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## **GLOBALIZATION AND THE DEMAND FOR SKILL: AN EXPORT BASED CHANNEL**

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## ABSTRACT

### Globalization and the demand for skill: An Export Based Channel\*

This Paper shows that international trade affects the demand for skill through an export-based channel. Our working hypothesis is that the very act of exporting requires an effort of skill upgrading, in particular among occupations related to marketing and development. Using firm level data, we estimate a model that breaks down production into two stages: product development and marketing, and actual production. Once we correct for biases arising from the endogeneity of export decision, we find strong support for our hypothesis. The skill requirement in development/marketing occupations increases with the share of exported output. Overall skill upgrading is as important among firms exporting to OECD countries as among those exporting outside of the OECD to the LDCs.

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# 1 Introduction

Across the past two decades, labor demand has shifted in favor of high skilled workers in most OECD countries. This has resulted in rising wage inequality in the United States and the United Kingdom, and in a dramatic increase of unskilled unemployment in continental Europe. Two main reasons have been suggested to explain this phenomenon. The first one holds that technological change has been biased towards high education workers (Krueger, 1993 and Berman, Bound and Machin, 1998).<sup>1</sup> The second one argues that trade integration observed during the same period has induced an increase in the demand for skill in developed countries mostly because imports from LDCs are relatively intensive in unskilled labor. While this last explanation rests on a well established theory -the standard Heckscher-Ohlin trade theory- it lacks empirical support. The major caveat is that the volume of North-South trade is still too low to convincingly explain the dramatic rise in inequality between skilled and unskilled workers observed in OECD countries (Krugman, 1995 and Katz and Murphy, 1992).

This paper studies a non Heckscher-Ohlin mechanism of the impact of globalization on the demand for skill<sup>2</sup>. In opposition to the import based channel emphasized by the standard trade literature, we explore an export based channel. We provide a simple model of the firm that we estimate using a firm level dataset. We show that the very act of trading and exporting requires a skill upgrading of tasks related to development and marketing. Furthermore, this effect is independent of the destination of export (North or South). Hence, our findings support the view that North-North trade, as well as North-South trade, can be responsible for the increase in the demand for skill. This last point is particularly important as globalization has mainly taken place among developed countries.

Why should exporting require more skill at the firm level ? Our starting point is that non-production activities such as marketing, selling, developing and customizing have a potentially very different content depending on whether they are performed for the domestic or a foreign market. By putting the emphasis on these tasks within the firm, we have in mind a model of the

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<sup>1</sup>A recent literature evaluates the impact on labor demand of the change in organization that accompanied the adoption of new technologies (Bresnahan et al. [2001], Caroli and Van Reenen [2001], Maurin and Thesmar [2000]) for example).

<sup>2</sup>Some recent papers have explored other non standard mechanisms. For example, Acemoglu (1999), and Thoenig and Verdier (2000) argue that skill biased technological change can arise in response to increasing international competitive pressure. Neary (2000) studies an oligopolistic model of trade where skilled labor is used in R&D as a barrier to entry.

firm close to the one developed initially by Piore and Sabel (1984) and more recently by Mobius (2000) and Thesmar and Thoenig (2000): in contrast to the era of mass production, where standardization, economies of scale and cost reductions were put to the fore, firms nowadays seek to constantly adapt their production to small changes in consumers' needs or innovations by competitors. In such a context: "so much of the value provided by the successful enterprise [...] entails service: the specialized research, engineering and design services necessary to solve problems; the specialized sales, marketing, and consulting services necessary to identify problems; and the specialized strategic, financial and management services for brokering the first two" (Reich, 1991). To capture these ideas and identify the relation between exports and skill, our model of the firm will break down production in two stages: a prerequisite effort of *marketing/development* to adapt the products to the market and a *production* stage to make them. Both stages involve unskilled and skilled workers.

Within this theoretical framework, we address the following three empirical questions: (a) do products for the export market require more skill-intensive *production*? (b) do products for the export market require more skill-intensive *marketing/development*? (c) does exporting lead to an *employment reallocation* from production to marketing? An additional hypothesis tested in this paper is whether the effect of the decision to export on the skill structure depends on the destination of the exports. The idea is that the changes a firm has to make to its production technique and/or its marketing strategies may differ depending on whether it exports to India and China or to the US and Germany.

We use a unique French database to shed light on these issues. This database is an unbalanced panel of approximately 5,900 French manufacturing firms tracked for five years from 1988 to 1992. It provides annual information on detailed occupational structure, production volume, export status (exporter/non-exporter) and, where relevant, export volume and the distribution of exports by destination country. The data makes the usual distinction, for each firm and each year, between production jobs and non-production jobs (i.e. jobs in the management, sales and Research departments). It also distinguishes between high-skilled jobs (engineer and technician level) and low-skilled jobs (manual and non-manual employee level) within the sets of both production and non-production jobs.

The central finding of our study is that the prerequisite for a firm to export is a greater reliance on high-skilled labor. This effect follows mainly from a skill intensification in mar-

keting/development activities (effects b). Moreover this impact on the demand for skills does not appear to be any greater when firms decide to export to developing countries (South) than when they export to France's leading developed partners (North). In contrast, we observe weak evidence for the causal effect of export on skill intensity in production related activities (effect a) and no effect on the share of non production activities (effect c). Finally, a back-of-the-envelope estimation shows that the increase in export at the national level may explain 25% of the increase in the share of skilled workers in total employment over the period of estimation.

The absence of effect on the production-related activities suggests that the nature of product is the same regardless of whether the firms sell domestically or abroad<sup>3</sup>. Our findings suggest however that domestic firms have an advantage over foreign firms in development/marketing activities. We may interpret this *market proximity effect* as an informational advantage. Indeed, finding the right fit between products and markets involves a specific knowledge of customers and competitors. On this dimension local firms can be suspected of having a comparative advantage. Another interpretation is that competitive pressure makes the development and market differentiation efforts more crucial and more difficult. When operating on international markets, firms face such pressure whereas on their local markets they can partially insulate themselves from foreign competition by exploiting local (explicit or implicit) protection barriers and all the non tradable dimensions of their domestic markets (such as consumer preferences for national goods, legal system, etc).

To our knowledge, few empirical studies have so far documented the links between export and employment structure within firms. Osterman (1994) finds that exporting establishments are more likely to adopt new forms of work organization (such as Team working, TQM, etc.) than non exporting establishments. Bernard and Jensen (1997) exhibit a positive correlation between exporting and within-firm job reallocation from production tasks toward non-production tasks. These papers however tend to favor interpretations of the relation between exports and skill structure that are different than ours: Osterman looks at the organization of work independantly of skill considerations, while Bernard and Jensen focus on occupations, rather than skills. Moreover in our paper we explicitly deal with the severe autoselection bias arising

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<sup>3</sup>This result is reminiscent of a commercial strategy of the US automobile industry in the 70s-80s. In response to the growing japanese competitive pressure occuring in the 70s, major automobile multinationals decided to develop a "world car" strategy. Quoting Hoffman and Kaplinsky (1988), "The idea was to produce mechanically "identical" cars in different markets but to fine-tune the design of each to meet the particular characteristics of each of the markets".

from the endogeneity of export decision<sup>4</sup>. For example, if exporting is the bastion of the most productive firms, we can suspect these firms to have generally more highly skilled manpower than the others. Indeed we find that the correlations between the variations in exports and the variations in the share of skilled workers correspond to biased estimates of the causal impact of exports on skills because of (a) measurement errors in the independent variable, which importance increases dramatically when models are taken in first-differences and (b) unobserved factors (such as the skill-biased technical change) that determine simultaneously the decision to export and the demand for skill. We rely on the panel dimension of our data and a new instrumentation strategy to alleviate these problems. Our approach is based on a model of the firm which makes it possible to give an economic interpretation to the estimated parameters and to justify the process of instruments' selection.

It should be emphasized that this model can be estimated only because of two advantages of our French dataset.<sup>5</sup> On the one hand, it provides information about destinations of exports which enable us to deal with the North/South issue. More importantly, it provides detailed information on both firms occupational and skill structures. The effect of international trade would have been harder to identify had our data not distinguished between the most highly skilled jobs and the least skilled ones, firstly within production activities and secondly within non-production activities. Indeed, our findings suggest that exporting has less of an effect on the distribution of jobs between production and non-production activities than on the skills level within each of the two types of activities. Finally, most existing papers assume that all workers employed in exporting units work for export markets only, which is clearly strongly overstating the number of workers affected by these markets. Our model does not make this assumption. It makes it possible to estimate the effect of exporting on skills without making any restrictive assumption on who works for the export markets or not.

This paper is organised as follows. The second section presents the administrative sources

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<sup>4</sup>See Clerides et al. (1998), and Bernard and Jensen (1999) for strong empirical support to this hypothesis.

<sup>5</sup>Both from the opening to trade and change in skill demand viewpoints, France is a fairly representative OECD country. It is one of the leading exporters worldwide and among the most open to international trade. In 1999, exports accounted for nearly 40% of gross domestic product as opposed to only 15% in the early 1970s. At the same time, France has among the largest and most persistent inequalities between high-skilled and low-skilled workers. Over the recent decades, the demand for unskilled labour has fallen unrelentingly and much more sharply than the number of unskilled workers in the French labour force. The relative wage of the least educated workers has not decreased, but their unemployment rate now stands at 20%, i.e. four times higher than for the most highly educated (See Goux and Maurin (2000 and 2001) for more details on inequality trends in France).



used and describes the main differences in employment structure between exporting and non-exporting firms. Section three develops the theoretical and economic framework used to interpret these differences and evaluate the effect of exporting on firms' employment structures. The fourth section details the econometric findings. The last section proposes some very simple extensions of the basic theoretical model in order to test for the impact of the learning effects associated with exporting.

## 2 Data and Main Facts

The data used in this paper are taken from files compiled annually by French customs and two French administrative databases: the *Enquête sur la Structure des Emplois* (the French survey on firms' occupational structure, hereafter ESE) and the *Bénéfices Industriels et Commerciaux* (the fiscal database on firms' production and profits, hereafter BIC).

The data collected by customs are used to compile the annual file of manufacturing firms exporting all or part of their production. This file contains detailed information on export volumes and destinations. The ESE gives the industry and employment structure by occupation for each establishment with over 20 employees and each year. The classification of occupations used by the ESE gives the type of function to which each job contributes (manufacturing, sales, logistics, etc.) and - within each function - the job's skills level (engineer/technician vs. manual/non-manual employee). The BIC information is taken from the section of the tax return in which firms declare their annual value-added. These three administrative sources<sup>6</sup> are taken together to construct an unbalanced panel of manufacturing firms with an average of 5,900 observations per year over the 1988-1992 period. Information is provided on (a) total sales, total employment and industry, (b) employment structure by function and skills, (c) whether the firm exports part of its production and, where relevant, (d) export volumes and destinations.

These data are presented in more detail in Appendix A. In the remainder of this section, we describe the basic differences in employment structure between exporting firms and non-exporting firms. The idea here is to establish the terms of the problem to be interpreted in the following sections. Our data reveal that, compared with non-exporting firms, exporting firms use more high-skilled labour and assign more jobs to non-production activities. This finding is

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<sup>6</sup>The firms are identified by the same identifying number in each of the three sources.

especially true for firms that export at least part of their production to non-OECD countries.

## 2.1 More High-Skilled Jobs in Exporting Firms

Some three-quarters of the firms in our panel export at least part of their production every year. Exporting firms use more highly skilled workers than non-exporting firms (Table 1). Over the 1988-1992 period, the proportion of high-skilled jobs (i.e. engineer and technician level) was 22% on average in the exporting firms and only 18.2% in the non-exporting firms, i.e. a difference of 25%. This difference is quite considerable. To get the measure of it, note that the share of high-skilled jobs in our sample rose only by some 2 points over the five years from 1988 to 1992. At this rate, the difference between exporting and non-exporting firms (3.8 points) corresponds to nearly ten years of replacing low-skilled labour with high-skilled labour.

One explanation of this is that the exporting firms have specific sales development problems and have to assign a larger share of their jobs to tasks that, by their very nature, demand more high-skilled labour than routine production tasks. A total of 30.6% of jobs in the exporting firms are given over to functions that are not directly associated with the production process (i.e. marketing/ development). This compares with an average of 25% in the non-exporting firms. Since the proportion of high-skilled jobs is on average four times higher in the marketing/ development departments than in the production departments, the emphasis placed by exporting firms on marketing/ development activities is automatically reflected by a more intense use of high-skilled labour.

Another explanation for there being more high-skilled jobs in the exporting firms is that these firms use more high-skilled labour in each of their basic activities. The share of engineers and technicians in production jobs is approximately 8% higher in the exporting firms than in the non-exporting firms (11.7% as opposed to 10.8%). The proportion of engineers and technicians in non-production jobs is approximately 5% higher in the exporting firms (45.6% as opposed to 43.2%).

## 2.2 Exporters' Sector Specialisation

A fairly simple interpretation of the skill differentials between exporting and non-exporting firms could be based on the Heckscher-Ohlin theorem. Since France has a relatively large supply of skilled labour, it takes part in world trade by specialising in industries that require

proportionally the most skilled labour. On this basis, exporting firms in France are more skilled than non-exporting firms because they work in sectors that demand the most of the factor in which France is relatively well endowed on a global scale, i.e. skilled labour. This interpretation can be tested by analysing the differences between exporting and non-exporting firms within the different industries. If the higher skills in exporting firms reflect solely their industry specialisation, then intra-industry differences between exporters and non-exporters should be negligible.

We calculated four indicators for each firm: The proportion of high-skilled jobs in total employment (*Skilled*), the proportion of marketing/ development related jobs (or non production jobs) in total employment (*NP*), the proportion of high-skilled jobs in production employment (*SkilledP*) and the proportion of high-skilled jobs in non-production employment (*SkilledNP*). We then carried out two regressions for each of these four indicators: (1) the first on a dummy variable indicating whether or not the firm exports, and (2) the second on this same dummy variable and on a set of 266 industry dummy variables. In both models, we only introduce a measurement for the firm's size (i.e., the log of total employment) as supplementary control variable. The (2) models evaluate the extent to which exporters' employment structures differ from non-exporters' employment structures within the different sectors. The differences between the results of model (1) and model (2) measure the extent to which the differences between exporting and non-exporting firms are due simply to different sector specialisation.

The results of these different regressions are presented in Table 2. They point to a quite clear finding: the industry effect explains only a small part of the employment structure differences between exporters and non-exporters. There remain considerable differences between exporting and non-exporting firms within the different industries.

France has many assets when it comes to international trade, especially in the food and aeronautics industries, and a large proportion of exporting firms are found in just a few sectors. Yet although this specialisation by French exporting firms is very real, it explains neither the high level of skills among their manpower nor the priority they place on management and sales development activities when they trade on foreign markets. In France, the industries in which exporting firms specialise do little to explain their employment structure and higher skills level.

## 2.3 The Importance of North-North Trade

There is a potentially more fundamental reason why it is so hard to interpret the link between exporting and skilled labour as being due to specialisation associated with comparative advantages. French firms trade mainly with the western European countries, i.e. with the Northern countries whose manpower is just as, if not more skilled than French manpower. Exports to the OECD countries represent an average 7% of the firms' production as opposed to only 1% for exports to the Southern countries (i.e. outside the OECD). It is hence extremely rare for a French exporting firm to trade solely with the Southern countries (Table 3). The exporting firms can be broken down fairly evenly between those that export solely to the Northern countries (30.3% of the firms) and those that export to both Northern and Southern countries (39.7%).

We analysed the extent to which the use of high-skilled labour varies by export destination by making the same statistical and econometric analyses as in the previous sub-section. This time, however, we identified not two, but four exporting and non-exporting types of firms: (i) firms exporting to both the North and the South, (ii) firms exporting solely to the South (note that these are very much in the minority), (iii) firms exporting solely to the North, and (iv) non-exporting firms. These findings are presented in tables 3 and 4. Interestingly enough, the firms that export at least in part to the South employ rather more skilled labour than those trading solely with the Northern countries. This holds true for both their actual production activities and their management, logistics and sales development activities. Technicians and engineers represent some 24% of the jobs in firms that trade with both the Northern and Southern countries, as opposed to some 19% of jobs in firms exporting solely to the North. The firms exporting at least in part to the South also assign a larger share of their jobs to non-production activities than those exporting solely to the North. These results hold true within the different industries (table 4). These findings may mean that it is not so much the decision to export as the range and complexity of trade relations that determine the firm's organisation and the skills level required for its jobs. These findings could also mean that only the most high-skilled firms are able to simultaneously export to markets as different as those found in the South and the North.

### 3 Theoretical Framework and Econometric Specifications

Four major facts emerge from the statistical analysis made in the previous section:

- (i) Exporting firms use much more skilled labour than non-exporting firms.
- (ii) This more highly skilled labour is found in each of the firms' component activities. The exporting firms use more high-skilled labour not only to ensure that the production process runs efficiently, but also to run their business properly administratively, logistically and commercially.
- (iii) This more highly skilled labour also reflects that exporting firms assign a larger share of their jobs to marketing/development tasks. By their very nature, these tasks require more high-skilled labor than production tasks.
- (iv) The employment structure differences between exporting and non-exporting firms are to be found within each industry.

Generally speaking, these findings can be interpreted in a number of non-exclusive but very different ways. Firstly, they could reflect a simple selection effect. According to this hypothesis, the correlation between the act of exporting and the share of skilled workers is not a relation of cause and effect. It is mostly due to unmeasured factors (such as managerial efficiency) which simultaneously explain the performance on foreign markets and the demand for skill. Bernard and Jensen (1999) emphasise the importance of these selection mechanisms.

The second possible interpretation is that exporting itself affects job skills levels. Exporting puts firms in contact with different customers and markets, which is a potential vehicle for learning new technologies and changing jobs. Bernard and Jensen (1999) and Clerides et al. (1998) find very weak support for this "learning by exporting" hypothesis.

A third potential interpretation is that upgrading skills is a necessary condition for each firm to succeed on foreign markets. In this case, adopting skill-intensive production technologies and/or marketing/development technologies is a prerequisite for exporting. Under this last hypothesis, the skill differentials between exporting and non-exporting firms reflect neither a direct causal effect of exports on job skills nor a pure and simple selection effect. They indicate that a firm's growth abroad has to tie in with adjusting its own business and especially

technological choices requiring more skilled labour. In the following, we construct a model to test this hypothesis. Our aim is to clarify whether the skill differentials between exporters and non-exporters reflects a mere selection process or whether they are also a sign of technological adjustments that necessarily accompany the development of trade abroad. Moreover, our model, while being simple, makes it possible to identify the effect of exporting on skill demand *without* making restrictive assumptions on who works for the export market and who does not.

### 3.1 The Theoretical Framework

We consider a firm whose activity requires the combination of a *marketing/development* stage which is devoted to finding consumer's needs, designing new products and acquiring market niches and a *production* stage. Each stage uses skilled labor and unskilled labor. Furthermore, we assume that the firm can sell its products on the domestic market, but can also ship its production abroad.

Let us start with specifying the production stage. We denote  $Y_d$  the volume of output produced for the domestic market and  $Y_x$  the volume of output produced for the foreign market. The corresponding production functions are  $F_d$  and  $F_x$  with:

$$Y_d = F_d(P_{Ld}, P_{Hd}) \text{ and } Y_x = F_x(P_{Lx}, P_{Hx}) \quad (1)$$

where  $P_{Ld}$  (resp.  $P_{Lx}$ ) represents the number of low-skilled employees that the firm assigns to production activities on the domestic (resp. foreign) market, while  $P_{Hd}$  (resp.  $P_{Hx}$ ) represents the number of high-skilled employees that the firm assigns to these activities on the domestic (resp. foreign) market.

Neither of the two markets' potential outlets are exogenous. They depend on the effort made by the firm to design, market, ship and sell its products. If  $D$  (resp.  $X$ ) represents the domestic (resp. foreign) demand created by these commercial efforts, we assume that:

$$D = \varphi_d(N_{Ld}, N_{Hd}) \text{ and } X = \varphi_x(N_{Lx}, N_{Hx}) \quad (2)$$

where  $N_{Ld}$  (resp.  $N_{Lx}$ ) represents the number of low-skilled employees that the firm assigns to *marketing/development* activities on the domestic (resp. foreign) market, while  $N_{Hd}$  (resp.

$N_{Hx}$ ) represents the number of high-skilled employees that the firm assigns to these activities on the domestic (resp. foreign) market. Functions  $\varphi_d$  and  $\varphi_x$  represent the technologies that create outlets for the firm's products<sup>7</sup>.

The goal of our econometric section is to test whether the functions  $F_d$  and  $F_x$  on one hand and  $\varphi_d$  and  $\varphi_x$  on the other hand, differ in term of skill intensity. In such a case, a rising importance of exports in total sales will affect the overall demand for skill. Given that we do not observe the distribution of workers across domestic and foreign activities, we have to be more specific about  $F_d$ ,  $F_x$ ,  $\varphi_d$  and  $\varphi_x$  to identify the differentials in skill intensity. Our basic assumptions will be that returns to scale are constant and that all production functions have constant elasticity of substitution between skilled and unskilled labor. Hence, marketing/development stage will be described by:

$$\begin{aligned}\varphi_d(N_{Ld}, N_{Hd}) &= A_d(N_{Ld}^\alpha + (\theta N_{Hd})^\alpha)^{\frac{1}{\alpha}} \\ \varphi_x(N_{Lx}, N_{Hx}) &= A_x(N_{Lx}^\alpha + (\theta\phi N_{Hx})^\alpha)^{\frac{1}{\alpha}}\end{aligned}$$

where  $A_d$  and  $A_x$  are technology parameters, while  $\theta$  denotes the skill intensity of development for the home market.  $\phi$  parameterizes the skill intensity differential between developing product for the export and domestic market. Parameter  $\alpha$ , ( $\alpha < 1$ ) provides a measurement of the elasticity of substitution (which is equal to  $1/(1 - \alpha)$ ) between the different types of labour (high-skilled and low-skilled). Similarly, production will be described by:

$$\begin{aligned}F_d(P_{Ld}, P_{Hd}) &= B_d(P_{Ld}^\beta + (\mu P_{Hd})^\beta)^{\frac{1}{\beta}} \\ F_x(P_{Lx}, P_{Hx}) &= B_x(P_{Lx}^\beta + (\mu\lambda P_{Hx})^\beta)^{\frac{1}{\beta}}\end{aligned}$$

where  $B_d$  and  $B_x$  are productivity parameters, while  $\lambda$  parameterizes the difference in skill intensity between production for export and domestic markets.

## 3.2 Skill Intensity in the marketing/development stage

Measuring the effect of exporting on skill intensity in the *marketing/development* stage means testing whether  $\varphi_x$  and  $\varphi_d$  differ in terms of skill intensity, i.e. whether  $\phi \neq 1$ . The firm solves the following program, for both export ( $k = x$ ) and domestic ( $k = d$ ) markets:

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<sup>7</sup>This type of modeling is similar to the R&D modeling in the horizontal differentiation growth models (Romer, 1990). In this framework,  $D$  (resp.  $X$ ) would be interpreted as the number of products in which the firm manages to gain a monopoly quasi-rent on the domestic (resp. foreign) market. From this point of view, our model can be interpreted as a Krugman and Helpman (1986) model, where the number of products depends on the firms' research effort.

$$\max_{N_{Hk}, N_{Lk}} \{p_k \varphi_k - w_H(P_{Hk} + N_{Hk}) - w_L(P_{Lk} + N_{Lk})\} \quad (3)$$

$$\text{s.t. } F_k(P_{Lk}, P_{Hk}) = \varphi_k(N_{Lk}, N_{Hk}) \quad (4)$$

where  $p_k$  represents the market price, assumed to be exogenous, while  $w_H$  and  $w_L$  represent the labour costs. Price  $p_X$  incorporates the effect of any transport (and/or customs) costs proportional to the quantities shipped across the borders. It also incorporates the effect of exchange rates and customs tariffs. Hence it varies a priori from one firm to the other in line with the quality and proximity of the infrastructures available to transport the products and the nationality of the firms' trading partners.

The firm's program is solved in Appendix B. Relative demand for skill in *Marketing/development* occupations is given by:

$$\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right) = \frac{1-\alpha}{\alpha} \cdot (1-\phi) \cdot \frac{X_{jt}}{D_{jt}} + \ln(\theta_{jt}) + \left(\frac{1-2\alpha}{\alpha}\right) \cdot \ln\left(\frac{w_{Ht}}{w_{Lt}}\right) \quad (5)$$

Calling  $u_{jt} = \ln(\theta_{jt}) + \left(\frac{1-2\alpha}{\alpha}\right) \ln\left(\frac{w_{Ht}}{w_{Lt}}\right)$  and  $\beta = \frac{1-\alpha}{\alpha} \cdot (1-\phi)$ , the reduced form equation that will form the basis of our empirical model is, for firm  $j$  observed at date  $t$ :

$$\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right) = \beta \cdot \frac{X_{jt}}{D_{jt}} + u_{jt} \quad (6)$$

In this analytic framework, evaluating the effect of exporting on skill is tantamount to identifying  $\beta$ . Depending on whether  $\beta$  is high or low, the customs and monetary changes fostering international trade will be accompanied by large or small replacements of low-skilled labour with high-skilled labour in marketing/development occupations.

The  $u_{jt}$  variable is not observed empirically. From a theoretical point of view, it depends on the relative costs  $\frac{w_{Ht}}{w_{Lt}}$  and on the technological parameter  $\theta_{jt}$ . This is also the case for the quantities produced  $X_{jt}$  and  $D_{jt}$  at optimum. In other words,  $u_{jt}$  is an unmeasured determinant of  $N_{Hjt}/N_{Ljt}$  which is potentially correlated with  $X_{jt}/D_{jt}$ . Within this framework, the estimation of  $\beta$  is not straightforward: the regression coefficient of  $\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right)$  on  $X_{jt}/D_{jt}$  is, in particular, a potentially biased estimator of  $\beta$ .

Estimating  $\beta$  calls for a plausible set of assumptions to be formulated as to the distribution of the  $u_{jt}$ . The simplest assumption is to postulate that this variable can be approximated by



the combination of an i.i.d. random variable and a firm fixed-effect<sup>8</sup>. Within this framework, estimating  $\beta$  calls for reasoning simply on first-differences, i.e. regressing  $\Delta(\ln(N_{Hjt}/N_{Ljt}))$  on  $\Delta(X_{jt}/D_{jt})$ <sup>9</sup>. As we will see, one of the problems with this strategy is that it sharpens the biases (towards zero) generated by the measurement errors.

Another possible identifying assumption is that there exists an instrumental variable that affects  $X_{jt}/D_{jt}$  (or of  $\Delta(X_{jt}/D_{jt})$ ) without being correlated with  $u_{jt}$  (or with  $\Delta u_{jt}$ ). From a theoretical viewpoint, the most natural candidate is the relative price of export and, more generally, any exogenous determinant of export prices, such as exchange rates. In the following sections, we will use a firm-level measurement of the effective nominal exchange rate as instrumental variable. This variable corresponds to the geometric mean of the contemporary French franc value of the Deutschmark and the Dollar weighted respectively by the firm's proportion of exports to a) the European Union and b) outside the European Union, in 1986 (i.e. two years before the beginning of the panel).

In dynamic terms, the corresponding identifying hypothesis is that, when the national currency depreciates (appreciates) compared with the effective currency of firm  $j$ 's trading partners, the export prices practised by this firm increase (decrease) and  $X_j/D_j$  increases (decreases), whereas the costs and technologies determining  $u_{jt}$  remain the same.

Before moving onto the presentation of the estimation results, we will extend our basic model in two directions to be able to test (a) the effect of international trade on the skills level of production jobs and (b) the effect of export destinations on job skills.

### 3.3 Skill Intensity in the Production Stage

Testing for differences in skill intensity in production amounts to asking whether  $\lambda \neq 1$ . A reduced form relation between skilled labor demand in production and exports can be derived in a similar way than above. Hence, by solving a similar optimization program, we obtain, for firm  $j$  at date  $t$  :

$$\ln\left(\frac{P_{Hjt}}{P_{Ljt}}\right) = \delta \frac{X_{jt}}{D_{jt}} + v_{jt} \quad (7)$$

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<sup>8</sup>Basically, this comes down to assuming that technological progress is neutral.

<sup>9</sup>A slightly more general assumption consists of postulating that the variations in  $u_{jt}$  can be represented as sector-based deterministic trends. In this case, estimating  $\beta$  is simply a question of differentiating the model and introducing sector dummy variables as additional explanatory variables into the differentiated model.

where  $v_{jt} = \ln(\mu_{jt}) + (\frac{1-2\beta}{\beta}) \ln(\frac{w_{Ht}}{w_{Lt}})$  measures the effects of technology and labor costs on the demand for skill in firm  $j$ 's production plants while parameter  $\delta = \frac{1-\beta}{\beta}(1 - \lambda)$  measures the skills intensity differential between the production technologies for the domestic and the foreign markets.

In this framework, identifying  $\delta$  raises exactly the same econometric problem as identifying  $\beta$ . This problem can be solved in the same way by using the information available on each firm's specific export destinations and the exchange rates corresponding to each of these destinations.

### 3.4 Exports and share of non production activities

Finally exporting may require more skilled workers simply because it necessitates more non production occupations (such as development, marketing, etc.) which are skill intensive. Hence, exporting could induces a reallocation of work from production to development/sales activity. This is precisely the hypothesis tested by Bernard and Jensen (1999).

More precisely, our model allows to derive a relation between the ratio of non production over production workers,  $NP_{jt}/P_{jt}$ , and the share of export  $\frac{X_{jt}}{D_{jt}}$  :

$$\ln\left(\frac{NP_{jt}}{P_{jt}}\right) = \zeta \frac{X_{jt}}{D_{jt}} + r_{jt} \quad (8)$$

Hereafter, we will jointly estimate the equations (6-7-8) in order to provide a comprehensive description of the impact of exporting on skill demand.

### 3.5 Export destination and job skills

Thus far, we have assumed that exporting requires the same type of development and sales effort for all exported product destinations. Yet exporting to Asia and South America usually raises potentially different legal, logistical and marketing problems for French firms to those raised by exporting to France's neighbouring European Union countries. To simplify matters, assume that there are  $K$  possible destinations for the exports, each requiring its own sales technology  $\varphi_{xk}(N_{Lxk}, N_{Hxk})$  with  $k = 1, \dots, K$ , where  $N_{Lxk}$  ( $N_{Hxk}$ ) represents the number of low-skilled (high-skilled) non-producers working on the firm's sales development in region  $k$ . In this framework, we check that the firm's program can no longer be separated into two distinct sub-programs, but into  $K + 1$ , and that equation (6) is generalised based on,

$$\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right) = \sum_{k=1}^K \beta_k \frac{X_{jkt}}{D_{jt}} + u_{jt} \quad (9)$$

where  $X_{jk}$  measures exports to region  $k$  and  $\beta_k$  how much more high-skilled labour is required by the export technology for region  $k$  than the sales technology for the domestic markets.

Assuming that the  $k$  destinations each correspond to a specific  $F_k$  production technology and that the unit costs of these technologies can be ranked from lowest to highest, we obtain the equivalent of (7) for the production jobs,

$$\ln\left(\frac{P_{Hjt}}{P_{Ljt}}\right) = \sum_{k=1}^K \delta_k \frac{X_{jkt}}{D_{jt}} + v_{jt} \quad (10)$$

The following section looks at the estimation of equations (6-7-8-9-10) using the matched Industrial and Commercial Profits/Employment Structure Survey/Customs data presented in Section 2.

## 4 Econometric Findings

Tables 5a-8 present the results of our econometric analysis of equations (6-7-8). We first estimated the models with variables taken in level in order to provide a benchmark for subsequent analysis (table 5a). We then turn to first-differences in order to eliminate the firm fixed effects (table 5b). As already pointed out, this estimation remains potentially exposed to two types of bias: (a) the biases created by errors affecting the measurement of  $\Delta \frac{X_{it}}{D_{it}}$ , and (b) the biases associated with the existence of skill-biased technological progress, i.e. associated with the existence of a  $\Delta\theta_{jt}$  or a  $\Delta\mu_{jt}$  simultaneously affecting the employment structure and the share of exports. To neutralise the measurement errors effect, we re-estimated the first-difference models by instrumenting the variations in the share of exports by its own lagged values (see Table 6). Finally, to neutralise the effects of both measurement errors and skill-biased technological progress, we re-estimate these models using the lagged values of a firm-level measurement of real exchange rate as instrumental variables (table 8).

We come up with two main findings: (a) the main conditions for export growth is skill upgrading in marketing/development activities and (to a lesser extent) in production activities,

and (b) this effect is largely underestimated when the biases associated with the existence of measurement errors and skill-biased technological change are overlooked. We will now look at these different points in more detail.

## 4.1 Estimation using the ordinary least squares technique

Table 5a shows the estimation of  $\beta$ ,  $\delta$  and  $\zeta$  under the assumption that (a) the  $\theta_{jt}$  and  $\mu_{jt}$  technological parameters are constant over time and across firms and (b) errors in the measurement of the independent variables can be neglected. In such a case,  $u_{jt}$  and  $v_{jt}$  correspond to random errors in the dependent variable and the estimation of  $\beta$  and  $\delta$  calls simply for regressing  $\ln P_{Hjt}/P_{Ljt}$  and  $\ln N_{Hjt}/N_{Ljt}$  on  $X_{jt}/D_{jt}$  using the ordinary least squares method<sup>10</sup>. According to these estimates, exporting has a positive impact on, by order of decreasing magnitude: (1) the share of non-production jobs, (2) the share of skilled workers in production jobs and (3) the share of skilled workers in non-production jobs. All estimates are significant at standard levels.

To get a first look at the importance of autoselection, table 5b presents OLS estimates of (6-7-8) written in *first-difference*. The  $\theta_{jt}$  and  $\mu_{jt}$  technological parameters can now vary across firms and be approximated by firm fixed-effects. Using first-differences neutralize the biases generated by such endogenous fixed-effects. Within this framework, the estimated effect of exports on the share of skilled workers in non-production activities is left almost unchanged. This provides preliminary support for our main working hypothesis. In contrast, the variations in the share of exports have no significant effect on the variations in the share of skilled workers in production tasks, nor on the variations in the share of non-production jobs. At first glance, the only actual prerequisite for exporting is to upgrade skills in the non-production departments. Another explanation for the very weak effect of exports on the share of non-production workers or on the skill level of production workers are the bias towards zero generated by measurement errors.

## 4.2 Measurement errors

In general, the greater the variance of the measurement errors (compared with the variance of the poorly measured explanatory variable), the larger the bias towards zero generated by

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<sup>10</sup>We also introduce year and sector dummy variables as additional regressors in order to neutralise the potential effects of changes in the structure of labour costs.

these measurement errors. In our case, when the export patterns are persistent (low variance of  $\Delta(\frac{X_{it}}{D_{it}})$ ) and when  $X_{it}$  and  $D_{it}$  are poorly measured, the bias affecting the least squares estimator is potentially very high<sup>11</sup>.

To neutralise this bias, we re-estimated the previous models using the instrumental variables technique and  $\Delta(\frac{X_{it}}{D_{it}})$  lagged two periods as an instrumental variable. Assuming that measurement errors do not persist over time, this strategy provides unbiased estimates for  $\beta$  and  $\delta$ . The results of this analysis are presented in Table 6. Two important conclusions can be drawn from this. Firstly, the magnitude of the estimated effects increases quite considerably. This result is consistent with the assumption of initially large measurement errors in  $X_{it}$  and  $D_{it}$ , which cumulate in the first-difference model in such a way that they considerably bias the OLS estimates towards zero. The second conclusion is that the only effect significantly different from zero at the usual levels is still the effect of exports on workers'skills in the non-production departments. These estimates suggest that a 25% increase in the share of exports in a firm's business would require the firm to raise the proportion of high-skilled management/sales jobs by approximately 10%

To complete our analysis of measurement errors, we also re-estimated the equations using the ordinary least squares technique. However, this time, we reasoned in terms of the sector-based mean of the variables studied<sup>12</sup>. Assuming that the measurement errors are not correlated between firms in a given sector, this strategy also provides unbiased estimators of  $\beta$ ,  $\delta$  and  $\zeta$ . The results of this procedure are presented in Table 7. Given the small number of observations, most parameters are only poorly estimated. Encouragingly enough, however, these sector-based estimates produce more or less the same type of re-evaluation of  $\beta$ ,  $\delta$  and  $\zeta$  as the instrumental variable procedure using  $\frac{X_{it-2}}{D_{it-2}}$ . We obtain an estimator of  $\beta$  that is five times higher than that obtained initially using the ordinary least squares technique and is virtually equivalent to the

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<sup>11</sup>If  $s_{\Delta X/D}^2$  represents the variance of the measurement error in  $\Delta(X_{jt}/D_{jt})$  and  $\sigma_{\Delta X/D}^2$  the true variance of  $\Delta(X_{jt}/D_{jt})$ , then estimator  $\beta_{OLS}$  of the OLS of  $\beta$  is written  $\beta/(1 + s_{\Delta X/D}^2/\sigma_{\Delta X/D}^2)$  (e.g. see Maddala, 1977). If, moreover,  $s_{X/D}^2$  represents the variance of the measurement error in  $(X_{jt}/D_{jt})$  and if these errors are not correlated over time, then  $\beta_{OLS}$  is rewritten  $\beta/(1 + s_{X/D}^2/(\sigma_{X/D}^2 - \sigma_{X/D,X/D}^2))$  where  $\sigma_{X/D}^2$  is the variance of  $X_{jt}/D_{jt}$  and  $\sigma_{X/D,X/D}^2$  is the covariance between two successive realisations of  $(X_{jt}/D_{jt})$ . With these notations, we can conceive that relatively large measurement errors (large  $s_{X/D}^2/\sigma_{X/D}^2$ ) combined with relatively persistent export patterns ( $\sigma_{X/D,X/D}^2/\sigma_{X/D}^2$  close to 1) can generate considerable biases. Note that the measurement errors in  $(X_{jt}/D_{jt})$  represent the cumulative effect of the measurement errors made in  $X_{jt}$  and  $D_{jt}$ . This cumulative effect is even greater when there is a negative correlation between the errors in  $X_{jt}$  and  $D_{jt}$ .

<sup>12</sup>Making sector-level regressions is tantamount to instrumenting by sector dummy variables.

estimator obtained using the lagged values of the share of exports as instrumental variables.

### 4.3 Endogeneity biases

The previous estimates are valid under the assumption that technological progress is neutral. Once it is no longer ruled out that  $\theta_{jt}$  and  $\mu_{jt}$  might vary over time, their differences  $\Delta\theta_{jt}$  and  $\Delta\mu_{jt}$  become potential determinants of the variations in the share of exports. In this framework,  $\Delta u_{jt}$  and  $\Delta v_{jt}$  are endogenous and the previous estimations of  $\beta$ ,  $\delta$  and  $\zeta$  are potentially affected by an endogeneity biases.

The magnitude and direction of these biases depend on the extent to which low-skilled jobs can be replaced with high-skilled jobs in the different functions. If high-skilled and low-skilled jobs are complementary inputs, then a skill-biased technological shock raises the relative productivity of the least skilled employees. At the same time, it raises production levels in the most unskilled activities. In other words, if the two skills are complementary inputs and if domestic-market-oriented activities are more unskilled-labour intensive than export-oriented activities, then skill-biased technological shocks will result in a drop in the share of exports in total business (because domestic production will benefit more than exports). This case corresponds econometrically to a negative correlation between  $\Delta X_{jt}/D_{jt}$  and  $\Delta\theta_{jt}$  (resp.  $\Delta\mu_{jt}$ ). In such a case, the estimates made in the above two sub-sections tend to underestimate  $\beta$ ,  $\delta$  and  $\zeta$ .

To neutralise this bias, we again used the instrumental variables technique. We no longer used the lags of  $X_{jt}/D_{jt}$  as instruments, but a variable that theoretically has no links with technological progress, i.e. the firm-level measurement of exchange rates described in the previous section<sup>13</sup>. This third wave of estimates confirms that the marketing/development activity is significantly more skill intensive for the foreign markets than for the domestic market. The estimated differential  $\hat{\beta}_{iv}$  is positive, significantly different from zero at the standard levels. A one-point increase in the share of exports is accompanied by a 1.94% increase in the ratio of high-skilled over low-skilled jobs in the management and sales development departments. Using this result, a back-of-the-envelope calculation shows that the increase in export at the national level can explain 25% of the observed increase in the share of skilled workers in total

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<sup>13</sup>We also estimated the first-stage model which confirmed the correlation between our instrument and the instrumented variables (i.e. share of exports). This regression can be obtained from the authors.

employment<sup>14</sup>.

The estimates using exchange rates as instruments also weakly suggest that production in the strict sense of the term is more skill intensive when the products are produced for export. The estimated differential  $\hat{\delta}_{iv}$  is positive and significantly different from zero at a 8% level. A one-point increase in the proportion of exports is accompanied by a 1.16% increase in the ratio of high-skilled over low-skilled workers within the production department.

The estimators obtained using exchange rates as instruments are larger than those obtained using the lagged values of the independent variable as instruments. In keeping with the above-developed analysis, this can be interpreted as reflecting the existence of skill-biased technological change in firms where high-skilled and low-skilled jobs are linked by complementarity relations. Given the low level of possible substitution of engineers and technicians with manual workers, technological progress biased in favour of the employment of engineers and technicians accelerates the substitution of skilled to unskilled workers and fosters the expansion of domestic-market-oriented activities to a greater extent than export oriented ones.

Lastly, estimates from table 8 confirm that exports have no significant effect on the share of non-production jobs. The causal impact of exports on skills would have been impossible to identify if our data had not distinguished between skilled and unskilled jobs within production and non-production activities.

#### 4.4 Skills and export destinations

In keeping with the analysis developed in sub-section 3.4, we tested the assumption that the technological change required to export varies depending on the export destination. For each firm and each date, we reconstituted the volume of exports to the OECD countries and the volume of exports to countries outside the OECD. We then estimated models 9 and 10 in difference, again using in turn (a) the ordinary least squares technique, (b) the instrumental variables technique taking our firm-level measurements of exchange rate as instruments<sup>15</sup>.

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<sup>14</sup>Indeed the average increase in the ratio ( $X/D$ ) at the national level is equal to 1.6 point per year. Moreover, the share of non production workers represents 30% of total employment and the ratio of skilled workers over unskilled workers in non production activities is around 1. Finally, the average growth rate of the share of skilled workers in total employment is around 0.5% per year in the data on the period 88-92.

<sup>15</sup>The measurement of effective exchange rate computed in section 4.3 has been broken down in two parts. One is the 1986 firm-level share of exports to non-OECD countries times the contemporary French Francs value of the US dollar. The second instrument is the 1986 firm-level share of exports to OECD countries times the current value of the Deutch Mark.

From a methodological viewpoint, the comparison of the different estimators again suggests the existence of measurement errors that bias the ordinary least squares estimators towards zero. These OLS estimators hence remain much lower than those obtained using the instrumental variables technique.

Regardless of the IV method used, the estimator of  $\beta_N$  is higher than the estimator of  $\beta_S$  and only the estimator of  $\beta_N$  is significantly different from zero. Exports to the Northern markets account not only for the bulk of French exports, but also seem to be the exports that call for the most extensive changes to the employment structures.

## 5 Extensions

We have avoided complicating the analysis by thus far disregarding the fact that exporting can be likened to learning and generate efficiency gains for all the firms' activities<sup>16</sup>. The estimation strategies hitherto used for  $\beta$  and  $\delta$  would not necessarily remain correct in the presence of such mechanisms.

In our model, learning phenomena can be modeled as a link between current productivity parameters and past export patterns. Using our notations, they can be modeled as dependence between  $A_{jt}$  (and/or  $B_{jt}$ ) and  $X_{jt-1}$ , the idea being that a firm is more efficient today (i.e.  $A_{jt}$  and/or  $B_{jt}$  are lower) when it has exported a lot in the past (i.e. high  $X_{jt-1}$ ). In such a case, the firm's problem becomes one of dynamic optimisation and the decision to export obeys much more complex rules than those corresponding to the static model used up till now. Exporting more today actually tends to improve the profits from exports tomorrow.

Nevertheless, we check that first-order relations (5) and (10) are still correct and do the same with our identification strategy for the skilled labour intensity differentials between sales technology and production technology (see Appendix B, Section 3). Insofar as exports make the firm more efficient across all markets (foreign and domestic), the learning phenomena do not alter the structural link between job skills and exports, nor the interpretation we gave to our econometric findings.

Another assumption neglected in this paper is that export efforts at a given moment in time can have persistent effects on the costs of exporting. In our model, the process that generates the persistence of exporting can be modeled as a link between the current marketing/development

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<sup>16</sup>See the references cited in Clerides et al. (1998).



(and/or manufacturing) costs for the foreign markets and past export behaviour. This means that it is no longer a link between past exports and all the efficiency parameters (as in the case of learning), but a link between past exports and the specific efficiency of exporting. In our model, this type of link corresponds, for example, to a dependence between  $\phi_H$  (or  $\lambda_H$ ) and  $X_{t-1}$ . As mentioned previously, when such time-related dependence exists, the firm's problem becomes dynamic and the decision to export becomes much more complex. Moreover, relations (8) and (12) are no longer correct in that coefficients  $\beta$  and  $\delta$  now potentially depend on past export performances. Assume, for example, that parameter  $\phi_H$  takes two different values on date  $t$  depending on whether or not exports were made on date  $t - 1$ . In this case, we verify (see Appendix B, Section 3),

$$\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right) = (\beta + \gamma 1^+(X_{jt-1})) \frac{X_{jt}}{D_{jt}} + u_{jt} \quad (11)$$

where  $1^+(x)$  is the dummy value taking the value 1 if  $x > 0$  and the value 0 if not. A negative  $\gamma$  parameter means that the fact of having exported in the past reduces the current exporting costs. Overlooking this type of process a priori results in an underestimation of  $\beta$ . To test this assumption, we estimated model (11) using the same econometric strategies as above. In general, our findings effectively show that  $\gamma$  is negative and that  $\beta$  is even higher than suggested by our previous estimates. Nonetheless, the estimates are highly inaccurate and unstable, which is why we have not detailed them here. There are apparently too few transitions between exporting and not exporting to be able to reasonably accurately identify the greater skills that firms need when they start to export and those they then need once they have established a steady exporting business.

## 6 Conclusion

In this paper, we find significant differentials in skill intensity between the technologies used by firms to sell their product on domestic markets and those used to sell on foreign markets. The prerequisite for exporting is an extensive restructuring of the non-production (ie. marketing/sales development ) departments, which is reflected by a significantly greater use of high-skilled jobs in these departments.

In our estimates, exporting has a positive and robust effect on the share of skilled workers

within the non-production departments. In contrast, we observe weak evidence for the causal effect of export on skill intensity in production related activities and no robust evidence for the effect of exporting on the distribution of workers across production and non production activities.

In other words, the demise of customs barriers and rise in international trade definitely form a factor for technological change and altered employment structures, albeit in a most particular way. They first and foremost form a vehicle for changing the firms' marketing/development departments. The skills required by the jobs created in these departments become increasingly critical as the firms broaden their horizons and their foreign market relations become more complex.

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## A The data

The data used are derived from combining a database built by French customs with two administrative databases: the Enquête sur la Structure des Emplois (survey on firms' occupational structure, hereafter ESE) and the Enquête sur les Bénéfices Industriels et Commerciaux (the fiscal database on firms' activities and profits, hereafter BIC). These three statistical sources were used to put together an unbalanced panel of manufacturing firms containing an average of 5,900 observations every year over the 1988-1992 period with information on employment, production, occupational structure and, where relevant, export volumes and destinations.

### A.1 ESE

In accordance with the law on employing people with disabilities, all French establishments with over 20 employees are bound to file an annual declaration comprising the detailed structure of their jobs in keeping with a classification of approximately 350 occupations. The French National Statistics Institute collects this information and draws up an annual file containing: (a) the establishment's SIRET (identifying) number, (b) the SIREN number of the enterprise to which the establishment belongs, and (c) the breakdown of employment by occupation. This study uses the files drawn up from 1988 to 1992. The French Occupational Classification (four-digits) identifies the type of function (manufacturing, logistics, sales/marketing, management/administration, research/development) to which the job contributes and the job skills level within each function. We arranged the skills levels into two groups: "high skilled" (executives/engineers and technicians/supervisors) and "low skilled" (skilled and unskilled manual/non-manual employees). To simplify the analysis, the functions are also put into two main categories: manufacturing/production and all functions not directly associated with the manufacturing/production process. These jobs are essentially management/administration and sales/marketing functions. See Maurin and Thesmar (1999) for a description of the jobs distribution by skills level and type of function. The data collected from the establishments are aggregated at the firm level (the firm's SIREN identifying number corresponds to the first eight digits of the establishment's SIRET identifying number).

### A.2 BIC and Customs Data

Every year, the French National Institute for Statistics and Economic Studies (INSEE) uses the available fiscal information on firms' activities and profits (BIC) to build a file of all manufacturing firms with their identifying number and level of production. Also every year, French customs build a file listing the export activity of French manufacturing firms. This customs information can be matched to the BIC file to form a database containing the following information on each firm: (a) the SIRENE identifying number, (b) the sector (NAP600 four-digit classification), and (c) the volume and distribution of exports by the exporting firms' destination regions. All the quantities are deflated by price indices calculated at detailed sector level

(NAP600) and by origin and destination for imports and exports.

The panel used in this paper is constructed by matching up this database with the ESE files. Our study is restricted to firms that leave the panel no more than once (i.e. we have eliminated those that leave, return and leave again).

The estimates presented in tables 1-9 use two datasets drawn from this panel. The first one removes all extreme values (top and bottom 1% of the distribution) of the level of the variables that are used in regressions:  $\log(\text{share of skilled in production})$ ,  $\log(\text{share of skilled in non production})$ ,  $\log(\text{share of non producers})$  and  $\log(\text{exports/domestic sales})$ . It is used in tables 1-5a, and has 29,548 observation, which corresponds to approximately 5,900 firms a year. The second dataset removes extreme values of the one year *differences* of these variables (using the same cutoffs), and is used in tables 5b,8 and 9 (6 and 7 use sectoral data). It has 20,168 observations, which corresponds to some 5,000 firms each year.

## B Firm Behaviour

Let the program be that defined by equations (3). We can write:

$$N_{lx}^* = X^* c_{lx}(w_H, w_L) \text{ and } N_{ld}^* = D^* c_{dl}(w_H, w_L) \text{ for } l \in \{H, L\}$$

where  $c_{lk}$  represents the unit factor demand  $l$  associated with technology  $\varphi_k$ .  $X$  and  $D$  are the quantities of good exported and sold domestically. Denoting  $N_H^* = N_{Hx}^* + N_{Hd}^*$  ( $N_L^* = N_{Lx}^* + N_{Ld}^*$ ) the total number of high-skilled (low-skilled) employees assigned by the firm to sales development activities. With these notations and assuming that  $X/D$  remains low<sup>17</sup>, we can develop  $N_H^*/N_L^*$  in accordance with,

$$\frac{N_H^*}{N_L^*} \simeq \frac{N_{Hd}^*}{N_{Ld}^*} \left( 1 + \frac{N_{Hx}^*}{N_{Hd}^*} - \frac{N_{Lx}^*}{N_{Ld}^*} \right) \quad (12)$$

This gives:

$$\ln\left(\frac{N_H^*}{N_L^*}\right) \simeq \ln\left(\frac{c_{dH}}{c_{dL}}\right) + \frac{X^*}{D^*} \left( \frac{c_{xH}}{c_{dH}} - \frac{c_{xL}}{c_{dL}} \right) \quad (13)$$

which is valid for all types of production functions provided they have constant returns to scale.

However, we have assumed that both functions  $\varphi_x, \varphi_d$  can be approximated by CES production functions. In this case, cost functions can be written:

$$C_d = A(w_L^{(1-\alpha)/\alpha} + (\theta w_H)^{(1-\alpha)/\alpha})^{\frac{\alpha}{1-\alpha}} \text{ and } C_x = A((w_L)^{(1-\alpha)/\alpha} + (\theta w_H / \phi_H)^{(1-\alpha)/\alpha})^{\frac{\alpha}{1-\alpha}} \quad (14)$$

Unit demand functions are:  $c_{lk} = \frac{\partial C_l}{\partial w_k}$  for  $l \in \{L, H\}$  and  $k \in \{d, x\}$ . Hence:

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<sup>17</sup>This is indeed confirmed by the data, where exports are on average 8% of total sales.

$$\left(\frac{c_{Hx}}{c_{Hd}} - \frac{c_{Lx}}{c_{Ld}}\right) = \left[1 - \frac{1}{\phi_H^{(1-\alpha)/\alpha}}\right] \left[\frac{(w_L)^{(1-\alpha)/\alpha} + (\theta w_H/\phi_H)^{(1-\alpha)/\alpha}}{w_L^{(1-\alpha)/\alpha} + (\theta w_H)^{(1-\alpha)/\alpha}}\right]^{1-\alpha} - 1 \quad (15)$$

Assuming  $\phi_H$  close to 1, a first order Taylor expansion of the previous equation yields:

$$\left(\frac{c_{xH}}{c_{dH}} - \frac{c_{xL}}{c_{dL}}\right) \simeq \frac{1-\alpha}{\alpha} \cdot (1 - \phi_H) \quad (16)$$

Plugging back (16) into (13) yields equation (5) from the main text.

## C Extensions

Let's assume that the sales technologies now depend on past exports in accordance with,

$$\varphi_{kt}(N_{Lk}, N_{Hk}) = A(X_{t-1})\varphi_k(N_{Lkt}, N_{Hkt}) \text{ where } k \in \{d, x\}$$

Function  $A(X_{t-1})$  represents the learning effects: the more the company has exported in the past, the more it has learnt and the more efficient it is today on both the export and domestic markets.

Assume that the productivity parameters  $\phi_H$  and  $\phi_L$  also depend on  $X_{t-1}$  such that we can write,

$$\phi_H = \phi(X_{jt-1})\phi_{1H} \text{ and } \phi_L = \phi(X_{jt-1})\phi_{1L}.$$

Function  $\phi(X_{jt-1})$  represents the impact of past exporting efforts on the specific cost of current exporting. We can normalise  $\phi_{1L} = 1$  and  $\phi(0) = 1$ . In this framework, the dependence between  $\phi_H$  and  $X_{t-1}$  makes highly inertial exporting behaviour possible. In the extreme case,  $\phi$  immediately reaches the value  $\frac{1}{\phi_{1H}}$  as soon as  $(X_{t-1} > 0)$ . In this case, selling for export raises no particular problem over selling on the domestic markets as long as the firm has exported the previous year.

With these notations, current profits on date  $t$  are written  $\pi_{xt}$  and  $\pi_{dt}$  with,

$$\pi_{xt} = (p_{xt} - C_F)A(X_{jt-1})\phi(X_{jt-1})\varphi_d(N_{Lxt}, \phi_{1H}N_{Hxt}) - (w_{Ht}N_{Hxt} + w_{Lt}N_{Lxt}), \quad (17)$$

$$\pi_{dt} = (p_{dt} - C_F)A(X_{jt-1})\varphi_d(N_{Ldt}, N_{Hdt}) - (w_{Ht}N_{Hdt} + w_{Lt}N_{Ldt}). \quad (18)$$

and the firm's goal is to maximise  $\Pi$  with

$$\Pi = E\left(\sum_{k=0}^{\infty} \beta^{t+k} (\pi_{xt+k} + \pi_{dt+k})\right),$$

where  $\beta$  is a discounted coefficient and where the expectation is derived from the anticipated future values of prices ( $p_{xt}$  and  $p_{dt}$ ) and wages ( $w_{Ht}$  and  $w_{Lt}$ ). In this framework, the decision to export or not on date  $t$  clearly depends on past exports and anticipated future cost and price structures. It hence obeys more complex dynamic rules than in the basic model. It is equally clear that if  $X_t^*$  and  $D_t^*$  represent the optimal decisions for date  $t$ , then we can continue to write,

$$N_{Kxt}^* = X_t^* c_{xKt}(w_{Ht}, w_{Lt}) \text{ and } N_{Kdt}^* = D_t^* c_{dKt}(w_{Ht}, w_{Lt}) \text{ for all } K \in \{H, L\}$$

which again produces a relation of the type,

$$\ln\left(\frac{N_{Ht}^*}{N_{Lt}^*}\right) \simeq \ln\left(\frac{c_{dHt}}{c_{dLt}}\right) + \frac{X_t^*}{D_t^*} \left(\frac{c_{xHt}}{c_{dHt}} - \frac{c_{xLt}}{c_{dLt}}\right) \quad (19)$$

with  $\left(\frac{c_{xHt}}{c_{dHt}} - \frac{c_{xLt}}{c_{dLt}}\right) \simeq \alpha\phi(X_{t-1})(1 - \phi_{1H})..$

Assuming that  $\phi(x)$  can be approximated by a function of the type  $1 - \theta 1^+(x)$  where  $1^+(x)$  is the dummy function taking the value 1 when  $x > 0$  and 0 if not, we end up with an econometric model of the type,

$$\ln\left(\frac{N_{Hjt}}{N_{Ljt}}\right) = (\beta + \gamma 1^+(X_{jt-1})) \frac{X_{jt}}{D_{jt}} + u_{jt} \quad (20)$$



Table 1: The employment structure of exporting and non-exporting firms.

in %	Exporters	Non exporters	Total
Share of skilled workers	22.0 (0.1)	18.2 (0.1)	21.0 (0.1)
Share of non-producers	30.6 (0.1)	25.0 (0.2)	29.1 (0.1)
Skilled share in non-prod.	45.6 (0.1)	43.2 (0.2)	44.9 (0.1)
Skilled share in prod.	11.7 (0.1)	10.8 (0.1)	11.4 (0.1)
Number of obs.	21425	8123	29548

Reading: We observe an average of 5,900 firms every year from 1988 to 1992, making a total of 29,548 observations. This sample is taken from the original raw dataset described in appendix A. Some 21,425 firms (73%) are exporters. The share of high-skilled jobs in the exporting firms stands at 22.0% on average.

Table 2: Differences in employment structure between exporting and non-exporting firms within industries.

	<i>Skilled</i>		<i>NP</i>		<i>SkilledNP</i>		<i>SkilledP</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
[Export=1]	3.3	2.8	4.6	4.6	2.8	1.6	1.0	1.1
	(0.6)	(0.2)	(0.4)	(0.3)	(0.4)	(0.4)	(0.2)	(0.2)
$\log(\text{empl.})$	0.6	0.4	1.3	0.7	-0.5	-0.6	-0.1	-0.0
	(0.2)	(0.1)	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)
Ind. Dum.	0	266	0	266	0	266	0	266
$R^2$	0.02	0.37	0.02	0.38	0.00	0.21	0.00	0.16

Reading: The sample used is the same as in Table 1 and has 29,548 observations. For each firm and each date, we calculated the share of high-skilled jobs in total employment (Skilled column), the share of non-production jobs (NP), the share of high-skilled jobs in non-production (Skilled NP) and this same statistic for production (skilled P). Each of these four variables (percentages) was regressed by the ordinary least squares method on a dummy variable taking the value 1 if the firm exports (model 1) and then adding 266 sector dummy variables (model 2). The standard deviations are given in brackets and are adjusted using the White method to correct for firm level heteroskedasticity.

Table 3: Firms' employment structures by export destination.

in %	Non export.	North only	South only	North and South
Share of skilled workers	18.2	18.9	21.3	24.3
	(0.4)	(0.4)	(1.5)	(0.4)
Share of non-prod.	25.0	26.2	26.3	34.2
	(0.4)	(0.4)	(1.6)	(0.4)
Skilled share in non-prod.	43.2	43.4	48.1	47.1
	(0.4)	(0.4)	(1.8)	(0.5)
Skilled share in prod.	10.8	10.7	11.5	12.4
	(0.4)	(0.3)	(1.1)	(0.3)
No. obs.	8,123	8,939	742	11,744

Reading: The sample is the same as in table 1: we observe an average of 5,900 firms every year from 1988 to 1992, making a total of 29,548 observations. Of this total, 8,939 (30.3%) export solely to the North, 742 (2.5%) export solely to the South and 11,744 (39.7%) export to the North and South. The average share of high-skilled jobs in the firms exporting solely to the North is 18.2%.

Table 4: Differences in employment structure by export destination and within activity sectors

Destination	<i>Skilled</i>		<i>NP</i>		<i>SkilledNP</i>		<i>SkilledP</i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
North only	0.8	1.6	1.1	2.4	0.6	1.0	0.1	0.6
	(0.2)	(0.2)	(0.4)	(0.3)	(0.4)	(0.4)	(0.2)	(0.2)
South only	3.1	1.7	1.2	2.2	5.1	1.6	0.8	0.5
	(0.7)	(0.2)	(0.9)	(0.7)	(1.0)	(0.9)	(0.4)	(0.4)
N. and S.	6.3	5.1	8.9	8.7	5.0	2.5	2.0	2.0
	(0.3)	(0.7)	(0.4)	(0.4)	(0.5)	(0.5)	(0.2)	(0.2)
$\log(\text{empl.})$	-0.1	-0.0	0.2	-0.1	-1.1	-0.8	-0.3	-0.2
	(0.2)	(0.1)	(0.2)	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)
Ind. Dum.	0	266	0	266	0	266	0	266
$R^2$	0.06	0.38	0.06	0.39	0.01	0.21	0.01	0.16

Reading: Same sample as in table 1, with 29,548 observations. For each firm and each date, we calculated the share of high-skilled jobs in total employment (*Skilled* column), the share of non-production jobs (*NP*), the share of high-skilled jobs in non-production (*SkilledNP*) and this same statistic for production (*SkilledP*). Each of these four variables (percentages) was regressed by the OLS method on four dummy variables standing respectively for exports solely to the North, solely to the South and simultaneously to both destinations (model 1). For each dependent variable, model 2 includes a set of 266 sector dummy variables. The standard deviations are given in brackets and are adjusted using the White method.

Table 5a: Effect of exports on firms' employment structures: an estimation using the least squares method.

	<i>skilledNP</i>	<i>skilledP</i>	<i>NP</i>
$(\text{Export./ Domestic})$	0.07	0.13	0.28
	(0.03)	(0.03)	(0.04)
Sector dummy	yes	yes	yes
Year dummy	yes	yes	yes
Observations	29,548	29,548	29,548

Source: Same sample as in Table 1. Reading: Let *skilledP* (*skilledNP*) be the share of high-skilled jobs in production (non-production) and let *NP* be the share of non-production jobs in total employment. The table gives the results of the regressions of these three variables on the *Export/Domestic* ratio, with the models incorporating the year and sector dummy variables as additional regressors. The estimates were made using the OLS technique. The standard deviations are adjusted by the White method.

Table 5b: Effect of exports on firms' employment structures: an estimation using the least squares method on first-differences

	$\Delta skilledNP$	$\Delta skilledP$	$\Delta NP$
$\Delta(Export./ Domestic)$	0.05 (0.03)	-0.01 (0.03)	-0.01 (0.01)
Sector dummy	yes	yes	yes
Year dummy	yes	yes	yes
$R^2$	0.001	0.002	0.002
Observations	20168	20168	20168

Source: We observe an average of 5,000 firms every year from 1989 to 1992, making a total of 20,168 observations. This sample is taken from the original raw dataset described in appendix A. Reading: Let  $skilledP$  ( $skilledNP$ ) be the share of high-skilled jobs in production (non-production) and let  $NP$  be the share of non-production jobs in total employment. Let  $\Delta SkilledP$ ,  $\Delta SkilledNP$  and  $\Delta NP$  be the annual variations in these variables. The table gives the results of the regressions of these three variations on the change in the  $Export/Domestic$  ratio, with the models incorporating the year and sector dummy variables as additional regressors. The estimates were made using the OLS technique. The standard deviations are adjusted by the White method.

Table 6: Effect of exports on firms' employment structures: a GMM estimate using the lagged shares of export as instruments

	$\Delta SkilledNP$		$\Delta skilledP$		$\Delta NP$	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta(Export./ Domestic.)$	0.38 (0.22)	0.34 (0.23)	0.07 (0.18)	0.08 (0.18)	-0.14 (0.09)	-0.16 (0.09)
Year Dummy	yes	yes	yes	yes	yes	yes
Sector Dummy	no	yes	no	yes	no	yes
No Obs.	13895	13895	13895	13895	13895	13895

Reading: Let  $skilledP$  (resp.  $skilledNP$ ) be the proportion of high-skilled jobs in production (non-production) and let  $NP$  be the share of non-production jobs in total employment. Let  $\Delta SkilledP$ ,  $\Delta SkilledNP$  and  $\Delta NP$  be the annual variations in these variables. Models 1, 3 and 5 give the results of the regressions of these three variables on the change in the  $Export/Domestic$  ratio. Models 2, 4 and 6 give the results of these same regressions when sector dummy variables are included as additional regressors. The estimates were made using the generalised method of moments, taking the  $Export/Domestic$  ratio lagged by two periods as the instrumental variable.

Table 7: Effect of exports on firms' employment structures: an industry level estimate.

	$\Delta skilledNP_S$	$\Delta SkilledP_S$	$\Delta NP_S$
$\Delta(Export./Dom.)_S$	0.55 (0.44)	0.28 (0.32)	0.33 (0.22)
Year Dummy	yes	yes	yes
Observations	64	64	64

Reading: For each sector and each year,  $skilledNP_S$  represents the average share of high-skilled jobs in non-production.  $SkilledP_S$  represents the average share of high-skilled jobs in production.  $NP_S$  represents the average share of non-production jobs in total employment. The table presents the results of the OLS regressions of these three variables' annual changes on the annual change in the average  $Export/Domestic$  ratio (and the year dummy variables). The variables used are means taken for the 16 industries of the manufacturing sector.

Table 8: Effect of exports on firms' employment structures: a GMM estimate using a firm level effective exchange rate as instrument

	$\Delta SkilledNP$	$\Delta SkilledlP$	$\Delta NP$	$\Delta SkilledNP$	$\Delta SkilledlP$	$\Delta NP$
$\Delta(Export./Dom.)$	1.94 (0.78)	1.16 (0.61)	-0.15 (0.33)	1.96 (0.76)	1.11 (0.59)	-0.18 (0.32)
Industry dummies	yes	yes	yes	no	no	no
Year Dummies	yes	yes	yes	yes	yes	yes
Sargan test (P)	0.15	0.27	0.90	0.16	0.28	0.90
No Obs.	18,518	18,518	18,518	18,518	18,518	18,518

Reading: Same sample as in table 5b. Same notations as for Table 6. The estimates were made using the generalised method of moments (GMM), taking as instrumental variables the firm level effective exchange rate lagged by 1 and 2 periods.

Table 9: Effect of export destination on the share of high-skilled jobs in management/sales development activities

	Skilled Prod		Skilled Nprod	
	OLS	GMM	OLS	GMM
$\Delta(Export_{North}/Dom)$	-0.02 (0.03)	1.44 (0.79)	0.04 (0.04)	2.49 (1.40)
$\Delta(Export_{South}/Dom)$	0.07 (0.07)	6.61 (10.90)	0.07 (0.08)	18.36 (21.48)
Sector Dummy	yes	yes	yes	yes
Sargan (P)	-	0.38	-	0.48
No Obs.	20,168	18,158	20,168	18,518

Reading: Same sample as in tabel 5b. The dependent variable in the four models is the change in the share of high-skilled jobs in non-production. The regressors for both models are the annual variations in the export/domestic production ratio and the annual growth in the interaction of this ratio with a dummy variable taking the value 1 when the firm exports to both the South and the North. The regressors for models 21 and 22 are the annual change in the exports to the Northern countries/domestic production ratio and the annual change in the exports to the Southern countries/domestic production ratio. The estimates were made using the generalised method of moments. The instruments are (1) the 1986 firm level ratio of South exports to non export sales times USD current level and (2) the 1986 firm level share of North exports to non export sales times DEM current level.