Innovation, productivity, and export: Evidence from SMEs in Lower Normandy, France

Movahedi, Mohammad and Gaussens, Olivier

CREM (UMR CNRS 6211)

7 September 2011

Presented in the Applied Microeconomics conference (JMA), 7-8 june 2012 in Brest - France

Innovation, productivity, and export

Evidence from SMEs in *Lower Normandy*, France

Mohammad Movahedi · Olivier Gaussens

Version may 2012

Abstract This paper presents an analysis of the crucial relationship between innovation, productivity, and export in SMEs. The primary aims of this study are 1) to evaluate the role of innovation in the premium export; and 2) to test the hypothesis of firm conscious self-selection in export markets. Innovation is measured with respect to its technological as well as non-technological dimensions, as defined by the Oslo Manual (2005). To this end, our database of SMEs, obtained from the survey conducted in the IDEIS project[1], provides highly pertinent information. We first evaluate apparent premium of exportation and that of innovation, i.e. the advantage of exporting (innovative) firms as opposed to non-exporting (non-innovative) firms in terms of productivity. In addition, we demonstrate the effectiveness of the export premium for high exportation firms that implement process and organization innovations. Finally, we analyse the effect of conscious self-selection from the export process that transforms an intention to export into a setting in capacity to export in short term. Conscious self-selection in export markets is revealed by simultaneously endogeneizing productivity and innovation output based on recursive non-linear model.

Mohammad Movahedi
Center for Research in Economics and Management (CREM)
UMR 6211 University of Caen Basse-Normandie, France
E-mail: mohammad.movahedi@unicaen.fr

Olivier Gaussens
Center for Research in Economics and Management (CREM)
UMR 6211 University of Caen Basse-Normandie, France
E-mail: olivier.gaussens@unicaen.fr

[1] cf. http://unicaen.fr/mrsh/projetideis/. This project is financed by the French Government, the region of Lower Normandy, and the European Union (European Fund for Regional Development).

Keywords Export process · Export premium · Innovation premium · Conscious self-selection effect
JEL-Classification C14, C35, D22, F12, O31

1 Introduction

It is well established that *ex ante* higher productivity level is directly linked to a firm's decision to export. This phenomenon, called 'self-selection effect', introduced by Bernard & Jensen (1999) and described empirically in a significant number of works[2], is generated by the presence of irreversible fixed costs associated with export (market research, recruitment of specialists in export, and consulting). Theoretical studies such as that of Melitz (2003) make predictions that are consistent with these empirical observations.

However, theoretical works on firm dynamics (Jovanovic, 1982; Hopenhayn, 1992) as well as on their application to our understanding of international trade (Bernard, Eaton, Jensen, and Kortum, 2003; Melitz, 2003) do not explain the origin of firm heterogeneity. Such studies assume that productivity varies between firms as a result of random technological shocks.

In recent studies, this gap has been resolved by identifying a new dimension in the relationship between productivity and export, more specifically, a causal relationship between innovation and productivity leading to exportation. Referred to as the 'effect of conscious self-selection', this dimension involves the determining role of firm investment activities to improve productivity. Productivity, in turn, allows a firm to

[2] See Greenaway & Kneller (2007), Wagner (2007) for a review of the related literature.

more easily overcome export costs, and hence to export (Yeaple, 2005; Constantini & Melitz, 2008). In this context, Yeaple (2005) proposed a model of homogeneous firms that face sequentially four major decisions involving, 1) entry, 2) choice in technology, 3) choice of whether or not to export, and 4) the type of workers to employ. In effect, firm heterogeneity increases because firms make an endogenous choice to employ different technologies and to hire different types of workers. Thus, these more advanced technological firms *ex ante* will export *ex post.* Constantini and Melitz (2008) show how non-technological factors may have an impact on the link between export and productivity. For example, they show that the anticipation of trade liberalization tends to motivate the decision to innovate with respect to the export market entry.

Several recent empirical studies have been carried out in an attempt to test the hypothesis of conscious self-selection. These studies, however, overlook two important elements[3]. First, they deal with innovation activities either as the key determinant of self-selection of firms for export, or as a complement to productivity. The firms become exporters, not due to their productive advantage, but because of their innovator status, independently of their level of productivity. Secondly, by placing SMEs and large enterprises in the same study, results are strongly biased. Researchers must not ignore the fact that a firm's size is a determinant factor of export propensity (Moen, 1999)[4].

The main objective of the present study is to verify the hypothesis of conscious self-selection, emphasizing the role of innovation activities as the main source of *ex ante* productive performance of firms before entering the export market. One of the contributions of this work is to view exporting as a process and to distinguish in this process, the design phase and the implementation phase. The originality of our approach consists in analyzing the effect of conscious self-selection from the export process that transforms an intention to export in a setting in position to export in the short term, without this resulting automatically in an effective export. If the opportunity or the desire to diversify can trigger the intention to export, the enterprise must be organized and put into a position to export: an increase in productivity is a necessary condition for development sustainable in export markets, based in particular on the recruitment and training of dedicated employees. However, after undertaking *ex ante* efforts to increase productivity to be in a position to export, it is possible *ex post* that the enterprise postpones its decision in light of specific hazards that it must face in foreign markets such as monetary and trading risks, country risks and the risk of default directly associated with business failure [5]. Then, in this study we examine whether the most productive non-exporting firms are willing to export in the short term and whether these firms have developed innovative activities to increase their productivity before eventually entering the export market. To determine this, we apply data retrieved from the 'IDEIS' survey[6]. This data provides information on firm export strategy as well as on innovation strategy. The applied definition of innovation is taken from the Oslo Manual (OECD, 2005), in which technological (product and process) and non-technological innovations (marketing and organization) are distinguished.

Our study is presented in two parts. We begin with a comparison of different groups of exporting / non-exporting and innovative / non-innovative firms in terms of their level of productivity with the aid of parametric and non-parametric tests. The objective is to estimate the 'export apparent premium' and 'innovation apparent premium'. More specifically, we wish to establish whether the exporting (innovating) or willing-to-export firms outperform firms that do not export (do not innovate) nor intend to export. Further, we will examine the role of innovation in productivity comparing exporting and non-exporting firms. In other words, is there an 'effective export premium'. Its absence would signify that the productive advantage of exporting firms is only apparent and would thus be associated with their innovative status. The foremost contribution of the present study is, indeed, to provide a qualified answer to this question.

The second stage of the study is devoted to evaluating conscious self-selection effect. Willing to export can be explained by higher productivity which, in turn, can be explained by innovation. To achieve this, we propose a recursive non-linear model composed of three endogenous variables: innovation output, productivity, and export. The estimation method is sequential, based

[3] See, for example, Cassiman, Golovko & Martinez-Ros (2010), Girma, Görg, & Hanley (2008) and Damijan, Kostevc, & Polanec (2010).

[4] In France, Only 21.8% of SMEs export versus 61.9% of large enterprises (250-5000 employees) - Sources: Douanes, INSEE (2011).

[5] From IDEIS survey (next footnote), among non-exporters only 56% of 'willing to export' in 2009 export effectively over the period 2010-11. Otherwise, the low keeping rate of export starters (for example the keeping rate to five years is 12.8% in France and Lower Normandy for all firms; source: Douanes, INSEE, 2011) confirms the difficulties of firms to enter effectively and sustainably on export markets.

[6] IDEIS Data derived from a representative (random and stratified) sample of 86 enterprises taken from the 803 manufacturing SMEs in Lower Normandy (France). cf. http://unicaen.fr/mrsh/projetideis/

on three steps. The probability of willing to export, is a result of productivity and other control variables explaining export propensity (firm size, local, and national market). Productivity itself is explained by the estimated propensity to innovate from human capital, financial, and innovation inputs.

The determining issue for economic policy may thus be summarized as follows: should firms be helped to export or to innovate? If conscious self-selection effect may be attested to, an effective aid policy should focus on the determinants of innovation to enhance firm productivity, thus facilitating exportation. Nevertheless, our approach suggests a complementarity between the two types of aid. If the innovation grants enable enterprises to innovate more to finally put in position to export, the export subsidies should in turn focus on firms willing to export (or in situation to export) in the short term and which have ultimate difficulties to enter the export market. Moreover, we can expect a return effect of exports on innovation enhancing productivity, combining a learning effect with the self-selection to form a virtuous cycle: export-innovation-productivity-export. In this paper, we are mainly interested in conscious self-selection effect, i.e. the sequential relationship of innovation-productivity-export.

The remainder of this paper proceeds as follows: in Section 2, we examine the empirical scholarship that pertains to the relationship between innovation, productivity, and export; Section 3 summarizes the data and variables; in Section 4, we deal with the estimation of innovation and export premiums; Section 5 is devoted to test conscious self-selection effect; and finally, section 6 concludes our paper with a sketch of research perspectives.

2 Review of related empirical studies

Empirical studies related to the theoretical works mentioned above, and that have sought to determine the causal links between innovation, productivity, and export, are quite recent. The common denominator in these works is their approach to innovation activity as a direct determinant of the export decision; productivity takes a secondary and complementary role (e.g., acting as a control variable) in the self-selection process.

These empirical studies use two types of innovation measures: innovation based on input and that based on output. Studies focusing on innovation input such as R&D fall short of statistically revealing a significant relationship between innovation and firm export propensity (Aw, Roberts, & Winston, 2007; Becchetti and Rossi, 2000; Lefevre, Lefevre, & Bourgault, 1998). Indeed, using R&D as a measure of firm-level innovation has at least two major limitations: 1) all innovative efforts do not lead to innovation output, and 2) only a few innovative SMEs invest in R&D activities.

In more recent works (see attached Table 1), the introduction of innovation output measures has significantly improved the estimation of the link between innovation and export propensity. For example, Cassiman and Martinez-Ros (2007), Caldera (2009), Van Beveren & Vandenbussche (2010), and Manez-Castillejo, Rochina-Barrachina, & Sanchis-Llopis (2009) used a probit model[7] to explain export decisions (Exp) in relation to innovation ($Inno$) and productivity ($Prod$) in the following way:

$$Pr(Exp_{it} = 1) = f(Inno_{it-1}, Prod_{it-1}, X_{it}) \qquad (1)$$

where i indexes firm, t time, and X control variables such as firm size and activity sector. To overcome the endogeneity problem of innovation into export[8] induced by learning effect[9], the various authors proceed in two ways: either they compare the non-exporters and 'starters'[10] directly by eliminating the exporting firms from the estimation (Van Beveren & Vandenbussche, 2010); or they use a dynamic model in which a lagged export variable is introduced as an explanatory variable (Caldera, 2009; Manez-Castillejo, Rochina-Barrachina, & Sanchis-Llopis (2009)). In addition, these studies join another equation to the baseline equation so as to explain innovation by several instrumental variables (often R&D). While Cassiman and Martinez-Ros (2009), Caldera (2009) and Manez-Castillejo, al. (2009) use the same data set, some differences between them in terms of sample and / or variables selection, lead to their contradicting results (see attached Table 1).

Various estimates in studies mentioned in Table 1, reveal several problems that are probably due to, 1) the sampling bias (e.g. the overestimation of large enterprises), and 2) the correlation between innovation variables (e.g. between product innovation and process

[7] These authors use a panel data. Thus, to control unobserved heterogeneity among firms, they add a random effect to the basic model.

[8] Few studies use matching techniques; these studies take into account the potential endogeneity between exporting and innovation decisions more directly (Becker & Egger, 2007; Damijan, Kostevc, & Polanec, 2010; Table 1).

[9] Exporting firms interact with foreign firms, research centers, and markets, and may thus take advantage of knowledge that are not available for local firms.

[10] Starters are the firms starting to export over the period for the first time.

Table 1 Empirical studies on the link between output innovation, export, and productivity

Autors	Sample	Methodology	Model	Main Results
Van Beveren and Vandenbussche (2010)	Belgium, 2000 and 2004	Starters vs. non-exporters	-Pr(Start$_{it}$=1)=f [lnTFP$_{it-4}$, Inno$_{it-4}$, X$_i$] -LPM (linear probability model) -endogenizing innovation with instrumental variable (IV)	Innovation (product and process) and productivity increase the probability of becoming an exporter
Cassiman and Martinez-Ros (2007)	Spain, 1990-99 SME/Large entreprise	Starters vs. non-exporters	-Pr(Start$_{it}$=1)=f(Inno$_{it-1}$, X$_i$) -probit model -endogenizing innovation with instrumental variable (IV)	Innovation (in particular product) increases the probability of becoming an exporter (more significant results for SMEs)
Caldera (2009)	Spain, 1990-2000	Exporters vs. non-exporters	-Pr(Exp$_{it}$=1)=f(lnTFP$_{it-1}$, Inno$_{it-1}$, Expt$_{it-1}$,X$_i$) -probit model -endogenizing innovation with instrumental variable (IV)	Innovation (product and process) and productivity increase the probability of exporting
Mez-Castillejo, Rochina-Barrachina, and Sanchis (2009)	Spain, 1990-2000	Exporters vs. non-exporters	-Pr(Expt_{it} = 1)=f(lnPT_{it-1}, Inno$_{it-1}$, Export$_{it-1}$,X$_i$) -trivariate probit model	No significant relationship
Bellone, Guillou , and Nesta (2009)	France, 2005 and 2002-04 SME/Large entreprise	Exporters vs. non-exporters	-Kolmogorov-Smirnov non-parametric test -lnTFP=α+ βExp$_{it}$+X$_i t$ for different sub-sample of innovative firms.	Absence (existence) of premium for the product (process) innovation in SMEs
Cassiman and Golovko (2007)	Spain, 1990-98 SME	Exporters vs. non-exporters	-Kolmogorov-Smirnov non-parametric test -lnTFP=α+ βExp$_{it}$+X$_i t$ -for different sub-sample of innovative firms	absence (existence) of export premium for the product (process) innovation in SMEs
Becker and Egger (2007)	Germany, 1994-2004	Exporters vs. non-exporters	-matching techniques	Product innovation increases the propensity to export.
Damijan, Kostevc, and Polanec (2010)	Slovenia, 1996-2002	Starters vs. non-exporters	-matching techniques	No evidence for the effect of innovation on the propensity to start exporting

innovation), and between innovation and productivity[11]. More fundamentally, these studies fall short of full analysis because the endogeneity of productivity into innovation, which is stipulated in the theory, is not taken into account.

Other innovation output oriented studies have used the Kolmogorov-Smirnov non-parametric test to determine to what extent innovation activities account for productive advantage of exporting firms relative to their non-exporting counterparts (export premium). If the test proves revealing, the "export premium" does not exist and the productivity gap between exporters and non-exporters is explained by their respective characteristics in innovation. These studies measure the productivity advantage of exporters over non-exporters among the various sub-samples of firms classified according to their innovation activities. For example, Cassiman & Golovko (2007) and Bellone, Guillou, & Nesta (2009) have found that product (process) innovating exporters do not differ (differ) significantly in productivity from non-exporting innovators (cf. attached Table 1). Their results confirm the predictions of theoretical works (Yeaple, 2005; Constantini & Melitz, 2008) in which an important source of firm heterogeneity in productivity is believed to lie in a different innovation strategy.

The present study seeks, first, to clarify the presence or absence of effective export premium in a SME sample, and secondly, to test conscious self-selection effect, i.e. the full sequence of innovation → productivity → willing to export.

3 Data and variables

The interest of this analysis is based on its cross-referencing of innovation, export and productivity variables. The relationship between innovation and productivity is evident although this is difficult to demonstrate (Griliches, 2000). Indeed, innovation refers to the creation of new value and to the reduction of value destruction (reducing costs). Exporting can be related to innovation since it leads to increased access to new customers and to new markets (product innovation), as well as to new distribution channels and new pricing methods (marketing innovation). In the same way, the export markets are considered more competitive, thus requiring process and organization innovation.

[11] Thus in Manez-Castillejo and al. (2009), the significance of the relationship between process innovation and probability of exporting disappears in the presence of productivity variable.

3.1 Data Sources

The data are derived from two sources. The first is the IDEIS survey that provides original information about innovation and export activities. IDEIS data was collected in 2009 from face to face interviews with entrepreneurs based on a set of questions (Gaussens and Houzet, 2009) referring to data from the period 2006-2008. It was based on a random and stratified sample of 86 manufacturing firms taken from the 803 manufacturing SMEs in Lower Normandy (France).

Financial data have been retrieved from the Diane database (Bureau Van Dijk) that stores accounts and balance sheets.

3.2 Variables definition and construction (see Table 2)

Innovation variables used in this study cover variables of innovation output and innovation input, and are exclusively derived from the data of the IDEIS survey. These variables are based on the typology of the Oslo Manual (2005) and reflect binary oppositions of 'doing' and 'not doing'.

For purposes of this study, a firm is innovative if, during the period 2006-2008, it has implemented a new or substantially improved product (or service) or process, or a new marketing method, or a new organizational method in business practices, workplace organization, and external relations. We further distinguish between technological innovations (product and process) and non-technological innovations (marketing and organization).

Identifying the full range of changes that firms must put into effect in order to improve its performance, in particularly with respect to productivity, requires a wider framework than that used for measuring technological innovation. By integrating marketing innovation and organization innovation into the study, we derive a more comprehensive paradigm that allows us to better account for changes that affect firm performance.

Binary variables of input innovation such as R&D and patent or trademark are also used.

For our study of export variables, we define (non) exporting firms as those that (do not) report being present on foreign markets (Europe and outside Europe) over the period 2006-2008[12]. Moreover, we make two important distinctions, 1) between non-exporting

[12] This information collected from the survey IDEIS has been cross-checked with the reported amounts of export (source: Diane database) from which individual export intensities have been derived (defined as the ratio of exports to sales)

Table 2

Variables	Description	Sources
AS	Average Annual Sales over the period t	DIANE
SFC	Average annual ratio self-financing divided by sales over the period t	DIANE
Exp	Binary variable equals to 1 if the enterprise exports over the period t, 0 otherwise	IDEIS
Inno	Binary variable equals to 1 if the enterprise innovates over the period t (an entreprise is considered innovative if it has made at least one innovation over the period t in the following areas: product, process, marketing and organization; Oslo manual, 2005)	IDEIS
InnProd	Variable with 3 categories: innovators in product, in another type, and non-innovators	
InnProc	Variable with 3 categories: innovators in process, in another type, and non-innovators	
InnMar	Variable with 3 categories: innovators in marketing, in another type, and non-innovators	
InnOrg	Variable with 3 categories: innovators in organisation, in another type, and non-innov.	
HK	average wage in the enterprise over the period t	DIANE
Nat	Binary location variable equals to 1 if the non-exporting enterprise serves its national market, 0 otherwise.	IDEIS
STL	Technological level of sector. Variable with three categories: lower-technology (reference category), medium-low-technology (MLT) and medium-high-technology (MHT).	
TFP	Total Factor Productivity according to the Tornqvist index (annex 1)	DIANE
RDInv	Binary variable equals to 1 if the enterprise does R&D in-house or registers patents, trademarks, drawings, designs over the period t, 0 otherwise	IDEIS
WE	Binary variable equals to 1 if the non-exporting enterprise is willing to export in t+1 over the next three years, 0 otherwise	IDEIS

t: 2006-2008 , t+1: 2009

Table 3 Export, innovation, and productivity

	non-exporter					exporter			Total
	non innovator	innovator	not willing to export	willing to export	total	non innovator	innovator	total	
N firms	14	49	47	16	63	2	21	23	86
TFP[a]	0,88	1,01	0,94	1,13	0,98	1,04	1,23	1,21	1,04
LP[b]	38,84	44,93	42,13	47,11	43,57	49,01	51,92	51,66	45,74
KP[c]	1,36	2,42	1,83	3,25	2,19	1,20	3,31	3,13	2,44
AS[d]	2809,64	3139,84	3198,53	2678,50	3066	4841,00	9076,48	8708	4575

[a]total factor productivity (average 2006-2008). The measure provides a productivity index: value higher (lower) than 1 indicates productivity enterprise is above (below) than average;
[b] labor productivity (average 2006-2008): value added per employee;
[c] capital productivity (average 2006-2008): value added per fixed productive capital;
[d] Sales (Keuros; average 2006-2008).

firms that are willing to export over the period 2010-2012 and those that are not willing to export in this period, and 2) between non-exporting firms that serve a regional (or local) market and those that serve a national market.

Firm performance has been measured according to productivity. In what follows, we will concentrate on the 'Total Factor Productivity' (TFP) index, that measures global productive efficiency of SMEs. The TFP variable is calculated by the non-parametric method of Tornqvist index (see Appendix 1) developed by Caves, Christensen, & Diewert (1982) and Good, Nadiri, and Sickles (1997). This measure provides a standardized index of TFP: a TFP that is higher (lower) than 1 indicates an enterprise whose productivity is higher (lower) than average.

Firm size (measured by sales) and technological sector provide the control variables implemented[13].

Table 3 provides a primary synthetic relationship between innovation, productivity, and export derived

[13] According to the sectors classification (OCDE, 1997) into four categories: low technology (LT), medium low technology (MLT), medium high technology (MHT) and high technology (HT).

from a sample of 86 SMEs located in the French region of Lower Normandy. At first glance, size and productivity prove advantageous for exporting (innovative) firms. It is worth to note that simultaneously 'non-exporters' and 'willing to export' firms are more productive on average than 'non-exporters' and 'not willing to export' firms. Also, we note that almost all exporting firms innovate.

4 Estimation of export and innovation premiums

The new international trade theory views firms as heterogeneous. Firm heterogeneity refers to differences in performance, particularly in terms of productivity. Productivity difference between firms is habitually explained with respect to technological sector and size. Indeed, it is expected that firms belonging to a higher technological sector are more productive due to externalities. Likewise, it is commonly observed that labor productivity is generally higher in large firms (OECD, 2008). The international trade theory focuses on export activities and, more recently, on innovation activities as predictors of productive heterogeneity between firms. Indeed, export and innovative firms are generally assumed to be more productive, regardless of their business sector or size. This productivity gap between exporting (innovative) firms and non-exporting (not innovative) firms is defined in the literature as the 'export premium' ('innovation premium'). We call these premiums apparent in the sense that the individual contribution of the export or innovation is not explicitly stated in the premium. These apparent premiums are identified in Table 3 above. They can be explained by two combined effects: a self-selection effect that takes into account the *ex ante* productive advantage needed to cover the exporting and innovation costs, and a learning effect that takes into account the feedback effect of export and innovation on productivity.

We performed Mann-Whitney-Wilcoxon non-parametric tests to examine the statistical significance of differences in productivity or 'apparent premiums' between different groups of firms (exporters / non-exporters, innovators / non-innovators). (Table 4 below)[14]

Our tests reject the hypothesis of equality between the average productivities (or distributions) of different groups: the exporting firms (those willing to export) have higher productivity levels and distribution on an average than non-exporting firms (those not willing to export). Overall, innovative firms are significantly more productive and this is especially true for innovative processes, confirming that firms invest in process innovations to directly increase the productivity of its factors.

To more formally test the theoretical predictions concerning the premiums, we applied the empirical approach put forth by pioneer Bernard and Jensen (1999) concerning the export premium. We estimate the export (innovation) premium in the context of a model in which the variables of size and technological sector are used as control variables:

$$lnY_{it} = \alpha_{it} + \beta X_{it} + \gamma lnAS_{it} + \delta STL_{it} + \epsilon \quad (2)$$

Y_{it} refers to the average productivity of firm i over the period 2006-2008 (LP for the apparent labor productivity, KP for the apparent capital productivity and TFP for the total factor productivity). X_t represents the variables export or innovation (over the period 2006-2008). Therefore, the coefficient β is an estimate of the export premium or the innovation premium. AS_t measures size based on sales during the period 2006-2008. STL_{it} defines the class of technological sector to which the firm belongs.

According to previous studies, the results in Table 5 show that SME exporters are significantly more productive than non-exporting SMEs. On an average, exporters are more productive than firms serving only domestic markets by 26% for total productivity, 24% for labor productivity and 38% for capital productivity. Export premiums estimated here are higher than those obtained by Crozet, Mejean, & Zignago (2011) and Bellone, Musso, Nesta & Quéré (2006), all of which are uniquely based on French data. This difference is mainly due to the fact that their samples are biased in favor of large firms (firms with fewer than 20 employees were excluded, and 80% of their sample firms are exporters). Indeed, with respect to the self-selection effect, export costs are relatively higher for SMEs since some of these costs are fixed. Moreover, high export intensity (more than 10%) increases the premium by 43% on an average, reflecting the presence of both a learning effect and variable costs for export.

The innovation premium is estimated using equation 2; 'innovator' signifies the realization of at least one type of innovation (product, process, organization, marketing). Innovation premium is also estimated separately for each of these types. Hence, firms are partitioned into three categories: innovators affected by the

[14] The graphs in Appendix 2 illustrate this differences in their cumulative distribution function.

Table 4 comparison of productivity levels between opposite groups of enterprises

					parametric Test $[H_0 : \mu_A = \mu_B]$		non-parametric Test $[H_0 : F(A) = F(B)]^b$			
Groups A	N_A	Groups B	N_B	$\mu_A - \mu_B^a$	t-test	P-value	M-W U	Wilcoxon W	Z	P-value*
exporters	23	non exporters	63	0.22	2.825	0.006	440	2456	-2.776	0.005
Willing to export	16	not willing to export	47	0.18	2.098	0.040	214.5	1342	-2.551	0.011
innovators	70	non innovators	16	0.18	1.919	0.058	382	518	-1.976	0.048
product innovators	32	non innovators	16	0.21	1.784	0.081	181	317	-1.641	0.101
process innovators	46	non innovators	16	0.22	2.196	0.032	223	359	-2.333	0.020
marketing innovators	24	non innovators	16	0.12	1.376	0.177	138.5	274.5	-1.478	0.139
organization innovators	47	non innovators	16	0.16	1.813	0.075	265.5	401.5	-1.745	0.081

the first four columns of the above table identify the enterprise groups A et B (with its number N) which are compared.
[a]average productivity of group A and B;[b]F (A) and F (B) : productivity distribution of groups A and B.
if p-value is less than 5% (10%), we reject the null hypothesis H0 with a 5% (10%) risk.

Table 5 Export premium estimation

Dependent Variable	intercept	βExp		AS	MLT	MHT	$R^2(R^2$ ajusted)
lnTFP^a	-0.932***	**0.261****		0.092***	0.238***	0.381***	0.361
	(0.254)	(0.110)		(0.033)	(0.079)	(0.085)	(0.313)
lnLP^b	-2.817***	**0.237***		0.103***	0.233***	0.180***	0.209
	(0.293)	(0.127)		(0.038)	(0.091)	(0.098)	(0.149)
lnKP^c	-0.355	**0.385***		0.046	0.316*	0.969***	0.271
	(0.689)	(0.205)		(0.089)	(0.183)	(0.205)	(0.235)
		Export intensity					
		> 10%	< 10%				
lnTFP^a	-1.047***	**0.435*****	**0.059**	0.107***	0.241***	0.376***	0.393
	(0.264)	(0.141)	(0.141)	(0.034)	(0.078	(0.084)	(0.321)

standard errors in parentheses;
[a]total factor productivity; [b]labor productivity; [c]capital productivity.
*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

estimated premium, other innovators, and non-innovators[15]. We apply the following equation:

$$lnY_{it} = \alpha_{it} + \beta X_{it} + \beta^{'} X_{it} + \gamma lnAS_{it} + \delta STL_{it} + \epsilon \quad (3)$$

in which β represents the premium for each type of innovation and β'_{it} reflect the intercept for the category corresponding to other innovations.

[15] Therefore, following the rule that the number of dummies be one less that the number of categories of the variable, we should introduce two dummies (Gujarati, 1988). Hence, we assign $X_{it} = 1$ to 'innovators affected by the estimated premium', $X'_{it} = 1$ to 'other innovators', and the base category will be 'non-innovators' and all comparison will be in relation to this category.

The estimation results of innovation premiums (Table 6) show the existence of a premium regardless of the variable of innovation output used. We note particularly that technological innovators (product or process) have 20% and 18% higher total factor productivity than the non-innovators all other things being equal. These results show that the self-selection and learning effects are likely to occur in accordance with what is expected especially for technological innovations. Conversely, it is interesting to note the lack of premium innovation associated with input variables of innovation (R&D and patenting; Table 6 below) which is consistent with the work on this subject (see above, section 2).

Finally, we note that as expected, the size and technological level of the sector affect firm productivity in a positive and significant manner.

Table 6 Innovation premium estimation

Dependent variable: $LnTFP$

Innovation sub-sample	intercept	β	β'	AS	MLT	MHT	R^2(R^2 ajusted)
Innovation	-1.099***	**0.170****		0.102**	0.208***	0.323***	0.357
	(0.227)	(0.074)		(0.028)	(0.066)	(0.073)	(0.357)
Product innovation	-1.094***	**0.183****	0.160**	0.101***	0.209***	0.325***	0.385
	(0.229)	(0.083)	(0.080)	(0.029)	(0.067)	(0.074)	(0.318)
Process Innovation	-1.088***	**0.203*****	0.102	0.101***	0.197***	0.326***	0.375
	(0.225)	(0.077)	(0.086)	(0.028)	(0.066)	(0.073)	(0.336)
Marketing innovation	-1.101***	**0.161***	0.175**	0.102***	0.206***	0.319***	0.357
	(0.229)	(0.088)	(0.078)	(0.029)	(0.067)	(0.076)	(0.317)
Organisation innovation	-1.111***	**0.158****	0.194**	0.103***	0.206***	0.318***	0.359
	(0.229)	(0.078)	(0.087)	(0.029)	(0.067)	(0.074)	(0.319)
R&D	-1.011***	0.012	—	0.109***	0.184***	0.321***	0.316
	(0.232)	(0.063)		(0.030)	(0.068)	(0.078)	(0.282)
Registers patents	-1.055***	0.203	—	0.117***	0.182***	0.316***	0.320
	(0.236)	(0.071)		(0.030)	(0.067)	(0.076)	(0.287)

standard errors in parentheses;

*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

β: corresponding premium for each of types of innovation; β': corresponding other innovation categories.

Table 7 Estimation of the effective export premium

Dependent variable: $LnTFP$

Innovator sub-sample	intercept	Exp	AS	MLT	MHT	R^2(R^2 ajusted)
Product innovation	-0.529*	0.109	0.048	0.203	0.421***	0.354
	(0.435)	(0.146)	(0,058)	(0.126)	(0.138)	(0.258)
Process Innovation	-0.700**	0.101	0.077*	0.133	0.360***	0.374
	(0.340)	(0.103)	(0.45)	(0.087)	(0.104)	(0.284)
Marketing innovation	-0.883**	0.159	0.089$^{\cdot}$	0.183*	0.396**	0.462
	(0.396)	(0.126)	(0.051)	(0.107)	(0.154)	(0.349)
Organisation innovation	-0.813**	0.094	0.085**	0.140	0.363***	0.357
	(0.317)	(0.098)	(0.041)	(0.090)	(0.100)	(0.296)

standard errors in parentheses;

*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

Table 8 Estimation of the effective export premium according to export intensity

Dependent variable: $LnTFP$

Innovator sub-sample	intercept	Exp(>10%)	Exp(<10%)	AS	MLT	MHT	R^2(R^2 ajusted)
Product innovation	-0.719	0.378	0.166	0.066	0.298*	0.552***	0.423
	(0.482)	(0.239)	(0.249)	(0.064)	(0.157)	(0.180)	(0.222)
Process Innovation	-1.040***	0.263*	-0.271	0.124***	0.153	0.264**	0.512
	(0.339)	(0.150)	(0.168)	(0.044)	(0.101)	(0.103)	(0.402)
Marketing innovation	-1.002*	0.206	0.067	0.105	0.167	0.382	0.473
	(0.584)	(0.195)	(0.226)	(0.075)	(0.139)	(0.169)	(0.243)
Organisation innovation	-1.079***	0.381**	0.99	0.114***	0.210**	0.459***	0.486
	(0.316)	(0.153)	(0.162)	(0.040)	(0.104)	(0.101)	(0.376)

standard errors in parentheses;

*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

The question now arises as to whether the premium export is effective. Previous works (see above, section 2) have shown that the premium export is associated with the innovative nature of the firm. To clarify this point, we estimate the premium export using equation 2, thereby obtaining the sub-sample of innovative firms (Table 7). The results show that the export premium depends on the innovative nature of the firms (β is not significantly different from 0) confirming with previous work. Nevertheless, this result must be put into perspective because using the variable of export intensity (>10% versus non-exporting) yields a significant premium exclusively for process and organization innovation (Table 8). This point can be understood as the learning effect associated with a substantial presence in more competitive foreign markets. Such presence requires greater effort to strengthen cost competitiveness directly obtained in more efficient process or organization innovation. Greater efficiency may be explained by access to knowledge or technology operating abroad and not available for firms that do not trade in foreign markets.

Finally, these results show that the productive advantage of exporting firms is largely explained by their innovation activities. The relation between productivity and export is indirect brought about through innovation. These findings are compatible with the conscious self-selection hypothesis (Constantini & Melitz, 2008) that the most productive firms are selected for export; their productive advantage is rooted in innovation activities. In the following section, we will examine the mechanism of conscious self-selection.

5 Estimation of conscious self-selection effect

We analyze the effect of self-conscious selection from the export process (see Figure 1) that transforms an intention to export in a setting in capacity to export in the short term resulting in the fact that the entrepreneur is willing to export in the next 3 years (Gaussens and Houzet, 2009). The enterprise intending to export, invests in innovation (in t) and thus becomes more productive (end t) as a means of overcoming the costs of exporting.[16]

Then, we decompose the model into three steps (Figure 2): in a first step the inputs of innovation explain the output of innovation, explaining itself productivity, in a second step; a third step explains the will to export by productivity.

In the third step, that tests the hypothesis of self-selection, willing to export (*WE*; Table 2) is explained by productivity (*TFP*; Table 2). Furthermore, we believe that willing to export can be influenced by firm size (*Sales*, Table 2). This influence is a priori ambiguous in that, if the larger enterprises can more easily overcome exporting costs, it is plausible that they do not export simply because there is no necessity to do so. On the other hand, small enterprises may be willing to export for purposes of growth. Finally, a location of enterprise market variable is introduced (*Nat*; Table 2). It shows whether the export strategy is in the continuity of a progressive expansion from regional markets to the national market.

The following two steps are based on the pioneering model of Crepon, Duguet, and Mairesse (1998) in which R&D is seen as explaining the output of innovation, with innovation output determining productivity. Thus, the second equation refers to the context of the estimate of the innovation premium (see above, section 4): productivity is explained by the innovation output, the size of the enterprise, and the technological level of the sector.

The first step introduces innovation output (*Inno*; Table 2) as an endogenous variable. Indeed, innovation output depends on decisions and efforts to innovate. Traditionally, R&D input is viewed as the most favorable input for explaining the output of innovation (Mairesse & Mohnen, 2011). This variable is significantly and positively associated with output innovation in most studies (Brouwer & Kleinknecht, 1996; Crepon, Duguet, and Mairesse, 1998; Mohnen & Dagenais, 2002; Raymond, Mohnen, Palm, & Schim van der Loeff, 2006; Griffith, Huergo, Mayor, & Peters, 2006). However, in an SME context, one can expect that this variable is less efficient, since relatively few SMEs perform R&D; they develop new knowledge internally in rather informal ways[17]. For this reason, we have plugged in the variable input of innovation (*RDInv*; Table 2), including the binary variable 'in-house R&D or not' to which we associate variables about industrial property: patents, trademarks, designs, and drawings. These variables serve to measure the inventive effort of the enterprise.

Following from this, human capital is likely to play an important role in the development of innovation (Greenan, 1996; Caroli and Van Reenen, 2001; Greenan and Mairesse, 2006). Innovation processes are, in fact, dependent on cognitive processes often involving tacit knowledge, particularly in SMEs. To assess the impact of human capital on the propensity to innovate, we use

[16] t indicates during the period 2006-2008, end t means the end of 2008, t+1 during the years 2009.

[17] 56% of SMEs that develop new knowledge internally do without in-house R&D (data from the survey IDEIS).

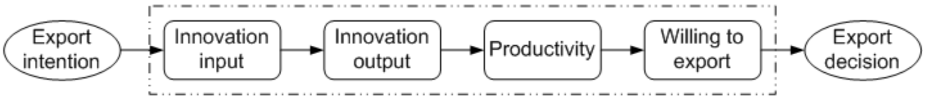

Fig. 1 Export process

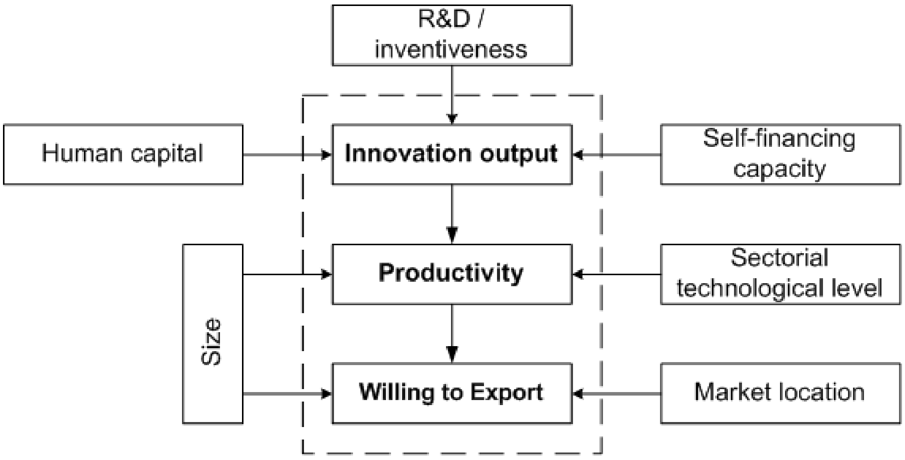

Fig. 2 model diagram

the average wage in the enterprise, which reveals the average qualification of employees (HK; Table 2).

The variables R&D, inventiveness, and human capital are evaluated on the same period as the innovation variable. Indeed, we assume that the innovation process is non-sequential, though an interactive and simultaneous one (Kline & Rosenberg, 1986; Herimalala & Gaussens, 2012).

Finally, it is expected that financial variables determine the innovation effort and the propensity to innovate, given that the innovation process proves complex and uncertain. According to the IDEIS survey, 69% of firms do not innovate due to the high cost of innovation, 66% due to lack of internal funds, and 33% due to lack of external funding. Moreover, entreprises tend to favor self-financing to start their innovation projects (Spielkamp & Rammer, 2009; Hall & Lerner, 2010). For these reasons, we introduced the lagged variable self-financing (SFC; Table 2), which should exert a positive influence on the propensity to innovate.

The econometric model used is a non-linear recursive model consisting of three equations reflecting the direction of causality between the endogenous variables is unilateral: output innovation → productivity → will to export. The model is applied to the population of non-exporting enterprises. Indeed, we compare non-exporting enterprises willing to export with those not willing to. This allows us to exclude the learning-by-exporting effect on productivity.

The model is as follows:

$$\begin{cases} Pr(WE_{it+1} = 1) = f(\ln \widehat{TFP}_{iet}, \ln AS_{it}, Nat_{it}) & \text{4a} \\ \ln TFP_{iet} = a + \beta \widehat{Inno}_{it} + \gamma \ln AS_{it} + \delta STL_{it} + \epsilon_{it} & \text{4b} \\ Pr(Inno_{it} = 1) = f(SFC_{it-1}, HK_{it}, RDInv_{it}) & \text{4c} \end{cases}$$

where $'et'$ refers to the end 2008, t to the 2006-2008 period and $t-1$ to the 2004-2006 period; i indexes firm.

The estimate method is sequential based on three steps: 1) a logit model in which the probability of innovating depends on the inputs for innovation; 2) a linear regression 'analysis of covariance (ACOV)' model where productivity depends on the predicted probability to innovate and control variables.; 3) a logit model where the probability that a firm wants to export based on the estimated productivity. This equation is used to test the hypothesis of self-conscious selection by endogenizing productivity. Under these conditions the errors in the same period in the three equations are uncorrelated which allows us to avoid bias related to simultaneous equation models. Thus in this recursive system, Maximum-likelihood estimations (MLEs) can be applied to each equation separately (Fienberg, 2007).

The goodness of fit for the logistic regressions (4a and 4c, table 9) is evaluated by the classification table and ROC curve analysis. The overall rate of correct classification is estimated as 76.2% and 82.5% respectively in equations 4a and 4c. A more complete description of classification accuracy is given by the area under

Table 9 conscious self-selection effect, equations 4a, 4b, 4c.

	Dependent variable	Explanatory Variables					Goodness of fit
		intercept	$\text{Ln}\widehat{PTF}$	LnAS	Nat		
4a	Willing to export	4.524	3.884**	-0.915**	1.959**		$(76.2\%)^{a}$
step 3	Pr(WE)	(3.390)	(1.831)	(0.468)	(0.904)		$[0.747]^{a'}$
		intercept	$\widehat{Pr(Inno)}$	LnAS	MLT	MHT	
4b	Productivity	-1.110***	0,486***	0,066**	0.236***	0.418***	$(0.494)^{b}$
step 2	LnTFP	(0.248)	(0.142)	(0.031)	(0.061)	(0.071)	$[0.459]^{b'}$
		intercept	RDinv	HK	SFC		
4c	Innovation	-8,943**	2,361***	2.558**	21.333**		$(82.5\%)^{a}$
step 1	Pr(Inno)	(4.046)	(0,969)	(1.133)	(10.075)		$[0.787]^{a'}$

standard errors in parentheses;

*significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.

^{a}: the good classification rate (in parentheses); $^{a'}$: the Area under the ROC curve [in brackets].

^{b} and $^{b'}$: respectively, R2 and ajusted R2.

the ROC curve, that is respectively 0.747 and 0.787 in equations 4a and 4c[18].

Estimates (Table 9) show that the effect of conscious self-selection is at work: the SMEs invest *ex ante* in innovation by mobilizing R&D and inventiveness, human resources and their own financial resources, to improve their productivity and to export *ex post*. The estimated propensity to innovate provides a good explanation for overall productivity, that, in turn, explains willing to export, as anticipated.

Moreover, it is interesting to note that, among non-exporting enterprises, those willing to export are smaller on average; they often seek to expand their size through external markets. Finally, the fact that an enterprise serves the national market (not just the regional or local market) increases the average probability of willing to export. The transition to export is the final stage of a progressive expansion from local markets to the national market.

We further find that productivity is positively and significantly explained by the estimated propensity to innovate, all things being equal. Also, for a given propensity to innovate, larger size, and higher technological level of sector impact productivity positively. Finally, the propensity to innovate is positively influenced by R&D, human capital, and self-financing as expected.

[18] As a general rule: ROC =0.5 suggests no discrimination (discriminating power not better than chance), $0.7 \leq \text{ROC} < 0.8$ is considered acceptable discrimination, and $\text{ROC} \geq 0.8$ is considered excellent discrimination (Hosmer and Lemeshow, 2000).

6 Conclusion

This paper contributes to a more thorough understanding of the relationship between innovation, productivity, and export. It tests the hypothesis of firm conscious self-selection in the export markets. In light of original data relative to SMEs in Normandy (France), two important points regarding the relationship between innovation, productivity, and export have been brought to bear:

1) The productive advantage of exporting firms is largely explained by their innovation activities. The relation between productivity and export is indirect and derived through innovation. These results are consistent with the hypothesis of conscious self-selection (Constantini & Melitz, 2008) stating that the most productive firms are selected for export, their productive advantage being rooted in innovation activities. However, we demonstrate the role of effective export premium (ie a productive advantage of exporting firms that actually depends on the export), for innovative firms in both process (as confirmed in previous works) and organization. We emphasize that these results are verified for firms with a sufficiently high export rate (>10%). We interpret these findings as a manifestation of the learning effect associated with significant participation in foreign markets;

2) Self-selection of more productive firms in foreign markets is revealed. What's more, our results make it possible to test the effect of conscious self-selection in endogenizing productivity and innovation. We have established that the capacity of an enterprise to enter foreign markets depends positively on the level of productivity which, in turn, depends on past innovation activities. SMEs invest *ex ante* in innovation by mo-

bilizing R&D and inventiveness, human resources, and internal financial resources, so as to improve their productivity, and thereby make export *ex post* possible. In addition, the results presented in this paper show that an export policy relies primarily on support for innovation: the development of R&D and inventiveness, financial aid for innovation, and human resource mobilization provide the necessary levers in favor of an export policy in SMEs. Moreover, This model support policies for picking the most adapted firms to export in the short term. These firms should receive priority export aids which are necessary to overcome risks associated with activities in foreign markets.

In conclusion, this study may be significantly furthered in two directions: 1) By stimulating the model with panel data, thereby making it possible to distinguish between the anticipation of exporting and actual export, results may be greatly strengthened; 2) A more detailed understanding of the learning-by-exporting effect on productivity through innovation activities will lead to a full analysis of the relationship between innovation, export, and productivity.

Appendix 1: Measurement of total factor productivity

In what follows, we use the TFP as a performance variable in order to understand the productive efficiency of manufacturing SMEs. The TFP variable is calculated by the non-parametric method developed by the Tornqvist index (Caves and al., 1982; Good and al., 1997). Its advantages are the direct calculation (no estimation required), ability to deal with multiple outputs and inputs, and with flexible and heterogeneous production technology. The measures are calculated individually for each firm as follows:

$$lnTFP_{it} = lnY_{it} - \overline{lnY_t} - \sum_{i=1}^{n} \frac{1}{2}(S_{ijt} + \overline{S_{jt}})(lnX_{ijt} - \overline{lnX_{jt}}) \quad (4)$$

where Y_{it} means the added value maded by firm i at time t, using inputs X_{ijt}. The index j represents the two inputs used, that is to say, the workforce and the fixed productive capital. S_{ijt} is the costs part of using the input X_{ijt} in total costs of the firm. This is calculated by dividing the produced value (value added) between labor and capital based on the reasoning that there is a strong relationship between the contribution of a factor in the production and her remuneration. Workers therefore receive compensation corresponding to their contribution, and the firm keeps the rest as compensation for the capital contribution. $\overline{lnX_{jt}}$ and $\overline{lnY_t}$ indicate the natural logarithm of the geometric mean of input j and output, respectively, for all firms at time t. The variables $\overline{S_{jt}}$ correspond to arithmetic averages of the input share j at time t. thus $\overline{lnX_{jt}}$, $\overline{lnY_t}$ and $\overline{S_{jt}}$ determine the values of the (representative) hypothetical firm of the economy use as a reference point for all firms.

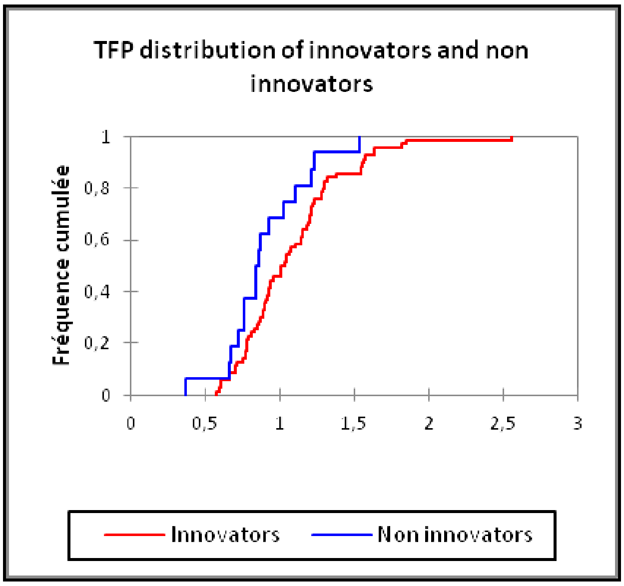

Fig. 3 TFP distribution of innovators and non-innovators

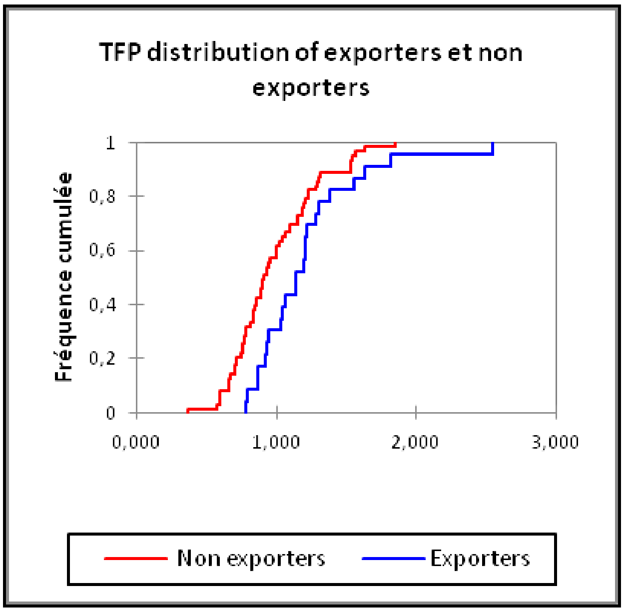

Fig. 4 TFP distribution of exporters ans non-exporters

Appendix 2: TFP distribution

References

1. Aw, B. Y., Roberts, M. J., and Winston, T., The complementary role of exports and R&D investments as sources of productivity growth, The World Economy, 30 (1), 83-104 (2007)
2. Becchetti, L., Rossi, S., The positive effect of industrial district on export performance of Italian firms, The Review of Industrial Organization, 16(1), 53-68 (2000)
3. Becker, S., Egger, P., Endogenous product versus process innovation and a firm's propensity to export, CESIFO Working Paper (2007)

4. Bellone, F., Guillou, S., Nesta, L., Is the export premium robust to innovation statistics?, OFCE - Working Paper (2009)
5. Bellone, F., Musso, P., Nesta, L., *Quéré*, M., Caractristiques et performances des firmes exportatrices françaises, Revue de l'OFCE, 98, 183-212 (2006)
6. Bernard, A. B., Jensen, B. J., Exceptional exporter performance: cause, effect, or both?, Journal of International Economics, 47, 1-25 (1999)
7. Bernard, A., Eaton, J., Jensen, B., Kortum, S., Plants and productivity in international trade, American Economic Review, 93 (4), 1268-1290 (2003)
8. Brouwer, E., Kleinknecht, A., Determinants of innovation: a micro econometric analysis of three alternative innovative output indicators, In A. Kleinknecht, Determinants of innovation, the Message from new indicators, 99-124, Macmillan Press, London (1996)
9. Caldera, A., Innovation and exporting: evidence from Spanish manufacturing firms, Review of world Economics, 146(4), 657-689 (2010)
10. Caroli, E., Van Reenen, J., Skill-biased organizational change? Evidence from a panel of British and French establishments, Quarterly Journal of Economics, 116, 1449-1492 (2001)
11. Cassiman, B., Golovko, E., Innovation and the export-productivity link, IESE Business School (2007)
12. Cassiman, B., Martinez-Ros, E., Product innovation and exports. Evidence from Spanish Manufacturing, IESE Business School (2007)
13. Cassiman, B., Golovko, E., Martnez-Ros, E., Innovation, exports and productivity, International Journal of Industrial Organization, 28(4), 372-376 (2010)
14. Caves, D. W., Christensen, L. R., Diewert, W. E., Multilateral comparisons of output, input, and productivity using superlative index numbers, The Economic Journal, 92, 73-86 (1982)
15. Constantini, J., Melitz, M., The dynamics of firm-level adjustment to trade liberalization, In E. Helpman, D. Marin, T. Verdier, The organization of firms in a global economy, Harvard University Press (2008)
16. Crpon, B., Duguet, E., Mairesse, J., Research, innovation, and productivity: an econometric analysis at the firm level, Economics of Innovation and New Technology, 7, 115-158 (1998)
17. Crozet, M., Mjean, I., Zignago, S., Plus grandes, plus loin... Performances relatives des firmes exportatrices franaises, Revue Economique, 62(4), 717-736 (2011)
18. Damijan, J. P., Kostevc, C., Polanec, S., From innovation to exporting or vice versa?, The World Economy, 33(3), 374-398 (2010)
19. Delgado, M. A., Farinas, J. C., Ruano, S., Firm productivity and export markets: a non-parametric approach, Journal of International Economics, 57 (2), 397-422 (2002)
20. Fienberg, S. E., The analysis of cross-classified categorical data, Springer, New York (2007)
21. Gaussens, O., Houzet, P., Innovation capacity of SMEs: business models and innovation patterns, University of Caen Basse Normandie, France, Survey Support, French edition (2009).
22. Girma, S., Görg, H., Hanley, A., R&D and exporting: a comparison of British and Irish firms, Review of World Economics, 144(4), 750-773 (2008)
23. Good, D. H., Nadiri, M. I., Sickles, R., Index number and factor demand approaches to the estimation of productivity, In M.H. Pesaran, P. Schmidt, Handbook of applied econometrics: micro-econometrics, Blackwell, Oxford (1997)
24. Greenan, N., Progrs technique et changement organisationnel: leur impact sur l'emploi et les qualifications, Economie et Statistique, 298, 35-44 (1996)
25. Greenan, N., Mairesse, J., Mesurer les changements organisationnels: une exploration partir de donnes couples employeurs/salaries, Revue conomique, 57(6), (2006)
26. Greenaway, D., Kneller, R., Firm heterogeneity, exporting and foreign direct investment, Economic Journal, 117, 134-161 (2007)
27. Griffith, R., Huergo, E., Mairesse, J., Peters, B., Innovation and productivity across four European Countries, Oxford Review of Economic Policy, 22, 483-498 (2006)
28. Griliches, Z., R&D and productivity: The econometric evidence, University of Chicago Press, Chicago (1998)
29. Gujarati, D.N., Basic econometrics, Mcgraw-Hill International Editions, New York (1988)
30. Hall, B.H., Lerner, J., The financing of R&D and innovation, In Hall, B., Rosenberg, N., Economics of Innovations, Elsevier, Amsterdam, 610-639 (2010)
31. Hatzichronoglou, T., Revision of the high technology sector and product classification, OECD Science, Technology and Industry Working Papers, 2 (1997)
32. Herimalala, R., Gaussens, O., X-Efficiency of innovation process: evaluation based on multi-objective data envelopment analysis. in Proceedings DEA Symposium 2012- Seikei University - Tokyo, 257-264 (2012)
33. Hopenhayn, H., Entry, exit, and firm dynamics in long run equilibrium, Econometrica, 60(5), 1127-1150 (1992)
34. Hosmer, D.W., Lemeshow, S., Applied Logistic Regression, Wiley, New York (2000)
35. Jovanovic, B., Selection and the evolution of industry, Econometrica, 50(3), 649-670 (1982)
36. Kline, S., Rosenberg, N., An overview of innovation, In R. Landau, N. Rosenberg, The positive sum strategy: harnessing technology for economic growth, National Academy Press, Washington D.C., 275-305 (1986)
37. Lefebvre, E., Lefebvre, L., Bourgault, M., R&D-related capabilities as determinants of export performance, Small Business Economics, 10(4), 365-377 (1998)
38. Mairesse, J., Mohnen, P., Using innovation survey for econometric analysis, In B. Hall, N. Rosenberg, Economics of innovation, Elsevier, Amsterdam, 1125-1155 (2010)
39. Mez-Castillejo, J. A., Rochina-Barrachina, M. E., Sanchis-Llopis, J. A., Self-selection into exports: productivity and/or innovation?, Applied Economics Quarterly, 55(3), 219-242 (2009)
40. Melitz, M., The impact of trade on intra-industry reallocations and aggregate industry productivity, Econometrica, 71, 1695-1725 (2003)
41. Moen, O., The relationship between firm size, competitive advantages and export performance revisited, International Small Business Journal, 18(1), 53-73 (1999)
42. Mohnen, P., Dagenais, M., Towards an innovation intensity index. the case of CIS-I in Denmark and Ireland, In A. Kleinknecht, P. Mohnen, Innovation and firm performance, Econometric Explorations of Survey Data, Palgrave, New York, 3-30 (2002)
43. OECD, Oslo Manual: guidelines for collecting and interpreting innovation (Third ed.), OECD and Eurostat (2005)
44. Raymond, W., Mohnen, F., Palm, F., Schim van der Loeff, S., An empirically-based taxonomy of Dutch manufacturing innovation policy implications, De Economist, 151(1), 85-105 (2006)
45. Spielkamp, A., Rammer, C., Financing of innovation - thresholds and options, Management and Marketing, 4(2), 3-18 (2009)

46. Sprent, P., Applied nonparametric statistical methods, Chapman and Hall, London (2001)
47. The Gallup Organization, E.C., SME observatory survey, European Commission (2007)
48. USA Trade Promotion Coordinating Committee (TPCC), 2008 national export strategy, The New Global Main Street (2008)
49. Van Beveren, I. V., Vandenbussche, H., Product and process innovation and the decision to export, Journal of Economic Policy Reform, 13(1), 3-24 (2010)
50. Wagner, J., Exports and productivity: a survey of the evidence from firm-level data, World Economy, 30(1), 60-82 (2007)
51. Yeaple, S. R., A simple model of firm heterogeneity, international trade, and wages, Journal of International Economics, 65, 1-20 (2005)