The demand for foreign languages in Italian manufacturing

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Abstract

Relying on a rich firm-level dataset, we investigate the factors underlying the demand for foreign languages (FL) by Italian manufacturing firms. As main determinants, we focus on innovation and internationalization activities, these latter ranging from export to FDI. In the empirical analysis, we first estimate the probability of demanding for the knowledge of at least one FL through a set of univariate probit models, in which we also control for other characteristics required by firms, like the type of job, the level of education, the type of experience and the knowledge of informatics. Then, we make the demand for FL interact with the demand for these characteristics by estimating a set of bivariate probit models from which we extract the joint and conditional probabilities. Our estimates show that the probability to demand for FL increases with firm size, human capital intensity, engagement in R&D and in exporting goods, whereas the other internationalization activities are not significant when considered individually. Instead, we find a strong and positive effect on FL demand of increasing commitment to internationalization. Moreover, R&D and internationalization acts like observable substitutes on FL demand. When we further make FL demand interact with other required attributes, we find that the impact of increasing exposure to internationalization is higher when the firm also demands for professional occupations with a university degree, for specific experience and for the simultaneous knowledge of informatics. We conclude that FL are a strategic asset for firms and, from a labor demand perspective, are complementary to high levels of human capital.

Keywords: foreign languages, innovation, internationalization, labor demand

JEL: F16, J23, L60

Acknowledgments

We acknowledge with thanks Gilberto Antonelli and the School of Development Innovation and Change (SDIC) for providing the dataset. We also thank all the participants to the seminar at the European Commission Joint Research Center in Ispra (IT) and all the participants to the AlmaLaurea International Conference on 'Human capital and employment in the European and Mediterranean area', Bologna, 10-11 March 2011. In particular, we thank Francis Green for useful comments on a preliminary version of this paper.

1. Introduction

Knowledge of foreign languages (FL) is playing a central role in the globalization process of national economies leading to a more and more internationalized and integrated world. To trade in such a context, local companies need to be able to communicate and to be understood by their trading partners spread around the world. However, there are some evidences that the European firms, particularly of small and medium size, lose business opportunities because they lack adequate foreign language skills (COM(2005)596 final).

A survey commissioned by the Directorate for Education and Culture of the European Commission in 2005 (CILT, 2006), estimates that 11% of the European small and medium exporting companies (around 945.000) may be losing business because they are incapable to communicate effectively with their international counterparts. The same study estimates an average loss per business over a three-year period of 325.000€[1]. These results, combined with the ones of the Adult Education Survey (AES) module, carried out between 2005 and 2008, on self-perceived language skills, highlight a mismatch between demand and supply of foreign language skills on the labor market. According to this survey, more than one-third of the European population aged 25 to 64 perceives that it does not know any foreign language, whereas a slightly smaller proportion declares to know one foreign language. The most commonly spoken foreign languages are English, French, Spanish, German, and Russian (which are also the most commonly thought in schools) (Eurostat, 2010).

Many European initiatives aim at reducing this gap in order to increase the opportunities on the labor market, including employability, labor mobility, and the freedom to study in other countries. More generally, these initiatives have the ambition to improve the integration among the European Union member states and to foster the economy of the whole Union (e.g. the flagships "Youth on the move" and "An agenda for new skills for new jobs" of the EU2020 strategy (COMM(2010)2020)).

According to the 2010 Eurobarometer Survey (Eurobarometer 2010), when recruiting higher education graduates, the major part of European countries rate FL skills as important, with only an average 10% which considers them as not important (Figure 1). In particular, the perceived importance of FL increases when firms are large, operate in manufacturing industry, have recruited and plan to recruit higher education graduates, and increase their international contacts (see Table 12a and 12b, pp. 93-94). More importantly, when asked what type of skill will be most important for new higher education graduates in the next 5-10 years, in many countries (Italy included) firms answered FL abilities (see Table 32.a p. 133), in particular larger, private, manufacturing and highly internationalized firms (see Table 32.b, p. 134).

FIGURE 1 HERE

In Italy as well firms are increasing the recruitment of people to whom is required the knowledge of at least one FL. Figure 2 shows the 2006-2010 picture for Italian firms by industry, employment size, required level of education and type of occupation.

FIGURE 2 HERE

[1] This figure is clearly underestimated because the survey identified only those situations where companies were aware of the business lost or potentially lost.

As one can see, the average trend of demand for workers knowing at least one FL is increasing over time, being particularly emphasized in the case of the service industry and of knowledge-intensive occupations. Therefore, there seems to emerge a positive correlation between the skill content of tasks and the workers' knowledge of FL.

With this picture in mind, the main purpose of this paper is to investigate which factors, among firm attributes and strategies, act as drivers of the demand for FL by Italian firms. Relying on a relatively new firm-level dataset on Italian manufacturing, we try to estimate the impact that firm structural characteristics (like size, industry, geographic location, physical and human capital) and strategic activities, like innovation and internationalization ones, have on the probability that firm require applicants to know at least one FL. Such a relationship is estimated while accounting for potential endogeneity issues and for the typology of the vacant job, the level of education required, the type of experience required, and the simultaneous demand for the knowledge of informatics.

In so doing, our contribution to the existing literature is threefold. From the labor economics perspective, we enrich the evidence on the determinants of labor demand and on the relationship between technology, trade and skill recruitment. From the international economics perspectives, we provide complementary evidence on the relationship between language barriers and trade, by looking at the opposite direction of causality with respect to the one commonly investigated. This evidence can also be useful for realizing that the relationship between FL and trade is potentially endogenous, so that each empirical analysis should carefully account for this issue. Finally, from a policy perspective, we identify a set of factors that can be used as a framework to direct policies for the promotion of FL learning toward specific groups of persons and firms.

The remaining of the paper is organized as follow. Next section reviews the literature on the economic role of foreign languages, with a particular emphasis on firm-level studies. Section 3 presents the data (3.1), provides some descriptive statistics on labor demand (3.2) and foreign languages demand (3.3), and describes the variables used (3.4). Section 4 presents the econometric analysis and estimation results. Finally, section 5 concludes.

2. Literature review

Despite the well recognized strategic importance of FL for firms, industries and countries, the empirical economic literature started to intensively study the economic role of FL since the late 90s only, primarily due to a chronic lack of suitable data.

In this respect, Figure 3 presents the results of an extensive - but not exhaustive – literature review considering empirical scientific and working papers published in economics journals, or by economics departments, containing the words "language"/"language skills"/"language ability" in their abstracts or among their keywords. Following this strategy, we selected around sixty papers published between 1985 and 2011 that can be grouped into three different subject areas according to the level of analysis (Figure 3a) and to the main research questions (Figure 3b).

FIGURE 3 HERE

The first subject area, which corresponds to the "economic of language" literature, studies the determinants and the labor market consequences (i.e. higher earnings, lower costs of assumption) of the destination-language proficiency of immigrants. According to this literature, the proficiency in the destination-language among immigrants increases with the level of education and the duration of residence in the destination country, while decreases with a greater age of migration and with a married status before migration. Furthermore, the investment in the acquisition of foreign language skills shows a high rate of return (private and social) encouraging immigrants to

invest in language training. Finally, immigrants with higher proficiency levels in the destination-language are more efficient in adjusting to the destination labor market. A comprehensive overview of this subject area can be found in Chiswick (2008).

A second subject area can be identified moving from the micro (individual-based) to the macro-level (country-based) of analysis. The literature belonging to this area basically aims at estimating gravity models for identifying the determinants of international trade flows and concludes that the lack in FL skills is a severe barrier for the expansion and intensification of these flows. The latest developments of this field are mainly associated to Hutchinson (2002), Melitz (2008), Sauter (2009) and Fidrmuc and Fidrmuc (2011).

Finally, the third subject area takes the firm as unit of analysis and studies the determinants of the demand to FL skills as well as the relationship between these skills and firms' international performance (i.e. export and import intensity, foreign direct investment, international joint ventures). A large number of papers belonging to this area provide qualitative analysis (mostly based on case studies) and deals with multinational companies (or more often with their top management). However, when the linguistic problem is empirically analyzed, it is often done considering simply the lack of adequate foreign language skills as a source of "transaction costs". Many authors contributed to this field, among which, for instance, Clarke (1999, 2000), Crick (1999), Enderwick and Akoorie (1994), Lautanen (2000), Schlegelmilc (1987, 1988), Thirkell and Dau (1998), Williams and Chaston (2004).

Summing up, the literature review reveals, respectively: an increasing interest by economists in language-related topics, driven mainly by the "economics of language" subject area; a marginal but increasing interest in the relationship between FL skills and international trade flows; and, finally, a decreasing interest in the relationship between firm's characteristics, foreign language skills demand, and international performances.

For what concerns the empirical literature on the economic role of FL within international business, the available evidence is scarce (Table 1), and generally suffers from several methodological limitations that allow for very limited conclusions. The first limitations come from the small sample size used, ranging from 46 (Obben and Magagula, 2003) to 219 companies (Fernández-Ortiz and Lombardo, 2009), and from the perspective adopted that is always country-specific. Furthermore, this literature is based on data collected through simple attitudinal surveys (i.e. ad hoc questionnaires or interviews) yielding qualitative or anecdotal evidence. Finally, in most of these studies, FL skills are self-reported, exposing the estimates to possible biases.

TABLE 1 HERE

Acknowledging these limitations, the firm-related literature stresses the presence of a positive correlation between the use of FL and some measures of business outcomes. More precisely, most of the works in this area find that firms' capability to acquire, or develop, adequate FL skills increases the likelihood to internationalize, improves foreign trade intensity and profitability, and lastly opens the firm to a wide range of trade geographic diversification strategies. However, although most firms are aware of the benefits generated by these skills, generally, they adopt no specific recruitment and training strategy with respect to FL.

Moreover, all these studies, both in the international business and in the gravity-model literature on trade flows, are focused on assessing the economic impact of FL, whereas the other way around, i.e. the effect of international trade on FL use or demand, has been, at least to our knowledge, never investigated.

Broadly speaking, the demand for FL can be framed into the literature on skill biased technological change and skill biased international trade (see Chusseau, Dumont and Hellier, 2008 for an extensive review). In this respect, FL can be considered as one particular type of skill which is required for operating existing, or new, machinery and equipment, or for working with computers

and ICT, or for reading and compiling research projects and applications, or for working in team with high-skilled personnel. In addition, FL can be required for managing the exports of goods and services, or for managing trade and shop activities in foreign countries, or for setting up new plants and training new personnel abroad, just to mention a few cases.

However, while a number of previous studies support technical change as the main driver of skill upgrading, leaving little room to trade (Green, Felstead and Gallie, 2003), in this case we do expect the opposite being true, as knowledge of FL can be considered the main tool for opening and increasing the internationalization commitment of firms. In other words, FL can be an example of skills for which international trade may play the dominant role in driving the relative demand with respect to technology.

3. Data and variables

3.1. The dataset

Data are drawn from the merge of three datasets: the IX wave of the Survey on manufacturing firms (*Indagine sulle Imprese Manifatturiere*), carried out by Unicredit (formerly Mediocredito Centrale and Capitalia) and covering the period 2001-2003; the dataset Excelsior (*Sistema Informativo Excelsior*), carried out by the Italian Chambers of Commerce (*Centro Studi Unioncamere*) and covering the period 2003-2005; the Observatory on the balance sheets of joint-stock companies (*Osservatorio sui bilanci delle società di capitale*), developed by *InfoCamere* relative to years 2001-2003.

The IX Survey on manufacturing firms gathers information on a representative sample of 4.289 manufacturing firms active over the period 2001-2003. In particular, while firms with more than 500 employees are fully represented, firms employing more than 10 and less than 500 employees are selected with respect to their geographical localization, their employment size and the sector of economic activity. This survey is of particular importance since it contains a rich set of information on firm characteristics and activities. For the purpose of the paper, we rely on information pertaining: (i) firm size, industry and area of localization; (ii) the labour force composition; (iii) innovation and R&D; (iv) internationalization activities[2].

Excelsior is a dataset developed by the Italian Chambers of Commerce in cooperation with the Italian Ministry of Labour and with the European Social Fund. It gathers information on the predicted demand for labour by a representative sample of about 100.000 privately-owned companies with more than 1 employee, and distributed all over Italy (Centro Studi Unioncamere, 2007). The dataset is organized into four sections, concerning respectively: (1) the predicted annual employment inflows and outfolws, by type of occupation (i.e.managers, clerks and plant operators); (2) the characteristics and qualifications required to new employees, such as age, experience, education, gender, immigration status, type of labour contract, further training after recruitment, the knowledge of FL and of informatics; (3) the firm use of 'a-typical' employment contracts; (4) actual training activities developed in each year. For the purpose of the paper, we mainly focus on section 2[3].

In this section, at year *t* frms are asked to predict their employment needs for year *t*+1, in terms of: (i) type of occupation required according to the ISCO-88 classification of occupations (up to the 4 digit level); (ii) the number of employees required for each occupation; (iii) a set of additional information concerning age, experience, education, gender, immigration status, type of employment contract, further training after recruitment, the knowledge of FL and informatics. In this case, each observation corrsponds to the 4-digit ISCO-88 type of occupation that the firm requires for year *t*+1, and, for each occupation, we know how many individuals are specifically

[2] This dataset has been extensively utilised in international trade studies on Italy. See, among the others, Sterlacchini (2001), Castellani (2002), Basile, Giunta and Nugent (2003).

[3] See Antonelli, Antonietti and Guidetti (2010) for an empirical analysis on firm-provided training based on section 4.

required, as well as their age class and experience, and a set of other characteristics among which the knowledge of foreign languages.

Finally, the third dataset provides information on balance-sheet variables relative to joint-stock companies active in the period 2001-2003. The Observatory on the balance sheets is conducted and managed by InfoCamere on the base of the information contained on the national register of firms, in which all Italian stock companies are recorded. This dataset represents a very rich source of data, since it covers the whole population of Italian stock companies: hence, it allows to handle more than 600.000 balance sheets every year. Our merged dataset gathers information on four variables: sales, labour cost, net material assets and value added.

We first merge the Unicredit sample with balance sheet data coming from the Observatory on the balance sheets of joint stock companies, and we obtain an initial wide-form sample of 1.545 manufacturing firms with more than 10 employees and active all over the period 2001-2003.

Then, we merge this dataset with data from Excelsior – section 2 for year 2004 – thus getting a sample of 1.239 firms, from which we further drop those having missing values in employment and balance sheet variables, and firms with less than 50 employees[4]. Finally, since we know the actual employment flows in 2004, we delete those firms which do not realize their 2003 predictions in year 2004, while keeping only those firms with a 2003 labour demand prediction that is fully realized in 2004. The final sample is made by 828 firms and 2.205 observations[5], i.e.types of occupations/jobs demanded in 2003 and actually employed in 2004[6]. Table 2 shows the structure of the sample before and after the cleaning procedure.

TABLE 2 HERE

3.2. Descriptive statistics: the distribution of labor demand among manufacturing firms

Table 3 shows how the demand for occupations is distributed among firms (panel A) by employment size (panel B), sector of economic activity (panel C) and by level of education required (panel D). In panel A we see how the total demand for labor is distributed among occupations: in 2004, technicians and associate professionals are the most required types of occupation (28%), whereas, if we look at the intensity of labor demand, namely at the number of individuals required per each occupation, plant operators can be considered as the most attractive (7.4). In panel B and C, we see how the demand for occupations and the average number of required individuals are distributed according to firm size and their industrial specialization (according to the Pavitt classification).

TABLE 3 HERE

From panel B it is easy to see that as firm size increases both the demand for high-skilled labor (i.e. occupations from 1 to 3) and the relative intensity increase as well. Interestingly, the demand for middle and low skill occupations (from 4 to 9) is higher for medium firms (100-249), but the intensity is still higher for large firms.

[4] Small firms have been deleted from the sample due to their strong under-representativeness. See Antonelli, Antonietti and Guidetti (2010) for details about sample construction.

[5] This additional cleaning allows us to focus only on realized predictions, thus avoiding possible cases of over and under evaluation of employment needs.

[6] This means that each firms demands for about 2.7 occupational titles and 4.7 individuals in 2004.

From panel C we note that specialized-suppliers tend to demand for medium and high-skilled occupations (1 to 4) more frequently, whereas the highest intensity is registered for firms belonging to scale intensive and science-based industries. In average terms, however, traditional (i.e. *Made in Italy*) and specialized firms (primarily represented by firms operating in the machine tools sector) show the highest propensity and intensity to demand for labor.

Finally, we interestingly note that the distribution of the demand for occupations follows a standard educational path: that is, the demand for managers and professionals is more concentrated among firms demanding for university laureates, while the demand for clerical staff is more concentrated among firms demanding for secondary school laureates, and the demand for plant operators and unskilled personnel among firms requiring less than secondary school degrees. When we look at the distribution of the demand for education, we also note that, when firms demand for secondary school degree, the type of occupation mostly associated is plant operator, followed by associate professionals.

3.3. The distribution of the demand for foreign languages among manufacturing firms

We now focus on the demand for foreign languages (FL). In this case, the only exact information we know is whether, for each vacancy (i.e. for each type of occupation required), the firm is also demanding for the knowledge of at least one FL[7]. Table 4, on this purpose, shows the distribution of occupation-specific FL demand by employment size, sector, innovation and internationalization status, as well as by other required characteristics like the type of job (managerial, clerical, operative), the level of education (basic school, secondary school and university) and type of experience (generic and specific).

In Table 4 panel A, for instance, we have both the within-occupation and the between-occupation distribution of FL demand. Interestingly, we note that for medium-high skilled occupations (1 to 4) there is higher frequency of FL demand, the opposite being true for low-skilled occupations (5 to 9). When looking between occupations, we see that the probability to demand for FL is mainly concentrated among professionals and technicians, whereas the probability of not demanding for FL is mainly concentrated on craftsmen and plant operators.

From panel B, instead, we can see the within-occupation distribution of FL demand by size and sector of activity. Again, the probability to demand for FL is over 50% among high-skilled occupations, and is somehow increasing with firm size, even if not monotonically. As before, and in line with the evidence emerging from the Eurobarometer 2010, the demand for FL seems to be more relevant among high-skilled occupations, regardless the type of sector (except for clerks in scale intensive industries).

With respect to innovation and internationalization activities, panel C shows that, apart from the case of supplier dominated industries, the majority of firms in all the other sectors and engaged in R&D and/or in internationalization activities ask for the knowledge of FL. Particularly strong is the demand for FL by specialized suppliers and science based industries engaged in exporting activities. Hence, this picture seems to confirm that technology and international trade are two main drivers of FL demand, regardless of the sector of activity.

Finally, panel D shows the distribution of FL demand within and between occupations, required levels of education, required type of experience and required knowledge of informatics. When looking within each type of occupation, we note that the knowledge of at least one FL is needed in the majority of cases for managerial, associate professional and clerical activities, whereas plant operators and unskilled personnel are rarely asked to know FL. However, when looking at the distribution between occupations, we see that FL skills are mostly required to technicians and associate professionals. When looking at the distribution within and between required education levels and types of experience, one should note that FL are clearly associated

[7] We do not know, instead, if the demand for foreign languages involves all the individuals required for each occupation.

with a tertiary degree and a job or sector specific experience. Finally, we interestingly note that, while within vacancies requiring the knowledge of informatics only the 37% also requires the knowledge of FL, the opposite is true for vacancies requiring the knowledge of FL: in this case, more than 90% also associate a demand for computer and informatics.

TABLE 4 HERE

3.4. Variables description

Following Section 2, we identify four main sets of variables potentially affecting the firm propensity to demand for FL: (i) controls on firm characteristics like sectoral specialization, geographical localization and size; (ii) variables capturing the human and physical capital of the firm; (iii) variables of technology; (iv) variables of internationalization commitment. Additionally, we include variables referred to other characteristics and qualifications required, like the type of occupation, the level of education, the type of experience and the knowledge of informatics, as well as their interactions.

Among firm characteristics, we first measure sectoral specialization through 13 industry dummies (according to ATECO2001 classification of manufacturing activities). Then, we include the area of localization (*Border*), as given by a dummy equal to 1 for firms located in the North of Italy, at the border with countries like France, Switzerland and Austria (i.e. Aosta Valley, Piedmont, Liguria, Lombardy, Trentino Alto Adige, Friuli Venezia Giulia and Veneto). Finally, firm size (*Size*) is measured by average 2001-2003 employment (in natural logarithm).

Firm physical and human capital are measured, respectively, by 2001-2003 average real net capital assets per employee (in natural logarithm) (*lnK/E*) and average human capital intensity of the workforce, as given by the employment share of non-manual workers (i.e. managers, executives and technicians, clerks and administrative staff) (*HC*).

For measuring firm innovation activities we employ two dummies[8] capturing firms' decision to invest both in new machinery/equipment (*M*) and in R&D (*R&D*)[9]. While the former can be considered as a proxy of capital-embodied technological change, the latter can be considered as a measure of innovation input, which is more oriented to the creation of new products and processes.

In line with the skill-biased technical change hypothesis, firms may ask for FL in order to efficiently operate new equipment, or for managing their research activities. These latter may require the drawing up of projects, the reading of calls for projects, the use of advance machinery, the reading and understanding of patents and blueprints, as well as the presentation of results in international conferences or to international partners.

In addition to innovation, we also focus on the internationalization activities of firms. In particular, our merged dataset allows us to consider not only exports, but also a set of other complementary activities, like foreign markets penetration, trade agreements, foreign direct investments, product and technical agreements, the purchase of patents from abroad, the purchase of business services, and delocalization (offshoring).

Export activities are given by a dummy (*Export*) equal to 1 for firms selling their products abroad between 2001 and 2003. Foreign markets penetration activities are measured through a dummy (*Mkt_pen*) equal to 1 if firms decided to promote their own products abroad either through own-managed structures or through local traders or local partnerships.

[8] Unfortunately, our dataset does not gather any information on investments in ICT and patents.

[9] In the estimates, we also considered the amount of investments in new machinery and R&D per-employee. However, due to the high number of missing values and since they are never statistically significant, hereafter we only consider the dummy variables. Moreover, we also do not consider here variables of innovation output, like product and process innovation, since they are never statistically significant and since they are strongly related to simultaneous R&D.

Other two dummies concern firms' engagement in trade (*Trade_agree*) and production/technical agreements (*Prod_agree*) with foreign partners. In addition, we also include a dummy for the purchase of patents from abroad (*Patent*) and a dummy for the purchase of business services (*Services*) from foreign countries, like transport, insurance, communication, financial, computer, R&D, design and engineering services. Finally, the last two dummies concern the decision to engage in *FDI* and in *offshoring* production activities to low-wage countries (like East Europe, Tunisia, Morocco and China).

Next to these, we also include a variable measuring the degree of internationalization commitment of firms. Relying on the so called 'Uppsala internationalization process model' (Johanson and Vahlne, 1977, 1990, 2009; Luostarinen, 1980; Benito and Gripsrud, 1992), we imagine the existence of a hypothetical *establishment chain* process[10] of firms' expansion into foreign markets, which begins from the decision to export goods, goes through the decision to penetrate foreign markets by commercial promotion operations and partnerships, and ends up with the decision to directly transfer production abroad through FDIs[11]. This sequential steps are mainly attributable to the increasing risk and uncertainty associated with international activities: therefore, rational firms pass from one stage to the following once they accumulate a sufficient amount of experience and knowledge of foreign markets.

From the empirical point of view, this idea has been translated, for instance, by Basile, Giunta and Nugent (2003), who develop the so called Foreign Expansion Index (*FEI*), whose aim is to account for the cumulative nature of internationalization activities of firms, just based on accumulating experience, knowledge and higher commitment.

In line with this literature, our FEI variable takes the value of 0 for purely domestic firms, 1 for firms that only engage in exporting activities, 2 for firms involved in exporting and market penetration operations, including trade agreements, and 3 for firms engaged in exporting, market penetration activities and FDI[12].

Finally, we split this variable into four dummies, *FEI_0*, *FEI_1*, *FEI_2* and *FEI_3* (being *FEI_0* the reference), in order to separately capture the marginal contribution of the increasing commitment to internationalization on the demand for FL. Table 5 shows the frequency of these internationalization activities and the correlation matrix.

TABLE 5 HERE

As a robustness check, we also re-estimate our model by including two alternative measures of foreign expansion, in order to properly account for product and technical agreements. Since the real nature of these activities is not fully clear from the questionnaire, we can consider them either as similar to trade agreements (as in Calia and Ferrante, 2008) or as alternative to FDIs (as in Federico, 2006). Therefore, we define two other indexes of foreign expansion, the first (*FEI*(*1*))

[10] Unfortunately, since we do not have information on the country of destinations of exports and other internationalization activities, we cannot test for the role of the second hypothesis characterizing the Uppsala model of firm internationalization, namely the *liability to foreignness*, which predicts that firms start expanding their activities into psychically closed markets, then exploring more distant ones when a sufficient amount of experience and knowledge has been accumulated.

[11] One can also think such a sequence of internationalization activities in terms of the amount of sunk costs involved in each step (Helpman *et al.*, 2004). For instance, we can reasonably think that sunk costs increase from export, which is mainly based on the packaging and transport of goods abroad, to market penetration activities, where firms, other than transferring goods, have to open and manage own proper activities and invest in advertising or promotional activities, up to the search for suitable partners in the case of trade agreements. Finally, FDIs require the highest amount of financial resources (and the highest amount of opportunity costs) since firms are involved in setting up and managing new plants and in monitoring the performance of foreign suppliers.

[12] In this case, we do not include the purchase of business services and patents from abroad, as well as offshoring, as they do not strictly represent a true vertical step into the foreign expansion process of the firm, but, rather, transitional stages (Basile, Giunta and Nugent, 2003).

including technical agreements with trade agreements and commercial penetration operations, while the second (*FEI*(*2*)) including them with FDIs. Results are shown in Table A1 in the Appendix.

4. Econometric analysis

The econometric analysis develops along three steps. First, we estimate the propensity of Italian manufacturing firms to demand for FL, using a set of univariate probit models in which we include innovation and internationalization variables separately and in interaction among them (Tables 6 and 7). In so doing, we also control for endogeneity and for alternative specifications of our FEI variable (Table A1 in the Appendix).

In the second step, we estimate a set of univariate probit models in which, as regressors, we include the demand for other qualifications, like the type of job position (managerial, professional/technical, clerical, operative), the level of education (basic school, secondary school, university), the type of experience (general, specific) and knowledge of informatics (Table 8). This exercise is given to show that the demand for FL is not independent from the demand for other characteristics and skills. In other words, in line also with the general picture emerging from the Eurobarometer (2010) survey, we investigate if the knowledge of FL is a kind of 'horizontal asset' which is associated to the demand for other qualifications.

Finally, we test this last exercise more consistently by estimating a set of multivariate probit models, in which we take into account the correlation among all these dependent variables (Tables 9 to 12).

Since each observation in our dataset corresponds to a single job vacancy, we are in presence of repeated observations for each firm (see footnote 6). Therefore, next to standard unweighted estimates, in Tables 6 and 7 we use frequency weights in order to account for the heterogeneous number of workers demanded by each firm. From Table 8 onwards, we only present results for weighted estimates[13].

4.1. Results from univariate probit estimates on FL demand

From Table 6, model 1, we first note that weighted estimates are in line with unweighted ones in identifying four variables as statistically significant in affecting FL demand: firm size, human capital, R&D and export. In particular, a 1% increase in firm employment size with respect to the mean increases the probability to demand for FL by an average 8%, while increasing the share of skilled personnel by 1% is related to a 41 to 53% increase. Other things being equal, larger and more human capital intensive firms show a higher propensity to ask new workers for the knowledge of at least one FL, reflecting the idea that FL are mostly utilized in complex organizations and for being able to interact with skilled colleagues who, in principle, do also speak FL on the job.

Among technology-related variables, only R&D shows a statistically significant coefficient: in particular, being an R&D firm increases the propensity to demand for FL by an average 6-7%. On the contrary, neither the stock of capital equipment nor investments in new machinery and equipment seems to affect the demand for FL. It can be the case, for instance, that firms invest in new machinery only if they already employ people with knowledge of FL; or, differently, it can be that firms, instead of employing new workers, opt for (re)training their current workforce on how to efficiently operate such new equipment (Antonelli, Antonietti and Guidetti, 2010).

[13] From Tables 6 and 7, one should note that the performance of our Probit models increases when the estimates are weighted. This is clear both from the value of the pseudo R^2 and from the share of correctly classified predictions. In addition, for all the specifications, the Hosmer and Lemeshow (H-L) goodness of fit test does not reject the null hypothesis of correct specification, and the Ramsey RESET test (applied to the corresponding linear probability specification) confirms that models have no omitted variables.

Looking at international trade variables in model 2, we find that being an exporter increases FL demand by 13-14%. Surprisingly, when export interacts with the other internationalization modes, results become weaker. In particular, we find a lower coefficient for firms that only export (around 6% and significant only at 10%), and a low effect of the interaction between export and market penetration for the unweighted regression only. Surprisingly, the effect of technical agreement on FL demand is negative (from - 8% to -12%). This can be due to the labor saving nature of these operations: since firms can transfer part of their production activities to foreign partners, as a sort of subcontracting abroad activity, they may reduce the demand for labor, and, consequently, the demand for FL[14]. All the other variables, when simply interacted with exports, are not statistically significant.

Differently, they turn to be significant once we include them into our measure of increased commitment to internationalization. From model 3 we find that as firms cumulate international activities, their demand for FL increases by 4% on average. Estimates of model 4 confirm this result: when we decompose the FEI variable into its four elements, we find that the effect of increased exposure to trade ranges from 13% to 19% (unweighted estimates), and from 15% to 18% (weighted estimates). As expected, these effects are much higher than the ones registered for technology-related variables.

In Table 7 we show the effect of the interactions between technology (R&D) and trade variables on FL demand. In model 1 we make R&D interact with export, whereas in model 2 and 3 we make R&D interact with FEI and its elements. Interestingly, all the three specifications confirm that technology and trade act like substitutes in driving FL demand. In other words, they are perceived by firms as equivalent in driving the demand for FL.

In Table 8 we include as regressors a set of dummy variables reflecting the demand for other characteristics and qualifications. For reasons of space, we report only the estimated coefficients related to these variables. In the first column, we include, among the other regressors, three dummies capturing the type of job position required, distinguishing between managerial, technical/professional and operative ones (keeping clerical positions as the reference). In the second column, we consider dummies related to the required level of education, namely basic school and university (being secondary school degree the reference). In the third, instead, we include two dummies measuring the demand for generic Vs specific experience. In the fourth, we control for knowledge of informatics, distinguishing between basic knowledge as a simple user and advanced knowledge as a programmer. In the fifth column, we include all these variables together, and in the last two columns we make the type of job position required interact with the level of education and the type of experience.

Our estimates show that almost all these variables are relevant in shaping the demand for FL. In particular, we find that the propensity to demand for FL increases with: (i) the demand for knowledge-intensive positions, whereas it decreases with the demand for manual and less skill-intensive activities; (ii) a high level of education; (iii) a specific type of experience; (iv) knowledge of informatics, in particular for programmers. These results are strengthened in the last two columns, in which we see that FL demand increases when firms also demand for high skilled position with a university degree and a specific type of experience.

TABLE 6 HERE

TABLE 7 HERE

TABLE 8 HERE

[14] This negative effect is also reproduced in Table A1 in the Appendix, once we make technical agreements to be part of our alternative foreign expansion indexes.

4.2. Endogeneity

Before proceeding with the multivariate analysis, we check for the existence of potential endogeneity issues in the estimates. In particular, two main sources of potential endogeneity may characterise the relationship between FL demand and firms' international trade activities: the presence of unobserved characteristics and reverse causality. The former may be due, for instance, to industry-specific unobserved factors, which may affect the demand for FL independently from international trade and innovation-related variables. In this case, we control for this issue by using our 13 two-digit industry dummies.

Since we avoid simultaneity issues by measuring explanatory variables at least one year before our dependent variable, the latter source of endogeneity may be due to the fact that some firms choose to export even without having the initial 'right' amount of FL capital, with the idea, formulated at year t, of requiring, at time t+1, workers with the knowledge of FL, i.e. only after exports have started and/or reached a certain amount of business. In this case, the positive relation between FL demand and export (or the other internationalization activities) comes from the effect that the accumulation of FL capital at time t+1, as predicted at time t, can have on internationalization choices at time t.

In order to control for this possible effect, we use the Smith and Blundell (1986) test of exogeneity, in which we assume that, under the null hypothesis, all the explanatory variables are exogenous. The test statistic is evaluated with respect to a Chi squared distribution in the number of potentially endogenous variables. For simplicity, we assume that the potentially endogenous variables are the ones related to internationalization, so that we test for the exogeneity of each of them separately. With respect to the export dummy, which is the one showing the highest frequency (see Table 5), the Smith and Blundell test statistics takes the value of 0.7154 with a p-value of 0.3977[15], so that we cannot reject the null hypothesis of appropriate model specification with the export variable as exogenous.

4.3. Multivariate probit estimates

However useful, the univariate approach ignores the potential cross correlation across the various "skill demand" variables for the same firms that are not reflected in observable characteristics. Due to these unobserved factors, a firm's demand for a variety of qualifications can well be related through the error components. Therefore, crucial cross-qualification information may be lost using a univariate approach.

For this reason, we first estimate a series of bivariate probit models in which we place our FL demand variable side by side the other dummies specified in section 4.1. In particular, in Table 9 we show the results concerning the demand for FL and for managerial, professional and clerical positions respectively; in Table 10 we consider the demand for education and knowledge of informatics; in Table 11 we consider the demand for experience. Since we are interested in the interactions between FL and other attributes, from each estimate we extract the marginal effects related to the joint and conditional probabilities (in italics). With the former we look at the probability to demand for FL and, simultaneously, for another specific attribute, whereas with the latter we consider the probability to demand for FL once the firm has required for a certain qualification yet. In other words, joint and conditional probabilities reflect two different time-sequences of labour demand: in the former case, the firm simultaneously demand for FL and other characteristics, in the latter the firm first demands for a specific job characteristic (i.e. the level of education, the type of job, or the type of experience), and, conditional on this, demands for the

[15] Results for all the other internationalizaton dummies, and for our FEI variable, do confirm that we cannot reject the null hypothesis of exogeneity of the explanatory variables, so that we can still consider our probit specification as appropriate.

knowledge of at least one FL. Then, in Table 12 we estimate a set of trivariate probit models, in which, as dependent variables, we include the FL dummy, the dummy related to the demand for professionals, and the dummies related to the level of education, the type of experience and knowledge of informatics respectively.

From Table 9 we first see that, apart from firm size and location at the national border, investments in new equipment and increasing foreign expansion significantly impact on the joint probability to demand for FL and for managerial positions. Differently, we find that, once demanded for a managerial position, the demand for FL is primarily driven by a higher share of human capital and export (FEI1), while a lower effect is played by R&D and FEI2 (i.e. export + foreign market penetration), with the coefficient of M turning to be negative.

A different picture seems to characterize the demand for FL and technical-professional positions. In this case, R&D and FEI variables play a significant role in affecting the joint probability, whereas they turn to be weakly or no significant at all when we look at the conditional probability. In particularly, we find that as the exposure to internationalization increases, the probability to demand for FL and for a technical position increases as well, passing from 11 to 17%, whereas the coefficient of R&D is lower (around 5%) and less significant. Differently, once the firm has already identified a vacancy for a technical position, the further demand for FL is only driven by firm size and human capital intensity.

When we pass to less qualified positions, we find that the effect of both technology and trade on the joint probabilities decreases or becomes statistically insignificant, whereas we find a more relevant effect on the conditional probabilities. For instance, we note that passing from FEI1 to FEI3, once opened a vacancy for a clerical position, increase the probability to demand for FL from 18 to 24%. Instead, when we look at plant operator positions, we find that only exports (i.e. FEI1) play a really statistically significant, but weak, effect on joint and conditional probabilities[16].

From Table 10 we see the estimation results with respect to education and knowledge of informatics. With respect to the former, the first six columns show that, a part from controls on size and human capital, a higher commitment into trade impacts more on FL demand the higher is the associated required level of education. However, we note that the process of foreign expansion does affect the joint probability of FL and education in different ways: the more the process becomes complex, in particular involving FDI, the higher is the probability for firms to demand for university laureates with knowledge of FL; when, instead, the process regards the first two steps, i.e. exports and market penetration, there is a higher probability to demand for secondary school laureates.

A still different picture emerges when we look at conditional probabilities. In this case, once demanded for a university laureate, firms ask for the knowledge of FL when they export and penetrate foreign markets, whereas when conditioning for the demand for a secondary school diploma, the probability to ask for FL is increasing with the transition from exports to FDI. This means that, as the exposure to trade increases, the demand for middle levels of education has to be "integrated" by a further demand for FL, whereas this is not the case for higher levels of education, the demand for which probably "includes" the one for FL.

Table 11 shows the results of the bivariate probit estimates involving the demand for FL and for the type of experience, distinguishing between no experience at all, generic and specific to the job or to the sector. When we look at the joint probabilities, it is easy to note that the marginal effect of our technology (R&D) and internationalization variables on FL demand is higher when firms also require a specific type of experience. Moreover, the joint demand for FL and specific experience increases as the process of foreign expansion increases. On the contrary, the joint demand for FL and generic experience is limited to the earliest stage of internationalization. A similar picture seems also to characterize the demand for Fl conditional on the demand for experience: even if the conditional probability increases with the FEI, we find that the marginal

[16] The stronger correlation between the FL and technical/professional job positions dummies is also reflected into the magnitude of the rho coefficient.

effects associated to specific experience are always higher than the one related to no experience and general experience.

Finally, in Table 12 we show the results of the trivariate probit estimates, in which, as dependent variables, we consider the demand for FL, the demand for professional/technical occupations[17] and, respectively, the level of education, the type of experience and the knowledge of informatics, both as a user and as a software programmer. For simplicity, we only report the marginal effects on the joint probabilities. Due to the highly non linearity in the parameters and variables involved, following Calia and Ferrante (2008), we compute marginal effects and standard errors for the predicted probabilities using simulations and numerical gradients. In particular, we simulate 500 sets of parameters from an asymptotic multivariate normal distribution, calculating each time the predicted probability and its derivatives with respect to mean of the covariates. Then we obtain 500 sets of predicted probabilities and marginal effects, and sample standard errors are further generated as estimates for the standard errors of the predicted probabilities and marginal effects.

Again, the estimates confirm the previous picture: the statistically significant variables are firm size, human capital intensity, R&D and, most of all, the index of foreign expansion. In particular, we find that a higher commitment into internationalization stimulates the simultaneous demand for FL, technical positions and, respectively, a tertiary level of education, a specific type of experience and a basic knowledge of informatics, namely as a computer user. Moreover, we still find that the marginal effects of FEI are always higher than the ones of the technology related variables, thus confirming our expectations on the dominant role of international trade over technological change in driving language skills accumulation[18].

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TABLE 9 HERE

TABLE 10 HERE

TABLE 11 HERE

TABLE 12 HERE

5. Conclusions

What drives the demand for FL by Italian manufacturing firms? We answer this question relying on a rich firm-level dataset which gathers information on firm characteristics and skill demand over the period 2001-2004. We first estimate a series of univariate probit models in which our explanatory variables refer to firm size, physical and human capital intensity, geographical localization, innovation and internationalization activities. Since foreign languages are also a tool for acquiring or developing other types of skills, we also estimate a series of univariate probit models in which, as regressors, we include the demand for other qualifications, like the type of job position, the level of education, the type of experience and knowledge of informatics. In order to better account for the cross correlation structure of these variables, we also estimate a series of multivariate probit models

[17] We choose professional occupations both from previous estimate results and also for computational reasons, as from Table 3, panel D, we know that this category displays the highest number of observations associated to a medium-high required educational level.

[18] As last control, we consider as dependent variable the demand for FL at year 2005. The estimates, not reported here for reasons of space, show that neither technology nor internationalization activities do have any statistically significant impact. Therefore, their effect on FL needs does not seem to be persistent over time, but vanishes after one year.

in which the probability to demand for foreign languages is also estimated jointly and conditional to the probability to demand for these other qualifications.

Differently from the traditional literature on skill-biased technological change, we find not only that increasing exposure to international trade does have a significant impact on FL demand, but also that it dominates technology related activities. In particular, we find that the internationalization activities of the firm stimulate the demand for FL once they accumulate over exports, which remains the most foreign language-intensive activity. Therefore, it is not the single internationalization activity per se that matters, but, rather, it is the increasing exposure to international trade which increases the needs for FL capital.

We also find that such an effect is particularly strong when the demand for FL is associated to the demand for high-skilled job positions, particularly associate professionals and technicians, a tertiary school degree, a sector-specific type of experience and a basic knowledge of informatics.

What drives the demand for FL, then, seems to be the accumulation of international trade activities over exports, when the internationalization process becomes more uncertain and risky to manage and thus requires a higher knowledge of FL in order to better communicate and interact with foreign counterparts (i.e. partners, customers, and local authorities), to get a higher knowledge on the functioning of foreign markets and to reduce cultural barriers with more distant countries (Kogut and Singh, 1988, Benito and Gripsrud, 1992).

These results lead us to conclude that FL are perceived by firms not only as strategic for developing their internationalization process, but also as complementary to other high-level skills, which are mainly reflected in higher level of required education and experience.

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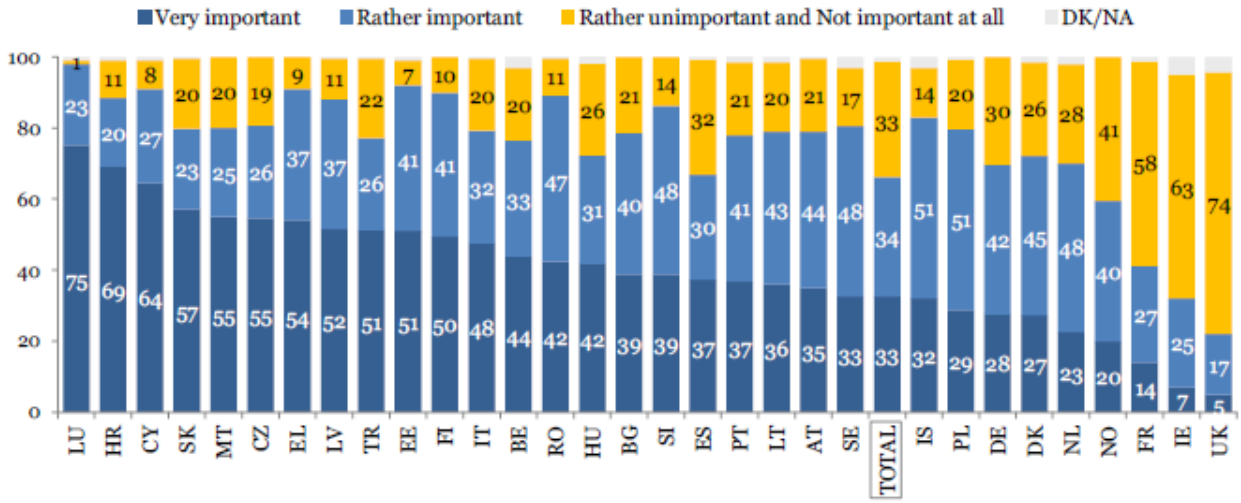
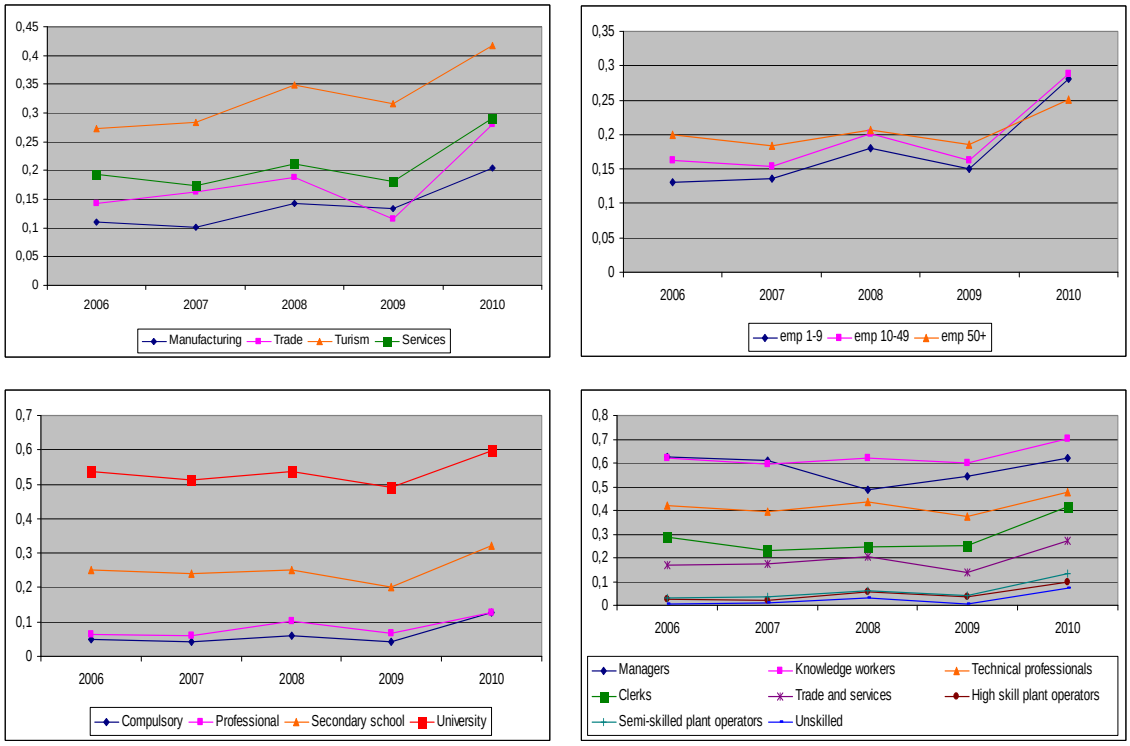
Figure 1. Importance of FL skills when recruiting higher education graduates



Source: Eurobarometer 2010, p. 18.

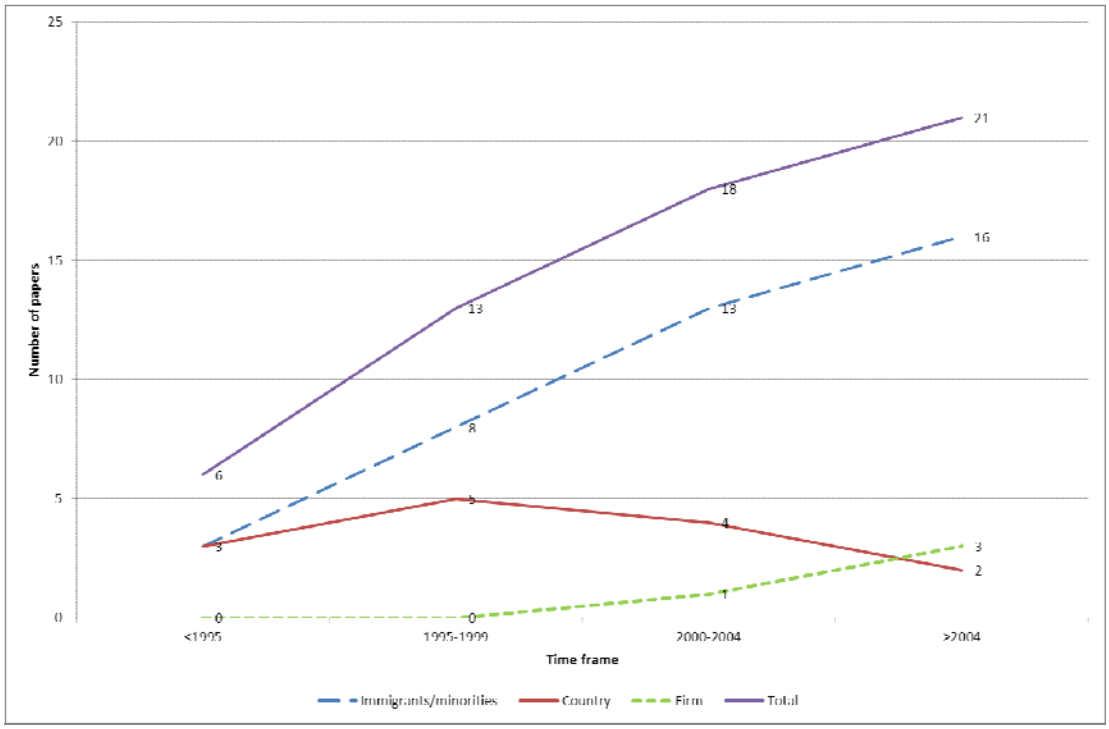
Figure 2. Share of firms demanding for the knowledge of foreign languages in Italy, 2006-2010



Source: our elaborations from Excelsior on-line database: http://excelsior.unioncamere.net

Figure 3. Literature review by subject area, period and research interest

(a)



(b)

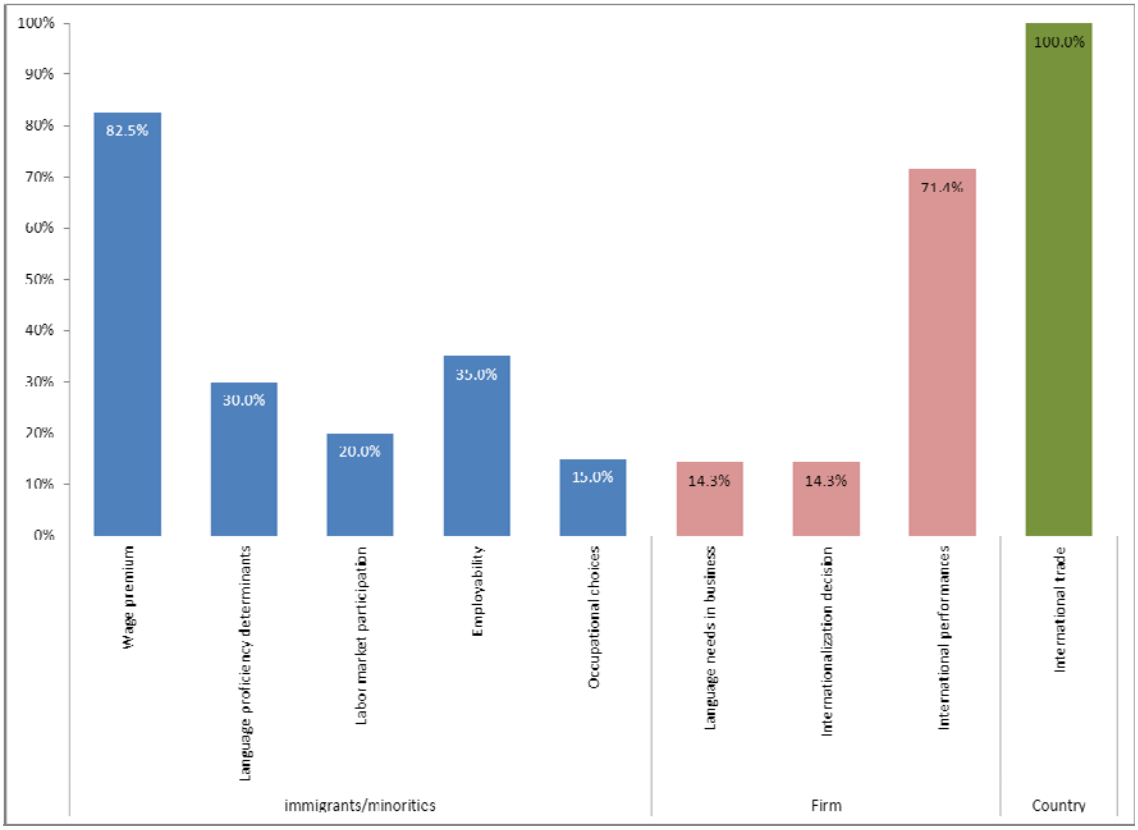


Table 1. Firm-related literature: main characteristics and results

1st author	Year	Issue		Sample		Methodology	FL		Results of interest
		FL-EXP	FL-USE	Size	Country		Self-report.	Dummy	FL are positively (+), negatively (-), or not related (=) with:
Schlegelmilch	1987	X		51	UK	t-test mean comparison	X		(+) EXP propensity & profit.
Schlegelmilch	1988	X		105	UK	Stepwise OLS	X		(+) EXP propensity
Enderwick	1994	X		38	NZ	Descriptive statistics	X		(+) EXP success
Haar	1995	X		67	BR	Factor and discriminant analysis		X	(+) EXP propensity
Clarke	1999		X	201	IE	Descriptive statistics	X		(+) EXP success
Crick	1999		X	185	UK	Descriptive statistics	X		(=) Recruitment strategy
Lautanen	2000	X		76	FI	Probit	X		(+) EXP propensity
Obben	2003	X		46	SWA*	Logit	X		(+) EXP propensity
Knowles	2006		X	74	UK	Descriptive statistics	X		(+) International. Success
Williams	2008	X						X	
Fernández-Ortiz	2009	X		219	EE	OLS	X		(+) geographic diver.
Shih	2010	X		103	TW	Logit	/		(+) EXP propensity

Notes: FL-EXP= relationship between FL demand and export performance; FL-USE=type of use of FL.

Table 2. Sample structure by employment size, geographical location and industry

	Before cleaning		After cleaning	
Firm size	**N.**	**%**	**N.**	**%**
Small (11-49)	306	19.81	-	-
Medium (50-249)	862	55.79	564	68.12
Large (≥ 250)	377	24.40	264	31.88
Area	**N.**	**%**	**N.**	**%**
North West	591	38.25	312	37.68
North East	508	32.88	296	35.75
Centre	237	15.34	124	14.98
South	209	13.43	96	11.59
Industry (Pavitt classification)	**N.**	**%**	**N.**	**%**
Supplier dominated	705	45.63	358	43.24
Scale intensive	271	17.54	150	18.11
Specialized suppliers	484	31.33	279	33.70
Science based	85	5.50	41	4.95
Industry (ATECO1991 classification)	**N.**	**%**	**N.**	**%**
DA – Food, beverages and tobacco	116	7.51	61	7.37
DB – Textile	162	10.49	78	9.42
DC – Leather	62	4.01	25	3.02
DD – Wood	36	2.33	21	2.54
DE – Paper, publishing, printing	77	4.98	35	4.23
DF + DG – Coke + Chemicals	99	6.41	52	6.28
DH – Rubber, plastics	83	5.37	45	5.43
DI – Non-metallic mineral products	92	5.95	51	6.16
DJ – Metal products	248	16.05	146	17.63
DK – Machinery, equipment	272	17.61	162	19.56
DL – Electrical and optical equipment	141	9.13	73	8.82
DM – Transport equipment	58	3.75	36	4.35
DN – Other manufacturing	99	6.41	43	5.19
Total	**1.545**	**100.0**	**828**	**100.0**

Table 3. The distribution of labour demand by occupation

Panel A	**N.**	**%**	**Ave. Int.**
1. Legislators, senior officials and managers	77	3.49	1.14
2. Professionals	265	12.02	3.62
3. Technicians and associate professionals	627	28.44	2.60
4. Clerks and administratives	154	6.98	2.5
5. Craft and related trade workers	374	16.96	5.95
6. Plant operators and assemblers	559	25.35	7.37
7. Elementary occupations	149	6.76	5.96
Total	**2.205**	**100.0**	**2.67**

Panel B	**50-99**		**100-249**		**250-499**		**500+**	
	%	**Int**	**%**	**Int**	**%**	**Int**	**%**	**Int**
1. Legislators, senior officials and managers	3.90	1.14	16.88	1.08	27.27	1.10	51.95	1.18
2. Professionals	6.79	1.11	23.01	1.67	27.16	1.75	50.94	5.54
3. Technicians and associate professionals	9.57	1.15	28.87	1.41	20.10	2.11	41.47	4
4. Clerks and administratives	9.74	1.07	32.47	1.56	22.73	1.94	35.06	4.13
5. Craft and related trade workers	16.31	2.08	41.98	3.57	16.04	5.12	25.67	12.80
6. Plant operators and assemblers	17.89	2.56	41.86	3.80	15.74	9.18	24.51	15.82
7. Elementary occupations	12.75	3.42	44.30	3.20	16.78	6.12	26.17	11.77
Total	**12.52**	**2.02**	**34.56**	**2.77**	**18.41**	**4.22**	**34.51**	**7.77**

Panel C	**Traditional**		**Scale**		**Specialised**		**Science**	
	%	**Int**	**%**	**Int**	**%**	**Int**	**%**	**Int**
1. Legislators, senior officials and managers	33.77	1.08	24.68	1.37	31.17	1.08	10.39	1
2. Professionals	24.91	2.43	18.11	4.85	37.74	3.12	19.25	4.96
3. Technicians and associate professionals	34.61	2.02	22.17	3.98	38.12	2.35	5.10	2.44
4. Clerks and administratives	29.22	2.64	21.43	2.61	43.51	2.34	5.84	2.56
5. Craft and related trade workers	52.40	5.26	18.72	6.49	26.74	6.96	2.14	5.38
6. Plant operators and assemblers	38.64	5.73	23.44	9.57	32.02	8.14	5.90	5.21
7. Elementary occupations	47.65	4.59	23.49	4.71	26.17	8.79	2.69	13.5
Total	**37.96**	**3.99**	**21.54**	**5.83**	**33.92**	**4.75**	**6.58**	**4.35**

Note: Int. represents the average number of individuals that each firm predicts, at year 2003, to employ for year 2004 by type of occupation.

Panel D	**University**	**Secondary**	**Basic**	**Total**
1. Managers	63	14	0	77
Column %	*11.50*	*1.32*	*0.00*	*3.49*
Raw %	*81.82*	*18.18*	*0.00*	*100.0*
2. Professionals	450	385	0	892
Column %	*82.12*	*36.18*	*0.00*	*37.87*
Raw %	*50.45*	*49.22*	*0.34*	*100.0*
4. Clerks	34	108	1	154
Column %	*6.20*	*10.15*	*0.17*	*6.49*
Raw %	*22.73*	*76.62*	*0.65*	*100.0*
6. Plant operators	1	557	592	1122
Column %	*0.18*	*52.35*	*99.83*	*52.15*
Raw %	*0.09*	*48.43*	*51.48*	*100.0*
Total (column %)	*100.0*	*100.0*	*100.0*	*100.0*

Table 4. The distribution of FL demand (predictions for year 2004)

	Raw %		Column %	
Panel A	Yes	No	Yes	No
1. Legislators, senior officials and managers	77.92	22.08	7.06	1.25
2. Professionals	83.02	16.98	25.88	3.32
3. Technicians and associate professionals	66.83	33.17	49.29	15.35
4. Clerks and administratives	54.55	45.45	9.88	5.17
5. Craft and related trade workers	6.15	93.85	2.71	25.90
6. Plant operators and assemblers	6.80	93.20	4.47	38.45
7. Elementary occupations	4.03	95.97	0.71	10.55
Total			100.0	100.0

Raw % (yes) **Panel B**	50-99	100-249	250-499	500+	Trad.	Scale	Spec.	Science
1. Legislators, senior officials and managers	66.67	76.92	76.19	80.00	84.62	63.16	75.00	100.0
2. Professionals	83.33	75.41	90.20	83.70	83.33	85.42	85.00	76.47
3. Technicians and associate professionals	66.67	65.75	57.94	71.92	91.75	69.78	66.11	93.75
4. Clerks and administratives	46.67	56.00	34.29	68.52	55.56	36.36	61.19	66.67
5. Craft and related trade workers	1.64	4.46	6.67	11.46	3.06	10.00	10.00	-
6. Plant operators and assemblers	2.00	6.84	4.55	11.68	5.09	2.29	12.29	6.06
7. Elementary occupations	-	4.55	-	7.69	4.23	2.86	5.13	-

Notes: Trad. = supplier dominated sectors; Scale = scale intensive; Spec. = specialized suppliers; Science = Science based.

Panel C	% R&D	%FL	% export	% FL	% internationalized	% FL
Supplier dominated	52.79	48.15	61.17	47.95	71.79	45.53
Scale intensive	51.33	58.44	58.67	54.55	73.33	52.73
Specialized suppliers	73.12	60.78	88.89	61.29	91.76	60.55
Science based	73.17	66.67	60.97	72.00	80.49	66.67

Note: % internationalized refers to the share of firms engaged in at least one internationalization activity; % FL refers to the share of firms demanding for the knowledge of at least one FL on the sub-group of R&D, exporting and internationalized firms respectively.

Panel D	% obs.	FL (% column)	FL (% raw)
Basic school	26.89	3.20	2.24
Secondary school	48.25	35.53	44.47
University	24.86	82.66	53.29
Managers	3.49	77.92	7.06
Professionals	37.87	73.53	72.24
Clerks	6.49	57.34	9.65
Plant operators	52.15	8.17	11.06
Generic experience	18.59	20.98	10.12
Specific experience	60.05	49.85	77.65
No experience	21.36	22.08	12.23
Computer	95.37	37.14	91.88

Note: *FL (% column)* answers the following question: among observations having 1 in the demand for that specific characteristic (i.e. education, type of job, experience), what is the percentage of observations for which there is also a demand for FL? *FL (% raw)*, instead, answers the question: among observation with a value of 1 in the demand for FL, what is the share of observations having also 1 in the demand for that specific characteristic?

Table 5. Sample distribution of internationalization activities and correlation matrix

Variables	% obs.	% firms	1	2	3	4	5	6	7	8
1. Export	89.84	87.44	1.0000							
2. Mkt_pen	35.33	33.82	0.2454	1.0000						
3. Trade agree	18.82	17.03	0.1724	0.3954	1.0000					
4. FDI	5.76	5.07	0.0976	0.2140	0.1713	1.0000				
5. Prod. agree	13.25	7.97	0.1194	0.1863	0.3363	0.1903	1.0000			
6. Patent	5.67	3.62	0.0500	0.1799	0.0028	0.1130	0.2007	1.0000		
7. Offshore	14.78	13.16	0.0935	0.0878	0.0895	0.5187	0.2289	0.0857	1.0000	
8. Services	26.03	25.60	0.1208	0.2318	0.1223	0.1363	0.2001	0.2345	0.0441	1.000
Variables	**% obs.**	**% firms**	**1**	**2**	**3**	**4**				
1. FEI=0	10.16	12.26	1.0000							
2. FEI=1	51.52	49.06	-0.347	1.0000						
3. FEI=2	33.29	32.31	-0.238	-0.728	1.0000					
4. FEI=3	5.03	4.25	-0.077	-0.237	-0.163	1.0000				
1. FEI(1)=0	10.16	12.26	1.0000							
2. FEI(1)=1	50.07	47.52	-0.337	1.0000						
3. FEI(1)=2	34.74	33.96	-0.245	-0.731	1.0000					
4. FEI(1)=3	5.03	4.25	-0.077	-0.231	-0.168	1.0000				
1. FEI(2)=0	10.16	12.26	1.0000							
2. FEI(2)=1	51.52	49.06	-0.347	1.0000						
3. FEI(2)=2	27.66	27.83	-0.208	-0.638	1.0000					
4. FEI(2)=3	10.66	8.73	-0.116	-0.356	-0.214	1.0000				

Note: all correlations are significant at 5%.

Table 6. Univariate probit estimates on FL demand

	(1)		(3)		(4)		(5)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.085***	0.076***	0.083***	0.079**	0.089***	0.081***	0.085***	0.076***
	(0.013)	(0.012)	(0.012)	(0.013)	(0.012)	(0.012)	(0.013)	(0.012)
Border	0.020	0.004	0.020	0.011	0.023	0.007	0.021	0.005
	(0.024)	(0.027)	(0.024)	(0.027)	(0.024)	(0.028)	(0.024)	(0.028)
HC	0.424***	0.519***	0.422***	0.521***	0.414***	0.511***	0.424***	0.519***
	(0.066)	(0.077)	(0.067)	(0.076)	(0.066)	(0.075)	(0.067)	(0.077)
lnK/E	0.009	0.009	0.008	0.006	0.005	0.004	0.009	0.009
	(0.015)	(0.017)	(0.015)	(0.017)	(0.015)	(0.017)	(0.015)	(0.018)
R&D	0.064*	0.065*	0.077**	0.078**	0.056*	0.061*	0.061*	0.064*
	(0.025)	(0.027)	(0.026)	(0.029)	(0.026)	(0.028)	(0.026)	(0.028)
M	-0.027	-0.068	-0.023	-0.055	-0.026	-0.063	-0.030	-0.069
	(0.063)	(0.063)	(0.065)	(0.063)	(0.064)	(0.061)	(0.064)	(0.064)
Export	0.125**	0.139***						
	(0.039)	(0.042)						
Export * R&D								
Export_only			0.066°	0.064°				
			(0.035)	(0.039)				
Export*Mkt_pen			0.056°	0.061				
			(0.033)	(0.038)				
Export*Trade_agree			0.006	0.001				
			(0.038)	(0.042)				
Export*FDI			0.063	0.042				
			(0.056)	(0.066)				
Export*Prod_agree			-0.083*	-0.115*				
			(0.038)	(0.041)				
Export*Patents			0.072	0.023				
			(0.060)	(0.070)				
Export*Offshore			0.007	0.039				
			(0.039)	(0.047)				
Export*Services			0.032	0.059				
			(0.032)	(0.037)				
FEI					0.041*	0.039*		
					(0.017)	(0.019)		
FEI=1							0.129**	0.146**
							(0.045)	(0.048)
FEI=2							0.134**	0.151**
							(0.051)	(0.055)
FEI=3							0.192**	0.183**
							(0.065)	(0.076)
Num. obs.	2205	1671300	2205	1671300	2205	1671300	2205	1671300
Pseudo R^2	0.089	0.0973	0.0893	0.0970	0.0869	0.0946	0.0889	0.0974
Correctly classified	66.62	68.18	65.90	67.05	66.35	67.70	66.76	68.16
H-L test (p value)	0.707		0.729		0.711		0.697	
RESET (p-value)	0.4462		0.9494		0.8528		0.4622	

Note: results concern marginal effects at the mean of the regressors. All estimates include a constant term. Cluster-robust standard errors are reported in parentheses. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant. Weighted regressions are based on frequency weights where each single firm is taken as the unit of frequency.

Table 7. Univariate probit estimates on FL demand: interactions between R&D and internationalization variables

	(1)		(2)		(3)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.084***	0.076***	0.089***	0.081***	0.084***	0.075***
	(0.013)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)
Border	0.021	0.008	0.023	0.008	0.021	0.008
	(0.024)	(0.028)	(0.024)	(0.027)	(0.024)	(0.028)
HC	0.437***	0.527***	0.423***	0.516***	0.430***	0.526***
	(0.067)	(0.079)	(0.067)	(0.077)	(0.068)	(0.080)
lnK/E	0.011	0.013	0.007	0.005	0.009	0.012
	(0.016)	(0.018)	(0.016)	(0.018)	(0.016)	(0.018)
R&D	0.274**	0.264**	0.151**	0.152**	0.275**	0.264**
	(0.080)	(0.080)	(0.047)	(0.053)	(0.079)	(0.080)
M	-0.045	-0.085	-0.035	-0.073	-0.052	-0.088
	(0.063)	(0.064)	(0.063)	(0.062)	(0.064)	(0.064)
Export	0.195***	0.195***				
	(0.043)	(0.049)				
Export * R&D	-0.242*	-0.224*				
	(0.092)	(0.090)				
FEI			0.094***	0.091**		
			(0.026)	(0.031)		
R&D*FEI			-0.081*	-0.079*		
			(0.034)	(0.039)		
FEI=1					0.216***	0.215**
					(0.055)	(0.061)
FEI=2					0.194**	0.207**
					(0.074)	(0.079)
FEI=3					0.328***	0.233*
					(0.086)	(0.099)
R&D*FEI=1					-0.237**	-0.221*
					(0.078)	(0.080)
R&D*FEI=2					-0.199*	-0.190°
					(0.094)	(0.090)
R&D*FEI=3					-0.249*	-0.174
					(0.076)	(0.101)
Num. obs.	2205	1671300	2205	1671300	2205	1671300
Pseudo R^2	0.089	0.0973	0.0888	0.0963	0.0922	0.0999
Correctly classified	66.62	68.18	66.58	67.81	66.76	68.71
H-L test (p value)	0.707		0.747		0.754	
RESET (p-value)	0.4462		0.5686		0.1656	

Note: results concern marginal effects at the mean of the regressors. All estimates include a constant term. Cluster-robust standard errors are reported in parentheses. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant. Weighted regressions are based on frequency weights where each single firm is taken as the unit of frequency.

Table 8. Univariate probit estimates on FL demand including human capital variables as regressors (weighted regression only)

Manager	0.269***				n.s.		
	(0.094)						
Professional	0.225***				0.139***		
	(0.043)				(0.045)		
Plant operator	-0.493***				-0.299***		
	(0.037)				(0.048)		
Manager*university						0.627***	
						(0.032)	
Manager*secondary						0.522***	
						(0.111)	
Professional*university						0.706***	
						(0.023)	
Professional*secondary						0.541***	
						(0.028)	
Clerk*university						0.495***	
						(0.067)	
Clerk*secondary						n.s.	
University		0.456***			0.151***		
		(0.033)			(0.043)		
Basic school		-0.394**			-0.081°		
		(0.0024)			(0.047)		
Generic experience			n.s.		n.s.		
Specific experience			0.258**		0.101*		
			(0.029)		(0.039)		
Manager*generic							n.s.
Manager*specific							0.618***
							(0.034)
Professional*generic							0.466***
							(0.052)
Professional*specific							0.629***
							(0.024)
Clerk*generic							0.447***
							(0.082)
Clerk*specific							0.510***
							(0.049)
Informatics (user)				0.569***	0.250***		
				(0.022)	(0.040)		
Informatics (programmer)				0.667***	0.261**		
				(0.029)	(0.069)		
FEI=1	0.119*	0.113*	0.148**	0.152**	0.119*	n.s.	0.155**
	(0.052)	(0.055)	(0.048)	(0.045)	(0.053)		(0.050)
FEI=2	n.s.	0.123*	0.158**	0.119**	n.s.	n.s.	0.148*
		(0.062)	(0.056)	(0.055)			(0.059)
FEI=3	n.s.	n.s.	0.171*	0.151*	n.s.	n.s.	0.145*
			(0.075)	(0.081)			(0.073)
Pseudo R^2	0.4198	0.3247	0.1485	0.3341	0.4553	0.3784	0.3522
Correctly class.	83.30	78.29	71.63	75.97	83.76	82.16	81.10

Table 9. Bivariate probit estimates of FL demand by type of occupation required: joint and conditional probabilities

	Manager 1	Manager 2	Profess. 1	Profess. 2	Clerk 1	Clerk 2	Oper 1	Oper 2
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.010***	0.011***	0.075***	0.072***	n.s.	n.s.	n.s.	n.s.
	*0.35**	*0.31**	*0.044****	*0.041***	*0.087****	*0.081****	*0.018***	*0.015***
Border	0.014*	0.015*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
HC	n.s.	n.s.	0.402***	0.408***	0.040*	0.039*	0.042°	0.046°
	*0.375****	*0.373****	*0.382****	*0.390****	*0.524****	*0.535****	*0.143***	*0.149***
lnK/E	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
R&D	n.s.	n.s.	0.052*	0.054*	0.012*	n.s.	0.011°	n.s.
	0.049°	*n.s.*	*n.s.*	*0.051°*	*0.052**	*0.055°*	*n.s.*	*0.022°*
M	0.015**	0.015**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	*-0.091**	*-0.097**	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
FEI	0.012*		0.038**		-0.007°.		n.s.	
	n.s.		*n.s.*		*0.057***		*n.s.*	
FEI=1		n.s.		0.113**		n.s.		0.025*
		*0.094**		*n.s.*		*0.181****		*0.057***
FEI=2		n.s.		0.131**		n.s.		n.s.
		0.076°		*n.s.*		*0.181***		*n.s.*
FEI=3		0.089°		0.168*		-0.023***		n.s.
		n.s.		*n.s.*		*0.235****		*n.s.*
Num. obs.	1671300	1671300	1671300	1671300	1671300	1671300	1671300	1671300
ρ	0.50***	0.50***	0.76***	0.76***	0.23***	0.24***	-0.86***	-0.87***

Note: results concern weighted regressions only marginal effects on joint and conditional probabilities (in italics), computed at the mean value of the regressors (and from a status of 0 to 1 for dummy variables). All estimates include a constant term. Cluster-robust standard errors are not reported for reasons of space. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant.

Table 10. Bivariate probit estimates of FL demand, level of education required and knowledge of informatics: joint and conditional probabilities

	University 1	University 2	Secondary 1	Secondary 2	Basic 1	Basic 2	Informatics 1	Informatics 2
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.062***	0.060***	0.035***	0.033***	n.s.	n.s.	0.075***	0.071***
	*0.28**	*0.25**	*0.078****	*0.074****	*0.007°*	*n.s.*	*0.078****	*0.074****
Border	n.s.	n.s.	n.s.	n.s.	-0.005°	-0.004°	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
HC	0.340***	0.347***	0.242***	0.243***	n.s.	n.s.	0.497***	0.504***
	*0.239***	*0.239***	*0.498****	*0.506****	*0.069**	*0.070**	*0.508****	*0.515****
lnK/E	n.s.	n.s.	n.s.	n.s.	-0.003*	-0.003°	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
R&D	0.034°	0.040°	0.031*	0.031*	n.s.	n.s.	0.060*	0.063*
	n.s.	*n.s.*	*0.060**	*0.063**	*n.s.*	*n.s.*	*0.061**	*0.064**
M	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
FEI	0.027*		0.020°		n.s.		0.040*	
	n.s.		*0.039**		*n.s.*		*0.040**	
FEI=1		0.071*		0.079**		n.s.		0.139**
		*0.101**		*0.143***		*0.025°*		*0.144****
FEI=2		n.s.		0.092*		n.s.		0.150**
		*0.103**		*0.151**		*n.s.*		*0.152****
FEI=3		0.171*		0.073°		n.s.		0.175*
		n.s.		*0.179**		*n.s.*		*0.180**
Num. obs.	1671300	1671300	1671300	1671300	1671300	1671300	1671300	1671300
ρ	0.73***	0.73***	-0.09*	-0.09*	-0.76***	-0.76***	-0.32***	-0.32***

Note: results concern weighted regressions only and marginal effects on joint and conditional probabilities (in italics), computed at the mean value of the regressors (and from a status of 0 to 1 for dummy variables). All estimates include a constant term. Cluster-robust standard errors are not reported for reasons of space. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant.

Table 11. Bivariate probit estimates of FL demand and type of experience required: joint and conditional probabilities

	No experience 1	No experience 2	General 1	General 2	Specific 1	Specific 2
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.006°	0.006°	0.008*	0.007*	0.067***	0.063***
	*0.060****	*0.056****	*0.058****	*0.055****	*0.080****	*0.075****
Border	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
HC	0.077***	0.078***	n.s.	n.s.	0.413***	0.418***
	*0.406****	*0.411****	*0.345****	*0.350****	*0.515****	*0.523****
lnK/E	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
R&D	0.017*	n.s.	0.017*	0.017*	0.054*	0.056*
	n.s.	*0.060***	*0.059***	*0.060***	*0.061**	*0.063**
M	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
	n.s.	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
FEI	0.009°		n.s.		0.027°	
	*0.034**		*0.025°*		*0.041**	
FEI=1		0.023*		0.019*		0.097**
		*0.117***		*0.107***		*0.158***
FEI=2		0.035*		n.s.		0.094*
		*0.137***		*0.113**		*0.162***
FEI=3		n.s.		n.s.		0.134°
		*0.161**		*0.133°*		*0.170**
Num. obs.	1671300	1671300	1671300	1671300	1671300	1671300
ρ	-0.31***	-0.31***	-0.32***	-0.32***	0.43***	0.43***

Note: results concern weighted regressions only and marginal effects on joint and conditional probabilities (in italics), computed at the mean value of the regressors (and from a status of 0 to 1 for dummy variables). All estimates include a constant term. Cluster-robust standard errors are not reported for reasons of space. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant.

Table 12. Trivariate probit estimates on the demand for FL, professional jobs and education/experience/knowledge of informatics (joint probabilities)

	FL*PRO*UNI	FL*PRO*SEC	FL*PRO*GEN	FL*PRO*SPEC	FL*PRO*USER	FL*PRO*PROG
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Size	0.045***	n.s.	n.s.	0.051***	0.049***	0.008**
	(0.010)			(0.010)	(0.011)	(0.003)
Border	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
HC	0.252***	0.103*	n.s.	0.339***	0.327***	0.039**
	(0.045)	(0.068)		(0.053)	(0.056)	(0.015)
lnK/E	n.s.	n.s.	0.011*	n.s.	n.s.	n.s.
			(0.005)			
R&D	0.038°	n.s.	0.017*	0.039°	0.055*	n.s.
	(0.020)		(0.008)	(0.023)	(0.024)	
M	-0.081*	n.s.	n.s.	n.s.	n.s.	n.s.
	(0.043)					
FEI=1	0.084*	0.096***	n.s.	0.136**	0.165**	n.s.
	(0.031)	(0.022)		(0.043)	(0.045)	
FEI=2	0.135*	0.121*	n.s.	0.173**	0.212***	n.s.
	(0.066)	(0.059)		(0.056)	(0.059)	
FEI=3	0.279**	0.131°	n.s.	0.230**	0.304***	n.s.
	(0.117)	(0.094)		(0.094)	(0.086)	
Num. obs.	1671300	1671300	1671300	1671300	1671300	1671300
ρ 21	0.75***	0.76***	0.76***	0.76***	0.76***	0.75***
ρ 31	0.73***	-0.07	-0.32***	0.43***	0.72***	0.32***
ρ 32	0.70***	-0.06	-0.26***	0.40***	0.72***	0.52***
LR test (ρ12=ρ13=ρ23=0)	901392***	469725***	508011***	599143***	989039***	510311***

Note: results concern weighted regressions only and marginal effects evaluated at the mean of the regressors. All estimates include a constant term. Estimated standard errors (500 simulations) are reported in parentheses. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant.

Appendix

Table A1. Univariate probit estimates on FL demand with alternative foreign expansion indexes as regressors

	(1)		(2)	
	Unweighted	Weighted	Unweighted	Weighted
Industry dummies	Yes	Yes	Yes	Yes
Size	0.084***	0.075***	0.085***	0.076***
	(0.013)	(0.013)	(0.013)	(0.012)
Border	n.s.	n.s.	n.s.	n.s.
HC	0.428***	0.522***	0.424***	0.524***
	(0.067)	(0.077)	(0.067)	(0.077)
lnK/E	n.s.	n.s.	n.s.	n.s.
R&D	0.068*	0.068*	0.060*	0.065*
	(0.026)	(0.028)	(0.026)	(0.028)
M	n.s.	n.s.	n.s.	n.s.
FEI(1)=1	0.135**	0.150**		
	(0.045)	(0.048)		
FEI(1)=2	0.121*	0.140**		
	(0.050)	(0.054)		
FEI(1)=3	0.190**	0.180*		
	(0.065)	(0.076)		
FEI(2)=1			0.128**	0.144**
			(0.045)	(0.048)
FEI(2)=2			0.150**	0.173**
			(0.052)	(0.055)
FEI(2)=3			0.122*	0.110°
			(0.060)	(0.067)
Num. obs.	2205	1671300	2205	1671300
Pseudo R^2	0.0890	0.0975	0.0887	0.0981
Correctly class.	66.49	68.03	66.80	68.43
H-L test (*p* value)	0.693		0.698	
RESET (p-value)	0.447		0.390	

Note: results concern marginal effects at the mean of the regressors. All estimates include a constant term. Cluster-robust standard errors are reported in parentheses. *** p<0.001; ** p<0.01; * p<0.05; ° p<0.1; n.s.= not significant. Results concern weighted regressions only.