Productivities and Comparative Advantages: A Multilevel Model Approach

Armando Rungi *

(Bocconi University & FEEM)
Preliminary draft: 29 October 2010

Abstract

This paper empirically investigates the relationship between product-level comparative advantages of France and within-industry firm-level heterogeneity. In particular I test the presence of a magnification effect, as predicted by Bernard, Redding and Schott (2007), for industries and products at comparative advantage. The availability of firm-level, product-level and industry-level data for France allows to contemplate different degrees of heterogeneity for the period 2001-2007 and to conclude that, after controlling for factor endowments, economies of scale and initial productivity differences, indeed some dynamic technological differences do emerge. The result is robust even after controlling for demand effects on the selection process, first directly with the inclusion of unbiased estimates of productivity and then indirectly with the inclusion of sector-specific elasticities of substitution.

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

* *Corresponding author*: IAM-Università Bocconi, Via Roentgen 1, 20136 Milan. (T)+39.02.5836.5406; (F)+39.02.5836.5439; armando.rungi@unibocconi.it

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

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

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 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

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

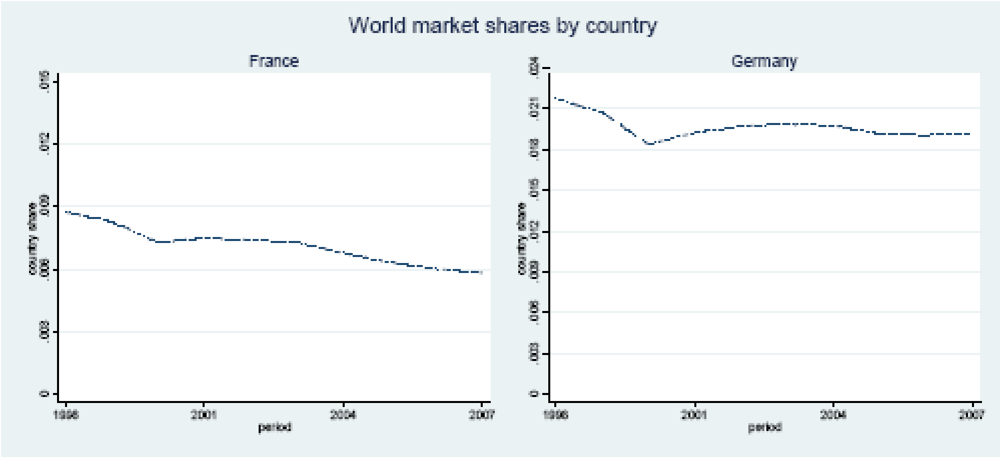
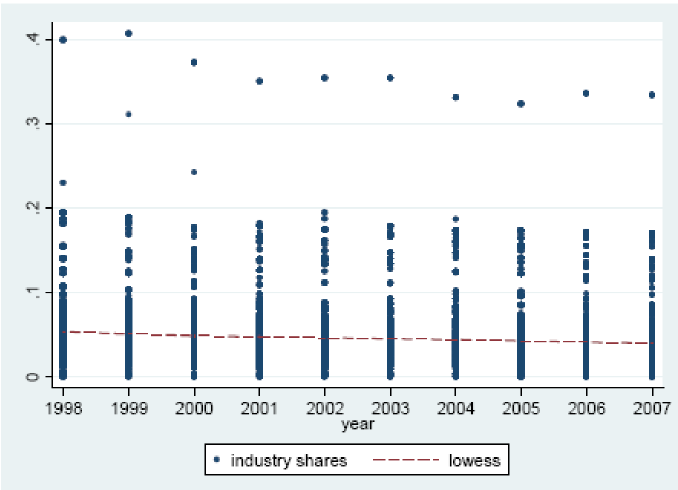


Figure 2: Industry world shares of France, 1998-2007. Source: elaboration on BACI by CEPII



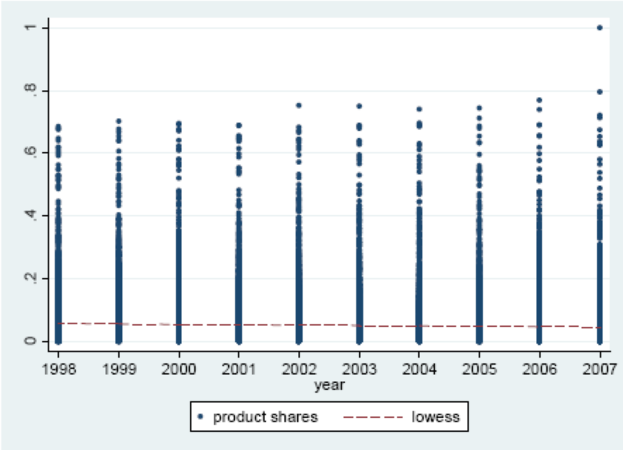
positions. That is, even if as Table 1 shows, exports are increasing in absolute terms, the accession of new global players (Asian emerging economies, new EU members, etc.) on the international scene have reduced the French trade in relative terms. But looking at aggregates and averages is misleading, or at least it leads to an incomplete understanding, as Figures 2 and 3 display.

Figure 2 shows the tendency of product market shares of France on total world exports disaggregated at HS 6-digit level[1], 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[2] curve, the dispersion of shares by products is much higher than the

[1] 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

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

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



one by industries, with some best performers reaching even 80% of the international market and in one case[3] 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

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

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		
HS 6-digit code	Denomination	Average perc change in share
020734	Fatty livers of geese	4.04%
284430	Uranium (depleted U235), thorium compounds, products	4.15%
291431	Phenylacetone	3.76%
293292	Benzodyoxol	10.29%
293319	Heterocyclic compounds with unfused pyrazole ring	2.69%
381720	Mixed alkylnaphtalenes	2.53%
911440	Clock or watch plates and bridges	2.77%

Worst performers		
HS 6-digit code	Denomination	Average perc change in share
382471	Containing chlorofluorocarbons	-5.40%
330123	Essential oils of lavander	-4.99%
020725	Turkeys, not cut, frozen	-4.53%
291212	Ethanal (acetaldehyde)	-4.06%
854610	Electrical insulators of glass	-3.94%
910620	Parking meters	-3.84%
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		
ISIC 4-digit code	Denomination	Average perc change in share
3330	Manufacture of watches and clocks	0.09%
2921	Manufacture of agricultural and forestry machinery	0.12%
1912	Manufacture of luggage, handbags and the like, saddlery and harness	0.12%
3512	Building and repairing of pleasure and sporting boats	0.12%
3313	Manufacture of industrial process control equipment	0.16%
2927	Manufacture of weapons and ammunition	0.31%
3530	Manufacture of aircraft and spacecraft	0.43%

Worst performers		
ISIC 4-digit code	Denomination	Average perc change in share
1554	Soft drinks and mineral waters	-0.76%
1552	Wines	-0.73%
2330	Processing of nuclear fuel	-0.55%
1542	Manufacture of sugar	-0.52%
3599	Manufacture of other transport equipment	-0.48%
2511	Manufacture of rubber tyres and tubes	-0.48%
3220	Manufacture of television and radio transmitters	-0.43%

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[4] 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 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:

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

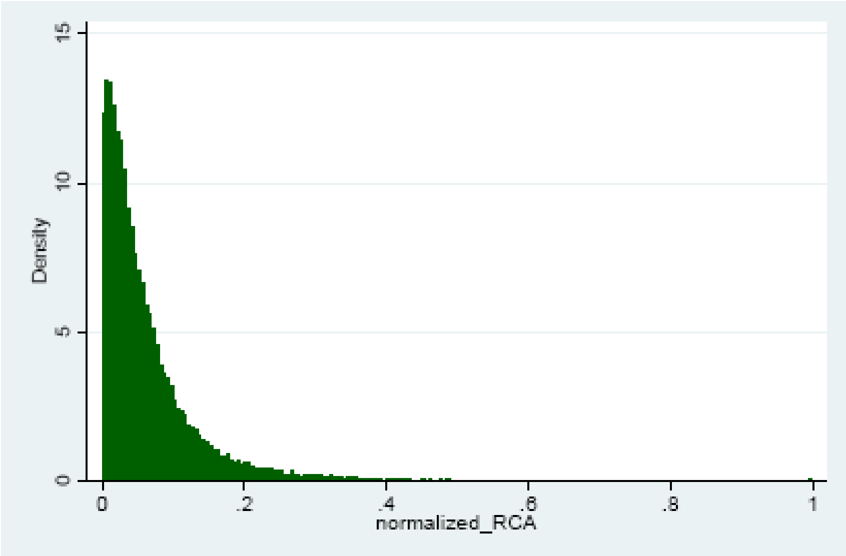
where the numerator is the exports of product s from France (F) at time t and the denominator is the total world (W) trade flows for the same product s at time t.However useful as a variable, the export performance as such is a measure of the absolute advantage of a country in a world market, whereas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

[4] 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

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



$$norm\_RCA_{st} = \frac{RCA_{st} - RCA_{st}^{\min}}{RCA_{st}^{\max} - RCA_{st}^{\min}} = \frac{\left[\frac{X_{st}^F}{X_{st}^W} - \left(\frac{X_{st}^F}{X_{st}^W}\right)^{\min}\right] / \frac{X_t^F}{X_t^W}}{\left[\left(\frac{X_{st}^F}{X_{st}^W}\right)^{\max} - \left(\frac{X_{st}^F}{X_{st}^W}\right)^{\min}\right] / \frac{X_t^F}{X_t^W}} = $$
$$= \frac{world\_share_{st} - world\_share_{st}^{\min}}{world\_share_{st}^{\max} - world\_share_{st}^{\min}} \qquad (3)$$

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 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:

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

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[5] firms grouped by NACE rev. 1 at 4-digit level of disaggre-

[5] 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, 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.

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

gation, 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.

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 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[6] if not trying to proxy unobserved productivity shock with materials instead of investment[7]. 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:

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

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

[6] 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.

[7] 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.

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:

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

where $Q_{It} = \sum (ms_{it}R_{it}/P_{It})$ is the aggregate industry output, Pit and P_{It} are respectively the firm-level price and the industry-level deflator, η is the industry-specific elasticity of substitution between products. The ratio $\frac{Pit}{P_{It}}$ 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:

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

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

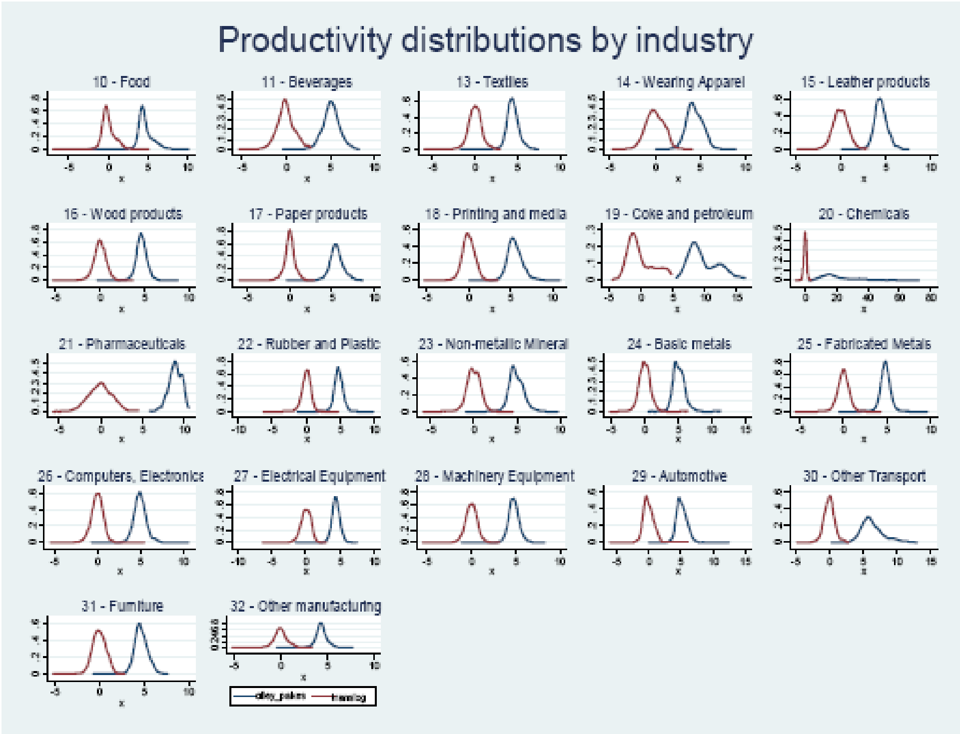
$$\ln Y_{it} = \widetilde{\beta}_0 + \sum_k \widetilde{\beta}_k \ln X_{kit} + \frac{1}{2}\sum_l\sum_k \left[\widetilde{\delta}_{lk}(\ln X_{lit})(\ln X_{kit})\right] + \widetilde{\gamma}_i - \beta_\eta \ln Q_{It} + (\xi^*_{it} + \varepsilon^*_{it}) \tag{10}$$

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[8], estimates

[8] 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

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



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.

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:

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

the very long right tail observed in the case of chemicals in Figure 5

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

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:

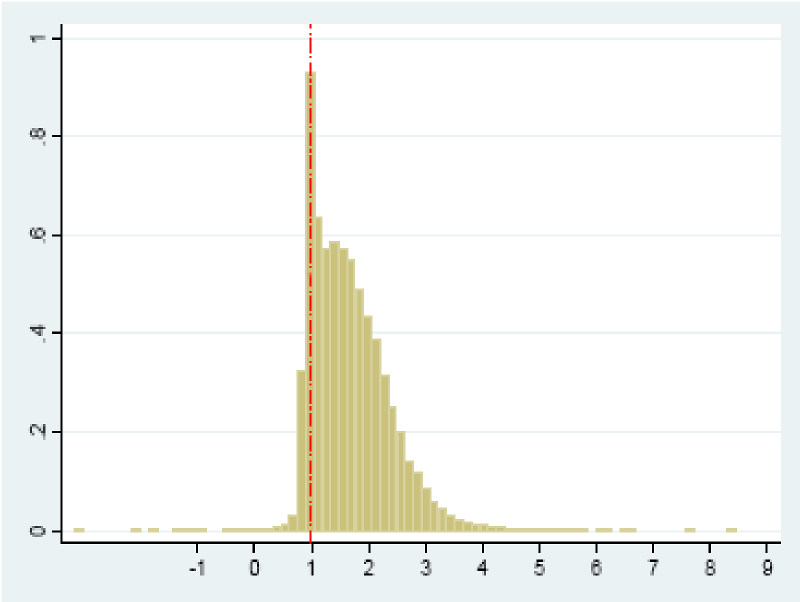
$$RTS_{it} = \sum_k \widehat{\beta}_k + \sum_l \widehat{\delta}_{kk} \ln X_{kit} \ln X_{kit} \tag{12}$$

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 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[9]. 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

[9] 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



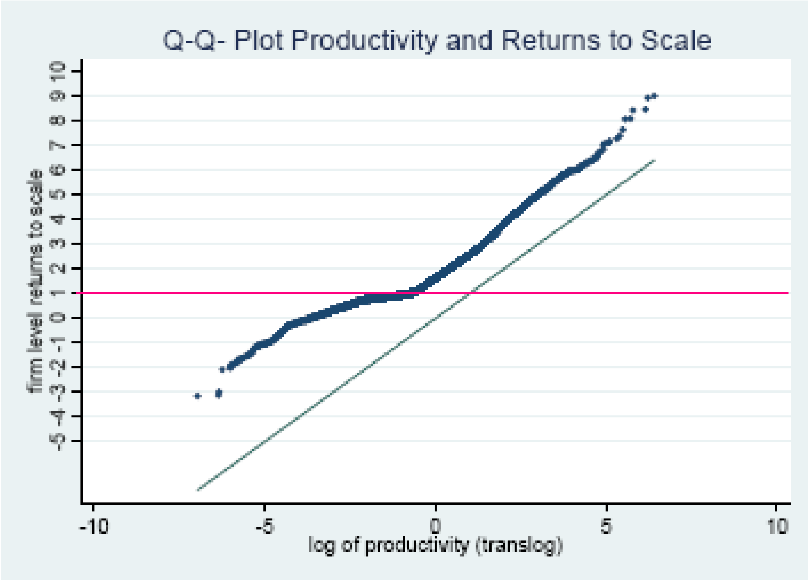
of one distribution corresponds the percentile of the other. If in general it is true that there is a positive relationship between productivities and economies of scale, it seems to be not linear. That is because, when proximate to economies of scale, firms have to increase by more the productivity 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.

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,

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



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:

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

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

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)* $\sum \delta_{kli} \ln X_{kit} \ln X_{lit}$	*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***

2-digit averages of this variable with the standard deviations through years and across more disaggregated sectors.

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

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

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

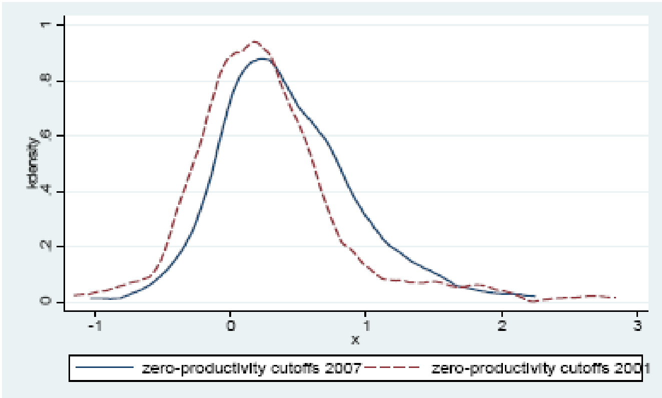


Figure 9: (Logs of) export cutoffs for French 4-digit industries. Source: elaboration on Amadeus by Bureau Van Djik

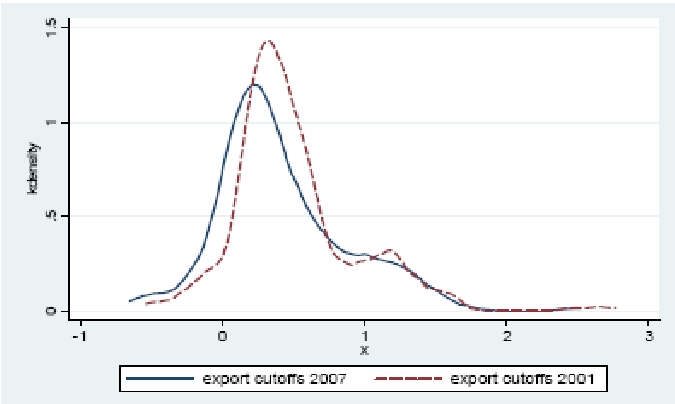
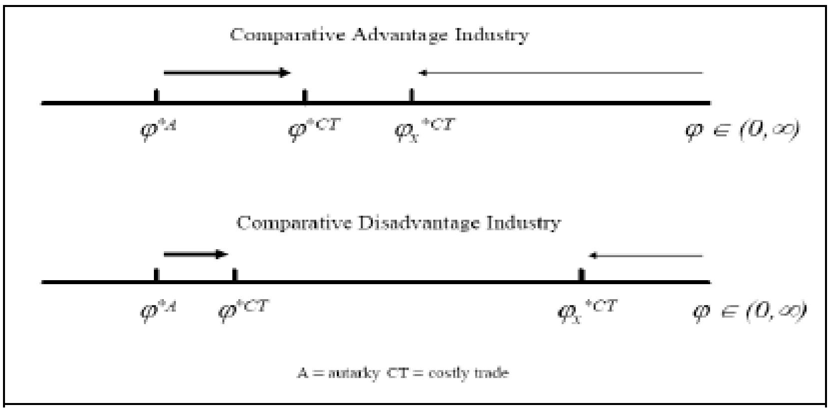


Figure 10: Differential cutoffs and the magnification effect. Source: Bernard, Redding and Schott (2007)



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 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):

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

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:

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

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:

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

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:

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

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 $\left(\chi^{(n)}\sim N(0,\vartheta)\right)$ 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:

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

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.

8. References

Akerman, A. and Forslid, R. (2007). Country Size, Productivity and Trade Share Convergence: An Analysis of Heterogenous Firms and Country Size Dependent Beachhead Costs. CEPR Discussion Paper no. 6545. London

Altomonte, C. and Colantone, I. and Pennings, E., (2010). International trade with heterogenous firms and asymmetric product varieties, mimeo

Antoniades, A. (2009): Heterogeneous Firms, Quality, and Trade,mimeo.

Balassa, B. (1965), Trade Liberalisation and Revealed Comparative Advantage, The Manchester School, 33, 99-123.

Beason R. and Weinstein D.E. (1996) Growth, economies of scale, and targeting in Japan (1995-1990), Review of Economics and Statistics, 78(2), pp. 286-295.

Bernard, A., Eaton J., Jensen, B, and Kortum, S. S.(2003). Plants and Productivity in International Trade American Economic Review 2003, Vol. 93, No. 4, September, 1268-1290

Bernard A. B. and Jensen B. and Redding S. J. and Schott P. K. (2007). Firms in International Trade. Journal of Economic Perspectives, American Economic Association, vol. 21(3), pages 105-130

Bernard A. B. and Redding S. J. and Schott P. K. (2007). Comparative Advantage and Heterogeneous Firms. Review of Economic Studies, 74: 31–66

Bernard A. B. and Redding S. J. and Schott P. K. (2010). Multiple-Product Firms and Product Switching American Economic Review 2010, Vol. 100, No. 2, May, 444-448

Berndt E. and Christensen L., (1973) The translog function and the substitution of equipment, structures, and labor in US manufacturing, 1929-1968. Journal of Econometrics, 1, pp.

81-114.

Christensen L. R. and Jorgenson D. W. and Lau L. J. (1973),Transcendental Logarithmic Utility Functions, Chapter 1 in Dale W. Jorgenson (1997a), pp. 1-28

Cleveland, W.S.; Devlin, S.J. (1988). Locally-Weighted Regression: An Approach to Regression Analysis by Local Fitting. Journal of the American Statistical Association (403): 596–610

Costantini J. A. and Melitz M. (2007). The Dynamics of Firm-Level Adjustment to Trade Liberalization, mimeo

De Benedictis L. and Tamberi M., (2002). A note on the Balassa Index of Revealed Comparative Advantage,Working Papers 158, Universita' Politecnica delle Marche (I), Dipartimento di Economia

De Loecker J.(2007). Product Differentiation, Multi-product Firms and Estimating the Impact of Trade Liberalization on Productivity. NBER Working Papers 13155

Eckel C. and Neary P., (2010). Multi-Product Firms and Flexible Manufacturing in the Global Economy. The Review of Economic Studies, Volume 77 (1), pp. 188-217(30)

Ghironi F. and Melitz M. (2005).International Trade and Macroeconomic Dynamics with Heterogeneous Firms. Quarterly Journal of Economics, Vol. 120, August 2005, pp. 865-915.

Ghironi F. and Melitz M. (2007). Trade Flow Dynamics with Heterogeneous Firms. American Economic Review, Vol. 97, May 2007, pp.356-361

Greenaway, David & Kneller, Richard (2007), Firm heterogeneity, exporting and foreign direct investment. The Economic Journal 117 (517): F134–F161

Griliches, Z. and Ringstad, V. (1971) Economies of Scale and the Form of Production Function, North-Holland Publishing Co., Amsterdam

Grossman G., Helpman E. (1995). "Technology and Trade" in G.Grossman and K.Rogoff, eds., Handbook of International Economics, vol.III, North Holland.

Helpman and Krugman (1985). Market Structure and Foreign Trade, MIT Press

Helpman, E. and Melitz M. and Yeaple S.(2004). Export Versus FDI With Heterogeneous Firms. American Economic Review, 94(1), pp. 300-316.

Kabundi, A., and F. Nadal De Simone, (2007), France in the Global Economy: A Structural Approximate Dynamic Factor Model Analysis. IMF Working Paper 07/129

Kabundi, A., and F. Nadal De Simone, (2009). Recent French Export Performance: Is There a Competitiveness Problem?. IMF Working Papers WP/09/2

Khan, T., (2006). Productivity Growth, Technological Convergence, R&D, Trade and Labour Markets: Panel Data Evidence from the French Manufacturing Sector. IMF Working Paper 06/230

Mayer, T., Melitz, M. and G. Ottaviano (2010). Market size, Competition, and the Product Mix of Exporters, mimeo

Mayer, T. and Ottaviano, G.I.P., (2008), The Happy Few: The Internationalisation of European Firms, Intereconomics: Review of European Economic Policy, 43, issue 3, p. 135-148.

Melitz, M. (2003), The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, Econometrica 71 (6): 1695–1725.

Norman, L., Kots S. and Balakrishnan S. (1994). Continuous Univariate Distributions, Volume 1, 2nd Edition, Wiley

Olley, S. and Pakes, A. (1996). The Dynamics of Productivity in the Telecommunications Equipment Industry, Econometrica, Vol 64 6, 1263-98.

Proudman, J. and Redding, S. (1998) Persistence and mobility in international trade. In: Proudman, James and Redding, Stephen, (eds.) Openness and growth : proceedings of the Bank of England academic conference on the relationship between openness and growth in the United Kingdom, September 15th, 1997. Bank of England, London

Rabe-Hesketh, S., Skrondal, A. and Pickles, A. (2004). Generalized multilevel structural equation modelling. Psychometrika 69, 167-190

Rabe-Hesketh, S., Skrondal, A. and Pickles, A. (2005). Maximum likelihood estimation of limited and discrete dependent variable models with nested random effects. Journal of Econometrics 128, 301-323.

Romalis, J., (2004). Factor Proportions and the Structure of Commodity Trade. The American Economic Review 94, 67–97

Syverson C. (2004). Product Substitutability and Productivity Dispersion. The Review of Economics and Statistics, MIT Press, vol. 86(2), pages 534-550, 08

Trefler, D. & Chun Z. S. (2000), Beyond the Algebra of Explanation: HOV for the Technology Age, American Economic Review 90 (2): 145–149

Vanek, J. (1968), The Factor Proportions Theory: the N-Factor Case, Kyklos 21: 749–756