restrict the analysis to industries that are present in all economies.

[9]For details, see $http://www.cepii.fr/anglaisgraph/bdd/TradeProd.htm$.

Table 4: Sectoral disaggregation

Industry code	Industry description
1	Food beverages and tobacco
2	Textiles
3	Wearing apparel except footwear
4	Leather products and footwear
5	Wood products except furniture
6	Paper products
7	Printing and Publishing
9	Chemicals
10	Rubber and plastic
11	Other non-metallic mineral products
12	Metallic products
13	Fabricated metal products
14	Machinery except electrical
15	Electric machinery
16	Professional and scientific equipment
17	Transport equipment
18	Other manufacturing

by the number of origin countries (15), times the number of destination countries (15), times the number of sectors (17), times the number of years (3).

Table 5: Descriptive statistics of the trade and geographical variables used.

	N. observ	Mean	St. Dev	Min	Max
Exports	11475	741204.9	4247073	0	113000000
Common Language	11475	0.06	0.24	0	1
distw	11475	729.44	378.53	69.29	1782.32
Population	31	11398.37	20014.15	709.97	82211.51

Note: Exports are in thousands of US dollars while distances *distw* are in miles and population is in thousands of inhabitants. The common language variable is a dummy variable.

The variable Exports in the table corresponds to trade flows (both internal and external to a country) in thousands of US dollars. The common language variable is a dummy indicating whether a couple of countries share a common official language.[10]

The distance variable *distw* is in miles and it has been constructed using the same methodology for both countries and French regions. In particular, our weighted distance *distw* uses small regions (NUTS3) data on great circle distances (based on latitude and longitude of the centroid of each region) and GDP (in 2000) inside each economy. The basic idea is to calculate the distance between two economies as the weighted average bilateral distance between their subunits with the

[10]In the CEPII database, there are two alternative common language indicators based on different definitions. One indicator considers that two economies share a common language as long as at least 20 per cent of the two populations speak that language. The other one is similar, but the threshold is now between 9 per cent and 20 per cent. We experimented with both indicators getting similar results.

corresponding weights determined by the shares of those small regions in the overall economy GDP. This procedure can be used in a totally consistent way for internal and external distances of both a country and a region. Specifically, following Head and Mayer (2002), we calculate the distance between economies l and h as:[11]

$$d^{lh} = \left(\sum_{p \in l} \sum_{r \in h} (GDP^p/GDP^l)(GDP^r/GDP^h) \ (d^{pr})^\theta \right)^{1/\theta} \tag{18}$$

where GDP^p (GDP^r) designates the GDP of NUTS3 region p (r) belonging to economy l (h). Economies l and h can be either French regions or EU countries included in the analysis. However, only country distances are needed (see Section 5.1) in the estimation of the gravity equation (17). Therefore, summary statistics reported in Table 5 refer only to the latter. The distances between French regions are used in a second step in order to determine regional trade freeness and perform our simulations. The parameter θ measures the sensitivity of trade flows to bilateral distance d^{pr} which, for the *distw* variable, is set equal to 1. The internal distance of a NUTS3 region (d^{pp}) is calculated from its area as $d^{pp} = (2/3)\sqrt{area^p/\pi}$ like in Head and Mayer (2002).[12]

In Section 7, we perform a robustness experiment using merchandise trade data on both imports and exports between French regions and our set of European countries, that come from the French Ministry of Transport (Système d'Information sur les Transports de Marchandises, or SITRAM, database). These data should in principle allow us to get a more detailed pattern of the trade between our 31 economies. However, matching the NSTR (Nomenclature for Transport Statistics) product classification of these data with our sectoral classification sometimes proves problematic (especially for the Food industry). Furthermore, we do not have reliable data on local French production by sector and for both reasons we decided to use the CEPII international trade data for the baseline estimation of the gravity equation (17).

Finally, data on population for our 31 economies come from the New Cronos database provided by EUROSTAT. They refer to the year 2000 and the unit is thousands of inhabitants.

5 Calibration

To gauge the impact of trade openness on domestic productivity, we need to recover the parameters of the model and in particular those of equation (12).

5.1 Trade costs

The starting point of our estimation strategy is the gravity equation (17). To estimate it we use *country-level* trade flows in order to get the freeness-of-trade matrix P_s, whose generic element is $\rho_s^{lh} \equiv \left(\tau_s^{lh}\right)^{-k_s}$. From equation (17), one can easily see that the only term that depends on both l and h is ρ_s^{lh}. In fact, the other terms either depend on the origin country only ($N_{E,s}^l \psi_s^l$), or on the destination country only ($L^h \ \left(c_s^h\right)^{k_s+2}$), or they are constant ($1/[2\gamma_s (k_s+2)]$). Therefore, as in Head and Mayer (2004) and Hummels (1999), one can isolate the effects of these latter terms

[11] In their original formulation, Head and Mayer (2002) use population instead of GDP data. However, we believe GDP is a much better measure to feature local demand.

[12] This latter formula models the average distance between a producer and a consumer on a stylized geography where all producers are centrally located and the consumers are uniformly distributed over a disk-shaped economy.

by means of dummies for origin (EX_s^l) and destination (IM_s^h) countries.[13] As to the freeness of trade, we follow Head and Mayer (2004), assuming that $\rho_s^{lh} = \exp(\beta^h + \lambda\ Lang^{lh})\ (d^{lh})^{\delta_s}$ if $l \neq h$ and $\rho_s^{lh} = (d^{lh})^{\delta_s}$ if $l = h$, where d^{lh} is distance between l and h, β^h is a coefficient capturing the fall in trade due to crossing country h border, and $Lang^{lh}$ is a dummy variable that takes value one if l and h share a common language. In other words, as is standard in the gravity literature, trade costs are a power function of distance, while crossing a border and not sharing the same language impose additional costs. Taking the log of equation (17) we thus get the following regression:

$$\ln(EXP_s^{lh}) = EX_s^l + IM_s^h + \delta_s\ \ln(d^{lh}) + \beta^h\ Border^{lh} + \lambda\ Lang^{lh} Border^{lh} + \epsilon_s^{lh} \qquad (19)$$

where $Border^{lh}$ is a dummy variable that takes value one if $l \neq h$ ('border effect'). Having estimated (19) at the country level, we then reconstruct trade freeness between a French region l and country h as $\rho_s^{lh} = \exp(\beta^h + \lambda\ Lang^{lh})\ (d^{lh})^{\delta_s}$, while the trade freeness between two French regions l and h is defined as $\rho_s^{lh} = \exp(\lambda\ Lang^{lh})\ (d^{lh})^{\delta_s}$, i.e, there is no border effect inside France.

In estimating (19), we use data from years 1999, 2000, and 2001 to run a single country-based regression in which we also put year dummies. The coefficient on distances is industry-specific while the border effect is economy specific. We do not consider economy-industry-specific border effects, because they impose too many parameters and their estimation would be inaccurate. It is important to stress that the specification used to estimate ρ_s^{lh} gives economy-industry-sector specific transportation costs and that in general $\rho_s^{lh} \neq \rho_s^{hl}$ due to border effects. Moreover, ρ^{ll} is always less than one due to internal distances.

In our econometric specification the sectoral variation of trade costs is captured by the δ_s coefficients. These estimated distance elasticities are reported in Table 6. In particular, 'Printing and publishing' are the least tradable goods, while 'Textiles' as well as 'Leather products and footwear' are characterized by the smallest trade costs. The estimated elasticities (average $\delta_s = -1.68$) are in line with previous findings for Europe by Head and Mayer (2004) - average $\delta_s = -1.38$ - and Chen (2004) - average $\delta_s = -1.68$.

5.2 Total factor productivity

After calculating ρ_s^{lh}, we still have to recover (for each sector) the shape parameter of the underlying Pareto distribution of productivity (k_s), and the M endogenous domestic cutoff c_s^h. For this we need to estimate the distributions of firm-level productivities for all sectors and economies. As a benchmark, we rely on simple OLS estimations based on the regression

$$\ln(VA_i) = const + a\ln(CAP_i) + b\ln(EMPL_i) + \varepsilon_i \qquad (20)$$

where VA_i is value added, CAP_i is capital (fixed assets), $EMPL_i$ is the number of employees of firm i and the sector/economy indices have been dropped to make the notation lighter. The estimated productivity of firm i is thus $\hat{Prod}_{i,OLS} = \exp(\hat{const} + \hat{\varepsilon}_i)$. The OLS estimator notoriously suffers from a simultaneity bias, but using the Levinsohn and Petrin (2003) estimator yields very similar results, which we report in Section 7.

Using equation (20), we first use the Amadeus/MIP database (in which France is considered as a single economy) to calculate country-level comparable productivities coming from the same database. Our OLS estimations of productivity are carried out separately for each of the 17 manufacturing industries, each time for all countries. Therefore, we assume *de facto* that the same

[13] This 'fixed effect' approach does not suffer from the specification problems of standard gravity equations discussed by Anderson and van Wincoop (2003). In particular, these authors show that fixed effects regressions generate parameter estimates that are very similar to those obtained using their multilateral resistance terms.

Table 6: Sectoral trade elasticities with respect to distance

Industry code	Industry description	δ_s
1	Food beverages and tobacco	-1.8739
2	Textiles	-1.1218
3	Wearing apparel except footwear	-1.4483
4	Leather products and footwear	-1.1913
5	Wood products except furniture	-2.1968
6	Paper products	-1.5381
7	Printing and Publishing	-2.6793
9	Chemicals	-1.5035
10	Rubber and plastic	-1.7645
11	Other non-metallic mineral products	-1.8935
12	Metallic products	-1.5784
13	Fabricated metal products	-1.8642
14	Machinery except electrical	-1.6296
15	Electric machinery	-1.2096
16	Professional and scientific equipment	-1.6514
17	Transport equipment	-1.6065
18	Other manufacturing	-1.8721
Arithmetic average		-1.6837

technology is used in all economies for a given industry, up to a scale factor (or Hicks-neutral, factor-augmenting technological lead).[14] With $\hat{Prod}_{i,OLS}$ in our hands, we can easily estimate the shape parameter k_s of the Pareto distribution (which is sector-specific only) using the following property. Consider a random variable X (our productivity) with observed cumulative distribution $F(X)$. If the variable is distributed as a Pareto with shape parameter k_s, then the OLS estimate of the slope parameter in the regression of $\ln(1 - F(X))$ on $\ln(X)$ plus a constant is a consistent estimator of $-k_s$ and the corresponding R^2 is close to one.[15] Table 7 shows the estimated k_s and the R^2 of our regressions by sector. For all sectors the R^2 is far above 0.8, which shows that the Pareto is a fairly good approximation of the underlying productivity distributions, and the average k_s is estimated to be close to 2. Large values of k_s characterize sectors in which the productivity distribution is skewed towards relatively small and inefficient firms ('Leather products and footwear', 'Wood products except furniture', 'Rubber and plastic', 'Fabricated metal products', 'Machinery except electrical'). Small values of k_s are associated, instead, with an even distribution of firms across all productivity levels and sizes ('Wearing apparel except footwear', 'Chemicals', 'Professional and scientific equipment').[16]

In a second step we calculate productivities for the larger sample of French firms contained in the EAE database and we re-scale these productivities in order to match France's average sectoral

[14]Indeed, the evidence provided by Trefler (1995) supports this assumption for all countries in our sample except Portugal. In unreported estimations, where we exclude Portugal, we find qualitatively similar results to the ones we report when Portugal is included in the sample. The fact that we do not carry out separate estimations by economy has strong empirical advantages. First, it allows us to have a better measure of productivity as for some economies there are very few economy-sector observations. Second, it avoids the following problem. If we found the sum of the coefficients a and b to differ between two economies, then our estimated average productivity would turn out to be higher in the economy with the lower sum simply because this would map into a higher value of the constant.

[15]See Norman, Kotz and Balakrishnan (1994).

[16]We have also tried alternative estimation techniques for k_s, such as the inverse of the standard error of $\ln(X)$. Overall results are very similar.

Table 7: Sectoral k_s and the R^2 from the regression method

Industry code	Industry description	k_s	R^2
1	Food beverages and tobacco	2.004	0.898
2	Textiles	2.248	0.872
3	Wearing apparel except footwear	1.804	0.904
4	Leather products and footwear	2.345	0.893
5	Wood products except furniture	2.454	0.871
6	Paper products	1.966	0.827
7	Printing and Publishing	1.988	0.898
9	Chemicals	1.811	0.848
10	Rubber and plastic	2.372	0.868
11	Other non-metallic mineral products	2.156	0.826
12	Metallic products	2.206	0.848
13	Fabricated metal products	2.450	0.875
14	Machinery except electrical	2.346	0.898
15	Electric machinery	1.930	0.881
16	Professional and scientific equipment	1.844	0.856
17	Transport equipment	2.062	0.861
18	Other manufacturing	2.128	0.900
Average		2.124	0.872

productivity as calculated from the first step.[17] Doing that, we are then able to calculate sector specific productivities for each of the 21 NUTS2 French regions considered that are comparable with those obtained in the first step. With all sector-economy average productivities in our hands, we can easily calculate the cutoffs c_s^h. In the model, they represent the highest cost (or equivalently the inverse of the lowest productivity) of active firms in an economy. The maximum likelihood estimator of the cutoff for a Pareto distribution is the minimum observed value. However, this is probably a rather unreliable method to implement with micro data because of extreme observations. Consequently, we prefer to use a moment estimator based on the formula of the mean of a Pareto. Specifically, if X (our productivity) follows a Pareto distribution with shape parameter k_s and cutoff x then its mean is $E(X) = x\ k_s/(k_s - 1)$. Using the economy-sector average productivities and the previously estimated shape parameters, this formula can be inverted to recover all the productivity cutoffs, which are simply scaled average productivities. Finally, cost cutoffs, which are needed in equation (12), are simply equal to the inverse of productivity cutoffs.

Table 8 shows average (across firms) OLS productivity by country obtained in the first step, as well as per capita GDP in PPS (EU11=100).[18] As one can see, the two measures are closely related, with the correlation being 0.61. The Table shows that our OLS estimates of productivity are generally in line with aggregate figures. A notable exception is Germany, whose omission increases the correlation between productivity and GDP to 0.88. The reason is that both the Amadeus and the MIP databases have a strong bias towards West German firms, which are known to be much more productive than East German ones. However, our simulations are not very sensitive to the exclusion of Germany, so we decided to keep it in the analysis.

[17] Interestingly, the k_s that would be obtained from the EAE database are very close (average=2.519) to those obtained with Amadeus (average=2.124).

[18] Per capita income in Purchasing Power Standard (PPS) should be a better measure of 'physical' productivity because it deflates nominal values by country-specific price indices. Data come from the New Cronos database provided by Eurostat.

Table 8: Productivity across countries: OLS estimations.

Country name	Country initials	OLS Productivity	Per capita GDP in PPS (EU11=100)
Belgium	BE	43.40	104.30
Germany	DE	63.82	101.60
Denmark	DK	50.26	114.56
Spain	ES	32.60	83.78
Finland	FI	37.19	102.59
France	FR	40.33	103.13
Great Britain	GB	39.05	102.14
Italy	IT	40.50	99.35
Netherlands	NL	42.43	108.53
Portugal	PT	24.33	73.08
Sweden	SE	34.57	106.91
Average		40.06	100.00

Note: Compared to Del Gatto, Mion and Ottaviano (2006), the industry 'Petroleum and Coal' is not considered here. This is why the numbers reported are slightly different.

Table 9 shows average (across firms) of our OLS productivities by French region, as well as per capita Gross Regional Product GRP (France=100) provided by the French National Statistic Institute (INSEE). Again, productivity averages are in line with aggregate numbers with the correlation being 0.87.

6 Simulation

So far, we have computed ρ_s^{lh} (and thus $|P_s|$ as well as $\left|C_s^{lh}\right|$), k_s and c_s^h. We also have L^h, which is the population of county h. We still do not know γ_s, ψ_s^l and f_s^l. However, since we know everything about (11) except the bundling parameter $\psi_s^l/(\gamma_s f_s^l)$, we can choose its value to fit that equation (by sector) for each of our 31 economies. The calibration of the model is now complete.

With the $(\psi_s^l/\gamma_s f_s^l)$'s we can finally simulate the model and evaluate the changes in the c_s^h's (the equilibrium cutoff production costs) induced by changes in the freeness of trade using equation (12).

In particular, we consider the three following scenarios:

1. A situation in which *international* trade barriers are prohibitive (i.e. $\rho_s^{lh} = 0$ for l and h in different countries). This provides an assessment of the overall 'costs of non-Europe' as measured by foregone productivity, were our 11 EU countries to become autarkic.

2. A situation in which *intra-national* French trade barriers are prohibitive (i.e. $\rho_s^{lh} = 0$ for l and h being two different French regions). This provides an assessment of the costs of losing intra-national trade for our 21 French regional economies in a world where they still trade with other EU countries ('costs of non-France'). Again, these costs are measured by losses in average productivity.

3. A situation in which trade impediments coming from border effects β^h are removed ('United Europe'). This provides an assessment of the gains from intra-EU trade in terms of average productivity that could accrue from full behind-the-border integration in the EU.

Table 9: Productivity across French regions: OLS estimations.

Region name	NUTS 2 Code	OLS Productivity	Per capita GRP (France=100)
Ile de France	FR10	57.27	154.80
Champagne-Ardennes	FR21	41.09	93.55
Picardie	FR22	41.19	80.65
Haute-Normandie	FR23	41.18	90.86
Centre	FR24	40.71	88.46
Basse-Normandie	FR25	38.08	81.52
Bourgogne	FR26	38.88	87.46
Nord-Pas de Calais	FR31	43.79	77.09
Lorraine	FR41	42.21	81.48
Alsace	FR42	42.67	98.08
Franche-Comté	FR43	39.82	87.66
Pays de la Loire	FR51	40.91	89.30
Bretagne	FR52	34.71	85.22
Poitou-Charentes	FR53	37.58	81.58
Aquitaine	FR61	39.37	87.98
Midi-Pyrénées	FR62	40.42	86.38
Limousin	FR63	36.45	80.96
Rhône-Alpes	FR71	46.21	100.28
Auvergne	FR72	37.50	82.75
Languedoc-Roussillon	FR81	36.52	76.10
PACA	FR82	43.11	91.05
Average		44.28	100.00

6.1 The Model's fit

Before turning to counterfactuals, it is important to evaluate the capacity of the model to reproduce facts on the distribution of firms' sales and export that are not directly related to the calibrated ($\psi_s^l/\gamma_s f_s^l$) and the estimated (k_s, ρ_s^{lh}, c_s^h) parameters. We focus on France for three reasons. First of all, France is the core country of our analysis of inter- vs intra-national trade. Second, we have better data coverage and quality for French firms in the Amadeus+MIP database, and we can further complement this information with the EAE database. Third, Eaton et al. (2004) provide evidence that French and US firms are very similar in terms of share of exporters, export intensity, etc. We exploit this similarity to give a richer description of the moments of various statistics in the population, referring to data from the US Census of Manufactures, as reported by Bernard et al. (2003).

1. **The share of firms that export**. In 2000, the share of exporters in the whole population of French manufacturing firms was equal to 22.26 %. This figure can be considered as fairly stable over time.[19] Eaton et al. (2004) report that 20% of the whole population of French manufacturing firms (roughly 40,000 out of 200,000) were exporters in 1986. This can also be compared to a 21% share of US firms exporting in 1992. Based on our calibration, 14.73% of French firms should export in 2000, which is close to the real share. For the sake of comparison, in Bernard et al. (2003) the simulated share of US exporters in 1992 is 51% compared with the observed 21%. Moreover, the region with the highest share of exporters is

[19] We thank Benjamin Nefussi of CREST-INSEE for computing this figure for us, using the appropriate dataset.

the "Nord-Pas de Calais" close to the border with Belgium - that Eaton et al. (2004) shows to be the most popular foreign destination for French exporters. "Ile de France" (the Greater Paris region) comes a close second.

2. **The size advantage of exporters.** When size is measured by domestic sales, exporters in the EAE dataset are 4.33 times greater than non-exporters. This compares to a predicted size advantage of 3.85 in our model. For the US, Bernard et al. (2003) report that exporters sell 4.8 times more than non-exporters on the US market. The top three regions in terms of this ratio are again "Nord-Pas de Calais", "Champagne-Ardennes" and "Ile de France".

3. **The productivity advantage of exporters**. In the EAE database, the productivity advantage of exporters over firms selling only on the domestic market is equal to 27.32%. This figure is likely to be underestimated since the database only covers French firms with more than 20 employees, many of which (73%) are exporters. For the US Bernard et al. (2003) report a 33% advantage. They use this difference in averages to calibrate their productivity variance parameter θ (which is closely related to our k_s), for which they find a value of 3.6. In contrast, our model predicts a 132% productivity advantage of exporting firms, which seems far too high. However, by re-scaling the k_s's from an average of 2.10 to an average of 3.73 we obtain a 33% productivity advantage, and we show in section 7 that our estimates are fairly robust to changes in the k_s of similar magnitude. "Nord-Pas de Calais" "Champagne-Ardennes" (also on the Belgian border) and "Ile de France" rank first, second and third in terms of the lowest productivity advantage of exporters.

4. **The fraction of revenues from export**. Here we exploit the observation by Eaton et al. (2004) that the distribution of exporters by their share of export revenue over total revenue is quite similar in the US and in France.[20] In Table 10 we compare the actual US distribution of this statistic with the predictions in Bernard et al. (2003) and our predictions. The second column, taken from Bernard et al. (2003), shows the actual percentage of exporting US firms getting a given share of their revenues from exports in 1992. The third column reports the simulated export intensity of US firms by Bernard et al. (2003), while the fourth column shows the results of our simulations for France. The actual distribution of export intensity is strongly skewed with 66% of the exporters getting less than 10% of their revenues from abroad. This feature is nicely captured in the simulations of Bernard et al. (2003), even though virtually no firm should sell more than 30% abroad. Our simulations do not match the high share of exporters declaring very little exports, but are still able to predict that few firms will get more than 30% of their revenues from abroad. The fit of our simulations to actual export intensity could be improved if we considered smaller values of k_s (but at the cost of a poorer match of the productivity advantage of exporters). Overall the model of Bernard et al. (2003) does a better job in predicting export intensity. Interestingly enough, the distribution of export intensity in Paris is very skewed in our simulations with 53% of exporters selling less than 20% abroad.

5. **Variability in size**. In the EAE database, the standard deviation of the log of domestic sales is 1.30, compared to 1.08 in our simulations. In our model heterogeneity in underlying efficiency explains 69% of the variance across sectors in log domestic sales. For the sake of comparison, in Bernard et al. (2003) the actual and simulated standard deviation in log domestic sales are 1.67 and 0.84 respectively; therefore heterogeneity in productivity explains

[20] The only noticeable exception is that in France more firms (but still less than 3% of exporters) make more than 90% of their revenues abroad.

Table 10: Export Intensity

Export intensity of exporters in %	Observed US	Simulated BEJK	Our Simulations
0 to 10	66	76	15.6
10 to 20	16	19	19.4
20 to 30	7.7	4.2	15.2
30 to 40	4.4	0.0	11.6
40 to 50	2.4	0.0	10.3
50 to 60	1.5	0.0	9.5
60 to 70	1	0.0	7.9
70 to 80	0.6	0.0	7.8
80 to 90	0.5	0.0	2.7
90 to 100	0.7	0.0	0.0

only 25% of the variance. As suggested by these authors, the unexplained variability could come from heterogeneity in tastes and demand weights across products, which both models fail to take into account.

6. **Variability in productivity**. In our framework, the variability of productivity (captured by k_s) is obtained through TFP estimations. The overall standard deviation in our log-TFP estimates is 0.58. This figure is roughly comparable to the standard deviation of the log of value added per worker *directly observed* in US Census data, which is equal to 0.75. While we calibrate our model on this statistic, Bernard et al. (2003) predict it, and find a value of 0.35, thus explaining only 22% of the variance in the log of productivity by heterogeneity in the underlying technology. To account for this underprediction, they argue that measurement errors in the US Census data can cause excess observed heterogeneity.[21] However, our methodology can shed additional light on their underprediction. Indeed a possible explanation is that they do not break down manufacturing into different sectors. By doing that in our framework, we find that the average within-sector standard deviation is 0.45. This amounts to productivity differences *across* sectors explaining as much as 40% of the overall variability in our framework.

In summary, not only does our model pick up some well-known qualitative features of plant-level data on export and productivity, but its calibration also goes quite far in fitting observed magnitudes.

6.2 Prohibitive *international* trade barriers and the 'costs of non-Europe'

Our first experiment consists in simulating productivity levels with non-Europe, understood as the imposition of prohibitive *international* trade barriers between the 11 EU countries, all else equal.

In order to get an idea of the magnitude of this effect at the *country* level and to evaluate how our results are sensitive to the splitting up of France into 21 sub-national units, Table 11 compares the average (across sectors) 'costs of non-Europe' by country in our 31-economy simulation to

[21] This is why they did not recover their variance parameter θ from actual productivity data in the first place, as we do.

those of a simpler 11-country simulation in which we treat France as a single economy.[22] Costs are measured as minus percentage changes in mean productivity with respect to the observed value in the year 2000. In the 31-economy model, the figure for France denotes an average taken across regions. Detailed 'costs of non-Europe' for each French region are reported in the next subsection where we compare them to the 'costs of non-France'

Table 11: The loss in average productivity from non-Europe in the two models : OLS estimations.

Country name	Country code	Cost of Non-Europe (%): 31-economy model	Cost of Non-Europe (%): 11-country model
Belgium	BE	18.78	17.14
Germany	DE	16.94	24.06
Denmark	DK	21.84	22.29
Spain	ES	10.40	10.31
Finland	FI	11.98	12.80
France	FR	8.08	13.20
Great Britain	GB	3.22	3.40
Italy	IT	6.58	6.98
Netherlands	NL	13.99	12.52
Portugal	PT	3.27	4.89
Sweden	SE	12.06	12.02
Average		11.56	12.69

Based on our simulations, the elimination of international trade reduces average productivity by 12.69% in the 11-country model and by 11.56% in the 31-economy model. These are sizeable numbers and suggest that the selection effect is an important channel through which the benefits of international trade materialize. In addition, the two estimates by country are very close to each other in all countries but France. The difference in the two numbers for France can be attributed to our method of computing within-economy distances, based on a disk-shaped economy approximation and the assumption of uniformly distributed consumers. Due to this approximation, we are likely to overestimate the real distance between sellers and consumers, thus reducing the importance of the 'intra-national' selection effect relative to the 'international' channel. As the approximation is less accurate when we consider France as a single economy, it is not surprising that we find a greater effect of the international selection effect in that framework. In this respect, splitting up France into 21 economies should provide more accurate results than in Del Gatto, Mion and Ottaviano (2006).

6.3 Prohibitive inter- and intra-national trade barriers, losses from autarky, and the 'costs of non-France'

We now compare the magnitude of the costs of non-Europe and costs of non-France for our 21 French regions. Results are shown in Table 12.

Costs of non-Europe Column five of Table 12 reports the 'costs of non-Europe' defined as minus percentage changes in mean productivity between the observed value in the year 2000 - $1/(c_s^h$ trade) - and the simulated scenario - $1/(c_s^h$ no EU trade). [23] For France as a whole, inhibiting international trade induces a productivity loss of 8.08%. This corresponds, using equation (13), to a 10.31% increase in average prices and markups and a 19.61% (7.12%) increase in average profits (quantities).

[22] The 11 countries simulation exercise has originally been performed in Del Gatto, Mion and Ottaviano (2006). Their estimations are slightly different from ours because we exclude the 'Petroleum and Coal' industry.

[23] As already said, the mean of the Pareto distribution $1/c$ is just a scaling of the lower bound of the support and this applies also to the distribution of costs c. We can thus compute percentage changes in average productivity simply as percentage changes in the relevant cutoff.

Table 12: Average productivity losses from 'non-Europe' and 'non-France' (French regions): OLS estimations.

Region name	NUTS 2 code	c_s^{hh} trade	c_s^{hh} no EU trade	'costs of non-Europe' (%)	c_s^{hh} no FR trade	'costs of non-France' (%)
Ile de France	FR10	0.042	0.044	-0.06	0.046	5.31
Champagne-Ardennes	FR21	0.052	0.063	13.35	0.081	32.99
Picardie	FR22	0.053	0.064	12.42	0.080	31.76
Haute-Normandie	FR23	0.051	0.056	8.04	0.067	21.10
Centre	FR24	0.053	0.061	10.07	0.079	31.80
Basse-Normandie	FR25	0.059	0.067	12.58	0.078	23.77
Bourgogne	FR26	0.053	0.056	5.48	0.081	33.12
Nord-Pas de Calais	FR31	0.052	0.057	6.78	0.060	11.67
Lorraine	FR41	0.052	0.058	11.87	0.067	22.50
Alsace	FR42	0.05	0.054	8.84	0.064	21.95
Franche-Comté	FR43	0.054	0.058	8.9	0.077	29.87
Pays de la Loire	FR51	0.052	0.055	5.61	0.070	25.50
Bretagne	FR52	0.053	0.062	8.15	0.069	22.39
Poitou-Charentes	FR53	0.055	0.058	5.32	0.079	30.06
Aquitaine	FR61	0.051	0.059	13.09	0.069	25.63
Midi-Pyrénées	FR62	0.051	0.056	9.31	0.069	24.75
Limousin	FR63	0.056	0.06	2.63	0.085	32.34
Rhône-Alpes	FR71	0.049	0.051	4.52	0.062	20.17
Auvergne	FR72	0.053	0.055	4.34	0.078	30.22
Languedoc-Roussillon	FR81	0.053	0.058	9.01	0.070	25.48
PACA	FR82	0.047	0.052	9.45	0.059	20.02
Average		0.052	0.057	8.08	0.071	24.88

Looking at detailed regional patterns uncovers a rich variability in the losses ranging from the -0.06% of Ile de France (the Greater Paris region) to the 13.35% of Champagne-Ardennes. The overall French average of 8.08% thus blurs a complex regional picture revealed by our simulations, suggesting that inter-regional disparities should not be neglected in this type of analysis. To what extent does geography account for these differences? Figure 1 shows the spatial distribution of the 'costs of non-Europe', while Figure 2 plots a measure of the accessibility of each region to international trade. This measure is equal to the average (across sectors and foreign origins) of the estimated ρ_s^{lh} excluding the ρ_s^{ll}: more precisely, $\bar{\rho}^h = \sum_s \sum_l \hat{\rho}_s^{lh}/((M-1)S)$, for $l \neq h$. The correlation is positive, as expected, but rather low (0.16). However, excluding Paris, which is something of an outlier in the data, increases the correlation to 0.27. While geography has some explanatory power, these findings suggest other determinants of the regional variability of the 'costs of non-Europe', namely differences in the underlying industry technology and entry barriers (as captured by the parameters $\psi_s^l/(\gamma_s f_s^l)$). In the model, economies having a better technology or lower entry costs enjoy greater gains from international trade (and therefore higher 'costs of non-Europe'). We can observe this in the particular case of the Paris region. The (inferred) underlying manufacturing technology in this region is found to be the worst in France (lowest $\psi_s^l/(\gamma_s f_s^l)$), while Paris has the highest observed productivity (see Table 9). In other words, once controlled for the size and density of the local market (relatively very high in Paris), and its accessibility to foreign markets, by means of equation (12), the model reveals that Paris is not very productive in the manufacturing sector. The high observed productivity is essentially due to the very strong internal competitive environment, that fosters selection of the best firms. That is why Paris would even slightly gain (negative cost) if trade with other very competitive EU firms were to be inhibited.

Costs of non-France The last column of Table 12 reports the 'costs of non-France', defined as minus percentage changes in mean productivity between the value observed in the year 2000 and the counterfactual value of $1/(c_s^h$, which we respectively denote by c_s^h trade and c_s^h no FR trade). For France as a whole, inhibiting intra-national trade would cause a productivity loss of 24.88%. This loss corresponds to a 36.03% increase in average prices and markups and a 69.28% (23.03%)

increase in average profits (quantities).

Interestingly, the difference between the productivity losses coming from the two channels does not seem to come from specialisation in intra-national trade. Indeed, French exports to our 10 destination countries account (in the year 2000) for 61% of overall exports and 22% of overall output in the French manufacturing sector, while $22,5\%$ of a French region's production on average is shipped to other French regions.[24] Although the magnitude of the two types of trade is thus virtually the same, competition from national firms has a stronger impact on regional productivity, due to proximity. Put differently, even though French firms are exposed to foreign competition of very productive firms in, say, Germany or Denmark, they are relatively far away from them (as measured by our trade freeness estimations) compared to their French competitors.

We pause here by noting that France is a relatively large compact-shaped country. The relative importance of intra- versus international competition in determining firm survival, selection and productivity might vary in other European countries. Of course, results might be very different for a smaller country like Belgium or for a long and narrow-shaped country like Italy. Another caveat is that we are not considering (for lack of comparable data) trade with other important developed (like the US and Japan) and developing (like India and China) countries. We must therefore be underestimating the productivity gains from the international trade channel. Nevertheless our simulations do suggest that, while the general debate about competition focusses on the international market, intra-national firm competition is still very important.

Disaggregating the 'costs of non-France' by region again reveals substantial variability in productivity losses, ranging from the 5.31% of Ile de France to the 33.12% of Bourgogne. Figure 3 shows the spatial distribution of the 'costs of non-France', while Figure 4 plots a measure of the accessibility of each region to intra-national trade as measured by the average (across sectors and French regions) of the estimated ρ_s^{lh} excluding ρ_s^{ll}. The correlation is now a bit lower than before (0.10), but excluding Paris raises it substantially (0.55) again. These results suggest that accessibility is (with the exception of Paris) relatively more important than differences in competitiveness within French boundaries.

Table 13: Effect of intra- and international trade barriers on average French productivity by sector: OLS estimations.

Industry code	Industry description	Costs of non-Europe (%)	Costs of non-France (%)	δ_s
1	Food beverages and tobacco	6.63	23.82	-1.8739
2	Textiles	15.93	28.71	-1.1218
3	Wearing apparel except footwear	15.07	33.02	-1.4483
4	Leather products and footwear	22.68	27.03	-1.1913
5	Wood products except furniture	5.45	17.54	-2.1968
6	Paper products	8.86	29.45	-1.5381
7	Printing and Publishing	2.31	13.01	-2.6793
9	Chemicals	6.92	30.84	-1.5035
10	Rubber and plastic	-3.06	20.32	-1.7645
11	Other non-metallic mineral products	8.26	22.51	-1.8935
12	Metallic products	7.16	28.19	-1.5784
13	Fabricated metal products	2.63	17.06	-1.8642
14	Machinery except electrical	5.03	20.66	-1.6296
15	Electric machinery	5.2	32.44	-1.2096
16	Professional and scientific equipment	9.04	27.89	-1.6514
17	Transport equipment	9.93	27.78	-1.6065
18	Other manufacturing	7.92	22.63	-1.8721
Average		8.08	24.88	-1.6837

We now turn to a comparison of these costs for France across industries. Table 13 shows the sectoral disaggregation of the average costs of non-Europe and of non-France for French regions.

[24] We thank Miren Lafourcade for computing this figure for us, using the intra-national commodity flow data from the SITRAM database.

As in Del Gatto, Mion and Ottaviano (2006), these costs vary considerably across industries. This result suggests that a simple one-sector macro perspective of trade and selection, as in Bernard et al. (2003), is far from being satisfactory. Columns 3, 4 and 5 reveal a high correlation across sectors between the costs of autarky and the elasticities of trade with respect to distance (δ_s). Both the 'costs of non-Europe' and the 'costs of non-France' are highly correlated with these elasticities (respectively 0.59 and 0.83). Therefore trade openness appears as a key factor to explain the magnitude of competition and selection in each sector.

6.4 'United Europe': removing border effects

We now compute counterfactual average productivity levels when the obstacles to trade that are captured by border effects in our gravity equation (legal, informational, technical costs...) are negligible. More precisely, we compute a new freeness of trade matrix and the corresponding cutoff productivity levels, setting all $\beta^h = 0$. This experiment corresponds to an (asymmetric) decrease of trade costs by 34.02%.

This trade cost equivalent variation might seem quite large. However, our estimate of β^h (the average border effect taken across countries) is equal to -0.97, whose absolute value belongs to the lower bound of recent studies.[25] In this sense, our subsequent estimates of the productivity gains from eliminating border effects should be considered as relatively 'prudent'. Nevertheless, some issues with respect to the interpretation of the elimination of border effects should be kept in mind before we show our simulation results. First, divergent national interests and the political influence of producer lobbies may prevent a complete integration process. Second, Wolf (2000) and Combes et al (2005), provide evidence that border effects also exist within a country, making questionable whether a 'complete' elimination of the international border effects is really feasible. Indeed, such 'persistent' border effects may not reflect any trade impediment but instead emerge as an empirical artifact stemming from the co-location of industries with vertical linkages. In this respect, Chen (2004) shows that the co-location mechanism has some impact on the estimation of border effects across Europe.

Table 14 exhibits the magnitude of the average productivity gain for our 11 countries, while Table 15 displays the same results for French regions.

Table 14 reveals considerable heterogeneity across countries, with productivity increases ranging from 1.17% for Portugal to 60.18% for Germany. Moreover, most of the gains are due to Germany, Belgium, and Denmark, whose competitiveness, as measured by $\psi_s^l/(\gamma_s f_s^l)$, is among the highest in the sample[26]. Overall the increase in productivity is large (19.80%). It corresponds to a 13.14% reduction of average markups and prices and a decrease of 22.57% (12.96%) in average profits (quantities). These numbers suggest that substantial gains can still be expected from further behind-the-border integration in the EU.

Gains for France amount to 8.86%. Adding this figure to the 8.08% gain from not being under autarky in 2000 yields an hypothetical 16.94% total productivity gain from international trade. This number is much closer to the 24.88% productivity boost coming from intra-national trade competition. This suggests that, even for a large and compact country like France, international trade (especially as we neglect trade with other partners) is likely to become a major channel

[25] See Anderson and van Wincoop (2003) and Chen (2004).

[26] In unreported simulations, we have also computed productivity levels in the absence of border *and* language effects. For Belgium and Germany we find much reduced values (in the 30-35 % range). This is likely to come from the fact that these two countries enjoy high productivity levels and share a common language. In our counterfactual scenario, bilateral trade between these countries creates artificially high productivity gains, which decrease substantially when language barriers to trade disappear in other countries.

Table 14: Gains from removing border impediments to trade: OLS estimations, countries.

Country name	Country initials	Gains from removing the border effect (%)
Belgium	BE	42.30
Germany	DE	60.18
Denmark	DK	35.98
Spain	ES	18.37
Finland	FI	15.01
France	FR	8.86
Great Britain	GB	3.61
Italy	IT	6.37
Netherlands	NL	9.66
Portugal	PT	1.17
Sweden	SE	16.28
Average		19.80

Note: the figure for France denotes an average taken over regions.

through which competition and selection stimulate productivity growth.

7 Robustness concerns

In this section we examine how robust our three counterfactual estimates are to changes in the techniques used to estimate TFP and trade frictions. We start by presenting these alternative techniques, then present the results.

7.1 Robustness checks

Levinsohn-Petrin estimation (LP) The OLS estimation of total factor productivity may suffer from a simultaneity bias. Indeed, managers may hire factors after observing idiosyncratic productivity shocks unknown to the econometrician. A greater realization of the shock will lead to greater factor demand. Then observed factor quantities will be correlated with the residual of the OLS regression in (20).

The bias can be removed by identifying an observable proxy variable for these shocks and introducing it as an additional regressor in (20). The proxy must be such that, according to economic theory, it can be expected to respond to the TFP realization observed only by the firm. Olley and Pakes (1996) use investment as an additional regressor, while Levinsohn and Petrin (2003) - henceforth LP - use intermediate inputs. Due to data availability constraints on investments, we can only use the latter technique. Furthermore, the Amadeus dataset does not include information on the cost of materials for Denmark and the UK, forcing us to restrict ourselves to 8 national and 21 sub-national economies.[27]

Aggregate productivity (AP) As a second robustness check, we use data on value-added per hour worked by sector-country pairs provided by the Groningen Growth and Development

[27]This is another reason why we chose to rely on OLS rather than LP estimates in the previous section. In addition, returns to scale estimated with this technique are in some cases significantly smaller than one. This is likely to come from heterogeneous definitions of input consumption across countries in the Amadeus dataset.

Table 15: Gains from removing border impediments to trade: OLS estimations, French regions.

Region name	NUTS 2 code	Gains from removing the border effect (%)
Ile de France	FR10	0.06
Champagne-Ardennes	FR21	-7.18
Picardie	FR22	3.52
Haute-Normandie	FR23	13.91
Centre	FR24	9.62
Basse-Normandie	FR25	23.04
Bourgogne	FR26	6.66
Nord-Pas de Calais	FR31	-2.46
Lorraine	FR41	-2.22
Alsace	FR42	1.83
Franche-Comté	FR43	5.37
Pays de la Loire	FR51	8.57
Bretagne	FR52	16.32
Poitou-Charentes	FR53	5.12
Aquitaine	FR61	38.23
Midi-Pyrénées	FR62	15.24
Limousin	FR63	2.86
Rhône-Alpes	FR71	6.07
Auvergne	FR72	4.32
Languedoc-Roussillon	FR81	17.13
PACA	FR82	19.98
Average		8.86

Centre (GGDC).[28] This robustness check allows us to address concerns with country coverage and sample representativeness in the Amadeus dataset. Country coverage concerns apply particularly to Denmark, Germany and Portugal, even though in the German case we were able to complement our data with the MIP dataset (provided by ZEW) to make this problem less severe. Sample representativeness concerns apply to all countries as the Amadeus and, to a lesser extent, the EAE dataset are biased towards large firms.

The GGDC data represent the most accurate and comparable measures of productivity at the industry level. Moreover, these measures, contrary to ours, are deflated by industry-specific producer price indices. However, the drawback of these data is that they do not take capital intensity into account.

Single-region firms (SR) A third concern regards French firms that own plants in several French regions. In this case, it is in fact not clear to which region we should attribute the productivity of the firm. While the EAE survey does allow us to distinguish between productive and non-productive establishments, it does not contain sufficient information to reconstruct the value added created by each plant. To address this concern, we simply exclude from our sample firms that operate plants in several regions. We are left with 19279 French firms (instead of 23203) to recover the distribution of TFP.

[28] Data on productivities come from the ICOP Industrial Database (New Benchmarks), at the NACE rev. 1 sector level. To convert these data to our 18-industry classification, we weight observations by total hours worked found in the GGDC 60-Industry Database. These data are available at *http* : *//www.ggdc.net*

Shape parameter (k) A fourth robustness check regards the estimation of the shape parameter k_s of the Pareto distribution of TFP. As argued by Bernard et al. (2003), TFP estimates are very likely to be biased because of measurement errors. Even if we take the optimistic view that these errors are uncorrelated with the 'true' unobservable productivity, this should deflate the estimate parameter k_s. This is because measurement errors add to the variability of TFP, whose standard error is a decreasing function of k_s under the Pareto assumption.[29]

Bernard et al. (2003) assume that the productivity of the most efficient producer of each good follows a Fréchet distribution. Their solution to the measurement error problem consists in inferring the shape parameter of this distribution from aggregate data. They proceed by matching the productivity and size advantage of exporters between simulation results and actual data. While this indeed solves the measurement error problem, it comes at the cost of imposing more assumptions on demand and market structure to recover the average productivity of exporters.

The absence of reliable data on exports in the Amadeus database prevents us from replicating the Bernard et al. (2003) exercise on a comparable basis for all economies. However, as a simple robustness check, we apply the figure found by these authors for the entire manufacturing in the U.S. (namely $k_s = 3.6$, for all sectors) to reconstruct our productivity counterfactuals.

Alternative border effects (ABE) A fifth robustness check regards the estimation of the country of destination-country-specific border effects. As is well-known in the literature, the magnitude of border effects is highly sensitive to both the estimation and the distance measurement methods.[30] Therefore our counterfactuals, and in particular the 'United Europe' experiment, might be also sensitive to alternative borders' estimations.

Starting from the very high value (-3.09) initially found for trade between Canadian provinces and US states by McCallum (1995), the literature has subsequently shown that border effects are of a much smaller magnitude with fixed effects for origin and destination countries being a useful tool to get reliable estimates.[31] Using this technique in our baseline estimation of gravity we find an average border effect of -0.97, which belongs to the lower bound of recent studies and is comparable to the estimate in Chen (2004) for Europe (-1.32). In this sense, our subsequent estimates of the productivity gains from eliminating border effects should be considered as relatively 'prudent'. Nevertheless, as shown by Head and Mayer (2002), using the arithmetic mean in the computation of distance based on sub-economy units - i.e setting $\theta = 1$ in equation (18) - also inflates border effects. To deal with this problem we perform an additional robustness check by adopting the alternative distance measure (ditwces) obtained using the harmonic mean ($\theta = -1$).

Internal distances (ID) The sixth robustness check applies to the measurement of internal distances. In our baseline simulations we measure them by using the weighted distance across sub-units or, when we deal with intra-NUTS3 distances, by means of the disk-shaped approximation. These internal distances are important because they allow us to introduce border effects in the gravity equations, i.e. to measure how disproportionately an economy trades with itself after controlling for distance.

However, it has been argued that internal distances suffer from mis-measurement and some researchers (like Bernard et al., 2003) prefer to use the (rather strong) assumption that intra-

[29] If X has a Pareto distribution with shape parameter k, then the standard error of $\ln(X)$ is equal to $\frac{1}{k}$. Consider then the standard error of $\ln(\hat{Prod}_{i,OLS}) = \hat{const} + \hat{\epsilon}_i$. As long as there is an uncorrelated measurement error in the estimates of $const$ and ϵ_i, the standard error of $\hat{const} + \hat{\epsilon}_i$ should be greater than that of $const + \epsilon_i$. Therefore the parameter k should be underestimated.

[30] See Head and Mayer (2002) and Chen (2004).

[31] See Anderson and van Wincoop (2003).

economy trade comes at no distance cost (in our terminology, that $\rho^{ll} = 1, \forall l$). To a certain extent, this just amounts to a choice of unit. Nevertheless, it is unlikely that the cost of shipping goods within a small country like Belgium is the same as the cost of shipping goods within Germany.

In order to neutralize the effect of internal distance mis-measurement, we first eliminate intra-national trade observations from the estimation of the gravity equation, i.e. those data that require internal distances. Note, however, that in this case border effects cannot be estimated anymore. Second, we choose the distance measurement unit in such a way that the intra-economy freeness of trade parameters in each sector (as hypothetically reconstructed from internal distances and the estimated elasticity of trade with respect to distance) equals 1 *on average* and we then actually set all ρ^{ll}'s equal to one.

Poisson Pseudo-Maximum Likelihood estimation of gravity equations (PPML) Another potential concern is the bias in our distance elasticity estimates. As shown by Santos Silva and Tenreyro (2006), interpreting the parameters of log-linearized models estimated by OLS (such as standard gravity regressions) as elasticities can lead to a serious bias when the true model is defined in levels and heteroscedasticity is at work. As a further robustness check, we thus apply the PPML estimation technique developed by these authors to our gravity model.

Regional trade data (RT1 and RT2) Finally, we also consider French regional trade data in order to get a more accurate measure of trade freeness between those regions and the 10 destination countries. In one robustness check (RT1) we enrich the CEPII data with imports and exports between French regions and our set of European countries when estimating the gravity equation (19). This augmented dataset should in principle allow us to get a more detailed picture of trade between our 31 economies. However, the match between the original NSTR (Nomenclature for Transport Statistics) coding of the regional trade data (by product) and our sectoral classification is sometimes problematic (especially for the Food industry). Furthermore, we do not have reliable data on the value of local French production by sector that are needed in order to estimate apparent regional consumption (EXP_s^{ll}). For both reasons we use CEPII international trade data as the baseline estimation.

As an attempt to get a more precise measurement of intra-France trade costs, we also consider alternative values of the elasticity of intra-national trade with respect to distance as provided by Combes et al. (2005). Their gravity regressions are based on data on commodity flows between French *départements* (NUTS3 regions) coming from the SITRAM database. The major drawback of these data is that they do not necessarily correspond to 'trade' between two given locations but simply shipments: goods arrived at the recorded destination may well be subsequently shipped to another French *département* or outside France for final consumption. Moreover, the commodity flow data provide only information about the quantity in physical units (weight), and not about their value. However, in the most comparable estimation of gravity, they find an average elasticity δ_s across sectors of -1.76 which is just 5% higher than our -1.68.[32] To check the sensitivity of our results to a different intra-France trade cost structure, we perform a further robustness check (RT2) in which we re-scale our δ_s (to match the average -1.76) in the computation of ρ_s^{lh} whenever l and h correspond to two French regions.

[32]The fact that the elasticity of trade with respect to distance is higher for intra-national compared to international trade is likely to be related to different transportation modes. Intra-national trade uses mainly ground transportation, which is shown by Disdier and Head (2004) to yield higher distance coefficients.

7.2 Results

Costs of non-Europe Table 16 offers a range of estimates of the 'costs of non-Europe' obtained through all our robustness checks. For the sake of comparison, we also report the OLS estimates presented in the previous Section.

First, we can observe that our new estimates are roughly consistent with the OLS estimates in all cases. Indeed, the European (including French) average cost of non-Europe amounts to a 11.58% productivity loss with OLS estimations, while it ranges from 9.72 to 17.20 % under alternative estimations. Note that the smallest figure is found under LP estimations, which involve a smaller number of economies due to data availability. It should therefore come as no surprise that the gains from EU trade are slightly underestimated with this technique.

Table 16: Costs of non-Europe: robustness checks.

Economy	OLS	LP	AP	SR	k	ID	ABE	PPML	RT1	RT2
BE	18.78	13.65	28.53	18.78	16.99	25.71	19.32	26.06	19.98	18.80
DE	16.94	21.19	7.61	16.96	22.51	11.47	21.02	23.82	18.35	16.97
DK	22.04	n.a.	33.21	22.06	22.24	24.22	20.15	33.54	25.43	22.08
ES	10.40	9.66	10.62	10.41	10.97	3.73	3.39	12.14	9.79	10.40
FI	11.98	13.70	23.63	11.99	10.63	7.78	18.46	13.97	13.92	11.99
GB	3.22	n.a.	5.51	3.22	3.71	2.25	3.04	5.63	3.91	3.22
IT	6.58	5.29	12.81	6.59	5.57	2.56	7.55	9.86	7.34	6.59
NL	13.99	15.15	21.39	13.99	13.24	17.63	16.85	20.33	14.67	14.00
PT	3.27	-3.79	2.11	3.27	3.07	5.14	4.65	6.62	3.79	3.27
SE	12.06	6.54	25.43	12.06	8.92	6.03	14.08	18.07	13.25	12.06
FR10	-0.06	-0.10	-0.05	-0.08	-0.02	8.30	0.39	-0.11	-0.10	-0.05
FR21	13.35	19.37	29.63	12.89	14.79	21.17	20.87	14.17	16.00	19.67
FR22	12.42	8.16	21.83	12.87	9.16	-3.63	16.20	13.32	12.05	15.44
FR23	8.04	1.79	16.29	8.19	7.42	20.31	21.15	12.15	6.28	9.77
FR24	10.07	6.12	20.10	10.06	9.58	12.96	15.32	11.08	10.54	13.06
FR25	12.58	1.68	21.57	13.13	10.04	23.04	22.52	15.90	12.37	15.12
FR26	5.48	3.74	14.57	5.67	5.50	11.68	12.34	3.26	5.71	7.94
FR31	6.78	8.60	15.25	7.73	5.18	18.40	17.23	-2.38	10.26	10.33
FR41	11.87	11.26	24.97	11.61	8.15	16.82	18.13	13.44	12.49	14.32
FR42	8.84	8.38	25.28	8.77	8.03	25.37	17.54	15.65	9.73	10.78
FR43	8.90	7.75	20.72	10.54	8.90	19.52	16.40	11.80	9.49	10.93
FR51	5.61	4.12	12.93	5.90	4.87	13.26	12.26	3.65	6.47	7.75
FR52	8.15	6.18	31.30	9.67	16.76	21.85	22.86	20.57	10.97	14.48
FR53	5.32	3.63	12.80	5.20	6.56	15.53	13.10	1.00	6.35	7.18
FR61	13.09	11.63	24.90	13.39	13.68	21.68	23.28	17.28	12.53	15.78
FR62	9.31	8.25	20.30	8.77	9.32	20.43	19.55	14.41	11.27	11.55
FR63	2.63	1.87	9.72	2.52	1.42	12.01	11.23	1.33	3.18	4.06
FR71	4.52	3.92	13.00	4.55	3.63	8.91	8.66	5.95	5.13	6.08
FR72	4.34	3.19	11.10	4.41	-2.21	14.58	12.13	3.62	4.98	5.98
FR81	9.01	7.31	18.33	6.43	9.74	18.42	18.23	13.02	10.50	11.16
FR82	9.45	8.21	19.90	9.55	10.66	18.61	15.92	12.83	4.04	11.59
France	8.08	6.09	18.31	8.18	7.67	16.15	15.97	9.62	8.58	10.62
Europe	11.58	9.72	17.20	11.59	11.41	11.15	13.13	16.33	12.64	11.82

Second, it appears that the OLS estimates slightly understate the extent of the 'costs of non-Europe'. However, we take comfort in the fact that the alternative estimates are extremely cor-

related with the OLS ones, suggesting a simple difference in scale. For instance the correlation between AP and OLS estimates is equal to 0.72 (and 0.84 if we exclude Germany).[33] Under the AP simulation, one may further note that the French cost of non-Europe is actually pretty high. This happens because labor productivity in France is the second highest in our sample. Therefore France is now predicted to have a better underlying technology and greater gains from trade with other partner countries.

The SR and k estimates are virtually identical to the OLS, while ABE ones suggest a higher cost of non-Europe for France. This latter result is due to the smaller estimates of border effects (the average is now -0.25) obtained with *distwces* that make observed international trade freer and so more costly to abandon. PPML results are also highly correlated (0.90) with our baseline. A greater magnitude was also to be expected under PPML as the literature finds smaller estimates of distance elasticities with this technique: for instance, Santos Silva and Tenreyro (2006) report coefficients that can be twice as small as in OLS estimations. With less severe trade frictions, rivals at a given distance will impose more competitive pressure on home firms. It follows logically that the cost of inhibiting international trade should be greater.

Table 17: Costs of non-France: robustness checks.

Economy	OLS	LP	AP	SR	k	ID	ABE	PPML	RT1	RT2
FR10	5.31	4.69	6.89	1.69	6.35	22.56	6.38	18.46	5.61	4.33
FR21	32.99	36.40	34.73	33.05	24.06	38.80	35.76	44.04	34.91	32.38
FR22	31.76	35.18	32.32	32.56	18.69	36.72	33.86	40.28	33.00	31.74
FR23	21.10	22.27	20.47	21.05	15.58	32.19	27.33	32.71	21.21	20.23
FR24	31.80	34.11	32.48	31.45	23.77	24.74	33.31	38.87	31.96	31.27
FR25	23.77	25.36	23.43	24.51	16.01	26.61	26.27	33.62	24.70	22.99
FR26	33.12	35.16	33.28	33.97	25.30	33.17	35.75	42.58	34.00	32.48
FR31	11.67	15.42	12.04	12.77	7.10	26.28	18.47	24.36	14.81	12.43
FR41	22.50	24.39	23.63	22.10	16.95	28.36	26.30	33.88	24.10	21.89
FR42	21.95	23.95	23.35	21.99	13.99	32.48	26.29	34.96	23.82	21.09
FR43	29.87	32.68	31.85	32.56	21.85	36.05	33.02	40.88	31.52	29.02
FR51	25.50	26.84	25.35	26.36	18.97	22.22	26.23	34.60	25.84	24.93
FR52	22.39	23.34	24.83	22.46	16.90	18.19	23.41	33.47	21.20	21.77
FR53	30.06	31.86	31.30	29.17	21.98	28.25	32.17	39.24	30.65	29.29
FR61	25.63	26.06	26.43	26.64	18.53	21.88	26.73	35.13	25.02	24.96
FR62	24.75	25.39	26.12	24.23	13.55	23.11	25.36	34.32	25.68	24.08
FR63	32.34	33.46	32.49	32.42	23.32	39.69	36.19	42.43	33.75	31.19
FR71	20.17	21.68	21.54	20.30	15.90	18.07	20.03	30.05	21.14	19.69
FR72	30.22	31.47	31.76	30.80	20.32	34.64	33.57	40.20	31.62	29.33
FR81	25.48	26.13	26.43	22.36	17.78	23.81	26.35	35.53	27.13	25.21
FR82	20.02	20.80	21.54	21.65	16.80	19.20	20.59	32.07	21.96	20.42
France	24.88	26.51	25.82	24.96	17.80	27.95	27.30	35.32	25.89	24.32

Some differences arise with ID estimates. The correlation with OLS estimates is still high (0.43), but with no internal trade frictions smaller economies (like Belgium or French regions) systematically lose more from the elimination of international trade. This comes as no surprise because by setting the internal freeness of both large and small countries to the same value we are systematically over(under)estimating the contribution of the internal competition of large (small)

[33] As mentioned earlier, there is a potential bias towards firms coming from former West Germany in the Amadeus dataset. We can only partly correct this bias by using the MIP dataset.

countries on their productivity. As a result a large (small) country appears to have an inferior (superior) technology. Finally, as for RT1, there is basically no major difference with respect to OLS and for RT2, unsurprisingly, constraining intra-national trade to have a higher elasticity with respect to distance increases the impact of international trade on selection and productivity for France.

Costs of non-France The results of the same robustness checks on the estimation of the 'costs of non-France' are displayed in Table 17. The correlation between the baseline OLS and other specifications is even stronger here, with only SR and ID results being slightly different for Paris (FR10). As for SR, some very productive Parisian firms have plants located in many regions. Neglecting these firms results in underestimating that region's underlying competitiveness parameter $\psi_s^l/(\gamma_s f_s^l)$, and therefore the gains from trade. Concerning the ID case, since the Paris region is the smallest in France, its underlying productivity (and thus how much it would lose) is also overestimated, for reasons stated above. Finally PPML results, although suggesting higher costs for the reasons already discussed, are extremely correlated (0.98) with our baseline. Crucially, comparing the two Tables, the core result on the relative magnitude of the costs of non-Europe and non-France holds across all alternative specifications: for an average French region it is always true that the costs of non-Europe are smaller than the costs of non-France.

United Europe Table 18 displays the gains from the 'United Europe' experiment. As with the costs of non-Europe, we still find that our OLS estimates are broadly consistent with alternative estimates. Correlations range from 0.73 to 0.90, with the only exception of the AP case (0.16). The discrepancies essentially come from Germany and French regions. As stated above, France performs much better than Germany in labor productivity rankings, while the converse is true in TFP rankings. In the ABE case, as expected, the costs of non-Europe are lower, because average estimated border effects are much smaller (and so there is less to gain from their removal), while imposing a higher elasticity of internal trade with respect to distance (RT2) increases the potential benefits for France stemming from more international integration. Finally notice that in the ID experiment border effects cannot be identified, which is the reason why we do not perform this robustness check here.

8 Conclusion

In this paper, we set up a multi-economy multi-sector model of inter- and intra-national trade with heterogeneous firms, monopolistic competition and variable markups. We then calibrate this model using country-level trade figures and firm-level data for 10 EU countries and 21 French regions.

Simulating counterfactual trade integration scenarios, we find that, in the French case, the selection effect due to *intra-national* trade is stronger than that of *international* trade. For an average French region, the disruption of international trade is found to decrease productivity by 8.08%, while the productivity loss due to no intra-national trade amounts to 24.88%. In these two experiments, prices and markups are also found to increase substantially (10.31% without international trade, 36.03% without intra-national trade), while profits will increase considerably (19.61% without international trade, 69.28% without intra-national trade) together with quantities (7.12% without international trade and 23.03% without intra-national trade). These results suggest that while the selection effect of international trade can be substantial, national markets still play an important role in shaping competition.

Table 18: Gains from United Europe: robustness checks.

Economy	OLS	LP	AP	SR	k	ABE	PPML	RT1	RT2
BE	42.30	28.00	17.21	42.48	12.89	12.38	16.35	47.64	30.12
DE	60.18	39.33	6.87	47.08	42.32	21.51	20.66	40.76	49.17
DK	35.98	n.a.	88.54	36.48	17.08	14.74	37.78	37.34	35.10
ES	18.37	30.43	35.43	18.52	9.18	1.76	14.64	18.23	16.57
FI	15.01	36.76	37.27	15.03	12.44	5.65	26.05	24.15	14.80
GB	3.61	n.a.	10.12	3.63	3.64	0.93	3.34	2.75	3.14
IT	6.37	5.47	18.56	6.50	4.59	0.98	6.51	5.42	5.81
NL	9.66	4.49	16.93	9.61	19.99	3.40	23.33	8.17	10.21
PT	1.17	8.96	0.86	1.17	0.49	1.40	1.47	1.60	1.16
SE	16.28	5.36	10.59	16.30	7.69	5.22	12.14	18.20	15.81
FR10	0.06	0.06	0.21	0.08	0.06	0.00	0.05	0.06	0.08
FR21	-7.18	-10.12	19.06	-7.61	-1.68	-2.92	-8.51	-8.71	-5.56
FR22	3.52	-4.27	18.11	10.34	3.53	0.34	8.44	7.63	6.29
FR23	13.91	-3.14	13.89	7.00	6.22	-0.55	16.75	9.29	10.78
FR24	9.62	2.77	18.14	10.17	10.10	1.62	11.85	28.22	18.70
FR25	23.04	-6.33	19.67	26.47	13.05	-0.40	27.02	29.22	35.83
FR26	6.66	4.09	19.18	6.92	6.14	3.17	5.44	5.81	11.65
FR31	-2.46	-5.97	1.49	-2.39	-1.50	-3.23	-3.19	-2.35	0.78
FR41	-2.22	-4.07	29.09	-2.57	-2.67	-0.78	-4.41	-3.47	2.69
FR42	1.83	6.77	54.55	1.64	-1.05	5.97	1.17	4.19	7.55
FR43	5.37	7.89	54.58	7.08	0.24	10.37	14.97	6.86	8.70
FR51	8.57	5.38	16.15	9.58	7.27	1.61	4.83	6.74	12.52
FR52	16.32	13.08	3.28	46.75	27.89	2.55	15.49	16.41	48.30
FR53	5.12	5.80	34.39	4.53	11.01	1.11	6.85	5.63	9.34
FR61	38.23	23.05	31.39	31.99	24.28	11.53	27.26	34.05	58.04
FR62	15.24	8.46	19.37	11.63	3.23	15.82	17.95	29.69	24.56
FR63	2.86	2.03	12.04	2.63	3.34	2.12	-1.47	2.42	5.17
FR71	6.07	5.34	43.26	6.07	3.24	5.10	6.51	4.92	11.86
FR72	4.32	2.38	30.65	4.46	8.27	1.85	2.81	3.50	7.50
FR81	17.13	12.69	39.86	15.29	14.32	11.50	21.66	18.02	26.43
FR82	19.98	22.16	46.74	25.35	10.87	19.17	30.72	30.43	33.46
France	8.86	4.19	25.00	10.26	6.96	4.09	9.63	10.88	15.94
Europe	19.80	18.11	24.31	18.82	12.48	6.55	15.63	19.56	17.98

Furthermore, we find that border impediments to trade (defined in an empirical way) also have significant effects on firm productivity. Simulating the complete removal of 'border effects', we find that productivity would increase by 8.86% for an average French region, with a corresponding decrease in prices and markups by 6.63% and a drop of average profits (quantities) of 11.77% (6.63%). The magnitude is larger for the 11 EU countries as a whole with a productivity gain of 19.80%, a decrease in prices and markups of 13.14% and a drop of 22.57% (12.96%)in average profits (quantities). Even 8 years after the completion of the European Single Market, substantial gains from international trade were still to be expected from further behind-the-border integration in the EU.

Our results withstand a battery of robustness checks related to the measurement of productivity and trade openness, with estimates of productivity gains and losses remaining substantial and close to the benchmark results. While the 1988 Cecchini Report offered some predictions of the benefits from the Single Market Programme (in the range of 4 to 6,5% of GDP), relatively little research

has been devoted to its ex post evaluation. Our results can, thus, be seen as a contribution in that direction that focuses on the effects of non-tariff barriers on productivity and markups.

There are, nonetheless, several issues that call for further research. Starting with the comparison between the costs of non-Europe and those of non-France, at first glance intra-national trade does not seem to be substantially more important than international trade. The export share of output in a typical French region is equal to 22%, while the intra-national trade share is 22.5%. However, given the trade costs frictions in 2000, intra-national competition still dominates in all specifications. The estimation of the relative degree of inter- vs intra-national openness is crucial for this result and we address this issue in a variety of ways using the best available data and estimation techniques. However, the lack of truly comparable intra-national and international trade data in the present study calls for additional investigation.

Second, we are probably underestimating the total effect of international trade because, even though the 10 countries in our sample represent 61% of French exports, we are not considering trade with other important developed countries (like the US and Japan) and developing ones (like India and China). This is due to the lack of comparable firm-level data. Third, intra-national results are likely to be very different for smaller countries than France (such as Belgium and the Netherlands) that heavily rely on international trade. It would also be interesting to perform a comparable exercise on similarly large European economies (such as the UK, Germany or Italy) that have a less compact geography than France and display starker inter-regional disparities. Fourth, the substantial productivity gains from further behind-the-border integration rest on the correct estimation of border effects. In particular, we have shown that the gains from 'United Europe' might be larger or smaller depending on the estimation technique and the distance measure but still remain substantial. Furthermore, the magnitude of our border effects belongs to the lower bound of recent studies, thus providing rather conservative predictions.

Finally, the interpretation of border effects is itself still debated. If we take the strong view that border effects entirely reflect some trade frictions, the available evidence on the sources of such frictions is rather mixed. On the one side, Head and Mayer (2000) show that non-tariff barriers to trade do not explain border effects in Europe while Hillberry (1999) finds little evidence that tariffs, regulations, information and communication costs explain border effects. On the other hand, Chen (2004) shows that technical barriers to trade and product-specific information costs do play a significant role in generating border effects while Turrini and van Ypersele (2006) highlight the empirical relevance of legal asymmetries. Wolf (2000) and Combes et al (2005) provide evidence that border effects exist also within a country making it questionable whether the 'complete' removal of 'borders' is really feasible. One possible explanation of such 'persistent' border effects is put forth by Chen (2004) who shows that, to some extent, those effects do not reflect any trade impediment but instead emerge as an econometric artifact from the co-location of industries related by input-output relationships.

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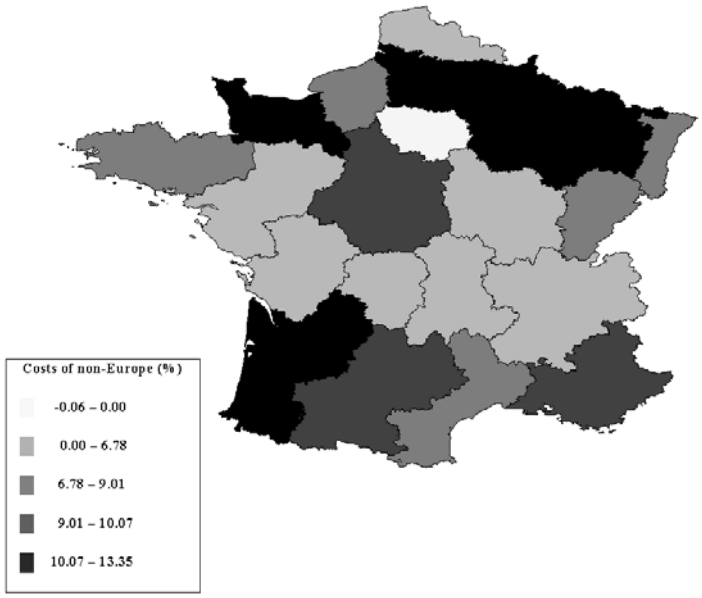

Figure 1: The costs of Non-Europe for French regions

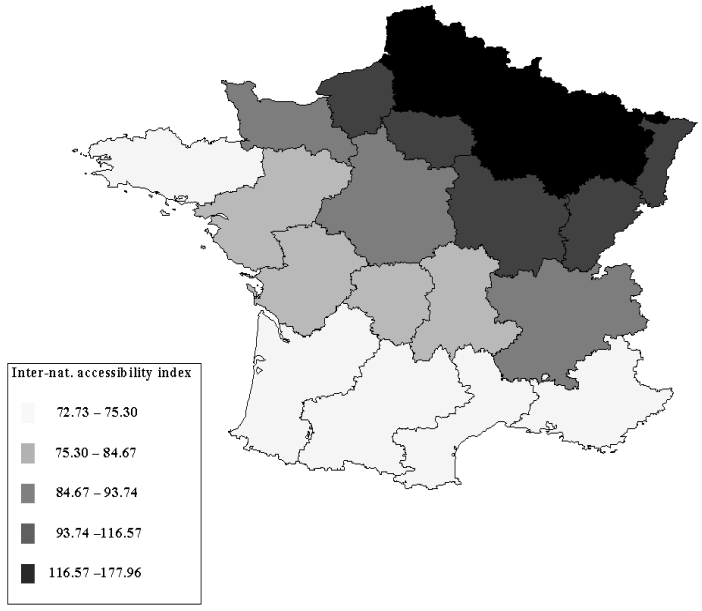

Figure 2: Accessibility to international trade for French regions

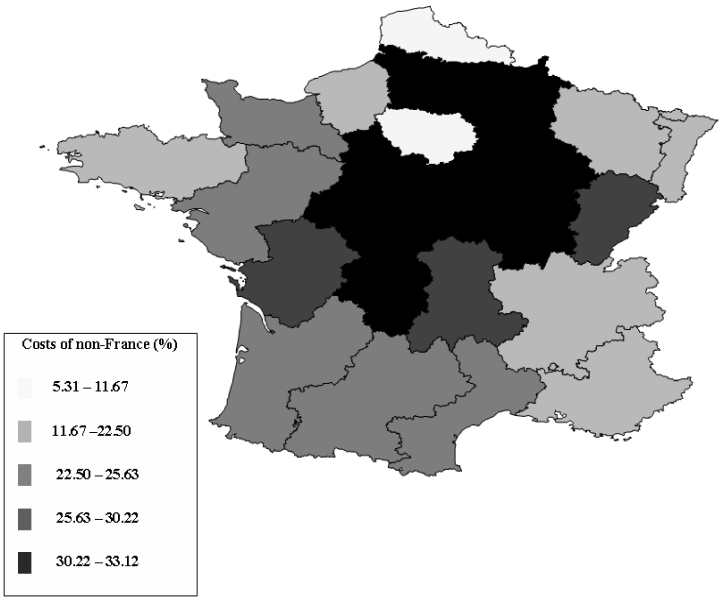

Figure 3: The costs of Non-France for French regions

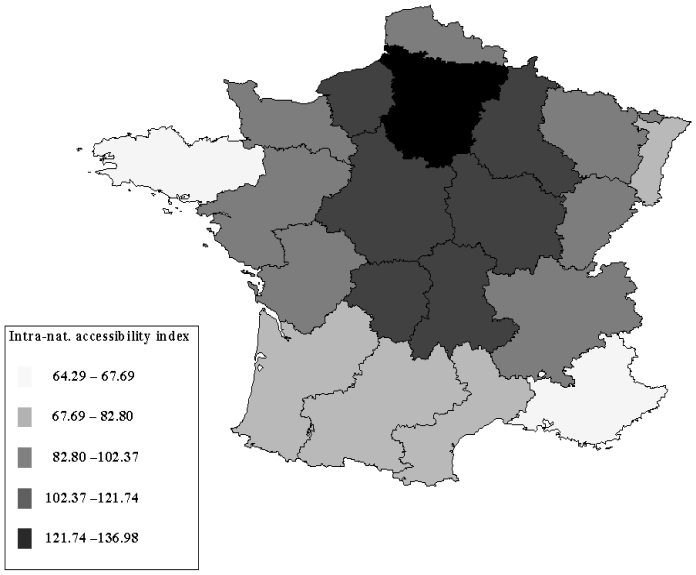

Figure 4: Accessibility to intra-national trade for French regions