DECLARATION FOR THE PhD THESIS

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Heterogeneous Firms and Heterogeneous Responses from Economic Integration:

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Università Commerciale Luigi Bocconi- Milano
PhD in International Law and Economics

Heterogeneous Firms and Heterogeneous Responses from Economic Integration: Empirical Studies

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to Alfredo, Antonella and Luisa

The most exciting phrase to hear in science,
the one that heralds new discoveries,
is not 'Eureka!' , but "That's funny..."
- Isaac Asimov -

CONTENTS

Introduction

Heterogeneous Firms and the Third Wave of Economic Integration

If it is true that in recent decades we have been observing a new wave of economic integration for which national economies are more and more intertwined to each other, it is also true that the responses of economic agents, and in particular firms, to such a fast and seemingly irreversible process have been different without a precedent as a reference to look at. This is essentially the message of this thesis that provides empirical evidence on three different aspects of the internationalization of firms: exporting activity, import of foreign intermediate goods employed in the production process and the creation of complex production chains crossing national borders.

As a matter of fact, economic history has seen at least three waves of economic integration, this last a term that I prefer to the inflated "globalization" since it neutralizes the considerations on political integration that are much less clear in a world that, from this point of view, at times shows to be more integrated and at times to be more fragmentated than in the past, depending on which level of analysis one adopts.

From an economic point of view, after the first wave at the beginning of the last century and the second in the aftermath of the second world conflict, the actual wave of economic integration, that can be dated since the 70s, has shown two novel features that make it peculiar (Hanson, Mataloni and Slaugher, 2003). The first peculiarity is an increased international trade in intermediate goods between firms located in different countries with respect to the classical trade in final goods, which are sold by firms to consumers around the world. The second peculiarity is the relative importance reached by flows of foreign direct investment in the latest decades, with investors locating economic activities around the world, beyond national borders, in order to exploit the competitive advantages that a particular geographical area can offer them. As Feenstra (1998) showed, in the early twentieth century inputs were only a minor part of trade and it is only with the decreasing trade costs and the adoption of information technology that the establishment of production chains, or as Krugman called them the "slicing up of the value chain", has been possible. Indeed, Hummels, Ishii and Yi (2001) calculated that only from 1970 to 1990 a third of export growth is attributable to trade in intermediates and recent estimates point out that in absolute value it accounts for a share between 56% and 73% of the actual trade flows in OECD countries as in Mirodou, Lanz and Ragoussis (2009). On the other hand, multinationals are now responsible for a large fraction of world trade and in the United States for example they account for over half of total exports (Slaughter, 2000), hence the study of their alternative modes of organization of production is of increasingly importance (see among others Helpman, 2008). From an even broader perspective, we could maybe say that tha actual wave of economic integration is characterized by an increasing movement of factors of production, since if from the 70s intermediate inputs and capital have quantitatively risen, in the last decade also labor through migration, historically considered the least displaceable, has followed rapidly (UN, 2004)

The theoretical framework underlying the empirical analysis of this thesis is the one provided by New New Trade theory for which only some firms within industries are able to internationalize their production either by exporting or by making FDI, because only the more productive among them are able to sustain the sunk costs entailed by the entry in a foreign market (see among others Bernard et al., 2003).

Indeed, the neoclassical hypothesis of a representative agent in a dynamic economic environment had been already demonstrated to be inadequate as a paradigm by Lancaster (1971), Quandt (1970) and Domencich and McFadden (1975). However it was only after the growing availability of individual specific micro-data in the recent decades that economists were able to develop new tools in order to capture the sources of manifest differences among apparently similar economic agents. These studies have shown the importance of sources of unobserved heterogeneity within aggregated data, especially once interpreting the empirical evidence. In particular, once switching from a macro- to a micro-level analysis we can detect the existence of both an aggregation problem and a heterogeneity problem, which are empirical issues than can bias the interpretation of economic behavior from empirical results.

Looking in particular at the activity of firms,on one hand we would have the heterogeneity of production units within a sector of economic activity, or even

within an entire economy, that are due to persistent differences across firms and over time that cannot be ignored. This entails that aggregate analyses or analyses based on the average rapresentative firm might be biased because of systematic unobserved characteristics of individual units, since for example size, productivity and, related to the latter, the international exposure of firms are very different among firms belonging to the same industry. On the other hand, the aggregation of different firms within a sector risks to cancel out many movements that might go in different directions (Fisher, 1969), summing together positive and negative responses and obtaining an average behavior that can be far from reality. With this respect, aggregate measures confronted over time or across industries tend to report a smoother behaviour, while the actual behaviour of individual agents would show "holes, kinks and corners" as Pudney (1989) had pointed out.

At the same time any study exploiting microdata have to manage with two additional empirical problems that are usually skipped when confronting aggregated data (Heckman, 2000). The first one is the attrition bias, i.e. the difficulty to follow the firms (or any other unit of observation) included in the sample for every year of interest; the second problem is known as a selection bias, and is due to the fact that some firms with some common systematic characteristics might be left out of the analysis.

It is only in the last decade, however, that international trade literature has tried to solve all previous empirical issues to better understand the internationalization of firms and what they mean when one wants to derive the costs and benetis of trade or industrial policies in an ever changing economic environment as it is the one we have faced in the latest years[1].

What I learnt as a broad message from this work, hence the title of it, is that not only firms have heterogeneous characteristics that make them different when coping with internationalization, but also that they can have heterogeneous responses or, better, differentiated strategies to outlive in this age of fast economic integration. These differentiated strategies, I think, are worth to be studied to anticipate the economic issues of the next future, i.e. the way national economies and their production systems adapt to the international economic integration that will undoubtedly continue for years to come.

In the first chapter of this thesis I analyze how comparative advantages of an economy and gains from trade can be affected by differentiated dynamics of restructuring within industries, empirically testing a model (Bernard, Redding and Schott, 2007) that reconciles new and old literature. New firms entering the market choose their own activity after knowing their relative profit expectations that are determined also by their relative productivity with respect to the incumbent firms. A relatively higher fringe of more productive firms can make the difference and if the sector already enjoys a comparative advantage, this latter can be reinforced by the stricter selection process boosted by new entrants.

In the second chapter, looking at the relationship between trade openness proxied by import penetration and productivity gains by firms, it is possible to assess how relatively important is the competition channel, for which firms compete in a fiercer economic environment with firms located worldwide, and the so-called vertical channel, for which firms are able to source intermediate inputs from abroad that are either cheaper than the domestic ones or are in general more efficiently used in the production process since they can also incorporate new technologies not available at home, In other words, firms can counter-balance the increased level of competition due to openness to trade after sourcing cheaper or better intermediates from abroad and hence enhancing their efficiency in terms of lower costs of production or better quality of the sold product. In the third chapter, looking at the second novelty of the ongoing integration process described above, I analyze how the degree of complexity of a global value chain, as developed by multinational business groups with different firms located worldwide, can be correlated to the productivity gains of single affiliated firms belonging to the same production network. In this case, among the benefits that can be sourced from affiliation, I test the importance of a softened financial constraint for a firm that can rely on either an intangible collateral provided by the group as a whole or on an internal capital market that overcomes imperfections of external capital markets.

Finally, I cannot hide to the reader of this thesis that my whole analysis is somehow biased in space and in time by the choice of European countries in all three chapters. A choice due to my specific interest in European economic integration that in the last decade has gone through major institutional changes and challenges (the adoption of a single currency, the enlargement

[1] For a review of the main theoretical and empirical issues about heterogeneous firms in international trade, see for example Redding (2010).

to new members). But I think that it is exactly because of these last experiments of enhanced economic integration that it is interesting to analyze this area of the world and the evidence that it provides as a lesson for a general process of interdependence among nations that is often considered irreversible but, in the case of Europe, has been consciously carried on in order to ensure an extension of peace, stability, democracy and prosperity also to future generations.

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Chapter I

Productivities and Comparative Advantages with Heterogeneous Firms: the case of France

1. Introduction

The quest for the determinants of a nation's comparative advantages has been dominated for almost two centuries by the assumption that firms were homogeneous within sectors, whether it was technological differences, factor endowments or economies of scale that underlay the structure of international trade. However, since the availability of microdata has increased in recent decades, empirical evidence has remarked the pervasiveness of heterogeneity and diversity in economic life (Heckman, 2000) and economic theorists not only in international trade had to move with times, centering more than in the past around the behavior of heterogeneous individuals in markets and other social settings. Hence, a flourishing literature has emerged in the last decade trying to explain why only some firms within industries are able to internationalize their production (Bernard et al. 2007b; Helpman, Melitz and Yeaple, 2004; Mayer and Ottaviano, 2008) either by exporting or by making FDI, showing that only the more productive among them are able to substain the sunk costs entailed by the entry in a foreign market (Melitz, 2003; Bernard et al., 2003; Akerman and Forslid, 2007). In the investigation of such a self-selection process scholars have gone so far introducing an intertemporal dimension (Costantini and Melitz, 2008), the possibility to adjust the product mix by multiproduct firms (Eckel and Neary; 2010; Bernard, Redding and Schott, 2010; Mayer, Melitz and Ottaviano, 2010), an endogenous level of competition (Melitz and Ottaviano, 2008; Altomonte, Colantone and Pennings, 2010), an extension of the notion of heterogeneous productivity from cost-efficiency to quality sorting after investing in innovation (Antoniades, 2009), eventually deriving also a general equilibrium model of macroeconomic dynamics (Ghironi and Melitz, 2005). The simplifying assumption of a one-sector economy with heterogeneous firms, common to all previous models, has already led to the discovery of an additional source of gains from trade observed after the opening up of an economy to costly trade, represented by the increase in average productivity boosted by a reallocation process from less productive to higher productive firms. However, it is only with the work of Bernard, Redding and Schott (2007) that it is possible to reconcile old and new trade theories, extending the analysis to the case of multiple factors of production and asymmetric industries and countries. In fact, once discriminating between sectors at comparative advantage and at comparative disadvantage, they first confirm the existence of an overall increase in aggregate productivity after opening up of an economy to costly trade, thereafter they also observe that the reallocation processes are different within the two categories of sectors and consequently also the average industrial productivities present a different dynamics.

In a model with endowment-driven comparative advantages and firm-level horizontal product differentiation combined with increasing returns to scale à la Helpman and Krugman (1985), the introduction of firm heterogeneity within and across industries allows for the emergence of dynamic Ricardian differences in technologies, magnifying the pre-existing comparative advantage. In case of costly trade, profit expectations by firms entering into the market are higher for the sector at comparative advantage, hence a fringe of firms decides to operate in this latter given a higher probability to export. The result is that on aggregate the average productivity grows relatively more in sectors at comparative advantages because of a higher level of competition and the possibility to smooth fixed costs on a relatively wider set of consumers, at home and abroad.

The aim of this paper is to test for the existence of such a magnification effect for France in the period between 2001 and 2007, after controlling for all other determinants of trade including factor endowments, initial differences in technologies and economies of scale, eventually controlling also for demand effects that can influence the self-selection process, as Syverson (2004) has showed but also Helpman, Melitz and Yeaple (2004) have hinted. Nonetheless, different degrees of heterogeneity are taken into account combining information provided by data at different level of disaggregation: industry-level, product-level and firm-level.

A test for the emergence of Ricardian dynamic differences across sectors is not only important to acknowledge an additional source of gains from trade, but it is also crucial in evaluating the effects that a trade liberalization has on overall industrial restructuring. Besides, if such dynamic differences in productivity can actually emerge, it is possible that an asymmetric trade liberalization (or the adoption of specific trade policies) can alter the ranking of comparative advantages once boosting firm reallocation in some sectors before than others.

In Section 2 we will sketch some stylized facts for the French export performance as derived from the literature and from our data, in Section 3 and 4 we will describe the construction of our indicators for the distributions of comparative advantages and for the determinants of trade. The estimation strategies are discussed in Section 5 and Section 6 concludes.

2. French export performance and product heterogeneity within industries

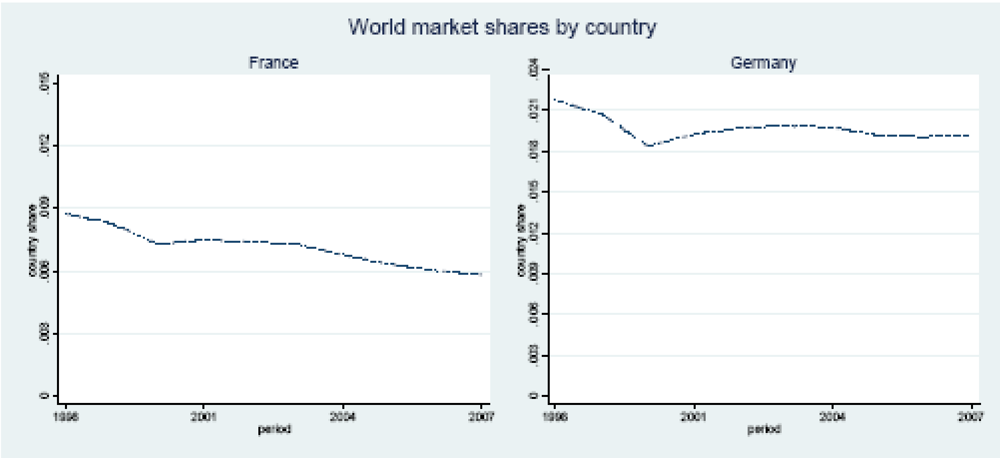
Even if France is the second largest importer among European nations after Germany, the country's foreign performance has deteriorated since 2000. If we look at Table 1, we can see that until 1999 French export performance was even better than German one in key world areas: EU, Asia, Japan, EU accession countries. However, in the period 2000-2006 the country was no more able to catch opportunities in the same way that Germany did from the enlargement of the European Union and the accession of Asian emerging economies on the international markets, as the fourth column of Table 1 shows.

From time to time the problem of French competitiveness arises and Kabundi and De Simone (2007; 2009) argue that traditional variables that determine international trade (the exchange

Table 1: Export trends per destination, France vs Germany, source: Kabundi and Nadal De Simone (2009)

		1980-2006	1980-1989	1990-1999	2000-2006
France	France to EU	1.7	2.3	**1.3**	1.2
	France to Asia	2.1	2.4	**1.7**	1.9
	France to Japan	1.9	3.5	**1.0**	1.5
	France to China	**3.8**	**5.6**	2.4	3.8
	France to Euro	1.6	2.3	**1.2**	1.2
	Franceto Accession Countries	2.6	0.0	**4.9**	2.6
	France to United States	1.9	2.8	1.9	1.1
	France to United Kingdom	1.8	2.7	**1.6**	0.6
	France to ROW	0.9	0.3	0.6	1.7
Germany	Germany to EU	1.9	2.5	0.9	2.2
	Germany to Asia	2.3	2.6	1.1	2.7
	Germany to Japan	2.2	3.9	0.3	1.5
	Germany to China	3.7	3.2	2.5	5.3
	Germany to Euro	1.8	2.5	0.6	2.1
	Germany to Accession Countries	3.2	2.1	4.4	3.0
	Germany to United States	2.3	2.8	1.9	2.2
	Germany to United Kingdom	2.0	3.0	1.2	1.8
	Germany to ROW	1.6	1.3	0.6	3.2

Figure 1: Average industrial market shares on world markets (world total=1). Source: elaboration on BACI by CEPII



rate, relative unit labor costs, ecc.) are insufficient to explain the recent decline in France's export shares. As a matter of fact, French productivity growth in manufacturing is not so much different from US (Kahn, 2006) and the real effective exchange rate is in line with fundamentals (Kabundi and De Simone, 2009), even if the adjustment tends to come from changes in employment and productivity rather than through wage flexibility.

Our data from Figure 1 confirm that French industrial market shares have slightly reduced in the period from 1998-2007, whereas German ones, after a first drop in 2000, have held their positions. That is, even if as Table 1 shows, exports are increasing in absolute terms, the accession of new global players (Asian emerging economies, new EU members, etc.) on the international scene have reduced the French trade in relative terms. But looking at aggregates and averages is misleading, or at least it leads to an incomplete understanding, as Figures 2 and 3 display.

Figure 2: Industry world shares of France, 1998-2007. Source: elaboration on BACI by CEPII

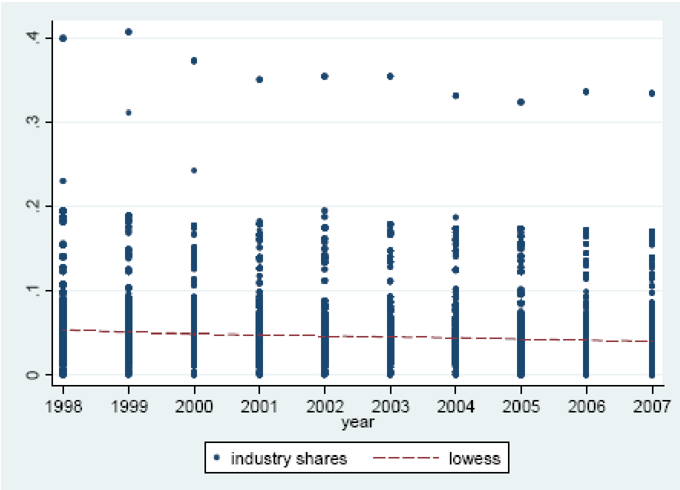


Figure 3: Product world shares of France, 1998-2007. Source: elaboration on BACI by CEPII

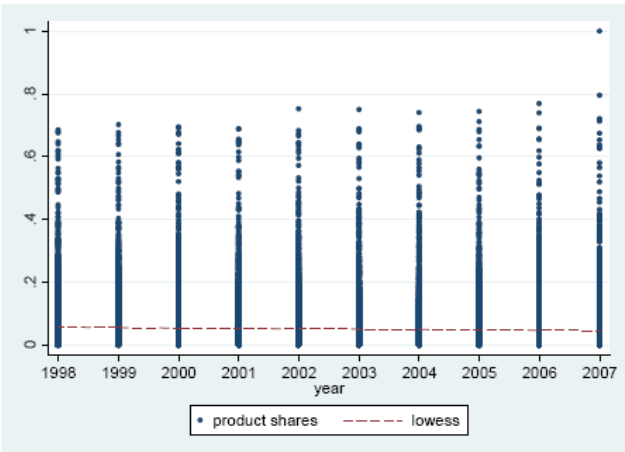


Figure 2 shows the tendency of product market shares of France on total world exports disaggregated at HS 6-digit level[2], whereas Figure 3 aggregates these latter by ISIC 4-digit industrial sectors. Even if the generalized decrease of French market shares is corroborated in both graphs by the lowess[3] curve, the dispersion of shares by products is much higher than the one by industries, with some best performers reaching even 80% of the international market and in one case[4] even the totality. Actually, what we observe is an increasing dispersion of product sharest hrough time that seems at odds with the previous considerations on export deterioration. Since single products are nested within broader industries whatever level of disaggregation we pick, and also firms can manufacture more than one product choosing within a product mix, it is more useful to look at export performance by product rather than by industry. Indeed, it is at this level of disaggregation that creative destruction occurs: new products build on the experience of older ones and they gain market shares at their expenses according to Grossman and Helpman (1985), because products evolve in scale of qualities. New products are higher substitutes of older ones and are more difficult to substitute across sectors. As Tables 2 and 3 show, within the same industry we can find products that are gaining ground and others that are losing appeal by consumers, but when we look at averages by sector we risk to draw conclusions on representative products that probably don't exist, whereas looking at the evolution of comparative advantages by products would allow us to capture the repositioning of firms and industries towards more innovative productions.

At the same time, however, some data on the determinants of trade such as factor proportions, economies of scale or productivity are available only at a more aggregated level and it implies that in our empirical analysis we have to cope with both an aggregation problem and a heterogeneity problem. On one hand, this latter is due to persistent differences across units of observations and over time because of some unobserved endogenous characteristics. On the other hand the aggregation of products and firms within sectors risks to cancel out movements in opposite directions. The exploitation of *ad hoc* econometric tools in Section 5 will be necessary to take into account both these problems.

3. Relative differences of comparative advantages and productivities

In order to measure comparative advantages by industry or by product, I exploited the BACI database by CEPII which reconciles trade flows reported by the importing and the exporting country[5] and where flows are disaggregated at HS (Harmonized System) 6-digit product level. Limiting the analysis to the case of France in the period 2001-2007, I demonstrate how it is

[2] Harmonized System classification of traded products proposed by UN statistical offices as the international standard http://unstats.un.org/unsd/cr/registry/regot.asp?Lg=1

[3] See Cleveland and Devlin (1988) for a description of this non-parametric method of fitting a graph.

[4] The phenylglycolic acid: an aromatic principle extracted from peaches and almonds

[5] BACI is developed by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and is based upon official data provided by UN ComTrade. It reconciles the declarations of the exporter and the importer through an harmonization procedure that takes into account transport costs. For further information: http://www.cepii.fr/anglaisgraph/bdd/baci.htm

Table 2: Best and worst performing products in terms of average percent change in world share in the period 1998-2007. Source: elaboration on BACI by CEPII

Best performers			Worst performers		
HS 6-digit code	Denomination	Average perc change in share	HS 6-digit code	Denomination	Average perc change in share
020734	Fatty livers of geese	4.04%	382471	Containing chlorofluorocarbons	-5.40%
284430	Uranium (depleted U235), thorium compounds, products	4.15%	330123	Essential oils of lavander	-4.99%
291431	Phenylacetone	3.76%	020725	Turkeys, not cut, frozen	-4.53%
293292	Benzodyoxol	10.29%	291212	Ethanal (acetaldehyde)	-4.06%
293319	Heterocyclic compounds with unfused pyrazole ring	2.69%	854610	Electrical insulators of glass	-3.94%
381720	Mixed alkylnaphtalenes	2.53%	910620	Parking meters	-3.84%
911440	Clock or watch plates and bridges	2.77%	330121	Essential oils of geranium	-3.55%

Table 3: Best and worst performing industries in terms of percent change in world share in the period 1998-2007. Source: elaboration on BACI by CEPII

Best performers			Worst performers		
ISIC 4-digit code	Denomination	Average perc change in share	ISIC 4-digit code	Denomination	Average perc change in share
3330	Manufacture of watches and clocks	0.09%	1554	Soft drinks and mineral waters	-0.76%
2921	Manufacture of agricultural and forestry machinery	0.12%	1552	Wines	-0.73%
1912	Manufacture of luggage, handbags and the like, saddlery and harness	0.12%	2330	Processing of nuclear fuel	-0.55%
3512	Building and repairing of pleasure and sporting boats	0.12%	1542	Manufacture of sugar	-0.52%
3313	Manufacture of industrial process control equipment	0.16%	3599	Manufacture of other transport equipment	-0.48%
2927	Manufacture of weapons and ammunition	0.31%	2511	Manufacture of rubber tyres and tubes	-0.48%
3530	Manufacture of aircraft and spacecraft	0.43%	3220	Manufacture of television and radio transmitters	-0.43%

possible to derive a dynamic indicator of revealed comparative advantages that is built on the basis of the Balassa (1965) Index providing however information on the changing relative position of simple export performances through time.

First of all I compute export performance as French world market shares for each product s at time t:

$$world\_share_{st} = \frac{X_{st}^{F}}{X_{st}^{W}} \tag{1}$$

where the numerator is the exports of product s from France (F) at time t and the denominator is the total world (W) trade flows for the same product s at time t.However useful as a variable, the export performance as such is a measure of the absolute advantage of a country in a world market, whereas I needed a form of comparative advantage that weighted for the changing country market power as the following:

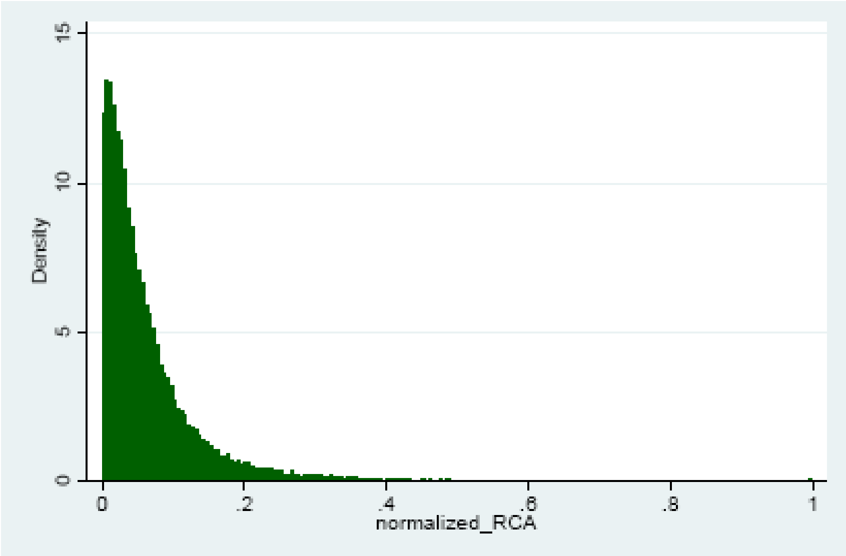
$$RCA_{st} = \frac{\frac{X_{st}^{F}}{X_{st}^{W}}}{\frac{X_{t}^{F}}{X_{t}^{W}}} \tag{2}$$

The export performance is then weighted in eq 2 by the denominator representing the total export flows from France at time t (X_t^F) on the total World trade flows at time t (X_t^W). This is essentially the Balassa (1965) Index of Revealed Comparative Advantages (RCA), according to which a value in the range $[0, 1]$ suggests a product in which the country share is below the country average, whereas a value in the range $\left(1, \frac{X_t^W}{X_t^F}\right)$ would point at a product in which the country specializes, i.e. the country share is above the country average. As De Benedictis and Tamberi (2001) have observed, however, the statistical properties of this index show an asymmetric distribution with a fixed lower bound and a variable upper bound that is country and time specific, whereas the demarcation value 1 is always fixed. In order to solve the asymmetry problem that arises from the Balassa (1965) Index we propose the adoption of a *relative difference* of the index as follows:

$$\begin{aligned} norm\_RCA_{st} &= \frac{RCA_{st} - RCA_{st}^{\min}}{RCA_{st}^{\max} - RCA_{st}^{\min}} = \frac{\left[\frac{X_{st}^{F}}{X_{st}^{W}} - \left(\frac{X_{st}^{F}}{X_{st}^{W}}\right)^{\min}\right] / \frac{X_{t}^{F}}{X_{t}^{W}}}{\left[\left(\frac{X_{st}^{F}}{X_{st}^{W}}\right)^{\max} - \left(\frac{X_{st}^{F}}{X_{st}^{W}}\right)^{\min}\right] / \frac{X_{t}^{F}}{X_{t}^{W}}} = \\ &= \frac{world\_share_{st} - world\_share_{st}^{\min}}{world\_share_{st}^{\max} - world\_share_{st}^{\min}} \end{aligned} \tag{3}$$

where $\left(\frac{X_{st}^{F}}{X_{st}^{W}}\right)^{\max}$ and $\left(\frac{X_{st}^{F}}{X_{st}^{W}}\right)^{\min}$ stand respectively for the maximum and the minimum of the country shares of product s at time t. The previous normalization from a relative differentiation allows me to bind the index in a range $[0, 1]$ obtaining a ranking among products that is year-specific. The demarcation value of the Balassa Index is lost in favor of a time-varying overall distribution from which it is possible to derive how the export performance of one product s

Figure 4: Revealed Comparative Advantages normalized on the distribution, year=2007



compares with the rest of the distribution for every year t. Hence, to derive a progress of a product in the distribution of comparative advantages, we can build our dependent variable as a dummy (rca_{st}) that equals 1 if the product has moved forward in the distribution from time t to time $t+1$ and equals 0 otherwise. An example for the distribution of export performances by product in 2007 as a result of eq 3 is reported in Figure 4.

As one can see from eq 3, the calculation of relative differences for comparative advantages eventually cancels out the country share $\frac{X_t^F}{X_t^W}$ at the denominators and allow to concentrate only on the evolution of the distribution of product shares, providing a year-by-year relativization of each share with respect to the rest of the distribution . This relativization property works to my advantage also when building a variable for relative productivities, which are one of the possible determinants of trade in a Ricardian model with different technologies. As in eq. 4, we would need world productivities both for a sector j at time t ($\overline{\varphi}_{jt}^W$) and as aggregate at time t ($\overline{\varphi}_t^W$) :

$$RP_{jt} = \frac{\frac{\overline{\varphi}_{jt}^F}{\overline{\varphi}_{jt}^W}}{\frac{\overline{\varphi}_t^F}{\overline{\varphi}_t^W}} = \frac{\frac{\overline{\varphi}_{jt}^F}{\overline{\varphi}_t^F}}{\frac{\overline{\varphi}_{jt}^W}{\overline{\varphi}_t^W}} \tag{4}$$

where the numerator shows the average j industry-specific productivity at time t ($\overline{\varphi}_{jt}^F$) weighted by national average productivity ($\overline{\varphi}_t^F$). Taking into account as before the time-varying distribution of average industrial productivities, the denominator again cancels out and we have:

$$\begin{aligned} norm\_RP_{jt} &= \frac{RP_{jt} - RP_{jt}^{\min}}{RP_{jt}^{\max} - RP_{jt}^{\min}} = \frac{\left[\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}} - \left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\min}\right] / \frac{\overline{\varphi}_{jt}^{W}}{\overline{\varphi}_{t}^{W}}}{\left[\left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\max} - \left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\min}\right] / \frac{\overline{\varphi}_{jt}^{W}}{\overline{\varphi}_{t}^{W}}} = \\ &= \frac{\left[\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}} - \left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\min}\right]}{\left[\left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\max} - \left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\min}\right]} = \frac{\left[\overline{\varphi}_{jt}^{F} - \left(\overline{\varphi}_{jt}^{F}\right)^{\min}\right]}{\left[\left(\overline{\varphi}_{jt}^{F}\right)^{\max} - \left(\overline{\varphi}_{jt}^{F}\right)^{\min}\right]} \end{aligned} \quad (5)$$

where $\left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\max}$ and $\left(\frac{\overline{\varphi}_{jt}^{F}}{\overline{\varphi}_{t}^{F}}\right)^{\min}$ stand respectively for the maximum and the minimum relative productivity for each period t. Further simplifying for the average national productivity, I obtain the relative differences for simple industrial productivities in the last member of eq. 5.

As in the case of comparative advantages, a progress in the distribution points at an improvement of the relative average industrial productivities and the index is again bounded between $[0, 1]$. I expect that relative differences of industrial productivities are positively correlated with a progress in the distribution of comparative advantages following a Ricardian model with different technological capabilities. In the next Section I describe the most proper notion of productivity to include in the econometric analysis of Section in order to insulate the relationship between comparative advantages and dynamic Ricardian differences explained by Bernard , Redding and Schott (2007), after controlling for all other possible determinants of trade.

4. Productivities and surroundings

4.1. Productivities

Four different notions of productivities have been calculated on the basis of a firm-level dataset of 100,048 manufacturing[6] firms grouped by NACE rev. 1 at 4-digit level of disaggregation, as collected from Bureau Van Djik's Amadeus database for the period 2001-2007. The firm-level dataset, of which we report the composition by economic activities in Table 5, provided me with the necessary information from balance sheet data for productivities and also for the export turnover, that is the firm-specific turnover obtained from selling products abroad. An important variable, this latter, that helped me in determining the export status of a firm for each year. As we can see from the last six columns of Table 5, the distribution of the export intensity is rather skewed and differentiated by sector, with only a small portion of firms that exports, but with some exceptional firms in the last percentile that can reach over 90% of turnover exported.

[6] The exclusion of firms belonging to sectors different from manufacturing (services and primary activities) has been necessary since the calculation of productivities for these firms has still an ambigous meaning. Nonetheless,

Table 5: Coverage of firm-level French data and distribution of the export turnover

	Coverage		export turnover as % of total turnover							
NACE 2-digit	N. firms	% firms	mean	sd	p25	p50	p75	p90	p95	p99
10	22876	22.74	1.75	8.81	0.00	0.00	0.00	0.97	8.54	48.94
11	1893	1.88	9.79	21.15	0.00	0.00	6.96	38.50	61.39	92.54
13	2701	2.68	14.13	38.70	0.00	0.42	17.95	53.25	71.14	93.19
14	3655	3.63	13.71	22.90	0.00	0.78	18.20	49.74	68.16	92.95
15	957	0.95	11.90	21.27	0.00	0.23	14.07	44.88	62.37	89.94
16	4910	4.88	6.25	16.06	0.00	0.00	1.83	22.04	44.03	79.77
17	1300	1.29	8.86	17.87	0.00	0.57	7.79	31.59	54.56	79.82
18	8830	8.78	1.88	8.16	0.00	0.00	0.00	2.81	9.38	44.33
19	73	0.07	4.72	12.86	0.00	0.00	0.81	15.68	25.86	64.20
20	2527	2.51	19.19	27.77	0.00	2.89	31.41	67.40	82.52	96.09
21	441	0.44	20.01	25.87	0.00	7.08	33.75	63.20	76.16	93.10
22	4149	4.12	9.89	18.03	0.00	0.61	11.15	35.37	51.55	81.05
23	4535	4.51	4.53	14.07	0.00	0.00	0.00	11.89	34.72	75.57
24	954	0.95	16.13	24.82	0.00	2.00	23.70	58.27	75.27	91.93
25	15642	15.55	6.10	14.80	0.00	0.00	3.20	21.12	39.26	75.07
26	3091	3.07	13.45	24.40	0.00	0.00	14.49	53.38	74.63	94.97
27	2174	2.16	11.61	20.93	0.00	0.00	13.59	44.89	62.33	87.59
28	6115	6.08	12.26	22.43	0.00	0.00	13.89	47.24	68.02	91.83
29	1656	1.65	8.37	18.87	0.00	0.00	4.70	31.30	52.43	93.04
30	777	0.77	15.77	25.54	0.00	0.65	23.79	56.92	73.84	96.19
31	4555	4.53	3.17	10.85	0.00	0.00	0.00	6.86	22.30	60.39
32	6792	6.75	6.13	16.96	0.00	0.00	0.07	20.76	46.95	85.32
Total	100603	100.00	6.76	17.80	0.00	0.00	2.17	24.21	47.59	83.67

The first measure of productivity computed by firm-level data is labor productivity ($labprod_{it}$) as value added on employees for each firm i at time t. Since labor productivity is a one-factor productivity, it is sensitive to changes in the combination of factors of production, therefore a notion of Total Factor Productivity (tfp_{it}) has been necessary and labor productivity will be used only for robustness checks. Among the alternatives offered in literature, I chose the Olley and Pakes (1996) methodology and a translog production function (Griliches and Ringstad, 1971; Christensen, Jorgenson and Lau, 1973). This latter was first estimated in the traditional way and then modified to correct any bias due to demand shocks adapting what De Loecker (2007) proposed for the case of a Cobb-Douglas function. The Olley and Pakes (1996) routine was at first chosen because it allowed me not only to control for the simultaneity bias, but also for the so called *state variables* of the firm (age and size) that could influence productivities and somehow proxy the increasing or decreasing elasticities to scale that a commonly used Cobb Douglas usually doesn't take into account. In fact, it is true that both size and age generally show a negative relationship with firm productivity. Unfortunately, the benefit of correcting the estimates for the simultaneity bias using Olley and Pakes (1996) is neutralized by two drawbacks of the methodology, the first being the already mentioned assumption of a constant elasticity to scale that is only partly corrected by the estimation of coefficients for *state variables,* the second

the relative differences of manufacturing market shares should keep out any bias in the calculation of market shares once restricting the analysis to only a part of traded goods.

is an unmeant assumption of an always positive investment by the firm.

The first drawback led me to the adoption of a more flexible translog production function, whereas it was not possible to solve the second drawback[7] if not trying to proxy unobserved productivity shock with materials instead of investment[8]. Also, in order to account for the relevance of economies of scale in the baseline specifications of eq 15-17-18, a translog production function has been taken as reference because it permits the identification of firm-level returns to scale as we will see in Section 4.2. Further, in an augmented version that I propose after adapting the suggestions of De Loecker (2007), it is also possible to retrieve a time-varying estimate for the elasticity of substitution within the industry ($subs\_elasticiy_{nt}$), which is another variable to be used in the ultimate baseline regression of eq. 18, and correct for possible bias due to changing demand in the period of analysis.

A translog specification for an industry production function is flexible enough to be considered as a second-order approximation of an arbitrary production function (Berndt and Christensen, 1973; Beason & Weinstein, 1996). Therefore we can write:

$$\ln Y_{it} = \beta_0 + \sum_k \beta_k \ln X_{kit} + \frac{1}{2}\left[\sum_l \sum_k \delta_{lk} (\ln X_{lit})(\ln X_{kit})\right] + \gamma_i + \varepsilon_{it} \quad (6)$$

where Y_{it} is the firm-specific output, X_{kit} and X_{lit} are k and l firm-specific inputs (labor, materials and capital). Firms fixed effects (u_i) are separated by the error term ε_{it}.The residual $(\ln \widehat{Y}_{it} - \ln Y_{it})$ is the logarithm of the Total Factor Productivity φ_{it}

Followimg De Loecker (2007), who observed that traditional productivity estimates of a Cobb-Douglas function could be affected by demand shocks, I modify the translog specification to capture the effect of an omitted price variable bias. As already noted by Klette and Griliches (1996), since most firm-level datasets observe revenues but not physical output and prices, an industry-level deflator is commonly used to deflate revenues R_{it}. In order to have a time-varying elasticity of substitution, I adopt a two-stage strategy: first estimating the uncorrected translog of eq. 6 and then correcting coefficients with the elasticity of substitution obtained by industry-year-specific estimations.

Starting with the same demand system proposed by De Loecker (2007) I have:

$$Q_{it} = Q_{It} \left(\frac{Pit}{P_{It}}\right)^{\eta} \exp(\xi_{it}) \quad (7)$$

where $Q_{It} = \sum (ms_{it} R_{it}/P_{It})$ is the aggregate industry output, Pit and P_{It} are respectively

[7] Olley and Pakes (1996) solve the simultaneity bias problem, that is the correlation of the choice of factors combination with productivity shocks, introducing an investment function that assumes a strictly positive relationship between firm-level investment from year $t-1$ to year t and the unobserved productivity shock: $i_{it} = f_t(k_{it}, \overset{+}{\varphi}_{it})$. The problem is that, given the constraint of the functional form which is a transformation in logs from levels, the investment can never be negative or zero. It means that trying to solve the simultaneity bias, the methodology introduces a more worrying selection bias. As a matter of fact, it is not uncommon that after a negative shock firms disinvest reducing their capital.

[8] Unlike the investment variable, materials are always positive. The result of this daring exercise have shown a correlation of firm-level TFPs with the classical translog production function of 0.88.

the firm-level price and the industry-level deflator, η is the industry-specific elasticity of substitution between products. The ratio $\frac{P_{it}}{P_{It}}$ can easily be interpreted as the firm-level relative price. Taking logs of the previous eq. and inserting it into an expression for (log) deflated revenues $\widetilde{R}_{it}$, I have:

$$\ln \widetilde{R}_{it} = \ln R_{it} - \ln P_{It} = \left(\frac{\eta}{\eta+1}\right) \ln Q_{it} - \frac{1}{\eta} \ln Q_{It} - \frac{1}{\eta}\xi_{it} \tag{8}$$

Until now the methodology of De Loecker (2007) has helped me in expressing deflated (log) revenues as a function of $\ln P_{It}$ which is (the log of) the industry deflator and $\left(\frac{\eta}{\eta+1}\right)$ which is the mark-up on physical output Q_{it}.Substituting in the eq 6:

$$\begin{aligned} \ln Y_{it} &= \left(\frac{\eta}{\eta+1}\right)\left\{\beta_0 + \sum_k \beta_k \ln X_{kit} + \frac{1}{2}\sum_l \sum_k \left[\delta_{lk}(\ln X_{lit})(\ln X_{kit})\right] + \gamma_i\right\} + \\ &\quad -\frac{1}{\eta}\ln Q_{It} - \frac{1}{\eta}\xi_{it} + \left(\frac{\eta}{\eta+1}\right)(\varepsilon_{it}) \end{aligned} \tag{9}$$

Finally, after some simplifications, the second estimated production function becomes:

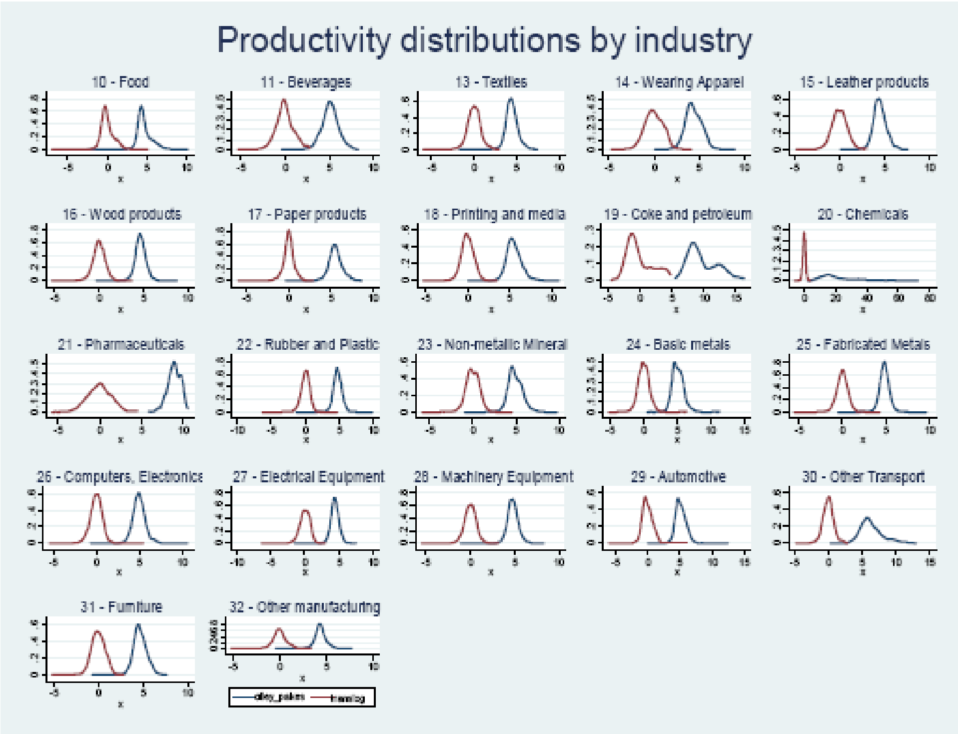
$$\ln Y_{it} = \widetilde{\beta}_0 + \sum_k \widetilde{\beta}_k \ln X_{kit} + \frac{1}{2}\sum_l \sum_k \left[\widetilde{\delta}_{lk}(\ln X_{lit})(\ln X_{kit})\right] + \widetilde{\gamma}_i - \beta_\eta \ln Q_{It} + (\xi^*_{it} + \varepsilon^*_{it}) \tag{10}$$

where, after having found the elasticity of substitution $\eta = -\beta_\eta^{-1}$, I can calculate the now unbiased estimators $\widetilde{\beta}_m = \left(\frac{\eta}{\eta+1}\right)\beta_m$, with $m = 0, k$, and $\widetilde{\gamma}_i = \left(\frac{\eta}{\eta+1}\right)\gamma_i$. The two components of the error $\left(\xi^*_{it} = -\frac{1}{\eta}\xi_{it}\right)$ and $\left(\varepsilon^*_{it} = \frac{\eta}{\eta+1}\varepsilon_{it}\right)$ reflect the combination of a demand and a supply system, letting the residual Total Factor Productivity be corrected by possible price shocks.

In Figure 5 I compare the estimates provided by the two-stage procedure I have just described with the productivity calculated adopting Olley and Pakes (1996). The first remarkable feature is a scale effect due to essentially to the missing correction in the translog case for unobserved productivity shocks. A scale effect that seems however not to affect the shape and the ranking of firms within industries, since apart from the chemical and pharmaceutical industries[9], estimates are highly correlated as Table 6 shows, with an average of 87.3. In Table 7 I also report the averages of estimated within-industry elasticities of substitution (in absolute value), that are calculated by 4-digit NACE rev. 2 sectors but are summarized for every 2-digit sector together with the standard deviation that gives an idea of the variability within industries and through time. The estimates for these latter are always above one, as expected, and significant.

[9] On the contrary, the strange shapes of productivities for chemicals and pharmaceuticals calculated by Olley and Pakes (1996) can be affected by what Ackerberg, Caves and Frazer (2006) noted after an identification problem arising from the two-stage procedure that uses labor input twice in the estimation. Moreover, the little variation observed by all inputs, for firms that are rather homogeneous in size within those industries can also have led to the very long right tail observed in the case of chemicals in Figure 5

Figure 5: Productivity distributions in logs of Olley and Pakes(1996) vs translog production function by NACE rev 2 industries



4.2. Returns to scale

Unlike the case of a Cobb-Douglas specification (as for example in Olley and Pakes,1996, but also in Levinsohn and Petrin, 2003), where elasticities of scale are assumed constant, with a translog specification it is possible to have differentiated and variable firm-specific returns to scale. After estimating eq. 10 I can indeed calculate firm-specific returns to scale that will be used to proxy the industry-level economies of scale, which are another possible determinant of export performance. Summing up the k-input shares defined as the partial derivatives for each input k to firm output Y_{it}, I obtain:

$$RTS_{it} = \sum_k S_{kit} = \sum_k \left[\frac{\partial \ln Y_{it}}{\partial \ln X_{kit}} \right] \tag{11}$$

where each k-input share is composed by a fixed part, common to all firms belonging to the same industry, and a variable part which depends on the firm input levels. With a three-input translog production function with labor, capital and materials, we would have:

$$RTS_{it} = \sum_k \widehat{\beta}_k + \sum_l \widehat{\delta}_{kk} \ln X_{kit} \ln X_{kit} \tag{12}$$

where $\widehat{\beta}_k$ is the estimated coefficient obtained for each (log of) input k = capital, labor, materials and $\widehat{\delta}_{kl}$ is the estimated coefficient for each interaction between (logs of) of inputs

Table 6: Correlations of Olley and Pakes (1996) firm-level productivities with translog productivities

2-digit	NACE REV.2 manufacturing activities	Correlation between productivities
10	Food products	0.965
11	Beverages	0.922
13	Textiles	0.959
14	Wearing apparel	0.936
15	Leather and related products	0.930
16	Wood and products of wood and cork, exc. furniture; articles of straw and plaiting materials	0.963
17	Paper and paper products	0.921
18	Printing and reproduction of media	0.818
19	coke and refined petroleum products	0.932
20	Chemicals and chemical products	*0.302*
21	Pharmaceuticals	*0.336*
22	Rubber and plastic products	0.957
23	Other non-metallic mineral products	0.949
24	Basic metals	0.948
25	Fabricated metal products	0.958
26	Computer, electronic and optical products	0.960
27	Electrical equipment	0.892
28	Machinery and equipment	0.967
29	Motor vehicles, trailers and semi-trailers	0.958
30	Other transport equipment	0.715
31	Furniture	0.965
32	Other manufacturing	0.954
	TOTAL	0.873

Table 7: Average elasticities of substitution by NACE 2-digit sectors

NACE 2-digit	Mean	standard deviation
10	7.37	8.47
11	9.18	13.06
13	6.25	7.31
14	7.07	8.16
15	6.57	7.57
16	18.90	36.84
17	5.33	7.97
18	3.62	2.89
19	1.12	0.35
20	38.22	67.31
21	8.07	9.16
22	1.75	0.51
23	23.04	78.52
24	3.23	2.36
25	7.91	9.45
26	2.47	2.29
27	7.06	7.49
28	5.55	6.33
29	23.38	40.61
30	6.48	8.13
31	4.32	4.07
32	5.94	4.07

X_{kit}. In the previous equation, the first term of the second member is common to all firms within an industry, whereas the second term is firm-year specific[10]. What I obtain is a firm-level variable expressed in terms of elasticity of inputs to output that, as Figure 6 shows, ranges from $(0, \infty)$, with some firms below unity suffering from diseconomies of scale and the bulk of them above unity that have reached the minimum efficiency scale and can benefit from economies of scale. In Table 8 it is possible to have a look at 2-digit industrial averages, decomposed by the fixed and the variable part.

In Figure 7 I report the relationship between estimates of productivities and returns to scale after eq. 10.plotting both distributions in a quantile-quantile graph, where at each percentile of one distribution corresponds the percentile of the other. If in general it is true that there is a positive relationship between productivities and economies of scale, it seems to be not linear. That is because, when proximate to economies of scale, firms have to increase by more the productivity in order to benefit from increasing returns to scale.

In order to derive a variable that proxies industrial economies of scale as one of the determinants of trade, I calculate 4-digit sector-level averages (rts_{jt}) from eq. 12 and I expect them to be positively correlated with a progression in the distribution of export performances of eq. 3.

[10] A time varying variable that can be eventually corrected for demand effects after the two-stage procedure described in the previous section to obtain a time varying elasticity of substitution

Figure 6: Firm-specific returns to scale after a translog production function

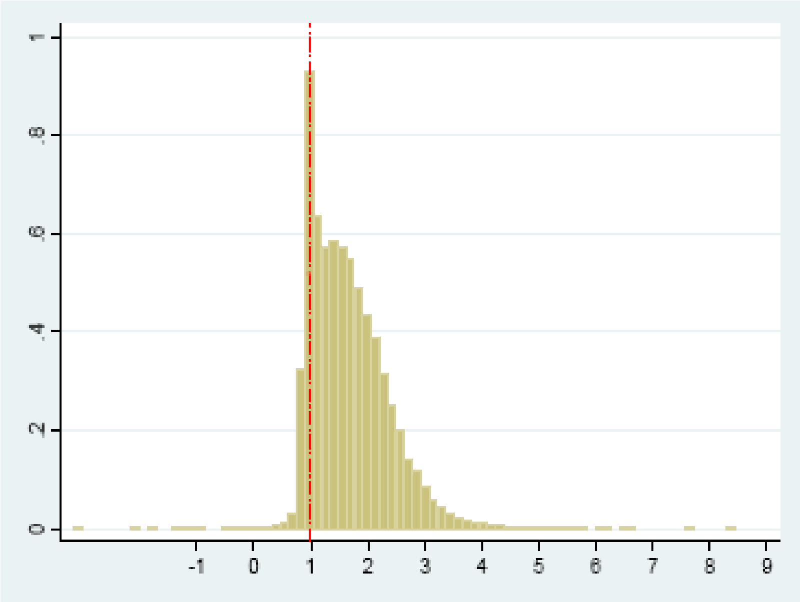


Figure 7: Quantile-Quantile plot of productivity vs firm-level returns to scale

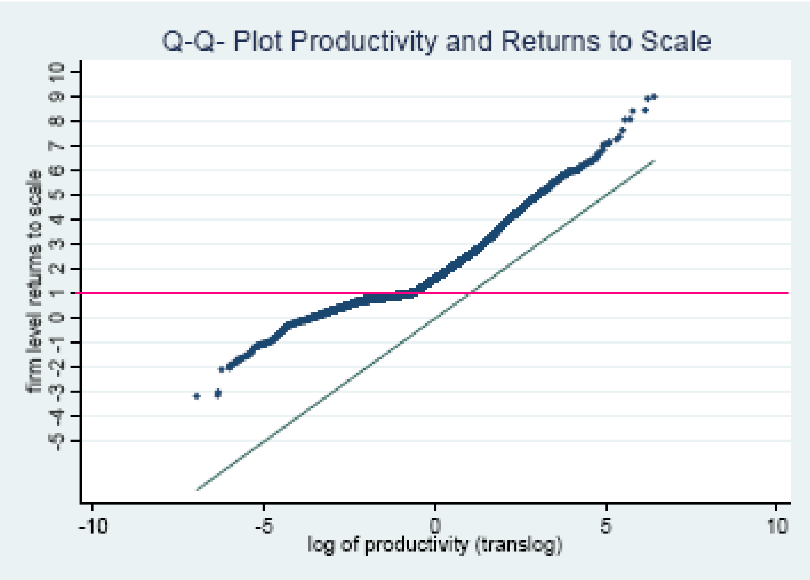


Table 8: Average of firm-specific returns to scale, three-input production function (k= Capital (C), Labor (L), Materials (M)).

NACE 2-digit	*Industry-specific term (A)* $\sum_k \beta_k$	β_{CC}	C*C	β_{LL}	L*L	β_{MM}	M*M	β_{CL}	C*L	β_{CM}	C*M	β_{LM}	L*M	*Firm-specific term (B)* $\sum \delta_{kh} lnX_{kit} lnX_{hit}$	*Average returns to scale (A) + (B)*
10	***0.966***	0.011	26.64	0.074	5.38	0.065	30.69	0.008	11.35	-0.032	27.67	-0.111	12.45	***0.519***	***1.484***
11	***0.884***	0.018	40.17	0.059	7.02	0.061	47.35	0.009	16.39	-0.047	43.16	-0.078	17.86	***0.741***	***1.624***
13	***0.879***	0.007	24.91	0.056	8.20	0.064	34.53	-0.002	14.48	-0.015	28.17	-0.104	16.95	***0.617***	***1.496***
14	***0.713***	0.010	19.80	0.036	6.77	0.085	31.15	0.004	11.48	-0.020	23.99	-0.103	14.07	***1.203***	***1.916***
15	***0.730***	0.000	21.58	0.053	8.62	0.059	32.43	0.013	13.58	-0.011	25.30	-0.091	16.45	***0.783***	***1.513***
16	***0.765***	0.006	23.96	0.071	6.42	0.069	34.59	0.006	12.36	-0.018	28.12	-0.110	14.88	***0.909***	***1.674***
17	***1.050***	-0.005	37.44	0.071	12.53	0.067	50.67	0.037	22.63	-0.012	42.92	-0.153	25.91	***0.418***	***1.469***
18	***0.836***	0.019	18.62	0.080	4.90	0.070	22.77	-0.002	9.55	-0.037	20.38	-0.109	10.82	***0.401***	***1.238***
19	***0.790***	0.010	54.92	0.101	15.01	0.060	77.35	0.001	29.73	-0.008	63.56	-0.137	31.40	***1.944***	***2.734***
20	***1.012***	0.011	40.82	0.033	11.99	0.053	51.59	0.031	22.86	-0.041	44.88	-0.084	25.21	***0.344***	***1.356***
21	***1.126***	0.008	58.84	0.038	19.31	0.039	64.56	-0.022	34.42	-0.016	60.93	-0.057	36.22	***-0.111***	***1.014***
22	***0.793***	0.006	32.16	0.050	10.84	0.072	44.56	0.014	19.11	-0.033	37.03	-0.094	22.39	***0.895***	***1.688***
23	***0.930***	0.001	27.03	0.093	7.08	0.059	35.52	0.012	13.88	-0.009	30.21	-0.133	15.55	***0.614***	***1.544***
24	***0.874***	0.001	43.03	0.054	15.32	0.073	56.58	0.032	26.40	-0.025	48.47	-0.124	30.14	***0.875***	***1.749***
25	***0.744***	0.006	24.55	0.085	7.70	0.054	31.17	-0.006	13.76	-0.010	26.75	-0.097	15.66	***0.628***	***1.372***
26	***0.906***	0.013	24.86	0.092	9.02	0.071	36.23	-0.027	15.55	-0.014	28.68	-0.122	18.38	***0.656***	***1.562***
27	***0.897***	0.002	27.65	0.069	11.39	0.076	43.80	0.023	18.74	-0.027	33.90	-0.129	23.10	***0.710***	***1.607***
28	***0.905***	0.005	24.80	0.095	9.12	0.077	40.31	0.007	15.57	-0.021	30.60	-0.142	19.45	***0.778***	***1.683***
29	***0.908***	-0.001	33.39	0.059	13.23	0.054	52.17	0.004	21.58	-0.009	40.43	-0.097	26.61	***0.735***	***1.644***
30	***1.006***	0.016	36.79	0.097	15.19	0.071	46.09	-0.023	24.98	-0.017	39.74	-0.138	27.12	***0.336***	***1.342***
31	***0.782***	0.008	16.62	0.029	5.09	0.074	25.26	0.026	9.08	-0.038	19.81	-0.087	11.29	***0.659***	***1.441***
32	***0.810***	0.010	17.40	0.086	4.22	0.067	19.95	-0.003	8.20	-0.024	17.66	-0.108	8.94	***0.461***	***1.272***

4.3. Productivity dispersions

In order to index differences in firm-level heterogeneity across sectors, Helpman, Melitz and Yeaple (2004) already parametrized productivity distributions drawing from a Pareto with the shape parameter k, where a higher dispersion (lower k) or a higher elasticity of substitution raised the dispersion of firm domestic sales and variable profits. Hence, they provided evidence that more dispersed sectors were also more internationalized. Indeed, in the theoretical model of Bernard, Redding and Schott (2007) the differences in productivity dispersions are explained by the industrial relative positions in terms of comparative advantage. After opennes with costly trade, average productivity increases by more in sectors at comparative advantages with respect to sectors at comparative disadvantages. This is due to the higher level of competition in the first sectors, where more entrants want to participate to higher expected profits and where a higher probability to export allow firms to smooth their fixed costs on a wider set of consumers, at home and abroad, and the selection process is harder. If in the case of Helpman, Melitz and Yeaple (2004) the differences in dispersions were only a signal of the relative degree of heterogeneity, in the case of Bernard, Redding and Schott (2007) the same differences are endogenous and motivated by sectoral characteristics such as differential factor endowments.

In this paper we first reproduce the correlation between export performances and productivity dispersions and then we will test the robustness of it against the structural relationship provided by Bernard, Redding and Schott (2007) that observed how heterogeneity was reinforced by the already described magnification effect.

After having obtained a complete estimated distribution of productivities from French firm-level data specific for each 4-digit sector j and time t following Section 4.1, I have calculated productivity dispersions following the methodology suggested by Norman, Kotz and Balakrishnan (1994) that assumes a Pareto distribution. I obtain a year-by-year cross-section estimates of the shape parameter ($k-parameter_{jt}$) for every industry j and time t according to the following specification:

$$ln(1 - F_j(\varphi_{it})) = k_{jt} * ln(\varphi_{it}^{\min}) - k_{jt} * ln(\varphi_{it}) \tag{13}$$

where φ_{it} is the firm-level Total Factor Productivity (TFP) in levels, $F_j(\varphi_{it})$ is the cumulative distribution of TFP for industry j, $\varphi_{it}^{\min}$ is the minimum of the distribution within the sector j at time t. The same exercise has been done for both TFPs calculated according to Olley and Pakes (1996) and according to the translog specifications of eq. 10. I expect that whatever the measure, an industrial dispersion is positively correlated (negatively if we take the k as the measure of skewness with a negative sign) with export performance since a more dispersed distribution of productivities within that sector implies a higher propensity to internationalize production as reported by Helpman, Melitz and Yeaple (2004). In Table 9 I summarize the 2-digit averages of this variable with the standard deviations through years and across more disaggregated sectors.

Table 9: Productivity dispersions (k-parameters) average by NACE 2-digit level

NACE 2-digit	Industry NACE rev. 2	elasticities of substitution	standard deviation
10	Food products	7.37	8.47
11	Beverages	9.18	13.06
13	Textiles	6.25	7.31
14	Wearing apparel	7.07	8.16
15	Leather and related products	6.57	7.57
16	Wood and products of wood and cork, exc. furniture; articles of straw and plaiting materials	18.90	36.84
17	Paper and paper products	5.33	7.97
18	Printing and reproduction of media	3.62	2.89
19	Coke and refined petroleum products	1.12	0.35
20	Chemicals and chemical products	38.22	67.31
21	Pharmaceuticals	8.07	9.16
22	Rubber and plastic products	1.75	0.51
23	Other non-metallic mineral products	23.04	78.52
24	Basic metals	3.23	2.36
25	Fabricated metal products	7.91	9.45
26	Computer, electronic and optical products	2.47	2.29
27	Electrical equipment	7.06	7.49
28	Machinery and equipment	5.55	6.33
29	Motor vehicles, trailers and semi-trailers	23.38	40.61
30	Other transport equipment	6.48	8.13
31	Furniture	4.32	4.07
32	Other manufacturing	5.94	4.07

4.4. Productivity cutoffs and the magnification effect

Models of firm heterogeneity presume two productivity cutoffs: one below which firms are not able to stay in the market (the zero-profit cutoff) having to stop their activity since they can not cover the fixed cost of production with expected profits; the other faced by only the more productive among the survivors, above which it is possible to export bearing the fixed cost necessary to acquire a market share abroad. According to the model of Bernard, Redding ans Schott (2007), the inclusion of sectors with different endowment-driven comparative advantages leads to a different dynamics in the reallocation process, as graphically illustrated in Figure 8 sourced from the original paper. Indeed, if it is true that average productivity increases in all sectors once we open to costly trade, it is also true that it increases more in sectors at comparative advantages. In this latter case, the zero-productivity cutoff moves to the right since we have a higher level of competition because there are more entering firms competing for better profit expectations, the selection process is tougher and potentially less productive firms exit the market. On the other hand, the export productivity cutoff move to the left because we have an increased probability to export for firms that were previously on the edge, producing only for the domestic market. The combined result is that the difference between the two cutoffs is narrower in sectors at comparative advantage where, at the end of the process, average productivity is even higher.

From our French firm-level dataset it is possible to derive both the zero-profit productivity cutoffs and the export productivity cutoffs at sector-level after the estimation of productivities following eq. 10. The first ($exit\_cutoff_{jt}$) is proxied as the average of NACE rev.2 4-digit (log of) productivities of the firms that exited the market in $t+1$ (i.e. were reported as non active in t), the second ($export\_cutoff_{jt}$) is computed as the average of (logs of) productivities of the exporting firms in t. The difference between them ($delta\_cutoffs_{jt}$) at time t is expected to be negatively correlated with comparative advantages in $t+1$ if the magnification effect is verified and a new source of gains from trade arises after the openness to costly trade.

In fact, in the case of France, we observe from Figure 9 and 10 that there is some preliminary evidence of a shift through time, where zero-productivity cutoffs tend to be tougher in 2007 with respect to 2001 and export productivity cutoffs show an enhanced probability to export.at the end of the period for less productive firms. What we will do in the next Section is to test the observed dynamics against the index of comparative advantage we have built in Section 3 after controlling for determinants of trade and demand effects.

5. Estimation strategies

In order to verify if there is a correlation between the progress within the distribution of product comparative advantages and the emergence of Ricardian technological differences, I begin with the estimation of both a Panel Probit and a Panel Logit regression and then, showing that they show comparable results, I switch to a Random Intercept Logistic regression that

Figure 8: (Logs of) zero-productivity cutoffs for French 4-digit industries. Source: elaboration on Amadeus by Bureau Van Djik

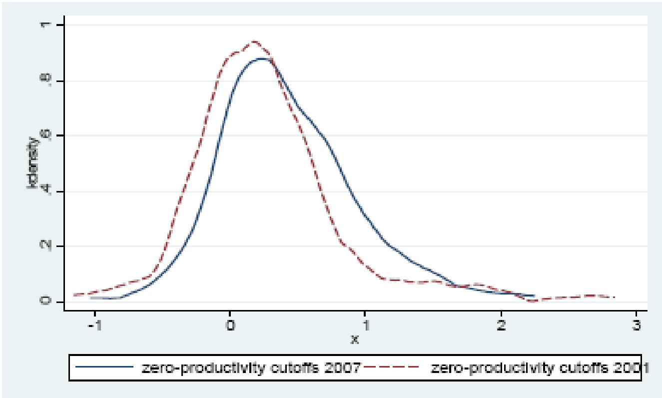


Figure 9: (Logs of) export cutoffs for French 4-digit industries. Source: elaboration on Amadeus by Bureau Van Djik

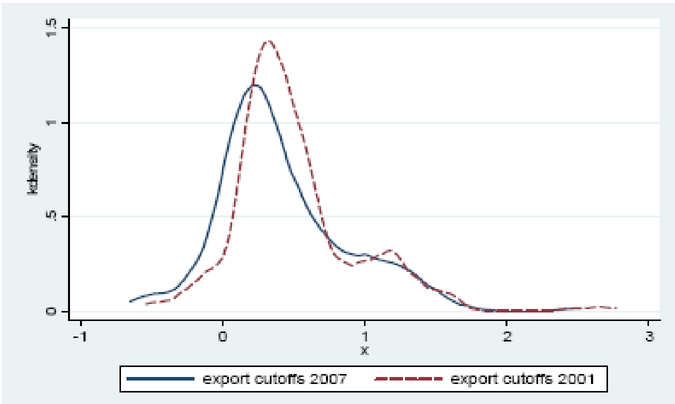
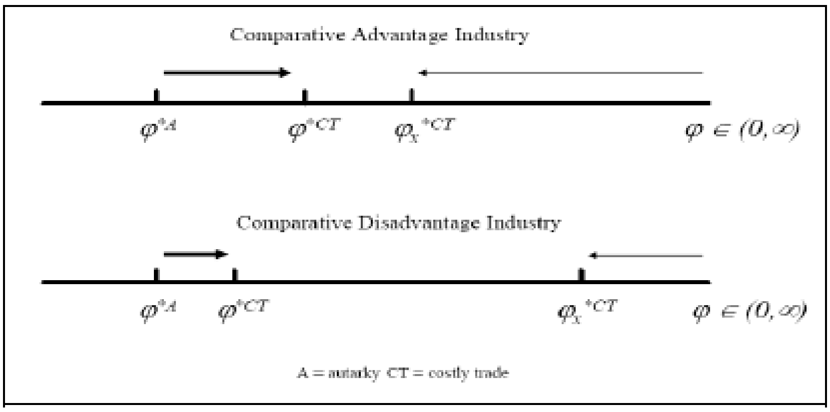


Figure 10: Differential cutoffs and the magnification effect. Source: Bernard, Redding and Schott (2007)



permits heterogeneity of products within industries to emerge and be measured by an estimated *ad hoc* parameter, with errors corrected for regressors that are specific for different nested levels. The first specification has included controls for the existence of a previous comparative advantage (RCA_{st-1}) at time $t-1$, the productivity dispersion of an industry ($k\_parameter_{jt}$), factor endowments (($capital\_intensity_{jt}$) and ($intangible\_content_{jt}$)) and finally a time fixed effect (δ_t):

$$
\begin{aligned}
logit\left\{\Pr(rca_{st}=1|X_{ij}\right\} \quad = \quad & \alpha_0+\beta_1 RCA_{st-1}+\beta_2 norm\_RP_{jt}+\beta_3 k\_parameter_{jt}+ \\
& +\beta_4 capital\_intensity_{jt}+\beta_5 intangible\_content_{jt}+ \\
& +\delta_t+\varepsilon_{st} \qquad (14)
\end{aligned}
$$

The second specification adds to the first Panel Logit the control for a correlation with the difference between industrial zero-productivity and export-productivity cutoffs of the following year ($delta\_cutoffs_{jt+1}$) and the average of firm-specific returns to scale by industry (rts_{jt}) .The former, as explained in the fourth Section, is expected to be negatively correlated to the dependent variable if Ricardian productivity differences emerge from further specialization in the products at comparative advantage (Bernard, Redding and Schott, 2007). The latter,instead, following Section 4.2 verify the importance of economies of scale as a determinant of trade specialization:

$$
\begin{aligned}
logit\left\{\Pr(rca_{st}=1|X_{ij}\right\} \quad = \quad & \alpha_0+\beta_1 RCA_{st}+\beta_2 norm\_RP_{jt}+\beta_3 k\_parameter_{jt}+ \\
& +\beta_4 capital\_intensity_{jt}+\beta_5 intangible\_content_{jt}+ \\
& +delta\_cutoffs_{jt}+rts_{jt}+\delta_t+\varepsilon_{jt} \qquad (15)
\end{aligned}
$$

From the third specification onwards I follow a multilevel model strategy (Skrondal and Rabe-Hesketh, 2004; Rabe-Hesketh, Skrondal and Pickles, 2005) that in our case takes the form of a Random Intercept Logistic Regression with the inclusion of an error component $\left(\zeta^{(j)}|X_{jt}\sim N\left(0,\psi\right)\right)$ which is sector specific and whose variance ψ approximates heterogeneity of products within sectors. Residuals $u_{st}|X_{st}$ will be independent across both products and industries and will be distributed according to a logistic. Industry error components will be independent across industries, but not across products that are nested within the specific industry. Levels are nested in the sense that one upper level can be perfectly partitioned in a series of minor levels and the nesting doesn't change through time. For the moment in the third specification I reproduce the model of eq 14:

$$
\begin{aligned}
logit\left\{\Pr(rca_{st}=1|X_{st},\zeta^{(j)}\right\} \quad = \quad & \alpha_0+\beta_1 RCA_{st}+\beta_2 norm\_RP_{jt}+\beta_3 k\_parameter_{jt}+ \\
& +\beta_4 capital\_intensity_{jt}+\beta_5 intangible\_content_{jt}+ \\
& +\delta_t+\zeta^{(j)}+u_{st} \qquad (16)
\end{aligned}
$$

In the fourth specification I include again the controls for difference between cutoffs and economies of scale as in eq. 15 within the same Random Intercept Logistic of the previous strategy:

$$
\begin{aligned}
logit\left\{\Pr(rca_{st}=1|X_{st},\zeta^{(j)}\right\} \quad = \quad & \alpha_0+\beta_1 RCA_{st}+\beta_2 norm\_RP_{jt}+\beta_3 k\_parameter_{jt}+ \\
& +\beta_4 capital\_intensity_{jt}+\beta_5 intangible\_content_{jt}+ \\
& +delta\_cutoffs_{jt}+rts_{jt}+\delta_t+\zeta^{(j)}+u_{st} \qquad (17)
\end{aligned}
$$

Finally, the fifth specification includes a control for the differentiation of product varieties within 2-digit level sectors ($subs\_elasticity_{nt}$), hence for the effect of a demand system as previously introduced in Section 3 and a further error component $\left(\chi^{(n)}\sim N\left(0,\vartheta\right)\right)$ for the level of 2-digit industries at which the elasticities of substitutions are calculated. In this specification also the variables deriving from productivity estimations ($k\_parameter_{jt}$, $norm\_RP_{jt}$, $delta\_cutoffs_{jt}$, rts_{jt}) are corrected for the presence of price shocks following the suggestions of Section 4.1:

$$
\begin{aligned}
logit\left\{\Pr(rca_{st}=1|X_{st},\chi^{(n)},\zeta^{(j)}\right\} \quad = \quad & \alpha_0+\beta_1 RCA_{st}+\beta_2 norm\_RP_{jt}+\beta_3 k\_parameter_{jt}+ \\
& +\beta_4 capital\_intensity_{jt}+\beta_5 intangible\_content_{jt}+ \\
& +delta\_cutoffs_{jt}+rts_{jt}+subs\_elasticity_{nt}+\delta_t+ \\
& +\chi^{(n)}+\zeta^{(j)}+u_{st} \qquad (18)
\end{aligned}
$$

6. Results

The first two columns of Table 10 confirm some classical results of trade theory, where technological differences à la Ricardo have a positive effect on the progress of a product in the distribution of comparative advantages, indicating that French specialization is in capital-intensive goods with a strong content of technology. As first attemps made by Helpman, Melitz and Yeaple (2004) have shown, here as well I verify that productivity dispersion, hence firm heterogeneity, is positively related to the internationalization of an industry as the positive and significant coefficient of the k-parameters testify. Once however in the third column I control for the presence of a magnification effect in the year that follows the internationalization, productivity dispersion *per se* loses significance in favor of a measure that better captures the heterogeneity. A wedge progressively differentiates reallocation processes of sectors with different content of comparative advantages, since even after controlling for initial Ricardian differences in productivity, further dynamic productivity differences emerge through time. According to the general equilibrium model of Bernard, Redding and Schott (2007), the discovery of a sector at comparative advantage incentives firms to enter and relocate in it because the expected profits are higher given the increased chances to export. The higher the mass of firms in the sector, the more competitive the selection process within that sector and the higher the average resulting productivity. If on one hand the zero-productivity cutoff increases, on the other hand the export cutoff becomes lower given the enhanced probability to export of firms within the sector. Here we observe a self-reinforcing process of enhanced comparative advantages as triggered by increasing average productivities that are added to factor endowments' differences à la Heckscher-Ohlin and pre-existing technological differences in capabilities à la Ricardo.This result is robust to other specifications reported in colum 4 and 5 that take into account the heterogeneity of products within industries. At a first glance also economies of scale play an important role in the determination of the pattern of specialization as the specification of the third column testify. It is indeed true that part of the advantage of the internationalization comes from the smoothing of fixed costs on a wider set of consumers and when both capital intensity and economies of scale are tested against heterogeneity of products, they become irrelevant. One possible explanation for this result is that reallocations of product mix usually occur within industries and if these latter, on average, can build their export performance on capital intensity and increasing returns to scale, single products have instead to rely on their own content of innovation to maintain and increase a share on world markets.

Finally, in the last colum of Table 10 we introduce a control for the elasticity of substitution and we observe that indeed part of the correlation between the progress in the distribution of comparative advantages and the productivity dynamics is lost, confirming the importance that demand shocks have on the reallocation process and the self-selection due to heterogeneity as Syverson (2004) and Helpman, Melitz and Yeaple (2004) showed.

The importance of relative productivity à la Ricardo is confirmed by the high and increasing point estimates across specifications, whereas a path dependence can be observed as given by the inclusion of the initial position in terms of comparative advantages (RCA_{st}) that states how good the export performance is at the beginning of the period.

7. Conclusions

This paper has first demonstrated how in France dynamic Ricardian differences emerge from firm heterogeneity following the theoretical model of Bernard, Redding and Schott (2007) after controlling for all other determinants of trade, but it also testifies how demand shocks can influence trade performance and comparative advantages. In particular, the confirmation of the existence of a magnification effect in terms of trade performance for sectors at comparative advantages entails first of all the acknoledgment of an additional source of gains from trade derived from firm heterogeneity. Secondly, different sectoral dynamics in costly-trade with heterogeneour firms implies a reappraisal of the effectiveness of industrial and trade policies. Indeed, if dynamic differences in aggregate productivity emerge among sectors, it is possible that an asymmetric trade liberalization (or the adoption of specific trade policies) can alter the ranking of comparative advantages once boosting firm reallocation in some sectors before than others.

The adoption of some specific econometric tools, such as the multilevel model specifications, the calculation of firm-specific returns to scale and of industrial elasticities of substitution have been useful to address different degrees of heterogeneity at product-level, firm-level and industry-level.

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Chapter II

Import Penetration, Intermediate Inputs and Productivity: Evidence from Italian Firms

1 Introduction

When analyzing the dismal performance of European economies in the last five years, most studies (e.g. Sapir, 2003) seem nowadays to agree in identifying the decline of European productivity vs. the US one as a major contributing factor. Consistently, in a very detailed study Daveri and Lasinio (2006) find that the current stagnation of the Italian economy is mainly a labour productivity problem, mostly driven by a decline in total factor productivity (TFP), especially in manufacturing sectors.

As a result, the need for productivity gains sit nowadays high in the agenda of European policymakers. Strangely enough, however, the relationship between productivity and trade openness is, more often than not, perceived as a negative one, periodically leading to protectionist calls throughout the EU member States.

And yet, a vast body of theoretical and empirical literature points to a positive relationship between trade openness and productivity. In particular, from a theoretical point of view, several channels might explain a positive effect of trade and trade liberalization on productivity. An increased product market competition, for instance, may stimulate firms to reduce their x-inefficiences or even lead the less productive firms to leave the market (Melitz, 2003 and Melitz and Ottaviano, 2005). Other important channels might be the increased availability of foreign (possibly better) intermediate inputs that can also stimulate technological innovation (see for example Grossman and Helpman, 1991) and possible scale effects due to the greater market size (Krugman and Helpman, 1985).

As for the empirical contributions, the cross-country studies of Ades and Glaeser (1999), Frankel and Romer (1999), and Alesina, Spolaore, and Wacziarg (2000) all found significant effects of trade on growth and productivity[11]. The finding is also confirmed in industry studies such as Trefler (2004), who finds an increase by 14% in labour productivity in those Canadian and US industries with highest output tariff cuts. In a developing country context, Shor (2004) analyzes tariffs for a sample of Brazilian industries, showing that input tariffs have a negative

[11] These studies have been criticised by Rodrik (2000) and Rodriguez and Rodrik (2001), on the grounds that that once institutional quality and geographic variables are taken into account the positive effect of trade on productivity disappears. In a recent study, however, Alcalà and Ciccone (2004) find a positive impact of real openness on productivity for 138 countries, even after controlling for institutional quality and geographic variables, when real openness is employed.

effect on productivity. At the firm-level, Tybout and Westbrook (1995), Krishna and Mitra (1998), Pavcnick (2002), Fernandes (2003) and Topalova (2004), all find positive effects of trade on firm-level productivity.

All the previously quoted studies, however, explore the "horizontal" channels through which the trade shock affects productivity, i.e. all those channels captured by *within-industry* measures of integration (such as import penetration in the same industry or output tariff reductions). As a result, the economic nature of the effects explored deals essentially with productivity gains led by competition effect. On the other hand, it might be interesting to explore also "vertical" channels, i.e. all those channels captured by *across-industry* measures of integration such as imported input, input tariffs or import penetration in the up-stream industries, especially in light of the recent trends showing that international trade in components is growing faster than trade in final goods (Hummels et al., 2001).

As a result, a growing literature has started to explore this second class of channels, which might yield a richer set of predictions on the relationship between trade flows and productivity gains. In particular, Amiti and Konings (2005) consider the impact of both output and input tariffs on productivity for a sample of Indonesian firms, concluding that a 10% reduction in output tariffs would increase productivity by 1%, while a 10% reduction in input tariffs would increase TFP by 3% on average, and by 11% in input-importing firms.

The present paper is related to this last strand of literature, since it aims at understanding whether import penetration matters for the productivity of local firms, and whether the impact is different when considering trade measures within or across (up-stream) industries and across different countries of origin of the imports. In particular, the exercise is carried out on a sample of roughly 35,000 Italian manufacturing firms operating in the period 1996-2003. The choice of Italy is driven by the peculiar behavior of the country: according to the OECD Factbook 2006, in fact, Italy is the only country among those surveyed which has displayed a negative average growth rate of its multi-factor productivity in the period 1996-2003 (-0.3 per cent), while at the same time experiencing an increasing trade openness.

Anticipating our main result, we find that import penetration positively matters for productivity, with an effect which is however differentiatied if considering within vs. across-industries (vertical) indicators. In particular, a 10% increase in the import penetration ratio of the same industry would result in a productivity increase of limited magnitude (around 0.05%), while an increase of 10% of the import penetration ratio in the up-stream industries would instead increase the productivity of the average firm by some 1.3%. These results however vary a great deal when considering the impact of trade openness with respect to different countries or group of countries trading with Italy.

The paper thus contributes to the literature in a number of ways. To the best of our knowledge, this is the first paper to consider in a core European country (Italy) both the “horizontal” and “vertical” channels through which economic integration might affect productivity, in the spirit of Amiti and Konings (2005). Second, we employ import penetration ratios rather than MNF tariffs to calculate import penetration. Although tariffs are a direct policy tool, while import penetration ratios are just equilibrium outcomes of import, export and production choices, it might be preferable to use trade-related indicators instead of tariff-related ones when interested in a positive analysis of the impact of economic integration on productivity. As proved by Karacaovali (2006), in fact, tariffs are likely to be endogenous to productivity; moreover, MFN tariffs are imperfect indicators of the effective protection because they are rarely the true tariffs applied. Third, we build the import penetration indexes for the up-stream industries using time-varying technology coefficients retrieved from Input-Output tables, thus directly observing the linkages across sectors in every considered year. Fourth, we differentiate the impact allowing the trade openness to vary across different countries of source and destination of trade.

The structure of the paper is as follows. Section two provides description and discussion of data used in the analysis, providing a picture of Italian imports through several measures of trade openness. Section three is devoted to introduce first our semi-parametric econometric estimation of total factor productivity, then to report estimates on linkages between productivity and the several measures of openness we use. Section four discusses the main results obtained and the relative robustness checks. Section five concludes.

2 Data description

2.1 The sample of italian manufacturing firms

A commercial dataset called AIDA, collected by the Bureau van Dijk, was used in order to retrieve balance sheet data relative to sales, value added, net tangible fixed assets, number of employees and ownership structure of the Italian manufacturing firms. The total sample was made up by 61,335 firms. Taking 2001 as the reference year and comparing sample data with the official Industrial Census of that year, these firms accounted for the 73% of total manufacturing value added and 54% of manufacturing employment. However, due to the quality of data, extensive data cleaning had been necessary. We adopted a two-stage data cleaning procedure. First, we dropped all those firms reporting negative values of any of the considered variables. Second, in order to get rid of outliers, we computed the growth rates of each variable and dropped all firms reporting growth rates smaller than the 1st or greater than the 99th percentiles of the relevant distribution. The resulting sample is constituted of 34,385 firms, representing the 40.7% of total manufacturing value added and 31.7% of manufacturing employment in 2001.

To validate our sample, we compared it with official data along three dimensions: geographical location, industrial activity and firms' size. Table 1 reports the geographical distribution of the firms in our sample. The number for each region ranges from 55 (Aosta Valley) to more than 10,000 (Lombardy). The correlation between the distribution of our sample and the distribution of the 2001 Census is 0.96 and significant at the 1 per cent level.

As for the distribution across industries, Table 2 shows how the number of firms for each NACE2-digits sector ranges from 119 in the case of sector 23 ("Manufacture of coke, refined petroleum products and nuclear fuel") to more than 5,000 firms in sector 29 ("Machinery and

Table 1: Geographical distribution of firms

Regione	Freq.	Percent
Abruzzo	602	1.75
Basilicata	121	0.35
Calabria	177	0.51
Campania	1,350	3.93
Emilia-Romagna	4,299	12.5
Friuli	1,048	3.05
Lazio	1,255	3.65
Liguria	409	1.19
Lombardia	10,415	30.29
Marche	1,258	3.66
Molise	65	0.19
Piemonte	2,956	8.6
Puglia	881	2.56
Sardegna	208	0.6
Sicilia	590	1.72
Toscana	2,729	7.94
Trentino-Alto Adige	486	1.41
Umbria	430	1.25
Valle d'Aosta	55	0.16
Veneto	5,051	14.69
Total	**34,385**	**100**

equipment"). Again, the correlation with the Census data is pretty good (0.71) and significant.

As far as firms' size is concerned, Table 3 shows the distribution across the size classes adopted by the Italian National Institute of Statistics. Firm size is measured by employment. Looking at firms for which employment data in 2001 is available, there is a fair representation of micro firms (11.2%). Clearly, the third column shows how this sample under-represents micro-firms, which in Italy account for more than 80% of total firms. This (relative) over-representation of large firms is clearly a drawback that must be taken in mind along all the analysis. However, since micro firms are not obliged to report balance sheet data, it is almost impossible to obtain otherwise these latter on a regular basis and we have to cope with an (albeit moderate) "size bias" of the sample.

The last relevant feature retrieved from our data is the firm ownership structure, which for each firm we were able to identify in 2004. Hence, we classified as foreign (FORMNE) those firms with a direct foreign participation greater than 10%, while we considered as domestic MNEs (DOMMNE) all those firms with participation abroad greater than 10% in 2004. We have got a total of 453 foreign firms and 1,365 domestic multinationals in our sample[12].

Table 4 shows some descriptive statistics of the sample. Panel A shows the descriptive statistics for the values of the different variables whereas panel B reports the information on growth rates.

[12] Note that we are dealing with the ownership data of the last available year, which prevents us from capturing any possible change of status in the period considered (as for example due to M&A operations). Although foreign ownership is not the main object of our analysis, this caveat should be taken in mind when discussing our results.

Table 2: Activity distribution of firms

CODE	NACE_DESCRIPTION	Freq.	Percent
15	Manufacture of food products and beverages	3,251	9.45
17	Manufacture of textiles	2,047	5.95
18	Manufacture of wearing apparel; dressing and dyeing of fur	1,437	4.18
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	1,470	4.28
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and..	1,086	3.16
21	Manufacture of pulp, paper and paper products	845	2.46
22	Publishing, printing and reproduction of recorded media	1,533	4.46
23	Manufacture of coke, refined petroleum products and nuclear fuel	119	0.35
24	Manufacture of chemicals and chemical products	1,511	4.39
25	Manufacture of rubber and plastic products	2,219	6.45
26	Manufacture of other non-metallic mineral products	2,278	6.62
27	Manufacture of basic metals	1,030	3
28	Manufacture of fabricated metal products, except machinery and equipment	3,530	10.27
29	Manufacture of machinery and equipment n.e.c.	5,171	15.04
30	Manufacture of office machinery and computers	234	0.68
31	Manufacture of electrical machinery and apparatus n.e.c.	1,599	4.65
32	Manufacture of radio, television and communication equipment and apparatus	490	1.43
33	Manufacture of medical, precision and optical instruments, watches and clocks	749	2.18
34	Manufacture of motor vehicles, trailers and semi-trailers	558	1.62
35	Manufacture of other transport equipment	447	1.3
36	Manufacture of furniture; manufacturing n.e.c.	2,781	8.09
	Total	**34,385**	**100**

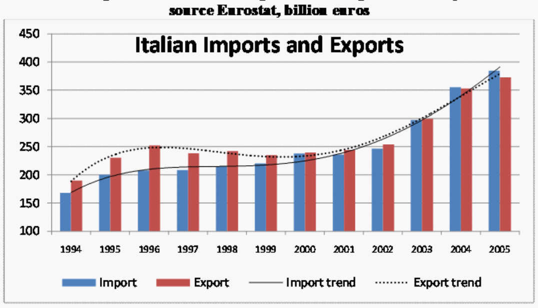
Table 3: Size distribution of firms

	Sample 2001		Census 2001		
size	Freq.	Percent	Freq.	Percent	Firm coverage
1-9	3,844	11.2%	447,859	82.5%	0.9%
10-19	4,881	14.2%	55,553	10.2%	8.8%
20-49	6,646	19.3%	27,075	5.0%	24.5%
50-249	4,641	13.5%	10,872	2.0%	42.7%
249-	809	2.4%	1,517	0.3%	53.3%
N/A	13,564	39.4%			2.5%
TOTAL	**34,385**	**100.0%**	**542,876**	**100.0%**	**6.3%**

Table 4: Descriptive statistics

(A)					
Variable	Obs	Mean	Std. Dev	Min	Max
PROD_DEFL	182149	1.29E+07	7.31E+07	204.2953	5.40E+09
Y_DEFL	182149	1.25E+07	7.16E+07	198.023	5.35E+09
VA_DEFL	182149	3154958	1.59E+07	10.49453	1.11E+09
M_DEFL	151898	7022836	4.95E+07	1.87991	4.98E+09
K_DEFL	182149	2669536	1.91E+07	4.735422	1.85E+09
L	178420	62.57517	357.8281	1	103761
(B)					
Variable	Obs	Mean	Std. Dev	Min	Max
DPROD	141526	0.063077	0.194417	-0.44328	1.980081
DY	141526	0.064328	0.203545	-0.47451	1.993963
DVA	141526	0.070475	0.248729	-0.62854	1.997875
DM	141526	0.0742	0.274415	-0.62274	1.999147
DK	141526	0.075576	0.341839	-0.67925	1.999518
DL	141526	0.069498	0.263197	-0.81667	1.982955

Graph 1: Trends for imports and exports in Italy, source Eurostat, billion euros



2.2 An analysis of Italian imports

Information on trade flows and production by industry has been provided by EUROSTAT. Values of imports and exports of the manufacturing sector were collected at a detailed product level according to the CN 8-digit classification used for custom purposes, for the period 1996-2004 and for different countries of origin/destination. The data were then reclassified at the 4-digit NACE rev. 1.1 level, using the relative correspondence tables provided by EUROSTAT. The product-based data, coupled with a geographical breakdown, thus allowed us to draw a detailed picture of the changing pattern of Italian imports in a relevant period. Data on production were collected using EUROSTAT with its PRODCOM database at a 8-digit product classification, whose codes were once again converted at NACE industry detailed levels as done for trade flows. In Graph 1 we report the trends of both imports and exports in Italy for the period of analysis, from which we can observe how, especially after 2001, imports have increased consistently and have converged towards the export trend.

First of all, looking at basic figures, openness on the import side has rapidly increased in the considered period, in Italy as in other European countries. In order to correct the general rising trend for world imports and to differentiate what's going on by industry, we used a simple ratio

Table 5: Import shares by sector

NACE 2-digit	1996	1997	1998	1999	2000	2001	2002	2003	2004
15	0.098	0.091	0.085	0.080	0.073	0.077	0.077	0.080	0.077
16	0.007	0.006	0.006	0.007	0.006	0.006	0.006	0.006	0.006
17	0.035	0.037	0.036	0.033	0.033	0.034	0.032	0.031	0.030
18	0.025	0.026	0.027	0.026	0.026	0.028	0.031	0.032	0.032
19	0.024	0.025	0.024	0.022	0.025	0.029	0.029	0.029	0.026
20	0.016	0.016	0.016	0.017	0.016	0.015	0.015	0.016	0.015
21	0.028	0.027	0.027	0.027	0.029	0.027	0.026	0.025	0.023
22	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
23	0.029	0.024	0.016	0.017	0.025	0.021	0.023	0.022	0.020
24	0.162	0.161	0.156	0.155	0.152	0.153	0.159	0.163	0.163
25	0.026	0.025	0.026	0.027	0.025	0.025	0.025	0.026	0.026
26	0.015	0.014	0.014	0.014	0.013	0.013	0.013	0.013	0.013
27	0.107	0.109	0.109	0.093	0.103	0.097	0.091	0.091	0.107
28	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
29	0.091	0.086	0.093	0.096	0.093	0.093	0.094	0.091	0.089
30	0.042	0.040	0.041	0.044	0.042	0.039	0.037	0.034	0.033
31	0.034	0.034	0.035	0.035	0.035	0.036	0.033	0.034	0.033
32	0.050	0.054	0.055	0.057	0.064	0.058	0.052	0.051	0.059
33	0.034	0.034	0.034	0.036	0.036	0.036	0.036	0.034	0.034
34	0.116	0.128	0.134	0.143	0.130	0.136	0.145	0.150	0.145
35	0.018	0.018	0.026	0.028	0.031	0.034	0.033	0.029	0.026
36	0.018	0.019	0.019	0.020	0.020	0.019	0.019	0.019	0.020
Total	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

IMP_sh_{Wjt} which is the share of industry j flows from world (partner W) at time t on total flows (from world) at time t:

$$IMP\_sh_{Wjt} = \frac{IMP_{Wjt}}{IMP_{Wt}} \quad (1)$$

Table 5 reports dynamics of these shares at NACE 2-digit industry level while in the following analysis of Section 3.3 it will be possible to employ more disaggregated shares.

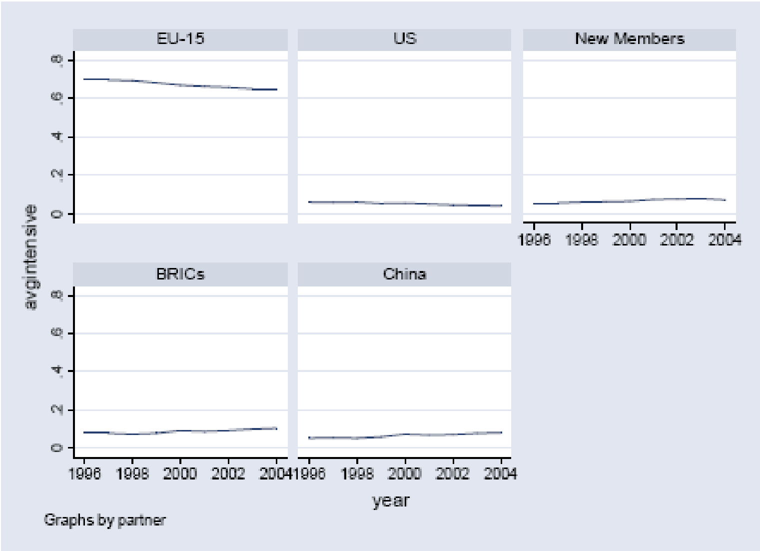
But import shares could be decomposed by an intensive and an extensive margin of trade following Hummels and Klenow (2002). These two margins allowed us to isolate variety from intensity, with the intensive margin (Int_mar_{zjt}) measuring trade intensity and the extensive margin (Ext_mar_{zjt}) catching trade variety. Int_mar_{zjt} is the importing country z's share of world imports in those product categories s produced within the specific industry j at time t , calculated as:

$$Int\_mar_{zjt} = \frac{IMP_{zjt}}{\sum_{r\ if\ r \neq z} \sum_{s\ \epsilon\ IMP_{zjt}} IMP_{rst}} \quad (2)$$

whereas Ext_mar_{zjt} is the fraction of world imports for the industry j at time t that occur in the product categories s, within industry j, which Italy imports from country z , computed as:

$$Ext\_mar_{zjt} = \frac{\sum_{r\ if\ r \neq z} \sum_{s\ \epsilon\ IMP_{zjt}} IMP_{rst}}{IMP_{Wjt}} \quad (3)$$

Graph 2: Average intensive margins by partner

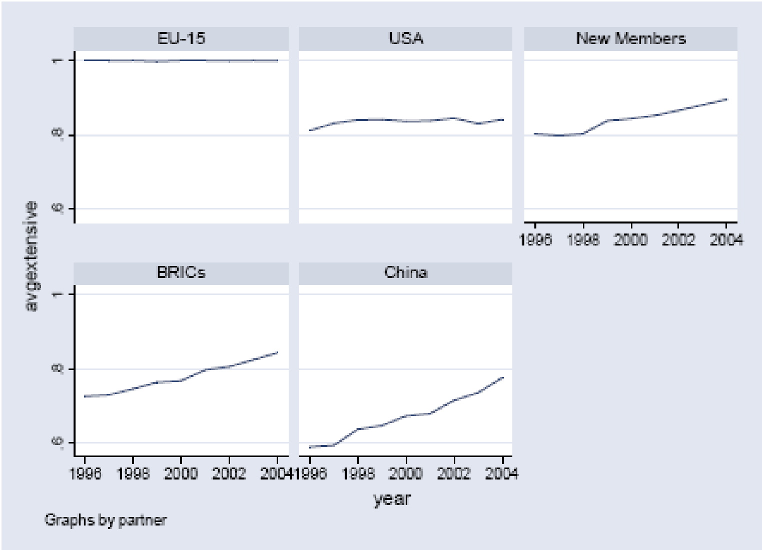


The denominator of the intensive margin is the numerator of the extensive margin and here it is net of country z's flows, with the aggregation of products by industries having been made possible by EUROSTAT correspondence tables as explained before. Decomposing by trade margins excludes the option of considering world as a partner, given the peculiar method of calculation which takes total trade as a benchmark. At the same time, every country-specific intensive margin multiplied by its own extensive margin is able to reproduce the import shares of that country for each j sector.

Import margins are differentiated by a number of representative partners: the European countries before the enlargement (EU-15), USA, the new member states of the European Union (NMS), the so-called BRICs (Brazil, Russia, India and China as new emerging markets) and China alone. Graph 2 and Graph 3 report time trends of intensive and extensive margins on average by partner.

As it is possible to see, there are structural differences in the exposure to international trade flows. First, considering the 15 countries of the European Union (EU 15) before the enlargement as a partner, both intensive and extensive margins reached high average ratios for all manufacturing industries, demonstrating once again a remarkable economic integration within the Union. In some cases, where extensive ratios equal one, there's no possible rise of trade in varieties. From United States (US), instead, many varieties are imported but intensity of trade is in general rather low and comparable with figures of the New Member States (NMS) after the enlargement, which anyway are on average rising within the considered period while US ones are more stable. Table 6 and Table 7 summarize trade margins as calculated before. Intensive margins for China alone are considerably high for some sectors (e.g. NACE18 - wearing apparel; NACE19 - Leather luggage and footwear) but still extensive margins reflecting extent of

Graph 3: Average extensive margins by partner



traded varieties are in general behind US ones, apart from textiles (NACE17), wearing apparel (NACE18) and leather luggage and footwear (NACE19). Figures for the group of BRICs (Brazil, Russia, India and China) show a wide range of imported goods, even if single countries are individually more specialized. These four countries taken together matter more than US in terms of import intensity when this latter is measured by intensive margins.

Finally, in order to weigh trade of an industry with its own changing demand we introduced the measure of horizontal import penetration and vertical import penetration, H_imp_{zjt} and V_imp_{zjt} respectively, from country z in industry j at time t. The horizontal penetration (i.e. import penetration ratios considering the industry of affiliation) is calculated as:

$$H\_imp_{zjt} = \frac{IMP_{zjt}}{IMP_{zjt} + PROD_{jt} - EXP_{zjt}} \tag{4}$$

where EXP_{zjt} are the exports of Italy to country z in industry j in year t, while $PROD_{jt}$ is the national output of industry j in year t.

The measure of the vertical import penetration, V_imp_{zjt}, is somewhat more complicated, since it reflects the linkages present in the up-stream industries. Following Smarzynska (2004), who has used a similar indicator in order to measure "vertical" FDI presence, the index is computed as the weighted average of the up-stream industries' horizontal import penetration ratios using as weights the time-varying input-output coefficients retrieved from the Italian Input-Output matrix, which distinguishes between general figures for intermediates and specific

Table 6: Intensive margins

	EU15		United States		New EU Members		BRIC		CHINA	
NACE2	average	standard deviation	average	standard deviation	average	standard deviation	average	standard deviation	average	standard deviation
15	0.84789	*0.00608*	0.02629	*0.00832*	0.02783	*0.00399*	0.09244	*0.01007*	0.03758	*0.00641*
17	0.43773	*0.06410*	0.01954	*0.00489*	0.13514	*0.03014*	0.13469	*0.01827*	0.09635	*0.01308*
18	0.25307	*0.02814*	0.00796	*0.00189*	0.21376	*0.02893*	0.23413	*0.02491*	0.15868	*0.03371*
19	0.21269	*0.01592*	0.01573	*0.00221*	0.24636	*0.01789*	0.20228	*0.01542*	0.12426	*0.00873*
20	0.55726	*0.00969*	0.03159	*0.00615*	0.17257	*0.01746*	0.07317	*0.00539*	0.04765	*0.00432*
21	0.80738	*0.01948*	0.02775	*0.00319*	0.05785	*0.01876*	0.05507	*0.00492*	0.02921	*0.00597*
22	0.75116	*0.01581*	0.05243	*0.00997*	0.02055	*0.01162*	0.04329	*0.00928*	0.04197	*0.00787*
23	0.28063	*0.05372*	0.08275	*0.02646*	0.02461	*0.01678*	0.14292	*0.02909*	0.03035	*0.01571*
24	0.79704	*0.00288*	0.05368	*0.00512*	0.02357	*0.00210*	0.02292	*0.00384*	0.01736	*0.00463*
25	0.70467	*0.01566*	0.04073	*0.00671*	0.03662	*0.01020*	0.07761	*0.00757*	0.07181	*0.00581*
26	0.68246	*0.05214*	0.01801	*0.00283*	0.09183	*0.02589*	0.12432	*0.03972*	0.07709	*0.03166*
27	0.66631	*0.03194*	0.02452	*0.00566*	0.07514	*0.00956*	0.08196	*0.00804*	0.02241	*0.00642*
28	0.69485	*0.03637*	0.03549	*0.01856*	0.09101	*0.01698*	0.06507	*0.02384*	0.05127	*0.01707*
29	0.69919	*0.01425*	0.07649	*0.01244*	0.03765	*0.00839*	0.03829	*0.01658*	0.03213	*0.01540*
30	0.77743	*0.02665*	0.05417	*0.01993*	0.01381	*0.00739*	0.03768	*0.01501*	0.03735	*0.01527*
31	0.67918	*0.02259*	0.07018	*0.01145*	0.04739	*0.01065*	0.07287	*0.01714*	0.06696	*0.01510*
32	0.72572	*0.03247*	0.06708	*0.01999*	0.03214	*0.00982*	0.03059	*0.01064*	0.02689	*0.01010*
33	0.62696	*0.01311*	0.16247	*0.01372*	0.02027	*0.00922*	0.04521	*0.01661*	0.04338	*0.01628*
34	0.81867	*0.02869*	0.02868	*0.00299*	0.06688	*0.01133*	0.01941	*0.00565*	0.00587	*0.00309*
35	0.47781	*0.08808*	0.12154	*0.02124*	0.07931	*0.04108*	0.09951	*0.04594*	0.08364	*0.04407*
36	0.51961	*0.04345*	0.03578	*0.00573*	0.07721	*0.01095*	0.15168	*0.02881*	0.13490	*0.02528*

Table 7: Extensive margins

	EU15		United States		New EU Members		BRIC		CHINA	
nace2	average	standard deviation	average	standard deviation	average	standard deviation	average	standard deviation	average	standard deviation
15	0.99965	*0.00026*	0.42962	*0.02605*	0.54999	*0.09425*	0.39401	*0.03930*	0.29922	*0.05338*
17	0.99994	*0.00003*	0.82722	*0.01495*	0.93941	*0.02264*	0.92896	*0.03366*	0.84641	*0.06309*
18	0.99999	*0.00002*	0.96153	*0.00927*	0.99556	*0.00189*	0.99732	*0.00237*	0.99129	*0.00787*
19	0.99980	*0.00037*	0.94415	*0.02423*	0.98951	*0.00751*	0.99250	*0.00377*	0.96266	*0.01540*
20	0.99974	*0.00021*	0.81916	*0.04269*	0.97201	*0.00722*	0.88583	*0.06785*	0.57634	*0.09331*
21	0.99998	*0.00003*	0.88211	*0.04543*	0.94600	*0.02151*	0.77774	*0.06497*	0.70564	*0.06599*
22	0.99993	*0.00020*	0.98022	*0.01468*	0.95142	*0.02009*	0.93907	*0.02283*	0.91678	*0.03475*
23	0.99276	*0.00988*	0.47456	*0.15479*	0.78982	*0.10308*	0.70455	*0.09639*	0.04658	*0.04628*
24	0.99914	*0.00056*	0.93914	*0.00503*	0.87133	*0.02365*	0.77777	*0.06601*	0.61510	*0.08938*
25	0.99994	*0.00016*	0.97982	*0.00694*	0.94575	*0.03538*	0.91083	*0.02635*	0.87081	*0.04414*
26	0.99999	*0.00002*	0.74721	*0.04365*	0.90270	*0.05176*	0.79533	*0.09722*	0.74444	*0.11662*
27	0.99878	*0.00110*	0.66247	*0.03088*	0.82152	*0.05608*	0.76959	*0.06133*	0.42854	*0.10954*
28	1.00000	*0.00000*	0.93818	*0.01763*	0.97119	*0.01173*	0.87477	*0.07797*	0.85489	*0.07725*
29	0.99938	*0.00114*	0.93885	*0.00683*	0.91097	*0.01803*	0.84428	*0.04768*	0.75272	*0.07571*
30	1.00000	*0.00000*	0.99271	*0.00685*	0.96829	*0.01641*	0.97840	*0.01441*	0.97375	*0.01624*
31	0.99998	*0.00002*	0.98971	*0.00343*	0.92966	*0.01958*	0.94785	*0.01180*	0.93060	*0.01979*
32	1.00000	*0.00000*	0.99072	*0.00683*	0.85427	*0.08429*	0.88938	*0.09384*	0.86970	*0.10391*
33	0.99989	*0.00016*	0.98763	*0.00619*	0.88593	*0.04072*	0.92315	*0.02445*	0.84647	*0.05924*
34	0.99998	*0.00005*	0.86372	*0.02969*	0.96480	*0.02465*	0.85327	*0.04237*	0.74138	*0.05798*
35	0.89678	*0.04526*	0.73640	*0.07238*	0.74252	*0.08171*	0.62091	*0.09328*	0.49261	*0.10951*
36	1.00000	*0.00000*	0.96630	*0.01483*	0.90741	*0.04668*	0.96701	*0.01171*	0.91246	*0.06232*

amounts of imports used by economic activities for production purposes[13].

$$V\_imp_{zjt} = \sum_{k\ if\ k\neq j} a_{kjt} \cdot H\_imp_{zkt} \quad (5)$$

where a_{kjt} is the weight of industry k as input of industry j at time t.

Table 8 is dedicated to simple descriptive statistics[14] on horizontal import penetration ratios taking whole world as a partner. Heterogeneity is significant among industries. From a 1.06 of average import penetration ratio registered by NACE industry 30 (office machinery and computers) to the 0.05 of NACE industry 22 (publishing and printing). As for the evolution over time of the import penetration ratios, Graph 6 reports dynamics of different industries. Also in this case there is a lot of trend heterogeneity, with an upward trend in some industries (e.g. textiles - 17 or wearing apparel - 18), almost at in others (wood -20; motor vehicles - 34), or decreasing (pulp and paper - 21; basic metals - 27). Obviously, here as in the case of trade margins, heterogeneity through time further increases if one looks at 4-digit industries, which are not reported.

Table 9 reports relevant descriptive statistics on vertical import-penetration indexes at 2-digit level of aggregation, revealing again a significant heterogeneity. The industry with the highest up-stream ratio is NACE industry 30 (office machinery and computers) while the one with the lowest value is NACE 20 (wood products).

The extent of heterogeneity among industries is depicted in Graph 5 showing the evolution of vertical penetration ratios, mainly different from the corresponding horizontal figures plotted in Graph 4.

As clearly summarized by Table 9 and Graph 5, average vertical import penetration ratios have rapidly grown for the period of concern if we look at emerging economies (BRICs or China alone) and found a renewed upward trend after 2000 in the case of the New Member States. United States count more for horizontal trade than for vertical trade and horizontal ratios are on average decreasing, at the contrary of New Members, BRICs and China among which increasing shares of Italian imports are apportioned.

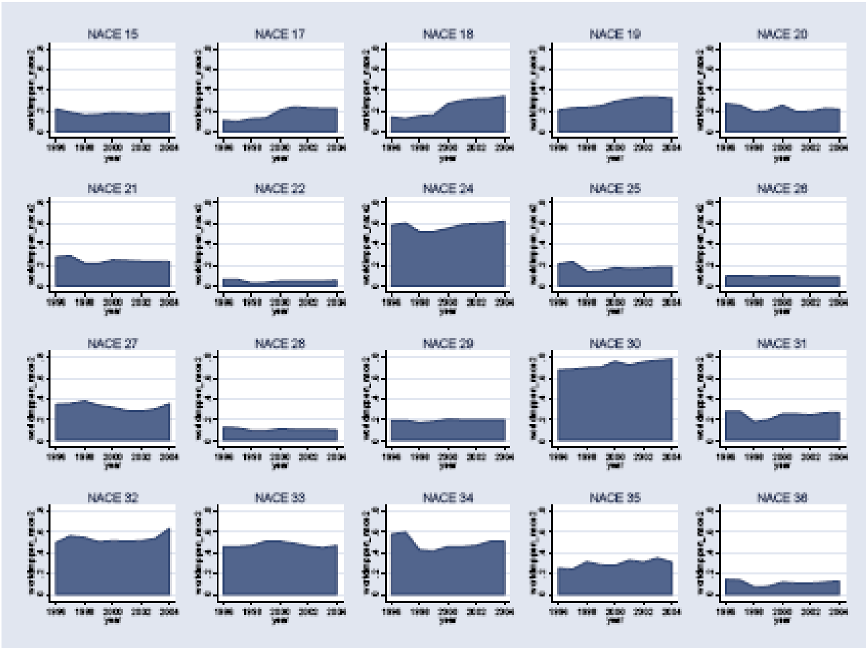
[13] In order to check whether the latter display a clear time-trend, we have checked the correlation between the 1996 and the 2003 input-output coefficients, which turned out to be very high and significant. However, a process of technological change is in some cases quite relevant, with differences in coefficients ranging from -15% (the weight of sector 23 - petroleum products - as input of itself) to +12% (the weight of sector 34 - motor vehicles - as input of itself).

[14] Variables in Table 6 are summarized at the 2-digit level of aggregation, whereas the actual horizontal import penetration ratios used in the dataset are at a 4-digit level of disaggregation. Vertical penetration ratios can be instead calculated only at 2-digit level because this is the only available disaggregation for Imput-Output technology as provided by ISTAT

Table 8: Import penetration ratios

nace2	Description	mean	standard deviation	1996	2003
15	Manufacture of food products and beverages	0.21072	0.02208	0.26231	0.20867
17	Manufacture of textiles	0.30323	0.14595	0.15319	0.42259
18	Manufacture of wearing apparel; dressing and dyeing of fur	0.44077	0.22894	0.22886	0.69184
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.89717	0.18940	0.74593	1.03761
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and..	0.25011	0.03790	0.30941	0.24571
21	Manufacture of pulp, paper and paper products	0.30107	0.03713	0.35220	0.29016
22	Publishing, printing and reproduction of recorded media	0.05051	0.01512	0.07464	0.04900
24	Manufacture of chemicals and chemical products	0.92891	0.10171	0.91582	1.02942
25	Manufacture of rubber and plastic products	0.26906	0.07459	0.35094	0.27090
26	Manufacture of other non-metallic mineral products	0.13378	0.01059	0.14060	0.11507
27	Manufacture of basic metals	0.44606	0.06029	0.51042	0.39553
28	Manufacture of fabricated metal products, except machinery and equipment	0.15642	0.02810	0.21059	0.14311
29	Manufacture of machinery and equipment n.e.c.	0.42364	0.06984	0.52519	0.41584
30	Manufacture of office machinery and computers	1.06182	0.06773	1.21683	1.02502
31	Manufacture of electrical machinery and apparatus n.e.c.	0.35810	0.07404	0.45735	0.38642
32	Manufacture of radio, television and communication equipment and apparatus	0.77910	0.04084	0.76118	0.77389
33	Manufacture of medical, precision and optical instruments, watches and clocks	0.76831	0.03694	0.77798	0.71595
34	Manufacture of motor vehicles, trailers and semi-trailers	0.81593	0.24934	1.30709	0.77380
35	Manufacture of other transport equipment	0.54493	0.08704	0.55319	0.62923
36	Manufacture of furniture; manufacturing n.e.c.	0.25170	0.14391	0.56380	0.20893

Graph 4: Average import penetration ratios



3 Econometric model

Let us start from a standard Cobb-Douglas production function

$$Y_{it} = AK_{it}^{\beta_k} L_{it}^{\beta_l} \tag{6}$$

where Y_{it} is a measure of production (in our case value added), K and L are the capital and labour inputs and β_k and β_l the inputs coefficients. A is total factor productivity (TFP). Since our aim is to verify in which way TFP is affected by import penetration, the first step of the analysis is to obtain an unbiased estimate of total factor productivity.

3.1 Productivity estimation

The traditional technique adopted to estimate the production coefficients and hence compute TFP starting from a (log-linearized) production function as in eq(6) is ordinary least squares. However, this technique is affected by several problems, among which the most serious is the so-called simultaneity bias.

Taking eq. 6 in logs one has:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \eta_{it} \tag{7}$$

In order to have a consistent OLS estimator, we need η_{it} (the residual) to be uncorrelated with both k_{it} and l_{it} (the regressors). However, as pointed out by Griliches and Mairesse (1995),

Table 9: Vertical import penetration ratios

nace2	Description	mean	standard deviation	1996	2003
15	Manufacture of food products and beverages	0.10188	0.01115	0.10316	0.11449
17	Manufacture of textiles	0.17997	0.03037	0.16769	0.20976
18	Manufacture of wearing apparel; dressing and dyeing of fur	0.25825	0.08437	0.17988	0.33053
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	0.12439	0.01298	0.14101	0.13184
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and..	0.08870	0.01018	0.09892	0.09395
21	Manufacture of pulp, paper and paper products	0.21076	0.02351	0.22458	0.22781
22	Publishing, printing and reproduction of recorded media	0.26820	0.02743	0.29601	0.27489
24	Manufacture of chemicals and chemical products	0.09767	0.00873	0.11280	0.08973
25	Manufacture of rubber and plastic products	0.54098	0.05172	0.55677	0.57737
26	Manufacture of other non-metallic mineral products	0.21873	0.02085	0.24756	0.20672
27	Manufacture of basic metals	0.16248	0.01794	0.17786	0.17581
28	Manufacture of fabricated metal products, except machinery and equipment	0.29018	0.03173	0.33481	0.26494
29	Manufacture of machinery and equipment n.e.c.	0.23700	0.03322	0.29347	0.22450
30	Manufacture of office machinery and computers	0.58794	0.03829	0.59389	0.59440
31	Manufacture of electrical machinery and apparatus n.e.c.	0.29286	0.02707	0.33572	0.27868
32	Manufacture of radio, television and communication equipment and apparatus	0.24443	0.02160	0.28820	0.23334
33	Manufacture of medical, precision and optical instruments, watches and clocks	0.30140	0.02987	0.34542	0.30577
34	Manufacture of motor vehicles, trailers and semi-trailers	0.23606	0.03009	0.28587	0.21065
35	Manufacture of other transport equipment	0.26871	0.03608	0.33456	0.26523
36	Manufacture of furniture; manufacturing n.e.c.	0.28856	0.02829	0.34026	0.27956

Graph 5: Vertical import penetration ratios

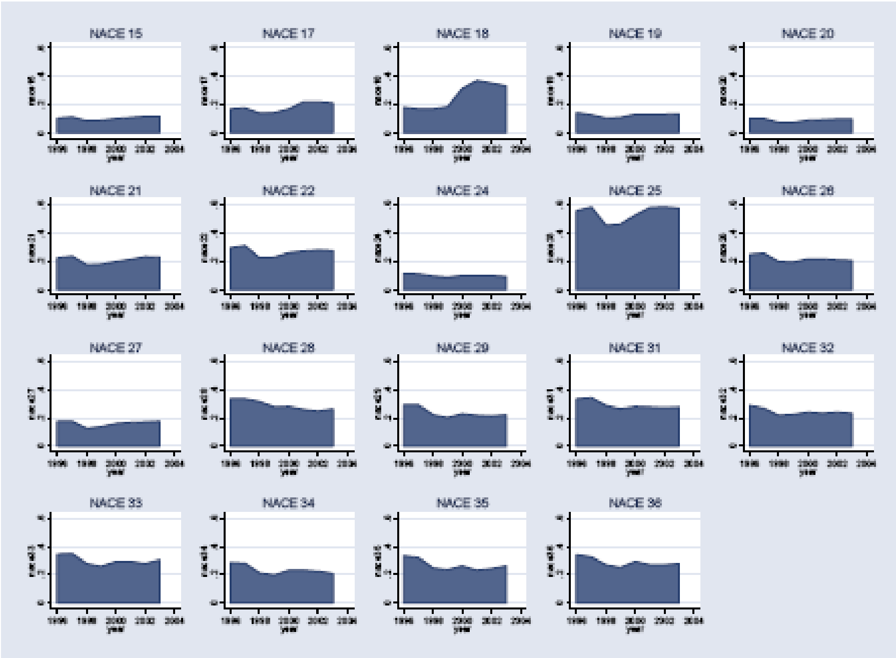
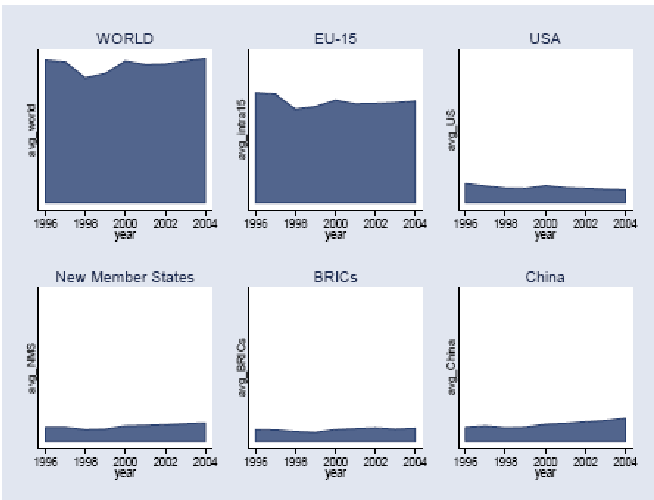


Table 10: Average vertical and horizontal import penetration by partner

All sectors (average)	Horiz.	Vertical	Horiz.	Vertical	Horiz.	Vertical
	mean		1996		2004	2003
World	28.35%	24.46%	29.27%	25.96%	29.61%	26.97%
UE-15	20.81%	15.72%	22.54%	16.87%	20.98%	16.83%
USA	3.23%	1.57%	4.07%	1.72%	2.75%	1.55%
NMS	2.97%	4.49%	2.75%	4.32%	3.59%	4.92%
BRICs	3.96%	1.22%	3.32%	1.02%	4.82%	1.77%
China	3.03%	0.69%	2.80%	0.48%	4.66%	1.13%

Graph 6: Average vertical import penetration by partner



profit-maximizing firms immediately adjust their inputs each time they observe a productivity shock, which makes input levels correlated with the same shocks. Since productivity shocks are unobserved to the econometrician, they enter in the error term of the regression. Hence, inputs turn out to be correlated with the error term of the regression, and thus OLS estimates of production functions are problematic. Olley and Pakes (OP, 1996) and Levinsohn and Petrin (LP, 2003) have developed two similar semi-parametric estimation procedures to overcome this problem.

Both techniques suppose that the productivity term η can be decomposed into two terms, so that eq(7) becomes:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + \varpi_{it} + \varepsilon_{it} \tag{8}$$

where ϖ_{it} is a productivity shock observed by the firm (but not by the econometrician) that is able to change the input choices while ε_{it} is a white noise uncorrelated to inputs. The key point in both the OP and the LP estimators is to "turn unobservables into observables", namely to find an observable proxy for the productivity term ϖ_{it}. In particular, the OP methodology uses investment as proxy while the LP methodology uses material costs.

Since the OP estimator will be our baseline model, we go into the detail of this methodology[15]. In the OP case, investment is the proxy employed. In particular, investment is supposed to be function of capital and productivity:

$$i_{it} = i_t (\varpi_{it}, k_{it}) \tag{9}$$

where i_{it} is the investment of firm i at time t. By inverting this function, it is possible to define ϖ_{it} as:

$$\varpi_{it} = h_t (i_{it}, k_{it}) \tag{10}$$

where $h_t = i_t^{-1}$. Using eq(10), eq(8) can now be written as

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + h_t (i_{it}, k_{it}) + \varepsilon_{it} \tag{11}$$

If we now define a new (unknown) function

$$\phi (i_{it}, k_{it}) = \beta_k k_{it} + h_t (i_{it}, k_{it}) \tag{12}$$

that can be proxied by a 3^{rd} or 4^{th} order polynomial in capital and investment, Olley and Pakes (1996) show that it is now possible to estimate consistently β_l and ϕ through OLS from the following equation:

$$y_{it} = \beta_l l_{it} + \phi (I_{it}, k_{it}) + \varepsilon_{it} \tag{13}$$

Then, in order to recover an estimate for β_k, one can define a function $V_{it} = y_{it} - \hat{\beta}_l l_{it}$ which,

[15] Both LP and OLS estimates will be presented as robustness checks.

by using eq(13), eq(12) and eq(10), can be written as:

$$V_{it} = \beta_k k_{it} + h_t (i_{it}, k_{it}) + \varepsilon_{it} = \beta_k k_{it} + \varpi_{it} + \varepsilon_{it} \quad (14)$$

Moreover, if we assume that our productivity term follows a first-order Markov process, i.e. that $\varpi_{it} = g(\varpi_{it-1}) + \xi_{it}$, eq(14) becomes

$$V_{it} = \beta_k k_{it} + g(\varpi_{it-1}) + \xi_{it} + \varepsilon_{it} \quad (15)$$

which using again eq(10) and (12) can be written as

$$V_{it} = \beta_k k_{it} + g(\phi_{t-1} - \beta_k k_{it-1}) + \mu_{it} \quad (16)$$

Eq(16), where g is an unknown function that can be proxied by a 3^{rd} or 4^{th} order polynomial and $\mu_{it} = \xi_{it} + \varepsilon_{it}$, allows estimating a consistent β_k through a non linear least square procedure.

Having obtained consistent estimates for β_l and β_k, it is then possible to calculate an unbiased measure of the firm level TFP as

$$tfp_{it} = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} \quad (17)$$

which can then be used as a dependent variable in the following model design.

3.2 Total Factor Productivity estimates

We have estimated separate production functions for each NACE2-digits sector. All our variables are deflated using 2-digit price deflators. The deflator for capital, following Smarzynska (2004), is the simple average of five industries capital deflators[16]. Table 11 shows the results obtained for the coefficients using the different techniques previously described. In particular, it is worth noting the expected up-ward bias of the OLS labour coefficients with respect to the OP or the LP estimates. As for the capital coefficients, OP coefficients are usually higher than OLS ones, while LP capital coefficients seem to be sistematically lower[17].

Using OP estimates as our baseline model, we report in Graph 7 the evolution of an aggregate TFP index[18] that shows a declining trend for our sample of firms, particularly from 2000 to 2003, consistently with the results of the studies previously cited. Graph 8 disentangles the evolution of the TFP index according to its geographical and industrial dimensions

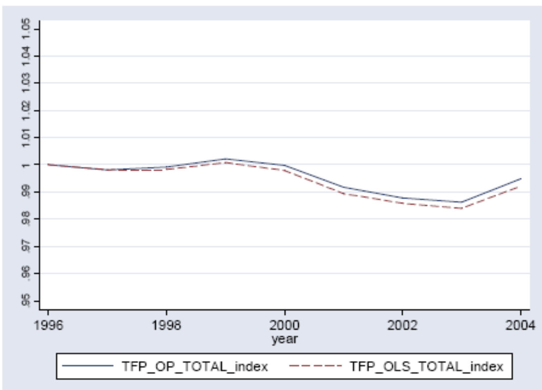
[16] NACE sectors 29 "Manufacture of machinery and equipment n.e.c."; 30, "Manufacture of office machinery and computers"; 31,"Manufacture of electrical machinery and apparatus " ; 34, "Manufacture of motor vehicles, trailers and semi-trailers"; 35, "Manufacture of other transport equipment".

[17] The negative OP capital coefficients for industry 22 "Publishing, printing and reproduction of recorded media" and 23 "Manufacture of coke, refined petroleum products and nuclear fuel" might be due to the small number of observations in these industries.

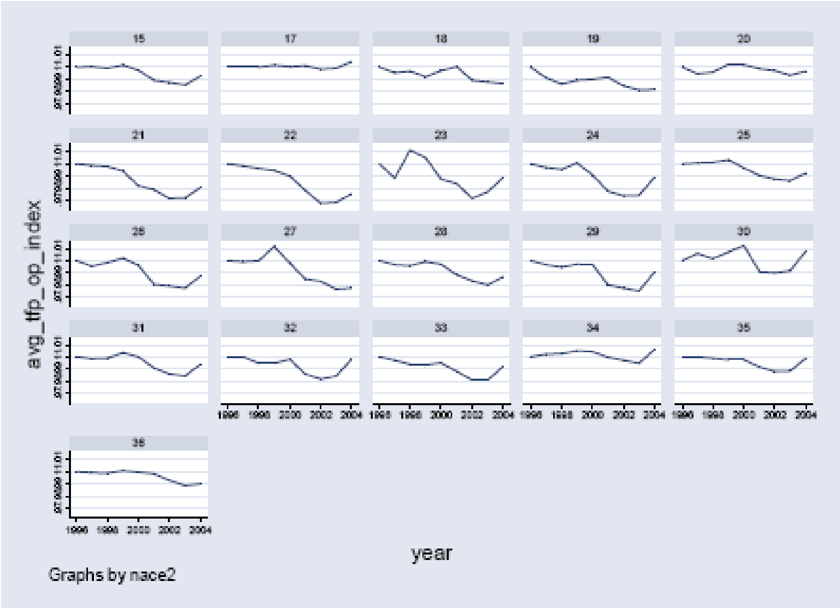
[18] The index has been computed as the ratio between the yearly unweighted average of the firm level TFP and its initial (1996) value.

Table 11: Estimated coefficients of productivity

NACE2	B_OLS_k	B_OP_k	B_LP_k	B_OLS_l	B_OP_l	B_LP_l
15	0.199286	0.1849	0.0908	0.807484	0.7669	0.7302
17	0.156383	0.2947	0.0911	0.767666	0.7646	0.6793
18	0.14598	0.1008	0.0817	0.785492	0.7606	0.6884
19	0.156995	0.2617	0.0607	0.772181	0.7706	0.6835
20	0.151688	0.2615	0.084	0.758334	0.7279	0.6773
21	0.163492	0.0124	0.059	0.829653	0.8149	0.7079
22	0.100989	-0.1478	0.0879	0.875345	0.8492	0.791
23	0.237177	-0.2347	0.1991	0.82989	0.6974	0.6793
24	0.125747	0.039	0.0475	0.880446	0.8631	0.7011
25	0.164333	0.1867	0.0977	0.807254	0.7641	0.7019
26	0.19005	0.2926	0.0837	0.795313	0.7589	0.7078
27	0.179544	0.2456	0.0982	0.809779	0.7515	0.7328
28	0.150927	0.1866	0.0687	0.805118	0.7702	0.7393
29	0.146798	0.1816	0.1125	0.82128	0.7957	0.7085
30	0.142311	0.1768	0.1554	0.806228	0.789	0.7742
31	0.146407	0.1709	0.0987	0.79652	0.7665	0.6984
32	0.129786	0.0636	0.0968	0.858254	0.8232	0.7427
33	0.131017	0.0884	0.0619	0.815538	0.7442	0.6917
34	0.126878	0.2201	0.0592	0.875367	0.8229	0.7351
35	0.17106	0.1074	0.0929	0.813883	0.816	0.7493
36	0.127275	0.1333	0.0693	0.806038	0.8168	0.6938



Graph 8: Average TFP by industry



As for the geographical heterogeneity of the TFP evolution, in Graph 9 we report the breakdown for the different regions.While many of the southern regions display a declining path, the majority of the northern regions are characterised by an almost flat path, with a little decrease in productivity from 2000 to 2003 and some signs of recovery in 2004[19].

3.3 Italian imports and productivity

The estimation strategy has been composed by three steps. First, once having obtained reliable TFP estimates, we have tested the relation of import shares of eq (1) from world with firm-level productivity by industry according to the following econometric models:

$$tfp_{ijt} = \alpha_0 + \alpha_1 IMP\_sh_{Wjt} + \theta_j + \delta_t + \epsilon_{ijt} \tag{18}$$

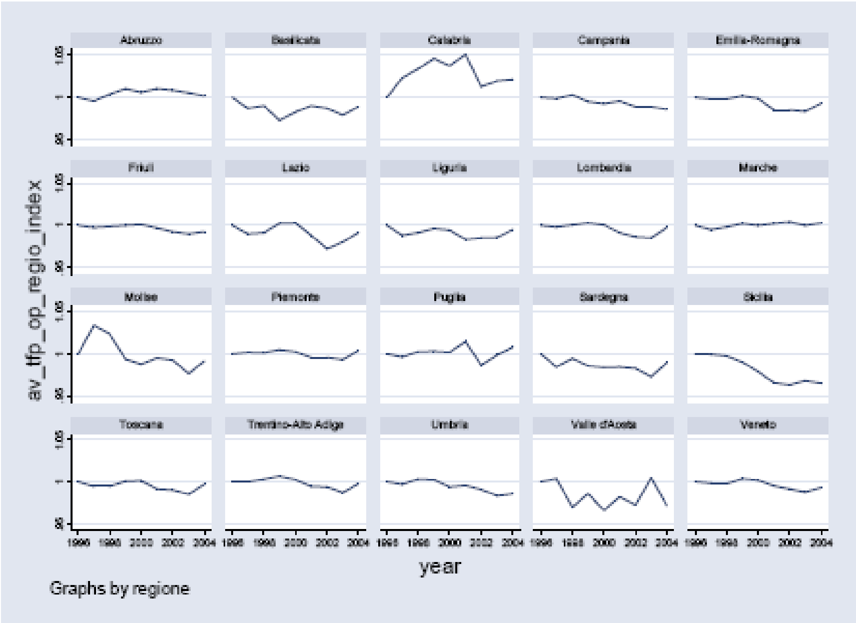
where tfp_{ijt} is the log-productivity of firm i operating in industry j at time t while γ_i and θ_j are respectively industry and time fixed effects. IMP_{zjt} allows us to taking into account heterogeneity of inflows by activity excluding the common potential time trend. The same specification has been conducted with IMP_sh_{Wjt} lagged one period

Then, differentiating import shares by the intensive (Int_mar_{zjt}) and extensive (Ext_mar_{zjt}) margins of trade according to eq(2) and eq(3), we have introduced a different econometric model:

$$tfp_{ijt} = \alpha_0 + \alpha_1 Int\_mar_{zjt} + \alpha_2 Ext\_mar_{zjt} + \gamma_i + \delta_t + \epsilon_{ijt} \tag{19}$$

[19] The path displayed by the Aosta Valley region might be due to the small number of observations

Graph 9: Average TFP by region



where γ_i and δ_t are now firm and time fixed effects.

Finally in the third step, weighing trade of an industry with its own demand and in order to take into account the increasing availability of intermediates from abroad, we have introduced a definitive econometric model:

$$tfp_{ijt} = \alpha_0 + \alpha_1 H\_imp_{zjt} + \alpha_2 V\_imp_{zjt} + \gamma_i + \delta_t + \epsilon_{ijt} \tag{20}$$

where the log-productivity is tested against the measure of horizontal import penetration H_imp_{zjt} of eq(4) and vertical import penetration V_imp_{zjt} of eq(6) with firm and time fixed effects.

4 Results

4.1 Main Results

Table 12a and 12b contain the main results of the analysis, obtained from the estimation of eqs(18, 19, 20). The Breusch-Pagan test rejected the Pooled OLS as a possible estimator, while the Hausman test identified fixed effect estimator preferable in this case to the alternative random effect estimator. The first two columns of Table 12a report the estimates[20] using import shares by industry from world, with the second one which lags import shares by one period to control for potential endogeneity of trade measures. In the latter case a greater openness seems to affect productivity at industry-level with a 1.21% increase at the margin.

[20] Hereafter, when estimation strategy implies the using of a log-level functional form with a ratio as independent variable, recovered semielasticities are used to compute marginal effects, which are then reported as estimates.

In succeeding columns trade margins by partner are lagged one period as before and, since we perform a regression on micro units using mainly aggregate variables as covariates (at the industry level), we control for the potential downward bias in the estimated errors by clustering the standard errors for all firm-level observations. In this case, once considering intensity of trade, a general negative effect arises with the enhanced intra-industry competition implied by considering the imports belonging to the precise and detailed economic activity of a single firm, with the exception of trade with New Members of European Union. where probably a certain degree of integration by offshoring activities is in operation. Increasing trade in varieties, within the same economic activity, are on average not significant for firm productivity if we consider both EU-15 and emerging countries. Signs are instead opposite when considering USA and New Members. An increased number of varieties from US, probably substitutes of domestic ones, have a negative effect on productivity, whereas new varieties coming from New Members have a positive effect on firm performance, once again a clue of intra-industry offshoring.

Column 1 of Table 9b presents the results of the model using import penetration indexes from the entire world. As clearly shown in eqs(4, 6), both horizontal and vertical ratios take into account production and exports, weighing detailed import flows by domestic demand. As it can be seen from estimates, then, horizontal import penetration ratios display a positive and significant coefficient, revealing however a quite small effect in absolute value. An increase in horizontal import penetrations, *ceteris paribus*, would result in an increase of productivity of around 0.05% at the margin. Also the coefficient attached to the import penetration in the up-stream industries is positive and statistically significant. However, most notably, its absolute value is sensibly higher: an increase in the "vertical" import penetration would result, *ceteris paribus*, in an increase of productivity by 9.8% at the margin.

Columns 2 to 6 report the results obtained running the same specification over the same group of countries of the previous specification. In Column 2 we explicitly test for the effects of the EU single market, limiting the calculation of import penetration indexes to the EU-15 countries. As it can be seen, both trade measures are positively and significantly associated to productivity gains, with the coefficient of horizontal import penetration once again smaller as when world trade is considered. In Column 3 we repeat the same exercise considering the Italian trade with the United States. Surprisingly, the latter analysis reveals that an increase in horizontal import penetration from the US is not significantly associated with an increase in productivity of Italian firms. Having conducted the same specification on a more aggregate level of import penetration (3-digit level) we found even a negative impact, maybe coming back to the result previously decribed in the case of extensive margins, where new varieties are suspected to be substitutes and in competition with domestic ones. Even US vertical import penetration does not display influence on TFP. Moving to the impact of Italian trade with the New Member States (Column 4), the results are in line with the ones obtained at the world level, and the same is true when considering trade with BRICs (Column 5). Concentrating on the impact of Chinese competition (Column 6), we can also see that trade with China eventually has a positive effect on the productivity of the Italian firms both if we consider the industry to which a firm belongs

Table 12a: Import shares, intensive and extensive margins, trade orientation and productivity

Dep var: ln(TFP) OP	World	World	EU-15	USA	NMS	BRICs	China
Import shares	.0273***						
	(.0056)						
Lagged import shares		.0121*					
Lagged intensive_margin			-.0733***	-.0043*	.0207***	-.0171***	-.0094***
			(.0169)	(.0024)	(.0030)	(.0033)	(.0026)
Lagged extensive_margin			.0486	-.0299***	.0200**	.0119	-.0007
			(.0603)	(.0084)	(.0089)	(.007)	(.0062)
Constant	9.19***	9.20***	9.22***	9.25***	9.18***	9.22***	9.22***
	(.007)	(.006)	(.061)	(.010)	(.009)	(.008)	(.007)
Firm fixed effects	no	no	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	no	no	no	no	no
Time fixed effects	yes	yes	yes	yes	yes	yes	yes
Observations	149,444	138,484	149,444	146,785	147,760	146,494	144,377

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator. Standard errors clustered at firm level

Table 12b: Import penetration, trade orientation and productivity

Dep var: ln(TFP) OP	World	EU-15	USA	NMS	BRICs	China
Lag_horiz_imp_pen	.0053***	.0019**	-.0001	.0001	.0016**	.0023**
	(.0014)	(.0006)	(.0000)	(.0003)	(.0008)	(.0009)
Lag_vert_imp_pen	.0980***	.0859***	.0095	.0692***	.0761***	.0494***
	(.0095)	(.0100)	(.0058)	(.0067)	(.0073)	(.0054)
Constant	9.06***	9.07***	9.16***	9.11***	9.11***	9.14***
	(.013)	(.012)	(.007)	(.007)	(.006)	(.005)
Firm fixed effects	yes	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes	yes
Observations	161,343	161,343	161,343	161,343	161,343	161,343

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator. Standard errors clustered at firm level

and if we consider the advantages coming from trade in intermediates. Even if this finding is not surprising for economists, it often is not so straightforward for policy-makers.

In Table 13 we analyse in more details our findings, interacting the trade measures with some characteristics of firms, in particular a dummy signalling whether the Italian firm is controlled by a multinational group (FOR_MNE), or whether the same domestic firm is a parent company with a participation abroad (DOM_MNE)[21]. All these firm-level characteristics seem to be positively correlated with productivity. In particular, Column 1 shows how foreign affiliates display a productivity which is around 23% higher than the average firm, while Italian firms with participations abroad seem, on average, to be 19% more productive than the other firms, in

[21] In this case, we introduce in the specification industry fixed effects, since firm effects are now captured by the FOR and DOM dummies.

Table 13: Import penetration, firm characteristics and productivity

Dep var: ln(TFP) OP	World	World	World	EU-15	EU-15
Horizontal_imp_pen	.019***	.019***	.019***	.024***	.024***
	(.004)	(.004)	(.004)	(.004)	(.004)
Vertical_imp_pen	.082***	.084***	.084***	.072***	.073***
	(.011)	(.012)	(.012)	(.012)	(.012)
FOR_MNE	.233***	.174***		.190***	
	(.008)	(.029)		(.037)	
DOM_MNE	.188***		.169***		.171***
	(.005)		(.017)		(.021)
Horizontal*FOR_MNE		-.001		.016**	
		(.008)		(.008)	
Vertical*FOR_MNE		-.052***		-.045***	
		(.016)		(.016)	
Horizontal*DOM_MNE			-.008		.012***
			(.004)		(.005)
Vertical*DOM_MNE			-.013		-.025***
			(.009)		(.009)
Constant	9.33***	9.34***	9.34***	9.39***	9.38***
	(.016)	(.016)	(.015)	(.023)	(.023)
Industry fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	158,983	158,983	158,983	159,276	159,276

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator.

line with the results of a vast literature on the productivity premia attributable to international firms.

When we interact these firm characteristics with our trade penetration measures, we find that foreign affiliates seem to take relatively less advantage than the average domestic firms from an increase in world trade penetration (Column 2), a clear indication that FDI in Italy tend to follow a market-seeking attitude, substituting trade with local presence. A similar finding is obtained for the Italian firms with a participation abroad (Column 3), a finding consistent with the fact that multinational groups in general tend to exploit different trade channels than the average domestic firm. Interestingly enough, however, when interacting the FOR or DOM dummies with the trade penetration within the EU-15 countries (Column 4 and 5), we have found that both domestic and foreign multinational firms operating in Italy do seem to benefit relatively more from horizontal penetration from other EU countries with respect to the average firm. The latter finding is again consistent with the idea that the advantages of market integration in Europe tend to be accrued relatively more by larger, international firms.

4.2 Robustness checks

In order to verify the accurateness of these results we performed some robustness checks. First, we employed different measures of productivity. Columns 1 and 2 of Table 14 report the results obtained when using alternatively the TFP obtained using, respectively, OLS estimates of the production function coefficients and labour productivity, measured as value added per employee. The results are qualitatively the same, with only a slight different in the point estimates with respect to Column 1 of Table 12b, our benchmark specification.

Columns 3 to 5 in Table 14 report a second set of robustness checks, running the specification in first differences for all the previously discussed productivity measures, thus wiping out unobserved firm heterogeneity[22]. Event through such a more demanding specification, the results are virtually unchanged, with only the effect of horizontal import penetration slightly less significant.

Another concern is related to the time-varying nature of the I-O import coefficients used to build the vertical import penetration ratio variable, since the latter might be endogenous to trade shocks and productivity[23]. To this extent, Column 1 of Table 15 reports the results that are obtained using the I-O import coefficients of 1996 (i.e. the starting period of our sample). The results obtained are almost identical, with only slight changes in the point estimates.

In Column 2 of Table 15 we have tested whether the results change using a different aggregation for our horizontal trade measure (at NACE2 rather than NACE4), since the lack of observation at this finer industry level might induce a systematic bias in our estimates. In Column 3 we report the results recalculating instead the trade penetration index excluding exports, i.e. bounding the index between 0 and 1, to test for the sensitivity of our coefficients. The results are qualitatively the same, with some slight differences in the point estimates. However, our main result of a large difference in the impact of the two import penetration indexes on productivity in favor of the vertical one is not altered.

Finally, as for trade orientation, we have controlled for a potential bias induced by technology gap among trade partners weighing import penetrations (both horizontal and vertical ones) by a country index based on yearly GERD (Gross Expenditure on Reasearch and Development) taking US as benchmark. These indexes, interacted with import penetrations, should allow us to catch the distance to technology frontier. Point estimates of horizontal penetrations in Table 16 are very similar to those in Table 12b, whereas coefficients for vertical penetrations are slightly lower but maintain significance and order of magnitude, from EU15 to China.

[22] If firm-specific fixed effects are spuriously correlated with other covariates, the latter might lead to potentially inconsistent estimates.

[23] It could be the case that a trade shock which increases productivity in an upstream industry leads over time to a more intensive use of inputs from the same industry.

Table 14: Alternative productivity estimates – World Import Penetration

Dep var:	ln(TFP) OLS	ln(lab_prod)	Δln(TFP) OP	Δln(TFP) OLS	Δln(lab_prod)
Horizontal_imp_pen	.008*** (.002)	.005*** (.003)			
Vertical_imp_pen	.122*** (.011)	.121*** (.011)			
Δ Horizontal_imp_pen			.003 (.002)	.004* (.002)	.004 (.003)
Δ Vertical_imp_pen			.093*** (.013)	.095*** (.013)	.114*** (.014)
Constant	9.52*** (.018)	10.58*** (.012)	.031*** (.003)	.030*** (.004)	.032*** (.004)
Firm fixed effects	yes	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes	yes
Observations	158,983	161,343	114,231	114,231	114,231

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator. Standard errors clustered at firm level

Table 15: Robustness and sensitivity analysis – World Import Penetration

Dep var: ln(tfp) OP	Fixed I/O coeff	NACE2 Index	Bounded Index (0-1)
Horizontal_imp_pen	.0060*** (.0013)	.0219*** (.0044)	.0257** (.0077)
Vertical_imp_pen	.0905*** (.0096)	.0741*** (.0101)	.1519*** (.0163)
Constant	9.07*** (.011)	9.05*** (.011)	8.98*** (.019)
Firm fixed effects	yes	yes	yes
Time fixed effects	yes	yes	yes
Observations	161,343	164,678	159,441

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator. Standard errors clustered at firm level

Table 16: Robustness and sensitivity analysis - Technology gap, trade orientation and productivity

Dep var: ln(TFP) OP	EU-15	NMS	BRICs	China
GERD_hor_import_pen	.0019**	.0002	.0017**	.0027**
	(.0005)	(.0001)	(.0008)	(.0009)
GERD_vert_import_pen	.0841***	.0593**	.0703***	.0290***
	(.060)	(.0063)	(.0069)	(.007)
Constant	9.07***	9.12***	9.12***	9.16***
	(.011)	(.007)	(.005)	(.003)
Firm fixed effects	yes	yes	yes	yes
Time fixed effects	yes	yes	yes	yes
Observations	161,343	161,343	161,343	161,343

***,**,* Statistically significant at 1%, 5%, 10% respectively
FE (within) estimator. Standard errors clustered at firm level

5 Conclusions

We have tested the impact of import penetration and trade margins on productivity using a sample of roughly 35,000 Italian manufacturing firms operating in the period 1996-2003. After considering the different impact of trade intensity and trade variety on productivity, in line with the approach of the most recent literature, we have considered the effect of both import penetration in the same industry (competition-led productivity gain) and of import penetration in the up-stream industries (to gauge the productivity gain led by better input availability). After having obtained unbiased productivity measures through the Olley and Pakes (1996) semiparametric estimation, we have regressed Total Factor Productivity on the two import penetration ratios, controlling for fixed characteristics.

Three main results emerged from this analysis. First, we find that import penetration positively matters for productivity, with an effect which is however differentiatied if considering within vs. across-industries (vertical) indicators. In particular, an increase in the import penetration ratio of the same industry would result in a productivity increase that ranges from 0.5% to 0.8% according to the TFP measure and the econometric specification. An increase of the import penetration ratio in the up-stream industries would instead increase average productivity by 9% to 12%. Second, both foreign firms and domestic firms participating in international networks are on average more productive than the other firms. The productivity premium of foreign firms ranges from 14% to 48% while the one of international domestic firms ranges from 10.1% to 41% according to the TFP measure and the econometric specification. We also find, however, that import penetration alone does not explain much of the individual variance in TFP levels, which is clearly (and not surprisingly) linked also to other relevant factors.

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Chapter III

Organizational Complexity of Multinational Groups and Productivity in an Enlarged European Union

1 Introduction

The alternative organizational modes of foreign production by multinational firms constitute an important variable in determining their relative performance. The choice to internalize some value-added activities, the degree of diversification, the size of investment and their worldwide location are all decisions that allow multinational firms to improve technical efficiency, increase profitability and more in general enhance competitiveness through a coordinated management of production activities. On the other hand, the increasing fragmentation of value chains, with firms making final goods through multiple stages located in multiple countries, is a peculiarity of the actual wave of economic globalization and it is testified by both an increase in trade of intermediate goods and a surge in foreign direct investment. Yeats (2001) noted that intermediates already accounted for 30% of world trade in manufactures, whereas official aggregated data for US and Japan show that around one third of trade flows were due to bilateral shipments from subsidiaries to parent companies (Helpman et al., 2008). More recent data for Italy have shown that at least 48.8 percent of manufacturing exports and 53.2 percent of manufacturing imports of foreign subsidiaries located in the country is due to trade within their own group (ISTAT, 2008). It means that half of the trade generated from Foreign Direct Investment (FDI) in this country should be considered intra-group trade. Through a sectoral analysis of US and Japan data, the OECD (2002) also suggested that the increasing trend in both intra-industry and intra-firm trade is revealing of the establishment of vertical production chains, especially with less developed countries.

In this paper, we explore one dimension of the vertical production chains, that is the complexity of organization of international production within multinational business groups as represented by the complexity of the worldwide control chains, and link it to the performance of their own affiliates.

By multinational business group we mean every multinational firm composed by a headquarter that controls at least one affiliate located abroad, whereas by complexity of the control chain we propose an index which ranges from zero to infinity, namely from the case of a parent company operating only one subsidiary in a foreign country to subsidiaries embedded in long control chains ramified in different world regions. Matching balance sheet and ownership data of subsidiaries with balance sheet and ownership data of parent companies, we are first able to piece together control chains of multinational groups and then derive a continuous firm-specific measure that we refer to as Global Index of Complexity (GIC) for organizational hierarchies defined by property rights. Relating this index to firms' characteristics, we have three important results.

First, we find that the simple affiliation to a business group implies a different firm performance. In particular, we observe that subsidiaries owned by groups with a worldwide presence explained by a hierarchical complex structure are more productive than simpler groups, which in turn are more productive than firms owned by foreign individual shareholders, although the relation becomes non monotonous for relatively higher levels of complexity. These results confirm the evidence provided by Khanna and Palepu (2000a; 2000b) for business groups (whether domestic or multinational) in emerging economies such as India and Chile, where they can alleviate market imperfections not only in financial markets (Chang and Choi, 1988) but also in product markets, labor markets and technology.

Second, different from the results of Nickell and Nicolitsas (1999) for UK, we find that financial pressure is negatively correlated with productivity, but that this pressure is softened by the affiliation to a group whatever its size. Further considering the different organizational modes of the finance function by the group as a whole (Kuppuswany and Villalonga, 2010) and the recourse to the stock exchange by single affiliates, we lean towards the hypothesis that the better reputation provided by the affiliation to the group for credit loans is more effective than the possibility offered by the development of an internal capital market in explaining a softening of the financial constraint, especially for firms in transition economies that require enormous financial resources only partially provided by young credit markets that operate in a context of information asymmetries (Konings et al., 2003).

The third result concerns a comparison between the performance of affiliates involved in the production of intermediate products and the ones that adopt a traditional strategy of market-seeking. The levels of productivity are on average lower for the affiliates that sell their standardized intermediate products to industrial consumers, whereas in the case of differentiated goods and services purchased by final consumers the affiliate is possibly able to apply a higher markup because of a lower elasticity of substitution. Moreover, when the intermediate production is controlled by a group with the development of an internal market for them, it is more likely that the internal price is chosen to be more favorable to the group, with the difference affecting the level of productivity. However, once looking at dynamics, i. e. the rates of growth of total factor productivities, the difference fades away and the benefits due to the affiliation to a business group prevail.

The geographical and time span of our analysis is the European Union in the period before and after the enlargement to Eastern Europe: the latter event can be used as a sort of natural experiment since, besides the global tendency of falling trade costs and technological progress that enables multinational firms to fragment production internationally, enlargement has induced an acceleration towards the creation of international value chains starting from a virtually FDI-free environment, thus allowing for a good control of initial conditions. In particular, we restrict our analysis to subsidiaries located in the new members of the European Union but owned by old members before the accession, with some insights on the relative performance of German and Italian groups. These two countries, indeed, are the two main investors in the area in terms of number of subsidiaries but their groups adopt different corporate structures and their subsidiaries report different results in terms of performance with respect to the average of old members.

The paper is organised as follows: in Section 2 we present some stylized facts of the East-West European integration, showing how this latter is essentially driven by the internationalization of value-added activities. In Section 3, we describe the procedure adopted to build our sample of international groups, splitted between parent company and foreign subsidiaries. In Section 4 we define the boundary of the multinational groups and we introduce the Global Index of Complexity, discussing some stylized facts related to this measure. The relationship between group complexity, financial pressure and productivity is reported in Section 5, while Section 6 concludes.

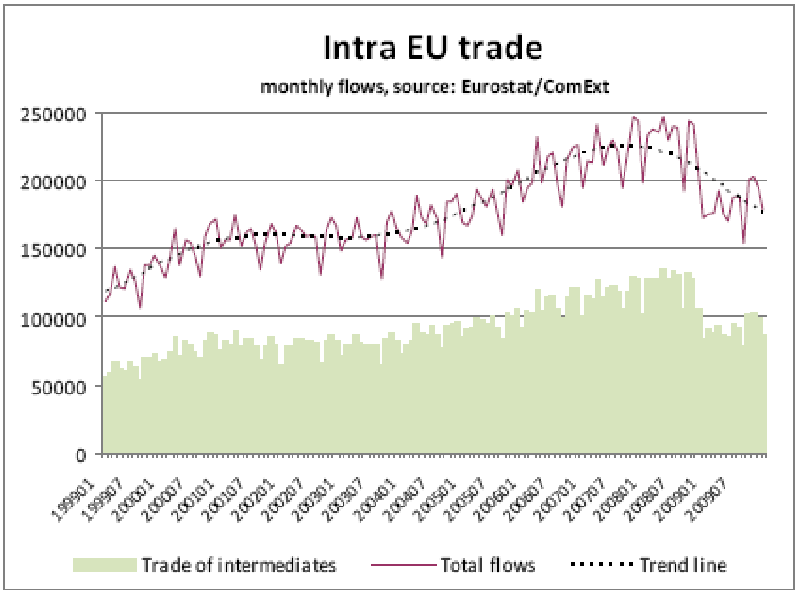
2 Foreign production in New Members of EU and East-West integration.

Long before the European enlargement to ten new members of Central and Eastern Europe (CEE) in 2004 and two others in 2007, trade flows between Eastern and Western Europe had been increasing as the result of the gradual trade liberalization induced by the Europe Agreements in the 1990s. At the date of accession, thus, only the formal adoption by the New Member States (NMS) of the EU Common External Tariff remained to be implemented, with trade barriers having already been progressively abolished during the accession negotiations. However, as shown by Figure 1, the trend in the growth of trade within EU did not stop at the accession date, but kept on increasing as economic integration in the enlarged single market acquired new and deeper forms.

The volume of monthly trade flows increased of a 119% rate in the decade from January 1999 to September 2008, the month after which we can observe a trade collapse as one of the effects of the financial crisis that let total exports shrink almost to the levels of 2004. Once decomposing the trade in intermediate products and final goods according to BEC-SNA categories[24], we note that most of the growth of the last decade is due to the category of intermediate products which are the ones that originate international production chains either as arm's-length relationships across different firm nationalities or as intra-firm trade for multinationals operating cross-border. This simple stylized fact for the European Union as a whole is further confirmed for the case of accession countries by Figure 2, where a measure of foreign production is provided by UNCTAD with aggregate flows of Foreign Direct Investment crowding to these countries from the rest of the world, both in million dollars and in percentage of the EU total. The steep path from

[24] BEC (Broad Economic Categories) is a classification of traded products that takes into account the final use of them. They are then aggregated according to SNA (System of National Accounts) categories that distinghish between intermediates at different stages of production (primary, parts and components, semifinished) and final goods (capital and consumption). http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=10&Lg=1

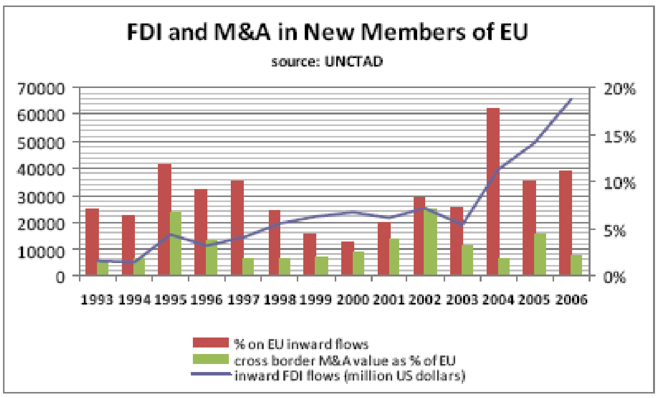
Figure 1: Trade and global value chains in European Union (1999-2009).
Source: own elaboration on Eurostat/ComExt



the beginning of transition showed an acceleration in 2004, the year of accession for ten New Members, reaching a considerable amount of 75,660 million dollars in 2007 and an average 9% if weighted against inward FDI destined to the Union as a whole. A figure that shows convergence towards the Western levels given the disparity in economic size from which they depart, since they account only for 7% of EU GDP but collect 21% of the population.

Even though in 2008 the percentage of FDI aggregate stock in New Members reached only a 3.95% respect to world total stock, there is a strong degree of heterogeneity in FDI to GDP per capita stock indices, till a peak of more than 80% for small open economies such as Bulgaria, Hungary, Estonia and Malta which are well above an average of 55% for the entire region.

Figure 2: Foreign Production in EU New Members (1993-2006).
Source: own elaboration on UNCTAD –Foreign Direct Investment Database



Given these trends in FDI flows, it is interesting to restrict the focus of analysis by category of investment. In the same Figure 2 we have also the relative importance of cross-border M&A's, which are one possible form of entry in a host country with a foreign economic activity, i.e. brownfield investment through the acquisition of an incumbent firm in the local market that excludes the greenfield investments and reinvestment of earnings. Even if at the beginning of 2000s the percentage of M&A's value covered almost the entire amount of FDI crowding to the region, newly-found affiliates and reinvestment of earnings from previous activities represent the bulk of the flows for the rest of the period, especially in the recent years after the accession.

A combined reading of Figures 1 and 2 provides first evidence of an economic integration based on the creation of international production chains driven by the establishment of multinational firms in New Members of the European Union that are able to trade in intermediate products with the rest of Europe, either destined to the internal market (within the group) or to other industrial consumers for further stages of production before reaching the final consumers.

3 The boundary of the Multinational Business Group

Following a widely accepted definition (Dunning and Lundan, 2008), we define a multinational firm as an enterprise that controls value-added activities in more than one country and we consider a foreign investor as an individual, an enterprise or a government that operates in a country other than the country of residence with a lasting interest (OECD, 1996). There is a slight but important difference among the two previous definitions that arise concerns about the delimitation of a boundary for foreign production. If in the first case we would have a clear example of a hierarchy created for the coordinated management of firms (or branches) as an alternative to market horizontal relations, in the second case the "lasting interest" of the investor does not imply control of management decisions, even if a considerable influence on an economic activity is always to be taken into account, and also it does not require the presence in different countries. Essentially, in the first case we would have a clear-cut case of internalization of foreign activities in order to minimize transaction costs (Williamson, 1985; Gatignon and Anderson, 1988; Hennart, 2000), whereas a foreign direct investor can be distinguished by a portfolio investor for the duration of the interest, this latter a wider definition that includes also, but not only, the case of internalized activities. From an empirical point of view, the concerns arisen are twofold: a) the first is a problem of threshold: which is the level of equity participation and/or voting rights that allows to define control within the hiearchy of a Multinational Firm? b) Second, how should we consider the case of firms owned by foreign individuals?

The first question has no straight answer, since control is defined in relation to the degree of other shareholders' participation[25] and can be rather considered firm-specific. For example, in the case of a public company, a minority share can allow control on the whole company either because the rest of equity is fractioned among unorganized shareholders or, as it is sometimes

[25] Or eventually by monopsonistic relationships between suppliers and industrial customers, where the bargaining power of a unique customer is such to define control.

the case for financial funds, the majority is not interested in the management but considers the investment essentially as a portfolio activity. The commonly accepted FDI threshold of 10% can then be considered too low or too high once looking for control, according to firm-specific considerations. Here we follow the consolidated experience of the international accounting standards (IAS/IFRS) and proxy control above a threshold of 50.01% of direct or indirect participation. In theory, a trade-off emerges when dealing with subsidiaries belonging to more groups: completeness of the control chain (boundary of the group) would call for a double counting of them by different groups, while a complete partition of the subsidiaries among groups would call for their belonging to only one single group. A threshold of 50.01% would seem more appropriate for the case in hand, but it could exclude some affiliates leaving them outside the boundary of any group and introducing a potential selection bias. We will control in the next sections if results change in case we include double-counting of firms with a lower threshold of 25.01%, that however in our sample account only for about 1%.

As for the firms that are considered foreign because they are directly owned by residents in another country, we split these FDI in two different subcategories: the first one is considered a multinational group when at least another firm is owned by the same individual and is located in another country, the second one is simply considered as originating an individually(or family-)owned internationalized firm but not belonging to a group.

More briefly, we define a Multinational Business Group as a set of at least two companies located in different countries and linked by a common control as defined by property rights above 25.01%. Adopting this criterion, and employing the Amadeus database by Bureau van Dijk[26], we are able to identify more than 129,114 globally-active groups in the European Union, of which only 30,301 have two or more subsidiaries abroad, the majority being represented by one foreign subsidiary owned by a parent company located in one of the EU members.

Within this wider set of companies we restrict our analysis to the European groups that, having their ultimate owner in one of the EU-15 countries, locate their affiliate(s) in at least one of the New Member States[27]. The period considered for the sample is 1998-2006, an interesting period for the progress of economic integration within European Union, when accession of New Members was first prepared and then implemented, but also when the euro was adopted as a single currency. Both events concur in fostering the creation of intra-European production networks.

The recent availability of ownership data lets us trace the whole control chain of each company, allowing us to match every subsidiary with the ultimate owner, up the chain, which ultimately controls the whole group to which the single subsidiary belongs.

Matching ownership data of ultimate owners with their subsidiaries, we have obtained a sample where, together with balance sheet data of every subsidiary, we have merged either the balance sheet data of the ultimate parent company in EU15 or some other ownership data of

[26] Amadeus by Bureau van Dijk collects more than 8 million European companies in ... countries.

[27] Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia on 1st May 2004; Bulgaria and Romania on 1st January 2007.

Table 1: Matching Ultimate Owners and affiliates: a dataset

Parent country	Number of firms involved				Indicators		
	Ultimate parent companies (A)	Group-owned subsidiaries (B)	Individually or family-owned subs (C)	Foreign-controlled firms in EU15 (B + C)	*Average number of subs by group (B/A)*	*Percentage of groups on the total EU15*	*Percentage of subsidiaries on the total EU15*
Austria	28	144	1,198	1,342	*5.14*	*1.71*	*6.04*
Belgium	97	239	472	711	*2.46*	*5.92*	*3.20*
Denmark	205	302	119	421	*1.47*	*12.52*	*1.90*
Finland	66	210	221	431	*3.18*	*4.03*	*1.94*
France	143	538	1,173	1,711	*3.76*	*8.73*	*7.70*
Germany	141	541	4,739	5,280	3.84	8.61	23.77
Greece	24	48	1,755	1,803	*2.00*	*1.47*	*8.12*
Ireland	6	36	43	79	*6.00*	*0.37*	*0.36*
Italy	67	175	6426	6,601	2.61	4.09	29.72
Luxembourg	6	129	20	149	*21.50*	*0.37*	*0.67*
Netherlands	98	303	614	917	*3.09*	*5.98*	*4.13*
Portugal	3	13	54	67	*4.33*	*0.18*	*0.30*
Spain	85	134	342	476	*1.58*	*5.19*	*2.14*
Sweden	520	740	328	1,068	*1.42*	*31.75*	*4.81*
United Kingdom	149	267	888	1,155	*1.79*	*9.10*	*5.20*
Total	**1,638**	**3,819**	**18,392**	**22,211**	***2.33***	***100***	***100***

the foreign owner in case of individual ultimate ownership.

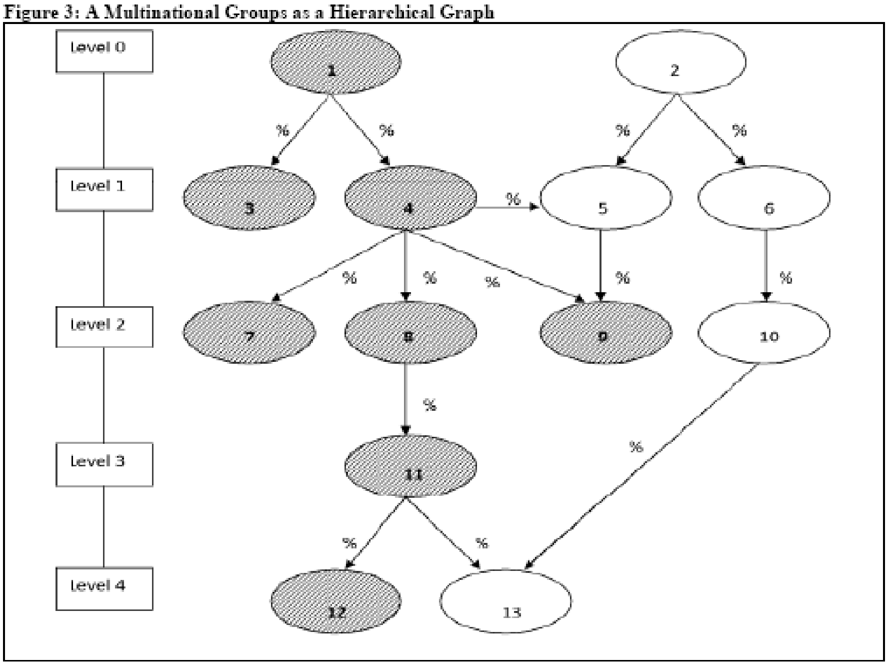
The sample includes firms engaged in every economic activity classified in NACE rev 1.1 at 4-digit codes, i.e. it also cover services. Table 1 provides a description of the sample in terms of nationalities and numbers.

Among EU15, Germany and Italy are the countries that, as our sample data show, host together parent companies which owns the majority of subsidiaries located in New Members, 23.77% and 29.72% respectively. More than German ones, Italian subsidiaries in New Members are in general individual(or family)-owned (97.3% of the Italian sample), with only 67 parent companies that own an average of 2.61 subsidiaries each. Here Sweden, Denmark and Luxembourg are the only old members of EU that have more corporate-owned than individually-owned subsidiary. In the case of Luxembourg, however, the data show that most of ultimate parent companies are often legal entities located in the country because of tax exemptions, but with clear foreign (different from Luxembourg) nationality.

4 The Global Index of Complexity (GIC)

In order to derive a synthetic measure of organizational complexity of the multinational network, we borrow from graph theory. Graph theory has among its scopes to observe and measure mathematical similarity of objects with a multidimensional nature and represent them in a graph form. Figure 3 is an example of a theoretical graph with its nodes and edges, where the first are elements of a more complex system connected together by the second ones in different and alternative ways.

Figure 3: A Multinational Groups as a Hierarchical Graph



From the draw of anorganic molecules to the representation of a file system on a computer, complexity of natural and social systems can be measured by some form of entropy tailored to the specific objects of analysis. Here we adapt a measure for entropy of hierarchical graphs (Emmert-Streib and Dehmer, 2007) to the measurement of the complexity of control chains of business groups operating abroad.

A hierarchical graph is any flat graph to which at least one parent node is added to assign functions to the other nodes (Palacz, 2003). In our measure, the nodes of the graph are the subsidiaries and the edges are represented by control participations. Hierarchical graphs are generalizations of tree graphs: if the latter ones provide for only one vertex from which several arms depart as in a tree but two different nodes are connected by only one edge, the hierarchical graphs allow for different ultimate vertices that can be directly or indirectly connected through several edges. Given the concept of hierachical graph as defined above, the adoption of it to represent a firm hierarchy as defined in transaction cost economics seems even obvious, whether it represents the organization chart of a single firm, its division in branches or the agglomeration of affiliates coordinated by a headquarter as in our case.

The algorithm we use to measure complexity of corporations requires a previous step in order to identify the boundary of the multinational group following the discussion of the previous paragraph and adopting the notion of control to determine the economic space that belongs to the firm. As international economic literature has often showed when analyzing spillover effects, influence on the management of a firm is possible with lower participation and in fact, it is not necessary to have complete control on a subsidiary to exert influence on management or to contribute positively with knowledge and experience. To the extent, following IAS/IFRS accounting standard, we have opted for a minimum threshold for direct or indirect control participation of 50.01%, since our objective is to trace the effects of hierarchical coordination. The consideration of cross-participations, i.e. the indirect participation of the headquarter through the stakes belonging to other affiliates within the group, allows to take into account the effective control exerted by the headquarter on the management of a single subsidiary.

Once we have identified the boundary of the Multinational Business Groups, we are able to draw the control chain of every corporation as in the example depicted in Figure 3, where the coloured objects represent nodes/subsidiaries belonging to the complex system of a single business group, whereas the other nodes can represent another business group interlinked with the first one. The draw clearly shows how mobile can be boundaries between groups: the exclusion of subsidiary 13 and the inclusion of subsidiary 9 in the first group, for example, is determined solely by the combination of control threshold and cross-participations.

There are however several dimensions that have to be considered for every group having at disposal the whole control chain : the number of nodes, in this case clearly linked to subsidiaries; the number of edges, in our case given by the control links; and the number of levels, represented by the vertical distance of subsidiaries from the ultimate owner.

The simplest version of a Global Index of Complexity (GIC) we propose is able to summarize the information content given by those dimensions in a unique numerical variable that can be fitted both to groups spreading their economic activity worldwide and to simple groups constituted by one parent company owning one subsidiary abroad. Given the scope of our analysis, we assume that domestic subsidiaries are all collapsed at level 0, with no distance from the parent company[28]. The Index thus assigns a discrete probability distribution $P : L \to [0, 1]$ to every level l, where probability is $p_l = \frac{n_l}{N}$ with n_l number of nodes on level l and N total number of nodes:

$$GIC = \sum_{l=1}^{L} p_l \log (1/p_l) = \sum_{l=1}^{L} \frac{n_l}{N} \log \left(\frac{N}{n_l} \right) \quad (1)$$

As such, the index ranges from zero, when a parent company operates all subsidiaries in a foreign country[29] at the same level l, to infinity. The higher the index, the more ramified are the control chains that have to be covered before reaching the final objective of the coordinated management decision. The logarithmic weight with base 2 assigned to the probability term of every level increases the measure of complexity (marginal complexity) when more subsidiaries (n_l) are included such that:

$$\frac{\partial GIC}{\partial p_l} < 0, \qquad \text{with } n_l \in \mathbb{N} \text{ and } n_l > 1 \quad (2)$$

[28] An alternative method can include all domestic subsidiaries in a level one, without regard of the actual level given by control links, and then beginning with foreign subsidiaries from level 2. The additive property of the Index allows then a decomposition between domestic and global complexity, once a complete partition of subsidiaries on levels is made.

[29] The Index is not monotonically increasing in the number of subsidiaries since we are interested more in the combination of subsidiaries and property passages that leaves room for complexity in the coordination procedure. The more the contemporary combination of nodes and levels you have to go through to implement a managerial decision, the more the difficulty to drive a bargain among conflictual stakeholders. See for example for a reference on minority shareholders

but with $\frac{\partial GIC}{\partial^2 p_l} > 0$, hence a decreasing marginal complexity in n_l number of subsidiaries for level l. This latter characteristic of the measure we adopt for complexity is consistent with the idea that, after an initial fixed cost substained by the parent company to implement a governance for the whole system, a marginal increase in the complex structure of the system would cost less and less to the parent company thanks to economies of scale.

The GIC is also increasing in the number of levels given that a new level would add another term to the sum, but this formulation of the Index does not discriminate among subsidiaries belonging to different levels, that is $\frac{\partial GIC}{\partial p_m} = \frac{\partial GIC}{\partial p_n}$ for $m \neq n$ two different levels when $m < n$. The complexity that another subsidiary adds to the general complexity is not differentiated for the level it belongs. To do it, we can give a penalty additional weight to the probability distribution of levels more distant from the parent company. We could thus rewrite another version of Index:

$$GIC^* = \sum_{l}^{L} l \frac{n_l}{N} \log \left(\frac{N}{n_l} \right) \tag{3}$$

where as before $l \in \mathbb{N}$ is the level/distance from the ultimate parent company that is now taken into account in the incremental complexity, since $\frac{\partial GIC}{\partial p_m} > \frac{\partial GIC}{\partial p_n}$ for $m < n$.

Here the rate at which marginal complexity decrease with the acquisition of subsidiaries depends on the combination of number of subsidiaries already at that level and the number of levels itself.

The choice between the simple Global Index and its augmented version should depend on considerations about the control that ultimate parent company have on more distant subsidiaries.

Another way to stress the distance (or complexity) could be the explicit introduction of the edge entropy in the measure, for example if we considered cross participations as a further dimension in the Index, or also if we wanted to count how many intra-firm trade connections are present within the group and their thickness. In the first case, as we have mentioned above, an affiliate can be finally owned through direct participation (held by the headquarter) and indirect cross participations (held by any other affiliates in the control chain) and the control participation should take into account both. But a proliferation of edges, i. e. the direct or indirect property links among members of the group, could be another factor determining complexity in the coordination of the Multinational Business Group that makes enforcement of management difficult the more distant the affiliate is considered in terms of property rights. We would have a joint probability distribution $p_{ij} = p_i^e * p_j^n$, such that $p_i^e = \frac{e_l}{E}$ and $p_j^n = \frac{n_l}{N}$, with e_l number of edges at level l and E total number of edges in the graph and the simple multiplication of the two events' probabilities to indicate that they are mutually independent. The Index in this latter case would be:

$$GIC^{**} = \sum_{i}^{L} \sum_{J}^{L} p_{ij} \log \left(1/p_{ij} \right) \tag{4}$$

$$\frac{\partial GIC}{\partial p_{ij}} < 0, \quad \text{with } n_l, e_l \in \mathbb{N} \text{ and } n_l > 1,\ e_l > 1 \tag{5}$$

with a decreasing marginal complexity in both nodes and edges, provided that we have at least one subsidiary and one control link on each level.

However, given the scope of our analysis, the combined consideration of a threshold and cross-participations at a preliminary step for the boundary suffices to single out controlled affiliates and their performance in relation to the size of the group, whereas this latter version of the Index would be useful to measure hierarchies that flow into some form of alliances (i. e. hybrid form of organization between hierarchies and markets) with some participations well below a control threshold but a certain degree of influence in management decisions. Of course in this latter case we would have no perfect partition of subsidiaries among final headquarters, but very ramified graphs where connections (edges) gradually fade out.

Interesting to mention, we think that this index would be also useful in the case of intra-firm trade, where one would have a measure of the integration of activities within the group based on the number of exchanges of intermediate products among affiliates. A hint on the degree of vertical integration of the group in the production process.

Applying our Index to the sample of subsidiaries and global ultimate owner described in Section 1, with a threshold for control participation at 50.01 percent, we have a GIC for parent companies located in EU15 and we can attribute this variable to 3819 subsidiaries located in the New Member States. As Table 1 shows, 18,392 firms have an individual ultimate owner and do not have an Index of Complexity, i.e. they fall into the category of foreign individually owned firms as discussed in Section 3. An in-depth analysis we have conducted on the ownership data has demonstrated that 92.9% of sample subsidiaries that are ultimatelly owned by individuals are also immediately owned by individuals, i.e. there is no control chain to consider for them. For the 7.1% remaining we cannot retrieve ownership data for ultimate owners.

A first useful exercise able to show investment strategies for corporate groups investing in New Members of EU is the decomposition of the GIC according to world regions. What we do is a separate calculation of the Index within a world region, isolating it from rest of the world[30]. Results are shown in Figure 4. Two interesting remarks emerge from this exercise. The first one is that sample groups are well rooted in developed countries, as from average GICs indicate: other "EU15" countries (different from country of origin), "North America", "Oceania"(essentially Australia and New Zealand) and "Rest of Europe" (countries not members of the EU) display thicker distributions. Instead, EU groups have a simpler corporate structure in less developed countries: "Latin America", "Far East and South-East Asia "(including China and India), "Middle East and Africa". Complexity in New Members sat between that registered for developed countries and that portrayed for less developed countries. The second remark is that, more than the geographical distance, data suggest a relationship between the development

[30] This exercise obviously excludes one-parent-one-subsidiary structures given that, if present, they had the unique subsidiary in New Member States due to the initial selection of the sample

Figure 4: Multinational Complexity in key geographical areas of business groups investing in New Members

of a hierarchy with a complex production network of subsidiaries and the quality of institutions of the host countries that should be further investigated. Beyond our sample, a first investigation on European business groups investing abroad has shown that the one-parent-one-subsidiary strategy is the most preferred in emerging countries. In particular, out of the 129,114 globally-active groups monitored within the EU, there are only 1,213 groups that have invested in China or India and 960 of them have invested in both China or India and the NMS.

In Figure 5 we present another interesting exercise, showing the kernel density (log) estimation for the complexity distribution of EU15 sampled groups, first confronted with German ones alone and then with Italian ones. The most simple complexity is given by a one-parent-one subsidiary control chain: looking at the thick left tails of the distributions we see that many groups operating in New Member States adopt this ownership structure, while this is relatively less the case for Italian and German groups, where however, as we have seen in the previous section, the bulk of firms are owned by individuals with no control chain (not reported in this figure). The other peak of the EU15 and German distributions is in the middle, with a not so high global complexity, with German groups that pull the average EU15 curve up. Italian groups are instead either relatively small or relatively large, with a striking absence in the center of the distribution of middle-complex groups.

The first important preliminary result we find, once differentiating between subsidiaries controlled by a group and firms controlled by foreign individuals (see Section 3 above), is that the simple affiliation to a corporate group, whatever his complexity, is related not only to higher productivity, but also to higher firm size and profitability.

In the following Table 2 we calculate the performance premia of affiliates owned by corporate vs. individuals or families: in the first column we adopt a simple OLS, while in the second column we include industry fixed effects in order to correct for possible correlation of firm-level measures with industry characteristics. Firm-level productivity is given by estimates of TFP

Figure 5: Multinational Complexity of German, Italian and other EU 15 groups investing in New Members

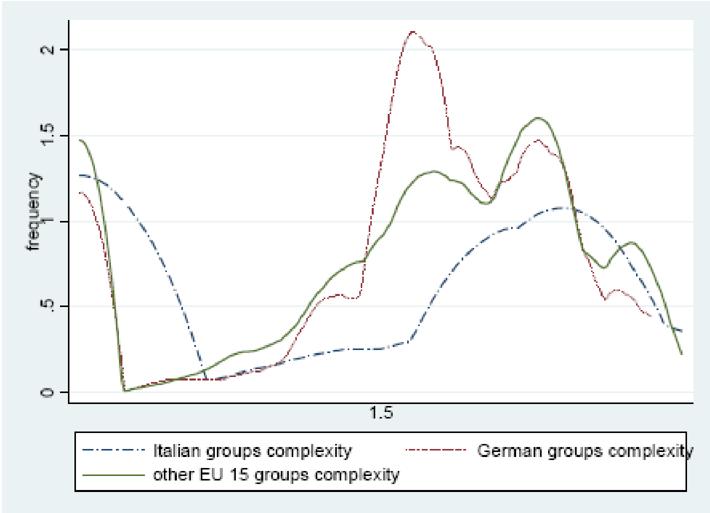


Table 2: Control premia for affiliates in New Members

	OLS	*OLS fixed effects*
Log TFP	*1.014****	*0.907****
	(0.011)	*(0.011)*
Log Value Added per Worker	*1.364****	*1.071****
	(0.018)	*(0.018)*
Log Turnover per Worker	*1.939****	*1.691****
	(0.015)	*(0.015)*
Log Employment	*2.269****	*2.183****
	(0.014)	*(0.014)*
Log Turnover	*4.401****	*4.071****
	(0.021)	*(0.021)*
Log Profit	*3.515****	*3.117****
	(0.024)	*(0.025)*

according to the Levinsohn and Petrin (2003) methodology[31] (see Appendix for details) and by labor productivity proxied by value added per worker and turnover per worker. Firm size is proxied by both number of employees and turnover, whereas profitability is represented by the profit/loss before taxation from the balance sheet.

On average, for subsidiaries located in the New Member States owned by EU15 residents, the affiliation to a group means a 90.7% difference in terms of TFP, with labor productivity even higher. Group-owned subsidiaries are on average fourfold bigger in terms of turnover, but also more than twice bigger in terms of employees and three times more profitable. As for profits, prudence is required because the favorable taxation in the countries of enlargement could have given incentive to the phenomenon of transfer prices which can cause displacement of profits within the group, a phenomenon that can not take place in our control subsample of individual-owned subsidiaries.

[31] The identification of a sectoral production function and a firm-specific residual for TFP has required the consideration of all the firms (including domestic ones) in every New Member country and every sector included in the original dataset for a total of about 2 million firms with data on capital, labor and intermediates provided by the Amadeus database by Bureau van Djik.

Table 3: National premia for German vs Italian affiliates

	Individually or family-owned		*Controlled by a group*	
	OLS	*OLS fixed effects*	*OLS*	*OLS fixed effects*
Log TFP	0.202***	0.223***	0.330***	0.292***
	(0.014)	(0.014)	(0.052)	(0.055)
Log Value Added per Worker	0.434***	0.322***	-0.171*	0.227**
	(0.029)	(0.029)	(0.095)	(0.089)
Log Turnover per Worker	0.402***	0.304***	0.524***	0.442***
	(0.020)	(0.020)	(0.065)	(0.065)
Log Employment	0.351***	0.371***	0.668***	0.455***
	(0.018)	(0.018)	(0.080)	(0.093)
Log Turnover	0.727***	0.515***	1.291***	0.973***
	(0.028)	(0.017)	(0.094)	(0.093)
Log Profit	0.404***	0.516***	1.186***	1.040***
	(0.033)	(0.033)	(0.116)	(0.114)

The higher performance of foreign affiliates with respect to firms owned by foreign individuals could be attributed to higher managerial pressure and/or to specific and standardized production and management processes experimented in other affiliates of the group. Especially the latter could be a qualification of what we generally refer to spillovers. Even if economic literature has showed that foreign-owned firms are more productive than domestic ones due to knowledge spillovers, the codification of them within a business group should allow a faster and better circulation whereas family-owned businesses, in which knowledge tends to be less codified, are less able to let spillovers circulate worldwide. As we will see in the next section, the international boundary of the group has its importance in the circulation of experiences. Size premia are even larger than productivity premia and this difference could be explained by the greater availability of resources that subsidiaries of corporate groups typically enjoy with respect to constraints that individually owned subsidiaries have to face.

A second important result is that the nationality of the parent companies seems to matter. Confronting German and Italian subsidiaries on productivity, firm size and profitability, we observe that German-owned firms perform better than Italian ones on average. That is what we report in Table 3, with the same methodology as before, but with the premium now calculated in terms of German vs. Italian ownership, for both types of ownership (corporate vs. individual or family-owned). Of course here the difference is to be attributed to organizational talents that owners and management of different nationality bring with themselves from home country.

German-owned firms are more productive, 22.3 percent if individually-owned and 29.2 if group-owned when we take TFP levels. Once controlling for industry fixed characteristics, also labor productivity is higher for German subsidiaries, with a ratio higher in case of individually owned firms that are 32.2 percent more productive than Italian ones This latter result could be in part explained by the fact that we know from our sample that German subsidiaries are usually more capital intensive with an average ratio between capital and labor of 238,000 euro for Germany and 183,000 euro for Italy. With a more capital intensive production process, ceteris paribus, a firm will register higher marginal labor productivity and lower marginal labor productivity. In fact, for German-owned firms we register a capital productivity, calculated as value added on fixed assets, which is 21.1 percent lower than Italian-owned firms. Size and profitability show premia for subsidiaries with a German ultimate owner which are almost twice as large in case they are corporate-owned.

5 Productivities, organizational complexity and financial pressure of foreign subsidiaries

Once having determined a ranking of productivity, and a correlation between type of corporate control and firm performance, it is worth further exploring this relationship in order to understand whether corporate ownership *per se*, or rather the characteristics associated to corporate control, namely the complexity of the group and financial pressures, matter for productivity.

We have already treated in Section 4 our proposal for the measurement of groups' extension of hierachical organization, the GIC in its first augmented version that takes into account a penalty for farther levels of distance from the headquarter. From the point of view of transaction cost economics the GIC can be also considered as the size of the group, i.e. the extent to which the Multinational Business Group has internalized value-added activities. A measure to be confronted with the size of the affiliate itself at the beginning of the period ($size_{it-1}$) and the size of the ultimate parent company at the beginning of the period (S_{it-1}), in order to have a complete overview of the effects of internalization processes on productivity. For the financial constraint instead, we prefer to adopt the measure suggested by Nickell and Nicolitsas (1999), through a firm- and time-specific ratio:

$$FP_{it} = \frac{interest\_payments_{it}}{profit\_before\_tax_{it} + depreciation_{it} + interest\_payments_{it}} \tag{6}$$

which is based on the cost of the credit rather than on the level of indebtness and/or leverage as done in other studies (Desai et al, 2008), since we argue that levels here could be the object of a specific financial strategy whereas the real cost paid for this strategy is the price that conveys information on the position of the firm on financial markets. Unfortunately we don't have data to measure the extent and the development by multinationals of an internal capital market since our firm-specific $interest\_payments_{it}$ can comprehend both interests paid to external resources and financial expenses for intra-group loans. We try however to verify if the recourse to the stock exchange (a dummy $quoted_i$ that equals 1 if the affiliate is quoted) has an effect on the financial constraint and, following Kuppuswamy and Villalonga (2010), if the specialization of the group in financial activities (a dummy $financial\_group_i$ that equals 1 if the headquarter is specialized in financial activities[32] and/or the majority of subsidiaries is involved in financial activities) is the cause of a softening of the financial constraints. A binary variable $group\_control_i$ separates the dataset between firms that are controlled by a group and individually owned firms, whereas another binary variable $intermediates_i$ disentangle between

[32] A financial activity here excludes the mere holding activity and administration of the group subsidiaries (NACE rev. 2, code 7010)

core activities involving the production of intermediate products (whether destined intra-group or to other industrial customers) and production of final goods and services[33].

We first estimate the following specification for Total Factor Productivity levels of all the firms included in the dataset:

$$
\begin{aligned}
\ln(TFP_{it}) \quad = \quad & \alpha_0 + \alpha_1 * \ln(size_{it-1}) + \alpha_2 * (FP_{it-1})^{\gamma} + \alpha_{3*} * group\_control_i + \\
& + \alpha_4 * group\_control_i * (FP_{it-1}) + \alpha_5 * quoted_i + \\
& + \alpha_6 * quoted_i * (FP_{it-1}) + \alpha_7 * financial\_group_i + \\
& + \alpha_8 * financial\_group_i * \alpha_9 * (FP_{it-1}) + intermediates_i + \\
& + \alpha_{10} * intermediates_i * group\_control_i + \mu_h + \eta_j + \theta_t + u_i + \epsilon_{it} \qquad (7)
\end{aligned}
$$

The results are reported in the first column of Table 4, where we adopt a Hausman-Taylor (1981) strategy with fixed effects for industry (η_j), host country (μ_h), time (θ_t) and the endogeneity through time of size ($size_{it-1}$) is controlled instrumenting with firm fixed effects (u_i).

The preference of a Hausman-Taylor (1981) estimation model on both a Fixed Effects model and a Random Effects model emerges as a result of a pre-estimation test proposed by Baltagi et al. (2003). The use of such a model specification allows us to introduce in our estimating equation fixed individual characteristics, such as the corporate ownership, controlling however for the correlation between some of these characteristics and the unobserved individual-level random effects. Following the pre-estimation strategy proposed by Baltagi et al. (2003), we performed a dual Hausman test, the first one confronting Fixed Effects model and Random Effects model, as we have just done before, and a second one comparing Fixed Effects and Hausman Taylor with a coherent choice of regressors suspected to be endogenous after the first test. If the result of the first test failed to prove consistency of Random Effects over Fixed Effects, the result of the second test has instead provided a direction for the consistency of the Hausman Taylor estimation strategy. As a further control on the correctness of the Hausman Taylor choice, we also have performed a modified (robust) version[34] of the Hausman test as proposed by Woolridge (2002), to avoid the shortcoming of the classical version that assumes Random Effects model as efficient, with α_i and ϵ_{it} independent and identically distributed.

The coefficient of firm size here is negative and significant meaning that larger firms show lower levels of productivity. But, considering the size itself as a control, we confirm that group-

[33] RPI classification of economic activities based on NACE rev. 1 4-digit codes.

[34] The robust version of the Hausman test proposed by Woolridge is based on the null hypothesis that after a first partial demeaning of the specification following Random Effects strategy, a further demeaning for individual time fixed effects is not significant. From the following specification:

$$y_{it} - \widehat{\theta}\overline{y_i} = (1-\widehat{\theta})\alpha_i + \beta(X_{it} - \widehat{\theta}\overline{X}_i) + \gamma(X_{it} - \overline{X}_i) + v_{it}$$

where $\widehat{\theta}$ is the estimated version of $\theta = 1 - \sqrt{\frac{\sigma_e^2}{T_i\sigma_\alpha^2 + \sigma_e^2}}$, γ is not significantly different from zero.

Table 4: Productivity levels, group size and financial pressure

Dependent variable : ln(Total Factor Productivity)	Hausman-Taylor (1)	Hausman-Taylor (2)
$\ln(size_{t-1})$	-.0956***	-.0736***
	(.0061)	(.0118)
$\ln(parent\_size_{t-1})$		.0028
		(.0030)
financial $pressure_{t-1}$	-.1287***	-.0736***
	(.0043)	(.0118)
squared financial $pressure_{t-1}$	-.0075***	-.0051***
	(.0004)	(.0008)
group control	.7779***	
	(.0380)	
financial $pressure_{t-1}$*group control	.0184***	
	(.0042)	
ln(GIC)		2.2280**
		(.7070)
squared_ln(GIC)		-1.2668**
		(.4693)
financial $pressure_{t-1}$*GIC		-.0078
		(.0103)
quoted	-.0312	-.3593
	(.2600)	(.4023)
financial $pressure_{t-1}$*quoted	-.0602	-.0261
	(.0388)	(.0527)
financial group	-.1840**	-.1748**
	(.0859)	(.0900)
financial $pressure_{t-1}$*financial group	.0013	-.0048
	(.0133)	(.0130)
intermediates production	-.1769***	-.3285***
	(.0402)	(.0782)
intermediates*group_control	-.1769**	
	(.0690)	
Constant	5.2578***	5.5030***
	(.0588)	(.3674)
IV firm fixed effects	Yes	Yes
Sector fixed effects	Yes	Yes
Host country fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	20,609	3283
Wald	3742.37 (26)	493.33 (27)

affiliated subsidiaries are 78% more productive, a result consistent with the preliminary evidence reported in Table 2. Ceteris paribus, financial pressure has a negative effect on productivity levels, contrary to what Nickell and Nicolitsas (1999) found for UK but consistent with a transition economies context where restructuring of firms' activities is crucial to reach competitiveness and it involves the employment of remarkable stocks of financial resources (Konings et al. 2003).

A Wald test for linear and non-linear hypothesis performed after the Hausman and Taylor (1981) estimation has helped us to provide the specification with the inclusion of a quadratic term ($\gamma = 1, 2$, respectively). Increasing levels of financial pressure have a proportionally increasing effect on TFP levels, i.e. the exposure to a harder and harder credit constraint makes restructuring more and more difficult. A result that makes sense and that opens up problems of informative asymmetries in financial markets, where the cost of the credit substained by restructuring firms is not related to the potential of the firm itself, but to the collateral it is able to provide. In fact, we have tried to include the total debt load in the specification (debt on assets), once controlling for financial pressure, but we have found it to be not significant on the levels of productivity. On the contrary, the positive and significant coefficient of the interaction term between financial pressure and group control shows that firms that are affiliated to a group have a softer financial constraint, with financial pressure having a proportionally lower effect on productivity with respect to individually owned firms. Unfortunately we cannot directly infere from these results if the relief is due to the creation of an internal capital market within the group or to a better reputation that an affiliate can provide as collateral when recurring to external financial resources. We verify however that the quotation on the stock exchange is neither among the determinants for the softening of the constraint nor a feature that suggests higher levels of productivity. Adopting instead the strategy of Kuppuswamy and Villalonga (2010), a striking result emerges for groups that have affiliates and/or headquarters involved in a professional financial activity (different from simple holdings). Here we have that they are on average 18% less productive than the ones that are owned by other groups with no prevalence of financial activities. Indeed these latter should be more interested in the integration of their subsidiaries in international value chains rather than in exploiting dividends as for any other financial investment, hence the exchange of best managerial procedures that could explaing the productivity premium. It is in fact clear from the data that most of the financial groups we can identify are essentially financial funds and there is also no evidence of a different credit constraint for affiliates belonging to them. A different reasoning applies to the noteworthy result for affiliates involved in the production of intermediates that are on average 18% less productive and even less in the case of group affiliation. The lower level of productivity can be due to the relative standardization of intermediate products destined to industrial consumers with respect to the provision of differentiated final goods and services purchased by final consumers. In the first case a greater elasticity of substitution could determine a lower markup, hence a lower price that in the case of an affiliate selling within its own group it is also an internal price more favorable than a market one. The interaction term between group-control and intermediates production confirm this latter expectation.

Restricting our analysis only to group-owned affiliates we estimate the following specification for which results are reported in the second column of Table 4:

$$\begin{aligned}\ln(TFP_{it}) \quad = \quad & \alpha_0 + \alpha_1 * \ln(size_{it-1}) + \alpha_2 * \ln(S_{it}) + \alpha_3 * \ln(FP_{it-1})^{\gamma} + \alpha_4 * \ln(GIC_i) + \\ & + \alpha_5 * \ln(GIC_i) * (FP_{it-1}) + \alpha_6 * quoted_i + \alpha_7 * quoted_i * FP_{it-1} + \\ & + \alpha_8 * fin\_group_i + \alpha_9 * fin\_group_i * FP_{it-1} + \alpha_{10} * intermediates_i + \\ & + \mu_h + \eta_j + \theta_t + u_i + \epsilon_{it} \qquad (8)\end{aligned}$$

In this case we substitute the binary variable that showed affiliation with our group size measure, the GIC_i in the second augmented version of Section 4[35] and we also control for the size of the ultimate parent (S_{it-1}). Results show that affiliation to a more complex hierarchy is associated to higher productivity levels. In line with what transaction cost economics argues, the benefits of a bigger hierarchy could range from an enhanced exporting activity due to intra-group trade, to superior managerial practices, access to standardized and codified technologies, better market information with respect to 'lonely knights' or better access to finance, thanks for example to a better reputation and to the support of a network of relations collected by the group. The relationship with productivity is however not monotone, with subsidiaries owned by medium-sized groups benefiting more from the affiliation to a global network than subsidiaries belonging to very complex groups. The results actually allow for the computation of a complexity threshold at 2.41 (the exponential of 0.88), below which benefits are definitely positive. From Figure 5, where we showed the k-density log distribution of complexity of EU15 business groups operating in New Member States, we can see that the threshold is set more or less in the middle with respect to the existing groups, that we however remember are only the groups investing in New Members for which we calculate worldwide complexity. In particular, we see that 59.5% of group-owned subsidiaries belong to networks below this threshold. If we separately consider German and Italian groups operating in the new member States we can moreover notice that the median and mode of our GIC index for Germany are set below the threshold, whereas the Italian distribution is relatively flat within the same range. From the subsidiary sample, about 54 percent of Italian subsidiaries belong to networks that show a complexity above the threshold, whereas the figure for Germany is only 23 percent. Hence, right where the complexity benefits more, Italian groups are relatively less present than German and EU15 ones. The latter is a structural weakness for the Italian organizational presence in the countries of enlargement which is hindering their exploitation of profit opportunities. Surprisingly, the coefficient for the interaction term between financial pressure and group complexity is not significantly different from zero. Comparing this result with the interaction term in the previous specification and recalling that our specification now includes only those firms that are corporate-owned, we

[35] It is the GIC plus one to calculate the logarithms and avoid the dropping of zero-complexity groups from regression estimates, that is the groups composed of one headquarter and one affiliate.

conclude that, once the corporate control is assured, the size of the network is not important in assessing the financial constraints the subsidiaries face. More than the wider internal capital market that a business group can develop, the better reputation of a firm that is controlled by a business group seems to be the crucial factor in determining the cost of the credit.

Besides the analysis of TFP levels done in the previous specifications, we perform a similar exercise for TFP growth rates to control if firm performance through time is influenced more by management coordination than by a cherry-picking selection bias with wider groups able to acquire affiliates with better perspectives given their information advantage. Again here, we first consider the whole dataset with group-owned and individually owned firms given the specification:

$$\begin{aligned}\Delta \ln(TFP_{it}) &= \alpha_0 + \alpha_1 * \ln(size_{it-1}) + \alpha_2 * (FP_{it-1})^{\gamma} + \alpha_{3*} * group\_control_i + \\ &\quad +\alpha_4 * group\_control_i * (FP_{it-1}) + \alpha_5 * intermediates_i + \\ &\quad +\alpha_6 * intermediates_i * group\_control_i + \mu_h + \eta_j + \theta_t + u_i + \epsilon_{it} \qquad (9)\end{aligned}$$

and then we restrict the dataset to group-owned firms for which we have the measurement of complexity:

$$\begin{aligned}\Delta \ln(TFP_{it}) &= \alpha_0 + \alpha_1 * \ln(size_{it-1}) + \alpha_2 * \ln(S_{it}) + \alpha_{3*} * \ln(FP_{it-1})^{\gamma} + \\ &\quad +\alpha_4 * \ln(GIC_i) + \alpha_5 * \ln(GIC_i) * (FP_{it-1}) + \alpha_6 * intermediates_i + \\ &\quad +\mu_h + \eta_j + \theta_t + u_i + \epsilon_{it} \qquad (10)\end{aligned}$$

and results are contained respectively in columns 1 and 2 of Table 5.

The results on the whole dataset show that on average firms affiliated to a group grow 8.64% more after controlling for the negative effect of firm size. An important result, this latter, that confirms the idea that corporate ownership assures the accession to benefits over time. The financial pressure, calculated as in the previous specifications, has a negative effect on the growth rate of productivity but is partly loosened for group affiliates, as a confirmation of one of the benefits of corporate control. The second column of Table 5 excludes once again firms belonging to individuals and concentrates only on group affiliates. Here we find a 5.9 percent positive effect of group complexity on the productivity growth rate, once controlling for firm size and ultimate parent size. The Wald test here excludes a non-linear specification for $\ln(GIC_i^*)$ and point estimates confirm a less stringent financial constraint on productivity growth for group-owned subsidiaries, but the interaction term between complexity and financial pressure rejects again the group complexity as one of the determinants for the softening of the constraint . Differently from the case of levels, we observe no difference in growth rates for subsidiaries involved in the production of intermediates. This is actually a confirmation of the fact that the productivity gap in levels is attributable to the relative standardization of production and a lower elasticity

Table 5: Productivity growth, group size and financial pressure

Dependent variable : growth rate of TFP	Hausman-Taylor (3)	Hausman-Taylor (4)
$\ln(size_{t-1})$	-.0963***	-.0432**
	(.0079)	(.0157)
$\ln(ultimate\_parent\_size_{t-1})$		-.0034
		(.0021)
financial $pressure_{t-1}$	-.0560***	-.0339***
	(.0053)	(.0021)
squared financial $pressure_{t-1}$	-.0034***	-.0022**
	(.0005)	(.0008)
group control	.0864***	
	(.0252)	
financial $pressure_{t-1}$*group control	.0144**	
	(.0049)	
ln(GIC)		.0589***
		(.0191)
financial $pressure_{t-1}$*GIC		.0050
		(.0066)
intermediates production	.0780**	-.0005
	(.0229)	(.0247)
intermediates*group_control	-.0215	
	(.0370)	
Constant	.2454***	.2252**
	(.0515)	(.0828)
IV firm fixed effects	Yes	Yes
Sector fixed effects	Yes	Yes
Host country fixed effects	Yes	Yes
Time fixed effects	Yes	Yes
Observations	15,438	3,902
Wald	403.33	105.53

of substitution with respect to final goods and services. Some characteristics, these latter, that however do not prevent firms to enhance competitiveness and performance within their own sector exploiting the benefits of the affiliation to a group.

6 Conclusions

We have investigated the performance of subsidiaries in the New Member States of the European Union that are owned by residents of the 15 original members. Within a context of firm heterogeneity, we have found that affiliates to business groups are more productive, bigger and more profitable than firms that are owned by foreign individuals. National premia have been found to be relevant in the case of German and Italian subsidiaries with respect to the average of the other investing countries in the sample, with German-owned affiliates more productive, bigger and more profitable than Italian ones. A new degree of heterogeneity has been tested through the adoption of a measure that we call Global Index of Complexity (GIC), which is able to summarize the complexity of a global value chain of a business group. After some stylized facts that depict sampled groups as more complex in developed countries with a pattern of complexity that could be differentiated by country of destination, we have found that Total Factor Productivity (TFP) of subsidiaries is strongly related to the worldwide complexity of the group to which they are affiliated. The results provided for productivity levels and growth rates after the affiiation confirm this positive correlation, but it was still not possible with available data to determine the direction of causality, that is whether affiliates are more productive because of their affiliation to bigger groups or the bigger groups themselves are able to pick out the better affiliates thanks to a more complete information on their perspectives. Probably it is a combination of both, where bigger groups are able to reduce information asymmetries before acquiring a new affiliate and afterwards the same affiliate has access to a variety of experiences that spill over within the group, or equivalently, to the stock of managerial procedures that is accumulated by increases in size and is redistributed from core to periphery as Penrose (1959) predicted. In this latter case, the wider the group, the more the subsidiary can benefit from affiliation, even if it is involved in the production of intermediates that can suffer from an internal price transfer effect when compared with independent firms, as we find in the case of productivity levels. Indeed, once looking at dynamics, i.e. at productivity growth rates, difference in performance for these latter firms fades away and the benefits from affiliation could prevail, confirming a premium for corporate control. Results, however, show that the relationship between productivity and global complexity is not monotone but decreasing, with small- and medium-sized groups that have a more clear-cut influence on productivity. Among the benefits of affiliation we test a loosening of the financial constraint that, after controlling for the organization of the finance function, we attribute to the intangible collateral that group reputation is able to provide, better than the development of an internal capital market. In emerging markets and transition economies the financial pressure that subsidiaries face should mainly be due to information asymmetries of credit institutions and the scarcity of financial resources makes the restructuring more difficult with a negative effect on productivity levels and growth rates. In this case a better reputation and additional resources are available to the single subsidiary through the participation to an international network.

Annex A: Levinsohn and Petrin (2003) productivity estimates

Let y_t denote (the log of) a firm's output in a Cobb-Douglas production function of the form

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \beta_m m_t + \omega_t + \eta_t \qquad \text{(A1.1)}$$

where l_t and m_t denote the (freely available) labour and intermediate inputs in logs, respectively, and k_t is the logarithm of the state variable capital. The error term has two components: η_t, which is uncorrelated with input choices, and ω_t, a productivity shock unobserved by the econometrician, but observed by the firm. Since the firm adapts its input choice as soon as it observes ω_t, inputs turn out to be correlated with the error term of the regression, and thus OLS estimates of production functions yield inconsistent results.

To correct for this problem, Levinsohn and Petrin (2003b), from now on LP, assume the demand for intermediate inputs m_t (e.g. material costs) to depend on the firm's capital k_t and productivity ω_t, and show that the same demand is monotonically increasing in ω_t. Thus, it is possible for them to write ω_t as $\omega_t = \omega_t(k_t, m_t)$, expressing the unobserved productivity shock ω_t as a function of two observables, k_t and m_t.

To allow for identification of ω_t, LP follow Olley and Pakes (1996) and assume ω_t to follow a Markov process of the form $\omega_t = E[\omega_t|\omega_{t-1}] + \xi_t$, where ξ_t is a change in productivity uncorrelated with k_t. Through these assumptions it is then possible to rewrite Equation (A1.1) as

$$y_t = \beta_l l_t + \phi_t(k_t, m_t) + \eta_t \qquad \text{(A1.3)}$$

where $\phi_t(k_t, m_t) = \beta_0 + \beta_k k_t + \beta_m m_t + \omega_t(k_t, m_t)$. By substituting a third-order polynomial approximation in k_t and m_t in place of $\phi_t(k_t, m_t)$, LP show that it is possible to consistently estimate the parameter $\widehat{\beta}_l$ and $\widehat{\phi}_t$ in Equation A1.3. For any candidate value β_k^* and β_m^* one can then compute a prediction for ω_t for all periods t, since $\widehat{\omega}_t = \widehat{\phi}_t - \beta_k^* k_t - \beta_m^* m_t$ and hence, using these predicted values, estimate $E[\widehat{\omega_t|\omega_{t-1}}]$. It then follows that the residual generated by β_k^* and β_m^* with respect to y_t can be written as

$$\widehat{\eta_t + \xi_t} = y_t - \widehat{\beta}_l l_t - \beta_k^* k_t - \beta_m^* m_t - E[\widehat{\omega_t|\omega_{t-1}}] \qquad \text{(A1.4)}$$

Equation (A1.4) can then be used to identify β_k^* and β_m^* using the following two instruments: if the capital stock k_t is determined by the previous period's investment decisions, it then does not respond to shocks to productivity at time t, and hence $E[\eta_t + \xi_t|k_t] = 0$; also, if the last period's level of intermediate inputs m_t is uncorrelated with the error period at time t (which is plausible, e.g. proxying intermediate inputs with material costs), then $E[\eta_t + \xi_t|m_{t-1}] = 0$.

Through these two moment conditions, it is then possible to write a consistent and unbiased estimator for β_k^* and β_m^* simply by solving

$$\min_{(\beta_k^*, \beta_m^*)} \sum_h [\sum_t (\widehat{\eta_t + \xi_t}) Z_{ht}]^2 \qquad \text{(A1.5)}$$

with $Z_t \equiv (k_t, m_{t-1})$ and h indexing the elements of Z_t.

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Final conclusions

The picture that emerges from this work is a complex one. Analyzing the modes of internationalization of firms (exporting, importing of inputs, creation of global value chains), we have seen that the responses to increased trade openness are different and imply different performances, that we have generally assumed as gains of productivity. In the first chapter we have tested the existence of an additional source of gains from trade due to an overall but asymmetric industrial restructuring between sectors found at comparative advantages or at comparative disadvantages. The socalled magnification effect leads to greater shifts in average productivity in the sectors that have better prospects of a good positioning on export markets. The market selection process being tougher in those sectors implies also major benefits from the economy as a whole, but we have also hinted to the fact that this could mean unexpected effects of trade policies, where an asymmetric liberalization of some sectors before than others could lead to a faster restructuring of the former since, ceteris paribus, it provides an incentive for firms to enter there where the profit expectations are higher.

In the second chapter we have seen how relatively important is the vertical channel of import penetration, since the importing of imputs that are cheaper or that previously were not available at home can compensate and alleviate the classical competition channel through which firms at home begin to compete more with firms worldwide thanks to decreasing tariffs and trade costs. It is possible however that these two channels can interact since the importing of cheaper varieties of intermediates allow firms to allineate prices to the new competitive levels of the imported goods and in this case both channels would be involved in the making of the final firms strategy. In this case we would see three possible responses to competition from abroad: a lower price due to a lower markup, a lower price thanks to lower production costs or alternatively the same price or even a higher one after a quality upgrade of products that exploits inputs of better quality. To differentiate among those three cases, productivity alone would be a poor indicator since it is traditionally calculated as a residual of a production function (see paragraph 3.1 of Chapter II but also Annex A to Chapter III) and we missed information on the possible changing quality of capital, labor and intermediates employed by the firm. It was however important to introduce the relative importance of the vertical channel and its different relationship with several geographical areas of origin of imports, among which China still represents a noteworthy player.

In the third chapter I explored another source of heterogeneity as derived from the establishment of coordinated hierarchies of firms located in different countries with different competitive advantages. We have seen how the complexity of control chains as one possible organizational mode (i.e. the size of the group) is positively related to the performance of the single affiliates and how it can be explained also by the benefits deriving of a softened financial pressure derived either by the development of an internal capital market or by the intangible collateral provided by the affiliation to a group. At the end we have been inclined to prefer the last reason after considering the organization of the finance function within the group.

Undoubtedly, while trying to understand some issues at stake, other interesting problems have emerged that are worth a further investigation. According to me, this is a fruitful field of study that has still to supply many tools to catch the complexities underlying the ongoing internationalization of production systems and the new challenges ahead in the next future.