Vertical integration, disintegration and ability to export*

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Abstract

Recent literature on trade has emphasized the role of firms' heterogeneities in export performance and trade specialization of countries (Melitz, 2003; Melitz and Ottaviano, 2005).

Exporting seems to be a strategy available only to most efficient and productive firms even in a framework with transport costs and no reciprocal dumping.

We do not know much about the internal organization of these smarter companies which are exporting part of their production. However, from related theoretical (Helpman, 2006) and empirical (Rossini and Ricciardi, 2005) literature we know that more efficient firms tend to be more vertically integrated than the average population on both a domestic and a crossborder basis.

The main purpose of this paper is to link the two streams of literature on firms heterogeneities and export, on one side, and vertical integration and export, on the other side. Then, we try to answer the question: is the exporting activity going to affect the degree of vertical integration making exporting firms more vertically integrated than non exporting firms? And, if so, why?

We investigate these matters at a theoretical tier and through a set of econometric tests on firm level data for 25 EU countries. At the theoretical level we consider a model with two countries each possessing one or two firms: one in case of vertical integration and two in case of vertical disintegration. We compare large and small vertically disintegrated or integrated firms in an environment with transport costs and home bias. Larger firms tend to be more vertically integrated and to engage in export activity. The theoretical conclusions are consistent with the empirical analysis which says that for larger firms exporting activity tends to boost the degree of vertical integration.

This provides some link between the two literatures, the first maintaining that only more productive firms export and the second stating that more productive firms are more vertically integrated. The emphasized link dictates that the more enterprises export the more vertically integrated they are. Why? It is mostly a matter of size and R&D commitment which enhances productivity.

JEL Classification: F12, L22, L24.

Keywords : Vertical Integration, Trade, Export Ability.

1 INTRODUCTION

The role of firms' heterogeneities in export performance and trade specialization of countries has become a new leitmotiv in international economics (Melitz, 2003; Melitz and Ottaviano, 2005). Existing firms display different degrees of efficiency. Least productive firms do not exit from markets, as perfect competition suggests, but simply survive, in an imperfectly competitive environment, making lower profits and confining their sales to the domestic market. Exporting becomes a job for more efficient firms since it involves additional costs, like transport costs (TC), that can be born only by the better equipped enterprises.

Firms are more efficient if they show higher productivity, i.e. lower unit costs. Then, the question is: Where do differential performances come from? The answer involves many aspects of production. We know that much is due to technology and process innovating R&D (Armour and Teece,1980; Brocas, 2003; Banerjee and Lin, 2001; Perry, 1989). Nonetheless, quite a crucial role is played by internal organization mode, which may provide actual efficiency advantages to a company (Mclaren, 1999, 2000). Other factors, such as location or particular market strategies (Pepall and Norman, 2001) may represent a further explanation of better performance.

The focus of our investigation is confined to some crucial features of exporting firms. Unfortunately we do not know much about the internal organization of these firms which are more efficient than the average and export part of their production. Nonetheless some hints come from related theoretical (Helpman, 2006) and applied (Rossini and Ricciardi, 2005) contributions. For instance, we know that more efficient firms tend to be more vertically integrated on both a domestic and a cross-border basis (Antras and Helpman, 2004; Grossman and Helpman, 2002; Buehler and Schmutzler, 2003). It is to this aspect of internal organizations of firms that we devote this study touching both empirical and theoretical aspects of the simple question: is exporting activity going to affect the degree of vertical integration (VI)? Or, in other words, are more vertically integrated firms exporting more than vertically disintegrated enterprises? And, if so, why?

To reply to this question at the theoretical level we consider a model with two countries each possessing one or two firms which may be either vertically integrated (VI) or vertically disintegrated (VD), large or small in terms of capital commitment, willing to export or not export.

We consider larger firms as bearing higher fixed costs and lower variable costs with increasing returns to scale. Theoretically we shall see in most (country) symmetric cases a kind of dominance of larger and more vertically integrated firms (Spengler, 1950). These enter-

prises are also more willing to export than VD firms, which, in many circumstances, tend to confine themselves to the domestic market. This result may be thought of as the extension and indirect proof of the statement that only more productive firms export. Here we see the confirmation that more vertically integrated firms are more productive and, therefore, export more. Our theoretical results will be quite comprehensive due to the consideration of many different, and sometimes extreme, scenarios. Our findings are consistent with empirical analysis maintaining that for larger firms exporting activity tends to boost the degree of VI. This is the main outcome of our econometric analysis of the relationship between VI and export orientation of firms, conducted on a sample of 10229 firms belonging to 25 EU countries.

Our study provides a partial link between two literatures, the first affirming that only more productive firms export and the second stating that more productive firms are more vertically integrated. The investigated liaison says that the more firms export the more vertically integrated they are. Why? From our study it seems to be mostly a matter of size, since larger firms are more VI.

The paper is organized as follows. In the next section we present the main model. In the third section we consider some simulations of the theoretical model. In the fourth section we report on empirical tests. Section five contains the conclusions.

2 THE SET UP

We consider two firms, belonging to two countries H and F, competing in a Cournot mode selling in both their domestic market and the rival's market. Each firm has four possible strategies: vertically integrate (VI), vertically disintegrate (VD), exporting (X) and non-exporting (no X). Countries are separated by transport costs of traditional iceberg type. This means that a portion $(1-t)$ of the value of the good exported is lost during the shipment from the country where it is manufactured to the country where it is bought. Moreover, each country suffers some home bias, i.e. consumers prefer domestically produced articles. Hence, foreign goods enter in the demand function with a "home bias discount" $s \in [0,1]$ leading to imperfect substitutability between home and foreign produced goods.

The demand curve in country H is:

$$p_H = a - q_H - s\, t\, q_{FF} \tag{1}$$

where: p_H is the market price of the final good sold in country H; a is the size of the market; $s \in [0,1]$ is the Home Bias indicator: the larger it is the lower is the Home Bias; t is the TC parameter whereby

$(1-t)$ is the share of value of a good used up during shipment to a foreign country; q_{FF} is the quantity of the good produced by the foreign rival sent to country H. If the rival based in F decides not to export, the demand function in H reduces to the first two terms on the right hand side.

The corresponding demand function in country F is

$$p_F = a - q_F - s\, t\, q_{HH} \tag{2}$$

and the meaning of symbols is the mirror image of those for country H demand function.

As far as the production organization is concerned firms may adopt either a vertically integrated (VI) arrangement or a vertically disintegrated (VD) one.

We assume that each firm faces two cost functions: one for the production of the good sold domestically and another for the share of production that is shipped abroad.

For the firm in country H the production costs for the share of goods exported are:

$$C_{HH} = e + (c+z)q_{HH} \tag{3}$$

where C_{HH} is the total cost of production of exports, made up by a fixed cost to operate on the foreign market e, which is a capital commitment of shareholders, a variable cost c of producing the final output and the cost of production of the input z manufactured in the upstream section of the VI firm. The cost of production of the input calls for the usual assumption of perfect vertical complementarity, whereby one unit of input is needed for each unit of output.

The total cost function for the share of the domestically sold output is:

$$C_H = f + (c+z)q_H \tag{4}$$

which looks similar to (3) but for the fixed capital commitment cost f which denotes a different investment required to sell at home as compared to exporting. This reflects the fact that for many firms the exporting activity requires either dedicated production lines or commercial networks in the foreign countries or both.

The profit function of the VI firm of H is:

$$\pi_H = p_H\, q_H + t\, p_F\, q_{HH} - C_H - C_{HH}. \tag{5}$$

If we consider VD we shall have to consider the two separate firms operating either in the upstream (U) or downstream (D) section of the vertical chain of production. The D firm observes the demand function for the final good and strategically sets its optimal quantity (Cournot competition) reaction function. The U firm knows the market reaction function of D and utilizes it to choose the optimal

price for the input it sells to D. Then, the cost function of the producer of the final good operating in the D section of the vertical chain of production will be:

$$C_{HH} = e + (c + g)q_{HH} \tag{6}$$

and

$$C_H = f + (c + g)q_H, \tag{7}$$

where g is the price of the input charged by the upstream (U) independent producer of the intermediate good required for the assembly of the final good in D.

Once the U firm has decided its optimal price the D firm uses it to pick from its own market reaction function the corresponding quantity of the final good to sell.

As far as country F is concerned, the costs of production of the VI firm are:

$$C_{FF} = ee + (ccc + zz)q_{FF} \tag{8}$$

and

$$C_F = ff + (cc + zz)q_F. \tag{9}$$

With VD they become:

$$C_{FF} = ee + (ccc + g_F)q_{FF} \tag{10}$$

and

$$C_F = ff + (cc + g_F)q_F. \tag{11}$$

Variables have mirror image meanings. As it may be seen, fixed and variable costs are different in country F with respect to H to allow for asymmetries among firms. Moreover, variable costs differ between the production of the exports and the production for the domestic market. This allows us to consider rival firms not only with different cost structure but also with different size.

We assume, following common wisdom and related literature, that a firm with larger fixed cost has lower variable costs.

The profit of firm in F is:

$$\pi_F = p_F\ q_F + t\ p_H\ q_{FF} - C_F - C_{FF}. \tag{12}$$

As anticipated between (5) and (6), with VD there is strategic interaction between U and D independent firms. This stage of the game is absent with VI since inputs are internally transferred at their marginal cost. There are at least two ways of modeling vertical strategic interaction between independent firms: resorting to a Stackelberg vertical relationship whereby the D firm plays a sort of follower role, or adopting a Nash-Rubinstein bargaining solution

(Nash, 1950; Rubinstein,1982). Which one is best? Unfortunately, the latter solution has market effects (price of the final good) quite close to VI and to vertical collusion. This makes its use not very attracting despite its wide diffusion in theoretical analysis of VI and VD (Antras and Helpman, 2004). As seen above, we choose the Stackelberg solution which has the disadvantage of being asymmetric, yet the advantage of being more close to market relationships.

By adopting the Stackelberg mode the game, in the VD case, becomes a 4 stage game. In the first stage each firm decides whether to go VI or VD, in the second whether to export or not to export. If the firm goes VI there is just a further market stage where each firm interacts with the foreign rival producer of the final good in a Cournot fashion. If the firm goes VD there will be vertical Stackelberg strategic interaction and, afterwards, the fourth stage with D market rivalry. The Stackelberg vertical interaction requires the D firm to set the quantity according to demand. Then the U firm decides its optimal input price to charge to the D firm on the basis of the quantity chosen by the D firm.

The game in reduced normal form appears as in Table 1 below.

TABLE 1

				H		
			VI	VI	VD	VD
			X	no	X	no
	VI	X	1 π_F, π_H	2 π_F, π_H	3 $\pi_F, \pi_H; \pi_{UH}$	4 $\pi_F, \pi_H; \pi_{UH}$
F	VI	no	5 π_F, π_H	6 π_F, π_H	7 $\pi_F, \pi_H; \pi_{UH}$	8 $\pi_F, \pi_H; \pi_{UH}$
	VD	X	9 $\pi_F, \pi_H; \pi_{UF}$	10 $\pi_F, \pi_H; \pi_{UF}$	11 $\pi_F, \pi_H; \pi_{UF}; \pi_{UH}$	12 $\pi_F, \pi_H; \pi_{UF}; \pi_{UH}$
	VD	no	13 $\pi_F, \pi_H; \pi_{UF}$	14 $\pi_F, \pi_H; \pi_{UF}$	15 $\pi_F, \pi_H; \pi_{UF}; \pi_{UH}$	16 $\pi_F, \pi_H; \pi_{UF}; \pi_{UH}$

As it can be seen, the number of payoffs in the cells is not constant.

In cells 1,2,5,6, there are 2 payoffs for each cell since the two firms, identified with their country initials, are VI.

In cells 3,4,7,8,9,10,13,14,there are 3 payoffs since one firm is VI while the other in VD and therefore we have to consider also the profits of the U firm.

In cells 11,12,15,16 we have 4 payoffs: two of D firms and two of U firms.

Payoffs presented are calculated in terms of profits per unit of capital invested.

This is a novel way to assess industrial payoffs we introduce in this paper. The rationale is that the choice of strategies on the basis of simple profits is not reflecting the financial investors' attitudes.

Shareholders aim at the maximum profit per unit of capital. Total profits is not a meaningful financial indicator. Managers who run the enterprise on behalf of shareholders usually maximize the return of capital invested. In our case we assume, for the sake of simplicity, that capital is proxied by fixed sunk costs. Therefore we shall put in the cells simply the ratios of profits over the fixed costs.

When comparing VI and VD we consider a VI firm on one side. On the other front we consider a D and a U firm. We first consider the choice of strategy as made by the D firm. However, we also marginally investigate what happens if the export decision was taken by U.

On the equilibrium properties of this game we do not dwell since they are similar to those presented in Rossini (2007) and in Lambertini and Rossini (2006). Instead, we go through a set of simulations to try to mimic some scenarios that will help in the econometric section. We resort to simulations since analytical comparative statics is not feasible.

3 SIMULATIONS

We simulate the above model in different scenarios and we describe the equilibria of the reduced form of the game represented in Table 1.

3.1 SCENARIO 1

The F firm faces low fixed costs for production and high fixed costs for exporting. It has higher variable costs for both the production of the goods sold at home and for the goods sold abroad. The H firm has higher production fixed costs and lower variable costs. For the export activity it has lower fixed costs. Also the U firm in F has higher variable costs, reflecting a sort of negative externality due to the small dimension of the D firm in F. This is actually a scenario where one small firm in F competes with a larger firm in H.

The calibration of this simulation is: $a = 1000; c = 1; t = 0.6; s = 0.5, z = 1; e = 100; f = 400; cc = 10; ccc = 15; ff = 10; ee = 150; zz = 6$. Results are in Table S1.

TABLE[1] S1

			H		
		VI	VI	VD	VD
		X	no	X	no
	I-x	1861; 688	2718; 294	2765; 197; 122796	3478; 73; 44290
F	I-no	10482, 1187	24205, 622	18563, 383; 156169	24205, 6185; 124501
	D-x	3037, 173; 105700	1153, 493; 138772	874, 324; 165657; 185775	1182, 142; 219903; 56808
	D-no	2620, 1194; 39312	6051, 622; 121032	4640, 430; 78230; 243621	6051, 155; 121032; 124500

This is a case in which the H firm is large while the F firm is small; H has larger fixed costs for domestic production, lower for exports. The larger firm makes lower profits per unit of capital invested. In the above Table we see that F has a dominant strategy (VI, no), while H does not have any dominant strategy and chooses the best out of the dominant payoffs of F, i.e.: (VD, no). Then the equilibrium of the entire game is (VI, no; VD, no).

We may confine to the VD subgame, for instance, because of a vertical restraint as in Rossini (2007). In this case the equilibrium for D firms is (no, X), which is Nash in dominant strategies.

If we were to allow for the U firms to set the equilibrium of the VD subgame, the equilibrium would be (X, X) which is Nash in dominant strategies. Which equilibrium should we credit? We assume that strategies are chosen by D firms since they face the final demand. But this is not entirely consistent with the leader role of U firms. After all, it would sound logically bizarre to assume that U firms decide whether the D firm should or not export. In any case there seems to be a conflict between U and D firms as to the exporting decision: a question worth to be more deeply investigated.

If we confine to the subgame VI the equilibrium is (no, X), which is Nash in dominant strategies.

The main conclusion from this first simulation is that, despite lower costs of exports, the large firm exports only if we confine to subgame VI and subgame VD. The small firm F never exports, neither in the entire game equilibrium nor in subgames equilibria. This is an important statement since it says that VI firms (and also VD) may export only if they are large. However, the small firm strategy may trap the large firm into a non-exporting corner, when there is no restriction about VD versus VI.

We shall see that the conclusions obtained in the subgames are confirmed by empirical analysis.

[1] **X** means exporting, **no** means non exporting. The third and fourth payoffs in the cells refer to U profits.

A further consideration should be given to the incentive U firms could provide to D firms to export.

3.2 SCENARIO 2

The calibration of scenario 2 is: $a = 100; c = 2; t = 0.6; s = 0.5, z = 1; e = 400; f = 50;$

$cc = 6; ccc = 9; ff = 10; ee = 150; zz = 4$. Here the F firm is smaller but faces lower exporting fixed costs than the larger firm.

TABLE S2

			H		
		VI	VI	VD	VD
		X	no	X	no
	VI-x	9; 7	17; 29	16; 2; 1281	23; 6; 557
F	VI-no	79, 9	202, 46	150, 3; 1516	202, 11; 1176
	VD-x	3, 10; 512	9, 41; 737	6; 3; 936; 1752	8, 11; 1375; 908
	VD-no	19, 12; 301	50, 46; 1013	37, 4; 637, 2285	50, 11; 1013; 1176

This scenario is less asymmetric than the previous one. There is an equilibrium in dominant strategies (VI, no; VI, no). In the subgame of U firms there is a dominant strategy (X, X). In the VD subgame for D firms the subgame equilibrium is (no , no). It seems that in this case the preference for VI is quite clear. Again the U firms may provide incentives to the D firms to export. However, there does not appear any desire to exporting neither in VD nor in VI. The benefits from exporting accrue mostly to the U section of production. It seems that when we increase the costs to exporting for the large firm, this drags down the exporting attitude also of the small firm.

3.3 SCENARIO 3

The calibration is: $a = 1000; c = 1; t = 0.9; s = 0.7, z = 1; e = 100; f = 400; cc = 10; ccc = 15; ff = 10; ee = 150; zz = 6$. Here we decrease transport costs and lower Home Bias leaving other variables as in Scenario 1.

TABLE S3

			H		
		VI	VI	VD	VD
		X	no	X	no
	I-x	1558; 555	2417; 288	2468; 139; 103885	2965; 71; 43293
F	I-no	10458, 822	24205, 622	19157, 270; 159568	24205, 155; 124501
	D-x	393, 842; 93223	821, 505; 148430	627; 249; 167405; 183806	826, 141; 209657; 85230
	D-no	2614, 996; 39222	6051, 622; 121032	4788, 299; 78748, 223724	6051, 155; 121032; 124501

For the entire game among D firms the equilibrium in dominant strategies exists and is (VI, no; VI, X), i.e. the largest firm goes VI and exports while the smaller firm goes VI but does not export. This again is a result which will be confirmed in the empirical tests.

In the VI subgame the equilibrium is (no, X). The larger firms exports. The smaller does not.

If we consider the subgame VD the equilibrium is: (VD, no; VD, X), i.e. the largest firm exports while the smaller does not. If we confine to U firms, F wants to export (dominant strategy), as it is for H.

3.4 SCENARIO 4

The calibration is: $a = 100; c = 2; t = 0.6; s = 0.5, z = 1; e = 20; f = 30;$ $cc = 10; ccc = 2; ff = 30; ee = 20; zz = 1.$

TABLE S4 (symmetric case)

			H		
		VI	VI	VD	VD
		X	no X	X	no X
	VI-x	59, 59	84, 35	86, 17; (1063)	108; 8; (408)
F	VI-no	35, 84	77, 77	61, 35; (1176)	77, 19; (1176)
	VD-x	17, 86; (1063)	35, 61; (1176)	22, 22; (1719; 1719)	36, 17; (2149; 804)
	VD-no	8, 108; (408)	19, 77; (1176)	17, 36; (804; 2149)	19, 19; (1176; 1176)

In this symmetric case where the two firms have same fixed and variable costs, there is an equilibrium in dominant strategies (VI, X; VI, X). Also if we consider the two subgames of VI and VD we find that there is an equilibrium in X: the dominant strategy is Exporting. This result is just reproducing the standard result

that firms prefer to export than not to export if TC and home bias are not to high. In case this does not occur we shall end up with non exporting dominant strategy for both firms (a simulation not reported, yet available upon request).

4 ECONOMETRIC TESTS

We have carried out a series of econometric estimations of the relationship between the level of VI and the export orientation of firms belonging to 25 EU countries.

The indicator adopted to statistically describe VI is the ratio between value-added and sales ($VIX_{ti} = VA_{ti}/Y_{ti} \in [0,1]$) at firm ($i = 1...n$) level in year t. This is an index of VI which captures most backward upstream vertical integration, while it is mostly silent on downstream vertical integration. Nonetheless, it appears as the best indicator of VI and is widely adopted in empirical analysis. The level of the dependent variable VIX_{ti} will be explained by a set of independent variables.

The first is the degree of export orientation measured by the ratio between the current value of exports over the value of sales by a firm ($X_{ti} = EXP_{ti}/Y_{ti} \in [0,1]$).

The second is the size of the firm proxied by the level of employment. This variable (N) has been normalized to one by using the ratio of the number of employees of each firm over the employment of the largest enterprise.

The third variable is the value of productivity at firm level measured by individual value-added ($PR_{ti} \in R^{+}$).

The fourth is the value of $R\&D$ commitment over the revenue. R&D activity figures include all kinds of investment without any distinction among product innovation, process innovation, export logistic innovation, R&D in transport technology and so on.

The data source is Osiris, produced by the Bureau Van Dijk[2]. Data cover enterprises which are listed in stock exchanges or large companies which are not listed. The firms belong to 25 EU member countries[3]. This database is the only one providing detailed figures on exports at firm tier.

We concentrate on year 2003 since the larger sample supplies the richest and more recent picture of the variables we are studying. The estimation is based on OLS.

[2] See: http://www.bvdep.com/en/osiris.html

[3] Austria, Belgium, Czech Republic, Cyprus, Denmark, Estonia, Finlandia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

4.1 Group 1: Size affinities

We investigate two specifications. One comprising size, productivity and exports as explanatory variables (model 1). A second one includes also R&D expenditure (model 2).

TABLE[4] T1: Large firms (Number of Employees $\geq$ 1000)

2003	model 1		model 2	
	coeff.(s.d.)		coeff.(s.d.)	
Const.	0.257	***	0.283	
	(0.009)		(0.022)	***
X_t	0.091	***	-0.015	
	(0.008)		(0.019)	
PR_t	0.001	***	0.001	***
	(0.000)		(0.000)	
$R\&D_t$			0.328	**
			(0.136)	
N_t	0.257		-0.030	
	(0.009)		(0.067)	
	1506	N. observations	336	
	0.117	R^2	0.130	R^2
	66.32	F(3,1502)	12.32	F(4,331)

From Table T1 we can see the estimates of two different specifications adopted for firms which are classified as large (with more than 1000 employees).

The first one uses three explanatory variables: X, PR and N. The first two seem to be statistically significant and to determine in a direct way the degree of vertical integration. This is consistent with what we found in simulation 3. Export orientation and productivity seem to boost VI. The size variable is not significant. However, we may notice that the test is performed on large firms, making for size to become somewhat irrelevant. Then, a first sum up, we may affirm that there exists an effect of export and productivity on VI for large firms.

The second specification includes R&D as an explanatory variable, whose coefficient is statistically significant at 5% level. However, the introduction of R&D crowds out and makes fuzzy the contribution of the export orientation variable in explaining VIX_{ti}. Probably this is due to the fact that exporting firms carry out more R&D than non exporting firms.

[4] * denotes statistically significant at 10%; ** at 5%; *** at 1%.

TABLE T2: Small-Medium size firms (Number of Employees ≤ 1000)

2003	model 1		model 2	
	coeff.(s.d.)		coeff.(s.d.)	
const.	6.587	**	-0.316	***
	(3.031)		(0.075)	
X_t	-3.737		0.065	
	(4.452)		(0.089)	
PR_t	0.001		0.007	***
	(0.001)		(0.000)	
$R\&D_t$			1.187	***
			(0.114)	
N_t	-3756.944		27.690	
	(2879.997)		(67.200)	
	1881	N. observations	351	
	0.002	R^2	0.7254	R^2
	1.400	F(3,1877)	228.51	F(4,346)

From Table T2 it appears that small firm behavior is quite far apart from large firms[5]. Here the level of VI is mostly explained by R&D and productivity (model 2). In this class of firms the effect of export does not seem to be either relevant or significant. As it can be elicited from the Appendix containing the description of the data set and from Rossini and Ricciardi (2005), the level of VI among small firms is highly volatile. This could make any interpretation of VI quite awkward for small firms. Moreover, small firms are also less trade oriented and more heterogeneous in terms of all explanatory variables. That means that the effect of export, on which we concentrate, cannot be deemed as relevant.

4.2 Group 2: R&D intensive firms

Here we consider firms which may defined as R&D intensive since they carry out more investment in R&D. We establish a threshold level of 4.1% of the value of sales, since the median of firms in terms of R&D investment is 4.1% of revenue (see Appendix).

[5] In addition to that we have to notice that our database is mostly based on medium - large firms, since it comprises listed firms and large non-listed firms.

TABLE T3

All firms

2003	model 1		model 2	
	coeff.(s.d.)		coeff.(s.d.)	
const.	-0.010		-0.042	
	(0.038)		(0.044)	
X_t	-0.108	**	-0.104	**
	(0.044)		(0.044)	
PR_t	0.007	***	0.007	***
	(0.000)		(0.000)	
$R\&D_t$			0.196	
			(0.133)	
N_t	-0.455	**	-0.419	*
	(0.215)		(0.216)	
	337	N. observations	337	
	0.8779	R^2	0.8787	R^2
	797.82	F(3,333)	601.05	F(4,332)

As it appears from Table T3, the effect of export orientation on VI is always negative. The more firms export the less integrated they are. Moreover, the smaller are the firms the more integrated they are. That runs counter previous results and may be due to the fact that R&D makes VI less desirable. In both models, size and export orientation overturn the results we have theoretically seen. R&D changes the results of the incentive to go VI for U and D firms and, therefore, the role of exports becomes somewhat obscure. The fact is that we do not theoretical priors linking R&D, export orientation and VI, even if there are contributions on the relationship between R&D and VI (Lambertini and Rossini, 2007; Acemoglu et al., 2005).

4.3 Group 3: Export intensive firms

Here we consider firms which export quite above the average (median = 26.4% of sales). The threshold to define export intensive firms is value of exports over revenue = 26.4%.

TABLE T4

2003	model 1		model 2	
	coeff.(s.d.)		coeff.(s.d.)	
const.	0.317	***	-0.349	***
	(0.082)		(0.064)	
X_t	0.204	**	0.140	**
	(0.093)		(0.068)	
PR_t	0.000		0.006	***
	(0.000)		(0.000)	
$R\&D_t$			1.214	***
			(0.105)	
N_t	-0.469		-0.253	
	(0.557)		(0.248)	
	1870	N. observations	547	
	0.003	R^2	0.7064	R^2
	1.92	F(3,1866)	326.02	F(4,542)

From table T4 above we see (model 2) that a very significant relationship exists once we consider R&D and export orientation together for export intensive firms. For these firms both R&D and export boost VI.

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5 CONCLUSIONS

Using an international duopoly model we have gone through the choices of firms concerning whether to go VI or VD and whether to export or not to export to a foreign market. We have considered symmetric and asymmetric scenarios in terms of firm dimension. Larger and vertically integrated firms export while vertically disintegrated firms tend to shun exports, mostly when they are smaller.

The theoretical results, associated to calibrated scenarios, are compared to the empirical tests coming from the investigation of the relationship between vertical integration and export orientation on a sample of 10229 firms belonging to 25 EU countries.

Among large firms, export orientation and size seem to boost VI, while, among small firms this does not occur. In the group of R&D intensive firms export orientation does not boost VI; moreover, the smaller firms are the higher is VI. The clearest result comes from the test performed among export intensive firms: when we confine to these firms it appears that export orientation boosts VI in a clear and significant way.

The theoretical and empirical results of the relationship between export orientation and VI are partially conclusive. The last result that among export intensive firms export activity increases VI accords with theory showing a dominance of VI.

There remains quite an open question as to the behavior of smaller firms. It is quite awkward to find a clear determinant of VI among small firms. The main reason may be due to the high volatility of the vertical organization among them. Unfortunately we do not know much on this fascinating and still open question.

Further research should investigate this open question and the triangular link and the causality between export orientation, R&D and VI.

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6 Appendix: some descriptive statistics.

Data used for our econometric analysis come from Osiris, a database set up by the Bureau Van Dijk.

We select Osiris since it provides additional data with respect to what is required by the IV EEC directive. In particular, Osiris contains data on exports, which are not required in the profit and loss accounts which constitute the compulsory information for firms, especially if listed in stock exchanges.

The dataset is composed by 10229 firms located in one of the 25 EU countries. Their geographical distribution is shown in Table A1:

Table A1

Countries	Firms (No)	Countries	Firms (No)
Austria	159	Latvia	69
Belgium	255	Lithuania	41
Cyprus	7	Luxembourg	63
Czech Republic	288	Malta	10
Denmark	273	Netherlands	357
Estonia	19	Poland	89
Finland	197	Portugal	119
France	1324	Slovakia	18
Germany	1187	Slovenia	18
Greece	285	Spain	286
Hungary	40	Sweden	528
Ireland	138	United Kingdom	4074
Italy	385	Total	10229

The sample is composed by large companies, mostly listed in the stock exchanges, whose size should be measured in terms of sales and number of employees. Further information on the firms included in our dataset is in table A2.

In our regressions, we identified subsamples composed by large or small-medium companies, R&D intensive companies, and export intensive firms. Table A3 shows the distribution of variables used to segment our sample and variables used in our regressions. The size variable is based on the number of employees and is normalized to one. The number of employees (table A2) has been used to identify large companies (firms with more than 1000 employees). Productivity has been used as an explanatory variable in our regressions. We use an index often applied in the literature (Del Gatto et al., 2006) given by the ratio between value-added and number of employees. The third column of table A2 represents the distribution of the investment in R&D over the level of sales. This index has been

used both as an explanatory variable and to identify R&D intensive firms, namely companies which invest more than 4.1% of their sales in R&D (the median). Similarly, the ratio of exports over sales is one of our key explanatory variables and a tool to identify export intensive firms, i.e. firms selling abroad more than 26.4% of their production (the median).

Table A2

Percentile	VI	Employees	Sales	Value Added	Profits
(obs.)	(3413)	(3858)	(4122)	(3793)	(3899)
10	0.142	37	6513.7	1271.8	3407
20	0.206	104	19931.4	6162.4	10362
30	0.259	201	41453.1	13284.2	21119
40	0.302	361	77940.2	24708.2	34999
50	0.348	624	134246.0	42558.0	59477
60	0.392	1116	226780.8	71897.0	101372
70	0.453	2056	429279.4	132376.6	182759
80	0.535	4214	939157.6	297323.6	411781
90	0.642	12257	2857464.0	857347.6	1142716
mean	0.372	6949.56	1744182.0	497639	744236.9

Table A3

Percentile	Employees (%)	Productivity	R&D (%)	exports/sales
	(3858)	(3640)	(939)	(4096)
10	0.000	16.7	0.002	0.000
20	0.000	37.4	0.006	0.000
30	0.000	49.2	0.015	0.000
40	0.001	58.0	0.025	0.086
50	0.001	66.5	0.041	0.264
60	0.003	75.8	0.065	0.453
70	0.005	88.3	0.116	0.674
80	0.010	112.0	0.186	0.872
90	0.030	188.4	0.423	1
mean	0.017	194.5	4.039	0.412