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Abstract

We present an empirical model of learning by exporting that focuses on the impact of a firm's persistent export behavior on its productivity. The model endogenizes a firm's export propensity using a probit specification that enables us to derive consistent estimates of export impact on productivity. In addition, we use a firm's human capital level, proxied by the share of highly educated workers, to test the ability of persistently exporting firms to learn. This impact is derived using a biprobit specification, which enables us to endogenize the joint probability of being a continuous exporting firm while highly endowed with a skilled workforce. The results strongly support the hypothesis that persistent exporters show a significant productivity premium compared to occasional exporters. Moreover, the education level of the workforce further increases productivity, with results supporting the hypothesis that highly educated shares of a firm's workforce enhance the ability to learn.

Keywords: export propensity, human capital, labor productivity, matched employer-employee data

JEL Classification: F10, J24, O15

1. Introduction

It is generally acknowledged that a firm's export behavior enhances its productivity (Bernard and Wagner, 1997; Bernard and Jensen, 1999). Empirical work has pointed to the role of learning by exporting, as firms can take advantage of knowledge flows in international markets (Love and Ganotakis, 2013), helping them develop better products and implement efficient production processes. Being exposed to international competition, they need to grow faster and adopt more efficient organizational structures.

The evidence is mixed (Wagner, 2001), however, suggesting that the (causal) relationship between firm export propensity and productivity may be biased by self-selection or reverse causation (Helpman et al., 2004). A general hypothesis tested by the literature is that exporters are intrinsically more efficient than non-exporters. This mechanism applies because operating in international markets brings about additional fixed costs that less efficient firms cannot afford when the flow of revenues generated by the internationalization process is insufficient to compensate them (Girma et al., 2004). Based on this idea, there should exist *ex ante* differences between exporters and non-exporters. However, what these differences consist of is controversial.

We argue that the productivity premium of exporting is related to a firm's ability to sell persistently in international markets, thereby showing a strong commitment to internationalization. We also argue that productivity gains are further increased when a persistent exporter uses better-educated workers more intensively, thus improving its ability to learn from competing in the international arena.

We develop our hypothesis based on previous evidence that a persistent exporter has more chances to develop the technical competencies needed to build new products or services and bring them to market over time. This process also entails engaging in complex investments requiring learning patterns different to those of occasional exporters (Love and Manez, 2019). At the same time, operating continuously in foreign markets also requires managerial skills to adapt strategies to changing competitive pressure. A large endowment of tertiary-educated workers allows a firm to complement the experimental skills needed to successfully sell products and services in foreign markets with the ability to operate there continuously (Ganotakis and Love, 2012).

In line with this view, this paper aims to answer the following research questions:

1. Is there a productivity gap between persistent exporters and occasional exporters?

2. Does human capital endowment, in terms of highly educated workers, amplify the positive impact on productivity for persistent exporters?

The first question represents a test of a firm's commitment to learning through exporting, whereas the second represents a test of the ability to learn. This pattern is at odds with occasional exporter behavior, which enables one to grasp a few global market opportunities only incidentally. Instead of using export propensity (Castellani 2002), we introduce the concept of a persistent exporter, reflecting a company's intertemporal export behavior based on a structured business strategy.

The second question relates to the knowledge required to undertake internationalization successfully and, therefore, to the role of company workforce skill, proxied in this case by the availability of tertiary-educated workers. It thus relates to a firm's ability to continuously learn by exporting and successfully undertake future strategic plans. We investigate these questions by simultaneously estimating productivity and export behavior, also controlling for workforce heterogeneity

and other firm-specific characteristics, following Van Ours and Stoeldrajier (2011) and Kampelmann and Rycx (2012).

Our contribution to the literature is twofold. Firstly, although we are not directly interested in testing causality between exports and productivity, our model takes into account the possible endogeneity of the export variable. We adopt a probit specification to assess a firm's export behavior, which may be persistent or occasional, and then use the predictions as an instrument in the productivity equation. This approach enables us to estimate a productivity equation with an endogenous export effect.

Secondly, using a recursive bivariate probit model we jointly estimate the probability of persistently exporting and intensively using high-educated workers. Following this approach, the interaction between exporting and a firm's human capital endowment is endogenized, thus testing the productivity impact of a firm's ability to learn by using a highly skilled workforce.

The paper is structured as follows. The next section discusses the proposed research questions in light of the relevant literature, and Section 3 presents the data set. Section 4 presents the empirical model, the results of which are discussed in Sections 5 and 6. Finally, Section 7 derives implications and conclusions.

2. *Research questions and related literature*

A considerable portion of the empirical research on the export-productivity relationship has obtained mixed results when analyzing the role of export propensity. Investigating the performance of exporters compared to non-exporters may not be enough, however, as the learning-by-exporting mechanism may be critically conditioned by the specific exporting behavior of the firm, and particularly its ability to accumulate the necessary knowledge to continuously operate in foreign markets and, thus, increase its competitive intensity over time.

In the context of the Italian manufacturing industry, analyzed using a cross-sectional estimation of labor productivity over 1989-1994, Castellani (2002) finds no impact on a firm's labor productivity growth when using a dummy variable indicating a presence in the export market. However, the effect is positive when considering export intensity, thus suggesting that a significant involvement in international activities accumulated through time is needed to gain benefits from internationalization.

Similarly, but using US plant-level data over 1984-1992, Bernard and Jensen (1999) find no differences in productivity growth between exporters and non-exporters overall. However, when distinguishing between temporary and persistent

exporters they report slightly higher productivity growth in persistent exporters compared to temporary exporters.

Using a similar modeling strategy and a panel of German firms over a long period (1993-2014), Schwarzer (2017) finds support for the learning-by-exporting hypothesis in manufacturing but less in services, with the effect in the latter tending to be limited in time. However, he finds significant productivity gains in both manufacturing and services firms exporting persistently during the observed period.

Using a panel of Swedish manufacturing firms and controlling for causality with a GMM approach, Andersson and Loof (2009) show that persistent exporters exhibiting high export intensity can gain a productivity premium, while temporary exporters or persistent exporters with low export intensity do not show any significant impact. It is worth noting that their definition of persistent exporter is related to an intensity measure, i.e., firms that export more than 50% of the production value. Conversely, our definition is associated with a firms' behavior and, therefore, with a continuous observation of positive export value over time. Thus, we define a persistent exporter as an enterprise for which we observe a positive export value in each year of the observed period. In contrast, an occasional exporter is an enterprise that shows positive export values for some years but not continuously during the observed

period. This definition implies, in any case, that persistent exporters have a significantly higher export-to-sales ratio.

Hence, the first research question we pose is whether being a persistent exporter determines a higher productivity advantage than occasionally exporting. Descriptive statistics of our sample of firms show that persistent exporters in the manufacturing sector comprise 21% of all enterprises, with an average export intensity—given by the export value to total sales—equal to 0.26; occasional exporters comprise 10% of the whole sample, with an export intensity equal to 0.07. The rest consist of non-exporting firms. In services, 94% of all enterprises are non-exporters; persistent and occasional exporters represent the same share (3% each), with an export intensity of 0.19 and 0.04, respectively.

The empirical literature has also attempted to understand how a firm acquires the skills and competencies needed to operate in international markets. On the one hand, learning by exporting incorporates various skills and competencies acquired through experience in global markets (Schultz, 1961). These represent the accumulated knowledge we refer to in our test of the first research question.

On the other hand, workers' education represents the additional knowledge dimension necessary to improving a firm's ability to learn. It plays a specific and crucial role in the

internationalization process, as a higher level of general education can increase a firm's ability to adopt strategic decisions and deal with complex problems related to international competition (Cooper, 1994).

Furthermore, it can strengthen a firm's managerial ability to enforce its market orientation (Narver and Slater, 1990; Gatignon and Xuereb, 1997; Hurley and Hult, 1998). Testing for the specific role played by this human capital component in the export-performance relationship is clearly conditioned by the availability of appropriate data. For example, in a cross-section of UK tech-based firms, Ganotakis and Love (2012) consider the level of general education as measured by the average years of formal education of entrepreneurs in a founding team. They find that a higher endowment of educated workers does not affect the decision to enter a foreign market (export propensity). Conversely, it has a positive effect on export intensity. This latter relationship is tested in the subsample of exporting firms using a tobit model. They conclude that although general education does not affect the decision to enter a foreign market, it can help develop the necessary competencies to compete in international markets once these are entered.

Anderson and Loof (2009) use the share of tertiary-educated workers to control for worker skill when testing for the

productivity-export relationship. Although they do not assess the impact on export behavior, the share of highly educated workers increases when moving from non-exporting firms to persistent exporters, with temporary exporters falling in between.

Munch and Skaksen (2008) use the share of workers with more than vocational training to measure skill intensity in a panel of Danish firms with more than fifty employees in order to investigate the interaction with export intensity in a Mincer-type wage equation. They find that the inclusion of an interaction term between export intensity and the proportion of better educated workers enters the wage equation with a significant positive effect. This effect also absorbs the direct effect of export intensity and education variables.

Thus, the second research question refers to whether a greater endowment of highly educated workers can amplify the productivity premium for persistent exporters. To answer this question, we restrict the analysis to the sub-sample of exporters and define a dichotomous education variable taking a value of one when the exporting firm has a share of tertiary-educated workers higher than the 75^{th} percentile of the statistical distribution. The reason for adopting such a transformation is the highly skewed nature of the distribution: median value equal to zero in both manufacturing and services, and a 75th percentile

value equal to 6% and 9% in manufacturing and services, respectively.

Considering that our panel consists of the population of Italian enterprises, where small exporting companies are also characterized by a low export intensity, we prefer to use an interaction term between the persistent exporter dummy and the tertiary education dummy to investigate our second research question.

3. Data

We use FRAME-SBS, the main statistical register developed by the Italian National Institute of Statistics (ISTAT) for the production of data on the structure and economic performance of Italian firms. This database integrates information from Structural Business Statistics (SBS), which is the primary data source for the economic variables required by EU regulation for the total population of Italian enterprises, and the Statistical Archive of Active Firms (ASIA-IMPRESE), which provides structural information on active Italian enterprises operating in the SBS domain. Given the different nature of manufacturing and services activities, with the latter typically providing intangible goods and having a lower propensity to export, we study these sectors separately in an unbalanced panel of firms

observed from 2012-2017 (Appendix 1 and 2 for data and variables' description).

We have, on average, more than 228 thousand firms in manufacturing and more than 927 thousand in services (excluding the financial sector and some personal and household services). In manufacturing, 32% are exporters (10% occasional and 21% persistent exporters), while in the services exporting firms represent a small 6%, equally distributed between occasional and persistent exporters (Table 1).

Table 1. Panel of manufacturing and services firms – 2012-2017 period

Manufacturing			
	obs.	*firms*	*%*
Exporters	433,704	72,284	31.7
occasional	*143,090*	*23,848*	*10.5*
persistent	*290,614*	*48,436*	*21.2*
Non-exporters	935,374	155,896	68.3
Total	1,369,078	228,180	100

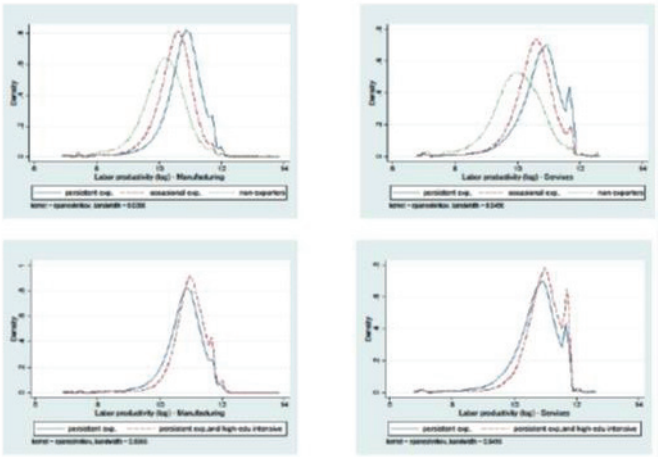
Services			
	obs.	*firms*	*%*
Exporters	347,618	57,936	6.2
occasional	*184,956*	*30,826*	*3.3*
persistent	*162,662*	*27,110*	*2.9*
Non-exporters	5,215,366	869,228	93.8
Total	5,562,984	927,164	100

Kernel distributions of the labor productivity variable's probability density functions highlight some insights that support our research questions (Figure 1). They show that in both manufacturing and services, exporter firms are generally

more productive than non-exporters. Among exporters, persistent exporters tend to gain an additional premium compared to occasional exporters.

They also show that a greater endowment of tertiary-educated workers may provide an additional productivity advantage to persistent exporters, as suggested by the right-hand shift of the density distribution in manufacturing and services.

Figure 1. Kernel probability density distributions – 2012-2017 period



In the productivity analysis, worker heterogeneity can be accounted for by considering differences in labor input that can determine upward or downward productivity shifts. An extensive literature has used matched employer-employee data

to include labor input characteristics such as worker age and gender and occupational factors (Haltinwanger et al., 1999; Hellerstein et al., 1999). To control for labor input characteristics, we derive information by integrating additional variables on demographic and job-related employment categories at the firm level. These variables stem from the ASIA Employment Archive. In the modelling strategy, we thus include as control variables the share of employees in the following worker categories: age, gender, types of work contract (temporary vs. permanent; part-time vs. full-time), and occupational status (executive, white-collar/blue-collar).

In conjunction with workforce characteristics, firm-specific heterogeneity also plays a crucial role in explaining productivity differentials (Foster et al., 2008; Syverson, 2011). With regard to export propensity—the key interest of this paper—the impact of firm size and innovation has been extensively analyzed as crucial determinants of business productivity, although under different frameworks. We consider firm size by including five size classes to capture the effect of productive scale. More than two thirds of manufacturing firms have less than ten employees, while the share increases to almost 90% in services, according to descriptive statistics (Appendix 1). Exporter firms are larger, on average, thus reducing the incidence of micro-firms to less

than half and two thirds in manufacturing and services, respectively.

We do not have information on firms' innovative behavior in such a large-scale data set, thus we consider the impact of innovation by looking at the sectoral technological level of the industry in which a firm operates. We adopt sector aggregation according to the level of technology and knowledge intensity (Eurostat).[1] Thus, we expect a positive effect on productivity for more advanced specialized sectors, as sectoral specialization can be seen as a proxy of an individual firm's technological level. Descriptive statistics show that less than a quarter of manufacturing firms operate in the high and medium-high technological sectors. However, the share increases to more than 30% in the subsample of exporting firms. In the services, the high-technology (dtech_5) and knowledge-intensive (dtech_6) firms represent slightly less than a quarter of the total. However, the share reduces to less than 10% among the exporter group.

Firm localization is captured by four dummy variables indicating Italy's Northwest, Northeast, Center, and South

[1] The classification is based on NACE Rev. 2. See the reference metadata in Euro SDMX Metadata Structure (ESMS) Annex 3 (high-tech aggregation by NACE Rev. 2); https://ec.europa.eu/eurostat/cache/metadata/en/htec_esms.htm

macro-regions. More than half of enterprises are localized in the northern part of Italy. Exporter firms are more concentrated in the Northwest (40% of manufacturing firms and 38% of services firms).

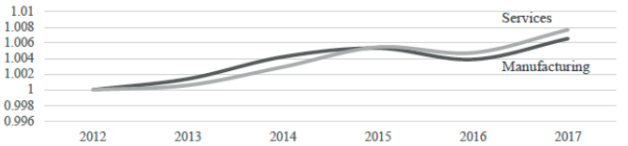
Physical capital should be included among the explanatory variables to avoid misspecification problems. International studies have also faced this issue and have only partially found appropriate solutions, as the inclusion of capital is driven by data availability. For this reason, Van Ours and Stoeldraijer (2011) use depreciation on fixed assets as a proxy for capital input. Their baseline results remain unchanged when this proxy is introduced, however. Kampelmann and Rycx (2012) instead use sector dummy variables, which are a poor proxy, although fixed capital assets are correlated with industry characteristics. It is worth noting that micro-econometric estimations that use capital input (Hellerstein et al. 1999; Aubert and Crepon 2003; Dostie 2011) show a relatively low elasticity attached to it.

Physical capital is not available in the original dataset. We present estimates for the manufacturing sector, incorporating a proxy for capital stock. We assign each firm a fixed capital-to-employee ratio (k) computed in the reference domain, defined by the joint consideration of the NACE division of activity, class size, and macro-region. Including the proxy for capital

stock in the manufacturing equation enables us to consider the omitted variable issue, at least in the manufacturing sector.

Despite the short period available, this rich dataset allows us to ascertain the main drivers of productivity. However, one should point out that a generalized stagnation of productivity growth—also confirmed by macro-economic evidence (European Commission, AMECO database[2])—characterizes this period. This fact, together with the limited availability of time series data, prevents us from specifying a dynamic model and, more specifically, a productivity growth equation and its implicit GMM estimation. Indeed, estimates of productivity growth are insignificant—as expected—given the tiny variation in productivity experienced over the whole sample period.

Figure 2. Labor productivity by sector (year 2012=1)



Note: Authors' calculation based on the panel of manufacturing and services firms – 2012-2017 period

[2] Since 2000, output per worker in Italy has been more than stagnant. In 2019, other developed countries exhibited higher labor productivity than in 2000—between 12% (Germany) and 28% (USA)—whereas in Italy labor productivity was only 1% higher than 20 years before.

4. *The empirical model*

To test the first research question, we adopt a three-equation system to estimate a firm's labor productivity and export behavior, i.e., whether it is a persistent or occasional exporter, as follows:

$$lprod_{it} = \beta_0 + \beta_1 persexp_{it} + \beta_2\, occexp_{it} + \beta_3 d\_hedu_{it} + \beta_4 W_{it} + \beta_5 E_{it} + \beta_6 Z_{it} + u_{it}; \quad 1.1)$$

$$persexp^*_{it} = \boldsymbol{x}'_{1it}\boldsymbol{a}_1 + \gamma_1 d\_hedu_{it} + \theta_{it} \qquad persexp_{it} = 1\ if\ persexp^* > 0, 0\ otherwise \quad 1.2)$$

$$occexp^*_{it} = \boldsymbol{x}'_{2it}\boldsymbol{a}_2 + \gamma_2 d\_hedu_{it} + \omega_{it} \qquad occexp_{it} = 1\ if\ occexp^* > 0, 0\ otherwise \quad 1.3)$$

The left-hand side of the productivity equation in 1.1) represents the log of a firm's real[3] per-capita value added as measured by the value-added-to-employment ratio. A firm's export behavior, i.e., being a persistent or an occasional exporter, is captured by two dummy variables, namely $persexp_{it}$ and $occexp_{it}$, while d_hedu_{it} is the tertiary education dummy. W_{it} and E_{it} capture worker- and firm-

[3] We use NACE 2-digit industry deflators to take into account the effect of price changes, thus providing a measure of real productivity. Also note that as far as value added is concerned, we do not observe a systematic profit gap between persistent exporters and the rest of the companies; indeed, in the first part of the sample period, the gap is positive but not operational anymore.

specific characteristics, while Z_{it} indicates the location effect. The error term is $u_{it} = \mu_i + \epsilon_{it}$, where ϵ_{it} is a normally distributed *i.i.d.* error component and μ_i allows for individual firm effects. *i* and *t* identify firm and time, respectively.

Industry effects are indirectly considered through their impact on the export variables as they enter the specifications in 1.2) and 1.3). One should also note that the ratio of exporting firms tends to increase with the technical level of the industry, at least in manufacturing.[4] In addition, this choice enables us to satisfy the identifiability conditions, implying that at least two exogenous variables are excluded from each equation.

The export variables *persexp* and *occexp* are estimated using a probit specification, where the vectors of explanatory variables ($\boldsymbol{x}_1 = \boldsymbol{x}_2$) include firm size, firm location, firm age, and technological conditions but exclude the specific workforce characteristics used as controls in the productivity specification.[5]

[4] The ratio of exporting firms is as follows: in manufacturing, 33% in high tech, 45% in medium-high tech, 32% in medium-low tech, 28% in low tech; in services, 5% in high tech, 2% in knowledge-intensive, 9% in other services (excluding household services), less than 1% in household services.

[5] According to the order condition for identifiability, we have to exclude two variables in each equation. Given the adopted empirical specification, all equations are overidentified. One can also note that

The model is estimated using a typical 2SLS methodology, although the export equations are indeed non-linear as they reflect a probit estimation. Therefore, we instrument the endogenous variables (*persexp* and *occexp*) in the productivity equation using the predicted values of the corresponding probit regressions on the system's exogenous variables.

We are aware that endogeneity issues may be raised for other explanatory variables, including company size and firm-specific features such as workforce characteristics. However, one should note that the use of a discrete representation of company size is justified by previous studies showing that increasing returns prevail from the early steps of the size ladder and the increase in productivity is constant when moving from the bottom to the top size rank (Bartoloni et al., 2022). This evidence complements a previous investigation pointing out that Italian companies cannot climb the size ladder. In other words, they may eventually grow but only within the same size class (Bartoloni et al., 2020). Thus, without loss of generality one can take the size structure as given and, therefore, consider it as an exogenous variable in this framework.

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the rank condition is satisfied as well, thus providing the sufficient condition for system identifiability.

Similar reasoning can be applied to the variables reflecting workforce composition. Given the period considered in the present analysis, such a structure appears stable and we can thus estimate firm productivity for a given labor input composition.

However, when addressing the second research question, we explicitly consider the endogenous interaction between a firm's human capital endowment and its export propensity, thus indirectly tackling the endogeneity issue concerning the human capital variable that in equation 1.1) is taken as exogenous. In addition, one should note that other dynamic specifications that may tackle endogeneity issues (e.g., GMM or GMMsys) cannot be successfully applied in this case given the short time period available and the nature of the of covariates, which either are relatively stable over the sample period or are qualitive.

To respond to the second research question, we first specify a baseline model for productivity with a specification similar to the one adopted for testing the first research question (equation 1.1) but including an interaction term between the persistent exporter and human capital dummy variables ($persexp_{it} * d\_hedu_{it}$) to measure the specific premium gained by persistent exporters that also employ better-educated workers. Then, we restrict our analysis to the subsample of exporter firms and specify the following productivity equation:

$$lprod_{it} = \delta_0 + \delta_1 (persexp_{it} * d\_hedu_{it}) + \delta_2 W_{it} + \delta_3 E_{it} + \delta_4 Z_{it} + v_{it} \quad 2.1)$$

where v_{it} is the error component with the same characteristics hypothesized in equation *1.1)*. Note that, in this subsample of exporter firms, occasional exporters represent the complement to persistent exporters; thus, the variable *occexp* is dropped from the list of regressors. In addition, as the specific interest here is to capture the possible productivity premium of continuous exporters with a higher human capital endowment, we also drop the non-interacted variables *persexp* and *h_edu*.

To jointly estimate the probability of exporting persistently while having a greater endowment of tertiary-educated workers, we adopt a recursive bivariate probit specification where the tertiary education dummy enters the *persexp* model as an endogenous variable. Thus, the variables *persexp* and *d_hedu* are simultaneously determined as follows:

$$persexp^*_{it} = x'_{3it} a_3 + \varphi d\_hedu_{it} + \varepsilon_{1it} \quad persexp_{it} = 1 \; if \; persexp^*_{it} > 0, \quad 0 \; otherwise$$

$$d\_hedu^*_{it} = x'_{4it} a_4 + \varepsilon_{2it} \quad d\_hedu_{it} = 1 \; if \; d\_hedu^*_{it} > 0, \quad 0 \; otherwise \quad 2.2)$$

$\boldsymbol{x}_{3it}$ and $\boldsymbol{x}_{4it}$ represent the vectors of explanatory variables of the two equations. In the bivariate probit model, the error

terms of two equations follow the bivariate standard normal probability distribution:

$$\phi_2(\varepsilon_{1it}, \varepsilon_{2it}, \rho) = \frac{1}{2\pi\sqrt{1-\rho^2}} \exp\left[\frac{-1}{2(1-\rho^2)}\left(\varepsilon_{1it}^2 + \varepsilon_{2it}^2 - 2\rho\varepsilon_{1it}\,\varepsilon_{2it}\right)\right]$$

where ρ is the conditional tetrachoric correlation between *persexp* and *d_hedu*. By adopting such a joint specification, we can derive the joint probabilities *Pr(persexp|d_hedu)* and then substitute these predicted values for the interacted term $persexp_{it} * d\_hedu_{it}$ in the productivity equation in 2.1).

5. *The commitment to exporting: persistent export behavior and productivity*

In line with our research questions, we focus on the effect of the export variables, although we briefly comment on the impact of the other explanatory variables.

In our preferred specification export behavior (either persistent or occasional) crucially hinges on a business' size,[6] as international markets enable a company to exploit economies of scale. At the same time, exporting may be considered the first step toward broader internationalization strategies, which are

[6] Majocchi et al. (2005) find support for this evidence within a sample of Italian companies.

clearly related to business size. Although there could be opportunities in specific industries for smaller firms (Wagner 2001; Kohn 1997), it is generally recognized that the globalization process over the last decades has brought about the need for organizational structures and resources that require an adequate business size.

Starting with the export behavior specification and according to the marginal effects presented in Table 2, manufacturing size positively impacts the probability of exporting persistently, although in a non-linear pattern (concave), implying an initial increase and then an almost stable pattern. Interestingly, this evidence is not confirmed when considering occasional exporters. The estimated probabilities decline from the 50-249 employees size class, signaling that occasional exporter behavior is typical of small enterprises. This result reinforces the previous consideration regarding the need for a more sophisticated organizational and managerial structure to compete in international markets.

Knowledge is another crucial factor affecting the export decision. Thus, and after controlling for industry technological opportunities, we introduce firm age to account for this factor. Accumulated knowledge and experience in technical and managerial issues may enhance a firm's ability to enter international markets (Love and Ganotakis, 2013; Roberts and

Tybout, 1997). Indeed, age increases the probability of being a persistent exporter by almost 3 percentage points (p.p.).

Technological opportunities matter, as the impact of the technological dummies is positive and decreases when considering the low-technology sectors. However, the impact is higher for the medium-high tech level. As expected, area dummies confirm a decreasing productivity pattern from northern to central and southern areas.

For services, on the whole, the evidence confirms that for manufacturing. However, the impacts are differentiated and somewhat less marked. The size effect is milder and linear, as is that of firm age, whose impact, although positive, is almost negligible. Technological levels do not positively impact export propensity, as firms in the "other services" category are relatively more inclined toward exporting. This group of firms is extremely heterogeneous, including commerce, tourism, cinema and television, transport, and other minor services. Moreover, one should note that the share of firms in high-tech services is tiny,[7] highlighting a relevant weakness of the Italian industrial structure.

[7] According to the descriptive statistics in Appendix 1, their share represents around 4%.

Education also matters, and its impact is strong and particularly relevant for persistently exporting companies. However, the impact of this variable is much greater in manufacturing than in services. In the former sector, the increase in the persistent export probability is more than 15 p.p., compared to 1.6 p.p. in services. Moreover, the effect is almost identical between occasional and persistent exporters. This result validates the relevance of the interrelation between internationalization and human capital resources, which will be more precisely pinpointed in the discussion of our second research question.

Table 2. Export status. Probit estimates (marginal effects) - 2012-2017 period

Variables	Manufacturing			Services	
	occexp	persexp		occexp	persexp
d_hedu	0.0146***	0.152***		0.0115***	0.0164***
	[0.000676]	[0.000968]		[0.000161]	[0.000140]
controls: firm's characteristics					
lage	0.0133***	0.0298***		0.00507***	0.00201***
	[0.000274]	[0.000395]		[6.06e-05]	[4.14e-05]
size_10-19	0.0482***	0.174***		0.0282***	0.0227***
	[0.000782]	[0.00110]		[0.000311]	[0.000246]
size_20-49	0.0185***	0.413***		0.0437***	0.0529***
	[0.00101]	[0.00159]		[0.000597]	[0.000573]
size_50-249	-0.0439***	0.596***		0.0470***	0.0739***
	[0.00103]	[0.00205]		[0.000969]	[0.00104]
size_250-499	-0.0676***	0.629***		0.0608***	0.102***
	[0.00217]	[0.00597]		[0.00333]	[0.00377]
size_500+	-0.0701***	0.621***		0.0764***	0.165***
	[0.00265]	[0.00783]		[0.00405]	[0.00517]
controls: sectoral and location characteristics					
dtec_1	-0.0226***	0.0160***	dtec_5	-0.0118***	-0.0117***
	[0.00125]	[0.00186]		[0.000159]	[7.23e-05]
dtec_2	0.0130***	0.0798***	dtec_6	-0.0212***	-0.0176***
	[0.000712]	[0.00100]		[9.84e-05]	[9.02e-05]
dtec_3	0.0153***	-0.00888***	dtec_7	-0.0291***	-0.0214***
	[0.000631]	[0.000823]		[9.39e-05]	[8.17e-05]
area1	0.0465***	0.168***		0.0195***	0.0298***
	[0.000838]	[0.00126]		[0.000210]	[0.000237]
area2	0.0476***	0.140***		0.0190***	0.0238***
	[0.000891]	[0.00133]		[0.000232]	[0.000242]
area3	0.0243***	0.120***		0.00823***	0.0145***
	[0.000903]	[0.00145]		[0.000203]	[0.000206]
Observations	*1 369 078*			*5 562 984*	
Wald chi2 (d.f)	*35,093(26)****	*286,772(26)****		*166,124(25)****	*190,168(25)****
ll (full)	*-423 068.41*	*-491 369.51*		*-693 790.60*	*-556 772.79*
Pseudo R2 (Mc Fadden's)	*0.0428*	*0.282*		*0.1412*	*0.2325*

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1. Time dummies included.
For *lage* the marginal effect is the change in probability due to a unit increase in the reference variable.
All the other dummy variables are at their reference value, equal to zero.
For a dummy variable, the marginal effect is the difference in probability when changing the value from 0 to 1.

Table 3. Labour productivity. Panel data estimates - 2012-2017 period

Variables	Manufacturing		Services	
	GLS (re)	IV - (re)	GLS (re)	IV - (re)
persexp	0.312***	0.448***	0.396***	0.748***
	[0.00307]	[0.0227]	[0.00357]	[0.0316]
occexp	0.0575***	0.0691**	0.0652***	0.336***
	[0.00166]	[0.0303]	[0.00145]	[0.0165]
d_hedu	0.161***	0.147***	0.171***	0.154***
	[0.00233]	[0.00379]	[0.00129]	[0.00139]
controls: workforce characteristics (W)				
male	0.264***	0.270***	0.122***	0.106***
	[0.00340]	[0.00330]	[0.00156]	[0.00172]
part_time	-0.420***	-0.429***	-0.353***	-0.319***
	[0.00289]	[0.00321]	[0.00128]	[0.00137]
temporary	0.0653***	0.0672***	-0.0749***	-0.0696***
	[0.00432]	[0.00430]	[0.00160]	[0.00165]
age_30-49	0.0772***	0.0752***	0.113***	0.101***
	[0.00301]	[0.00302]	[0.00132]	[0.00135]
age_50+	0.0473***	0.0395***	0.136***	0.117***
	[0.00391]	[0.00399]	[0.00182]	[0.00186]
executives	1.211***	1.163***	1.238***	1.143***
	[0.0365]	[0.0367]	[0.0145]	[0.0157]
white collars	0.368***	0.354***	0.420***	0.379***
	[0.00474]	[0.00640]	[0.00159]	[0.00183]
controls: firm's characteristics (E)				
k	0.0337***	0.0338***		
	[0.00178]	[0.00176]		
size_10-19	0.0275***	0.0249***	0.0399***	0.0147***
	[0.00238]	[0.00321]	[0.00145]	[0.00155]
size_20-49	0.100***	0.0806***	0.0658***	0.0241***
	[0.00400]	[0.00654]	[0.00268]	[0.00291]
size_50-249	0.160***	0.116***	0.0636***	0.0124**
	[0.00646]	[0.0107]	[0.00479]	[0.00523]
size_250-499	0.196***	0.136***	0.0707***	0.000956
	[0.0161]	[0.0185]	[0.0111]	[0.0119]
size_500+	0.226***	0.156***	0.0699***	-0.0216
	[0.0222]	[0.0240]	[0.0171]	[0.0186]
controls: location characteristics (Z)				
area1	0.318***	0.300***	0.220***	0.211***
	[0.00300]	[0.00409]	[0.00163]	[0.00189]
area2	0.311***	0.295***	0.231***	0.222***
	[0.00308]	[0.00388]	[0.00172]	[0.00194]
area3	0.163***	0.154***	0.135***	0.130***
	[0.00327]	[0.00361]	[0.00170]	[0.00181]
Constant	9.349***	9.341***	9.568***	9.569***
	[0.0165]	[0.0162]	[0.00194]	[0.00200]

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Observations	*1 369 078*		*5 562 984*	
R^2	*0.3575*	*0.3492*	*0.2847*	*0.272*
within	*0.0038*	*0.004*	*0.003*	*0.0029*
between	*0.3561*	*0.3473*	*0.3003*	*0.2877*
σ_u	*0.5457*	*0.488*	*0.657*	*0.7445*
σ_e	*0.3616*	*0.3618*	*0.4023*	*0.4032*
ρ_u	*0.6948*	*0.6452*	*0.7272*	*0.7823*

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1. Time dummies included. In the IV equation the endogenous variables (*persexp* and *occexp*) are instrumented using the predicted values of the corresponding probit regressions on the system's exogenous variables. *dtech_5* and *dtech_6* (Knowledge-intensive and High-technology sectors) were included, whereas *dtech_8* (other services) excluded to satisfy the identification conditions.

Looking at productivity (Table 3), being a persistent exporter exerts a significant impact, entailing almost a 45% increase in productivity for manufacturing firms once export behavior is endogenized according to the panel IV estimation (col. 3). Conversely, the gain in productivity for occasional exporters, although significant, shows a milder impact, as the productivity premium is slightly less than 7%. However, this evidence is confirmed in services—with a stronger impact—which may be due to the fact that exporter enterprises are few and are concentrated among larger firms.

The availability of a relatively high share of human capital positively affects productivity, with an impact that is homogeneous across manufacturing and services (about +15%)

when considering the IV estimates. This effect is magnified by the impact of the shares of executives and managers.

The positive effect of the proportion of male employees (and hence the negative effect related to the proportion of female employees) is likely related to the negative impact of the part-time worker ratio, which is correlated with the proportion of females.

The age structure of the workforce also plays a role, with the middle-aged employee ratio positively affecting productivity, confirming other international estimations based on microdata (VanOurs and Stoeldrijer 2011). Although some specific issues arise, this overall picture is shared between manufacturing and services.

More precisely, the effect of firm size is positive, with productivity increasing monotonically in manufacturing, whereas in services it increases and then decreases, with an insignificant additional impact in the IV specification. This may be explained by the few exporting companies in services being in the largest size classes, and the stronger effect that the endogenized propensity to export exerts on productivity may be related to this issue.

To summarize, there is clearcut evidence that a firm's commitment to exporting is a significant and crucial driver of productivity (research question 1), also controlling for other

firm-specific characteristics and endogenizing the export behavior. This should be emphasized as we propose a simultaneous model in which the export propensity depends on specific firm and industry characteristics, enabling us to consider a firm's selection process when deciding to internationalize.

6. *The ability to learn: export and human capital interaction*

In order to consider the interaction between human capital and persistent exporting, thus testing attitudes regarding learning from internationalization, we first present results from the baseline model for productivity in which the export and human capital dummy variables are also interacted (Table 5, cols. 2 and 5). Then, we present results for the exporter firms to test whether the use of skills provided by highly educated workers brings about a greater ability to compete in international markets, thereby determining a productivity premium (cols. 3-4 and 6-7)[8].

[8] In the initial stage of the estimations, we also considered the non-interacted *persex*p and *d_hedu* variables. These variables captured most of the effect on productivity, while the results for the interacted term were weakly positive in services. Given that we already tested the role of export and human capital endowment variables in the

In the baseline model for the manufacturing firms, the interacted variable continues to provide a positive and significant impact on productivity, even when controlling for the distinct effects of *persexp* and *d_hedu* (col. 2). The coefficient for the instrumented interacted variable refers to the increase in productivity caused by a one-unit increase in the probability of being a persistent exporter firm while being endowed with a large share of highly qualified workers.

For exporting businesses in the manufacturing sector, a one p.p. increase in such a probability determines a more than 28% increase in productivity (col. 4). This result suggests that within exporter firms, a significant premium in productivity is gained when a company adequately manages the competencies of its internal human capital and its ability to compete in international markets. This evidence provides, therefore, a positive answer to the second research question initially proposed.

Looking at the corresponding impact for services, one should note that the services sector is highly heterogeneous. Thus it is somewhat challenging to derive significant results by applying the proposed model to the whole industry. For this reason, we have decided to focus on a subset of sectors

baseline model, we preferred to drop the non-interacted terms to allow for a better disclosure of their complementary effect, which represents the core test of the second research question.

belonging to the so-called *High-Technology Services*, which include postal and courier, information and communication, and R&D services. One can also note that this impact in the baseline model is not significant after controlling for the non-interacted variables (col. 5). Conversely, it turns out to be significantly positive.

Table 4. Export status. Bi-Probit estimates - 2012-2017 period

Variables	Manufacturing			High Technology services		
	d_hedu	persexp		d_hedu	persexp	
		coeff.	marg. eff.		coeff.	marg. eff.
d_hedu		0.765***	0.0408***		0.278	0.00354*
		[0.0385]	[0.00135]		[0.200]	[0.00183]
age_30-49				0.190***		
				[0.0101]		
age_50+				-0.530***		
				[0.0132]		
lage		0.118***	0.00507***		0.0592***	0.000742***
		[0.00159]	[0.000198]		[0.0101]	[0.000189]
size_10-19	0.752***	0.537***	0.0912***	0.926***	0.354***	0.0126***
	[0.00307]	[0.0102]	[0.00296]	[0.00982]	[0.0716]	[0.00320]
size_20-49	0.947***	1.133***	0.235***	1.241***	0.578***	0.0273***
	[0.00400]	[0.0141]	[0.00492]	[0.0164]	[0.0886]	[0.00660]
size_50-249	1.424***	1.577***	0.468***	1.507***	0.798***	0.0490***
	[0.00576]	[0.0224]	[0.00660]	[0.0249]	[0.0991]	[0.0110]
size_250-499	1.907***	1.636***	0.610***	2.008***	1.102***	0.0974***
	[0.0200]	[0.0347]	[0.0101]	[0.0983]	[0.127]	[0.0224]
size_500+	2.059***	1.597***	0.625***	2.249***	1.698***	0.246***
	[0.0272]	[0.0394]	[0.0121]	[0.121]	[0.126]	[0.0397]
dtec_1	0.432***	0.0309***	0.0232***			
	[0.00626]	[0.00862]	[0.00111]			
dtec_2	0.305***	0.271***	0.0302***			
	[0.00319]	[0.00528]	[0.00114]			
dtec_3	-0.0422***	-0.0325***	-0.00302***			
	[0.00312]	[0.00336]	[0.000223]			
area1		0.603***	0.0294***		0.557***	0.00915***
		[0.00433]	[0.000956]		[0.0306]	[0.00202]
area2		0.501***	0.0246***		0.550***	0.0103***
		[0.00445]	[0.000815]		[0.0319]	[0.00227]
area3		0.426***	0.0210***		0.424***	*0.00712***
		[0.00477]	[0.000716]		[0.0325]	[0.00168]
Constant	-1.266***	-2.125***		-0.451***	-3.051***	
	[0.00351]	[0.00641]		[0.0106]	[0.0877]	
Observations		*1 369 078*			*208 152*	
Rho		-0.1342		-0.0028711		
Wald test of Rho = 0						
Chi2(1)		35.178		0.000549		
Wald chi2 (d.f)		456,981(31)***		*26,561(27)***		
ll (full)		-1190349		*-143 172*		

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1; time dummies included.

Table 5. Labour productivity. Panel data estimates - 2012-2017 period

Variables	Manufacturing			High Technology services		
	GLS (re) all	GLS (re) exporters	IV - (re) exporters	GLS (re) all	GLS (re) exporters	IV - (re) exporters
persexp	0.308***			0.175***		
	[0.00359]			[0.0389]		
occexp	0.0576***			0.0478***		
	[0.00166]			[0.00641]		
d_hedu	0.157***			0.168***		
	[0.00282]			[0.00505]		
persexp*d_hedu	0.0119**	0.188***	0.286***	0.0465	0.455**	0.0470*
	[0.00471]	[0.00357]	[0.00707]	[0.0439]	[0.221]	[0.0251]
controls: workforce characteristics (W)						
male	0.264***	0.285***	0.289***	0.0605***	0.0725**	0.0902**
	[0.00340]	[0.00648]	[0.00620]	[0.00742]	[0.0330]	[0.0353]
part_time	-0.420***	-0.420***	-0.432***	-0.478***	-0.590***	-0.569***
	[0.00289]	[0.00667]	[0.00649]	[0.00672]	[0.0356]	[0.0373]
temporary	0.0654***	0.0900***	0.0870***	-0.0633***	0.0208	-0.00669
	[0.00432]	[0.00916]	[0.00904]	[0.0119]	[0.0586]	[0.0608]
age_30-49	0.0772***	0.0441***	0.0404***	0.117***	0.180***	0.172***
	[0.00301]	[0.00687]	[0.00677]	[0.00746]	[0.0366]	[0.0373]
age_50+	0.0474***	-0.0183**	-0.0243***	0.136***	0.227***	0.221***
	[0.00391]	[0.00825]	[0.00808]	[0.0102]	[0.0495]	[0.0505]
executives	1.208***	1.104***	1.016***	1.106***	0.990***	0.930***
	[0.0365]	[0.0529]	[0.0507]	[0.0300]	[0.0860]	[0.0941]
white collars	0.368***	0.386***	0.370***	0.232***	0.254***	0.249***
	[0.00474]	[0.00747]	[0.00750]	[0.00820]	[0.0327]	[0.0333]
controls: firm's characteristics (E)						
k	0.0337***	0.0718***	0.0721***			
	[0.00178]	[0.00305]	[0.00294]			
size_10-19	0.0275***	0.0214***	0.0224***	0.0452***	0.147***	0.129***
	[0.00238]	[0.00390]	[0.00383]	[0.00565]	[0.0196]	[0.0223]
size_20-49	0.0999***	0.0910***	0.0877***	0.0802***	0.199***	0.170***
	[0.00401]	[0.00560]	[0.00541]	[0.00929]	[0.0240]	[0.0293]
size_50-249	0.159***	0.139***	0.123***	0.0859***	0.207***	0.166***
	[0.00649]	[0.00750]	[0.00736]	[0.0150]	[0.0278]	[0.0365]
size_250-499	0.194***	0.166***	0.137***	0.118***	0.248***	0.181***
	[0.0161]	[0.0163]	[0.0156]	[0.0338]	[0.0529]	[0.0634]
size_500+	0.223***	0.205***	0.168***	0.258***	0.405***	0.292***
	[0.0222]	[0.0192]	[0.0187]	[0.0559]	[0.0554]	[0.0823]

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controls: location characteristics (Z)						
area1	0.318***	0.240***	0.237***	0.401***	0.255***	0.233***
	[0.00300]	[0.00527]	[0.00513]	[0.00771]	[0.0322]	[0.0355]
area2	0.311***	0.221***	0.215***	0.362***	0.208***	0.182***
	[0.00308]	[0.00542]	[0.00528]	[0.00796]	[0.0328]	[0.0370]
area3	0.163***	0.102***	0.102***	0.272***	0.212***	0.191***
	[0.00327]	[0.00608]	[0.00590]			
Constant	9.349***	9.348***	9.336***	9.829***	10.14***	10.12***
	[0.0166]	[0.0284]	[0.0274]	[0.0113]	[0.0548]	[0.0569]
Observations	*1 369 078*	*433 704*		*208 152*	*9 862*	
R2	*0.3575*	*0.2797*	*0.2735*	*0.3182*	*0.3009*	*0.3182*
within	*0.0038*	*0.0023*	*0.002*	*0.012*	*0.0081*	*0.012*
between	*0.3561*	*0.2847*	*0.2838*	*0.3427*	*0.3157*	*0.3427*
σu	*0.5456*	*0.5084*	*0.4387*	*0.5614*	*0.4878*	*0.5614*
σe	*0.3616*	*0.3295*	*0.3296*	*0.3775*	*0.3491*	*0.3775*
ρu	*0.6947*	*0.7041*	*0.6391*	*0.6886*	*0.6613*	*0.6886*

Robust standard errors in brackets; *** p<0.01, ** p<0.05, * p<0.1. Time dummies included. The endogenous variable persexp*d_hedu is instrumented using the predicted values from the biprobit regression (Table 4).

for the instrumented interacted variable (+4.7%), although substantially lower than in manufacturing (col. 7). This result is not unexpected, as services show a lower propensity to export than manufacturing, even when considering the relatively technologically advanced activities.

The evidence highlights that competing in international markets and successfully learning from this behavior requires a relatively high proportion of skilled labor. According to our bivariate probit specification (Table 4, col. 4), in manufacturing,

the persistent export probability is significantly increased (4 p.p.) when companies have a larger endowment of educated workers. One should recall that the marginal effect in this specification is related to the joint event (*P11*), that is, the firm is a persistent exporter and at the same time, has a highly educated workforce ratio above the 75th percentile.

Interestingly, this effect is stronger in manufacturing than in services (the *High-Technology Services* sector), where, in general, the model does not fit as well as in the former industry. Indeed, the explanatory variables entail a milder effect, and the correlation between the two equations' errors is significantly small. This result highlights how difficult it is to model the interaction between human capital and exporting behavior in a sector less exposed to international competitiveness, as testified to by the ratio of persistent exporters, which is about 3% in services as a whole and 1.5% in high-technology services, compared to 21% in manufacturing. Services are indeed extremely heterogeneous and, even when considering a subset of activities classified as highly technologically intense, it is particularly challenging to derive significant and robust conclusions from the modeling of export behavior and human capital interactions.

One should note that the derived marginal effects in the biprobit specification cannot be directly compared to the

marginal effects derived in the previous section, as the latter refer to an unconditional export probability. Nevertheless, the two outcomes are coherent and confirm the role of human capital endowment as an amplifier of the ability to export.

Furthermore, by looking at the marginal effects attached to firm size, the clear increasing pattern on the persistent export probability is confirmed and combines with a similar pattern observed for productivity. This result is coherent with international comparisons (OECD 2014) and reflects gains from returns to scale but also better managerial and workforce skills that we have indeed considered as a determinant of both productivity and export propensity. In this framework, policies aimed at limiting the obstacles to company size growth may stimulate productivity and the economy's overall growth. However, as suggested by Medrano-Adàn et al. (2019), the design of size-dependent policies should be considered from a broader perspective and also focused on stimulating organizational, managerial, and entrepreneurial skills.

7. Conclusions

In this paper, we use firm-level microdata to test the hypothesis that firm export persistence is a crucial driver of productivity. This investigation falls within the debate on learning by exporting and the related empirical tests.

We use a strict definition of persistent export behavior to identify firms continuously exporting over the entire sample period. Conversely, we identify occasional exporters as firms with positive export sales for at least one period under investigation.

Focusing on export persistence enables us to more precisely identify the core of exporting companies and, therefore, their commitment to undertaking such activities even in future periods. In addition, this enables us to endogenize export behavior using a simultaneous model in which export propensity is modeled using a probit specification together with a productivity equation that therefore incorporates an instrumented export variable. This choice differentiates our work from the literature using alternative measures, i.e., the ratio of exporting sales to total sales. We find a significant difference between the impact of persistent and occasional

exporters, suggesting that the proposed research question requires a positive answer. It should be underscored that this result is obtained in a productivity specification that controls for firm size, workforce characteristics, sectoral technological opportunities, and physical capital.

In order to validate the second research question regarding a firm's ability to learn by exporting by using its human capital endowment, we specify an additional model that incorporates the interaction between persistent export behavior and the firm's endowment of highly educated workers. Along these lines, we specify a biprobit model to determine the joint probability of being a persistent exporter and being endowed with a high educated-workforce ratio. We then focus on the subsample of exporting firms operating in manufacturing and knowledge-intensive business services, showing that the ability to learn—proxied by the endogenous interaction between persistent exporting behavior and the human capital variable—significantly affects productivity. The effect is strong and significant in manufacturing and milder in the selected knowledge-intensive services firms. This latter result testifies to how difficult it is to grasp the human capital endowment advantage in the services sector, which is less exposed to international competitiveness.

While validating our second research question, this result indicates a path for future research. The present work uses worker education to proxy the human capital productivity gain for persistent exporters. Indeed, it is crucial to identify and test alternative measures describing both personal knowledge and workforce skills that may adequately capture the full range of human capital needs allowing firms from a differentiated sphere of activities to compete in the global marketplace.

The results also suggest that growth in firm size is crucial to increasing productivity and exports and building a highly educated workforce. We observe clear, positive, and increasing effects of firm size on productivity, export persistence, and workforce human capital, suggesting that policies to remove obstacles to firm-size growth should be considered.

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Appendix 1. Descriptive statistics

Variable	Manufacturing				Services			
	All		*Exporters*		*All*		*Exporters*	
	Mean	*S.D*	*Mean*	*S.D*	*Mean*	*S.D*	*Mean*	*S.D*
lprod	10.30	0.77	10.67	0.65	10.00	0.86	10.58	0.74
occexp	0.10	0.31	0.33	0.47	0.03	0.18	0.53	0.50
persexp	0.21	0.41	0.67	0.47	0.03	0.17	0.47	0.50
export_int	0.06	0.16	0.20	0.23	0.01	0.06	0.11	0.20
d_hedu	0.23	0.42	0.41	0.49	0.22	0.42	0.36	0.48
male (vs. female)	0.68	0.33	0.67	0.27	0.42	0.40	0.58	0.32
temporary (vs. permanent)	0.08	0.16	0.07	0.13	0.14	0.27	0.09	0.19
part_time (vs. full-time)	0.27	0.35	0.16	0.24	0.54	0.42	0.29	0.34
age_30-	0.19	0.26	0.15	0.18	0.26	0.33	0.18	0.24
age_30-49	0.58	0.29	0.60	0.22	0.55	0.36	0.60	0.28
age_50+	0.23	0.26	0.26	0.21	0.19	0.29	0.22	0.25
executives	0.01	0.03	0.01	0.04	0.00	0.05	0.02	0.07
white collars	0.19	0.25	0.28	0.23	0.39	0.44	0.52	0.36
blue collars	0.81	0.26	0.71	0.24	0.60	0.44	0.46	0.36
lage	2.64	0.95	2.89	0.86	2.48	0.92	2.67	0.86
k	9.24	0.72	9.52	0.76	-	-	-	-
size_10-	0.68	0.46	0.42	0.49	0.88	0.33	0.67	0.47
size_10-19	0.18	0.39	0.27	0.44	0.08	0.27	0.19	0.39
size_20-49	0.09	0.28	0.19	0.39	0.03	0.17	0.09	0.29
size_50-249	0.04	0.19	0.10	0.31	0.01	0.11	0.04	0.20
size_250-499	0.00	0.06	0.01	0.10	0.00	0.03	0.01	0.07
size_500+	0.00	0.05	0.01	0.08	0.00	0.03	0.01	0.07
dtec_1(manu) ou *dtec_5(ser)*	0.04	0.18	0.04	0.19	0.00	0.19	0.03	0.17
dtec_2(manu) ou *dtec_6(ser)*	0.20	0.40	0.28	0.45	0.19	0.39	0.06	0.24
dtec_3(manu) ou *dtec_7(ser)*	0.26	0.44	0.27	0.44	0.17	0.38	0.02	0.13
dtec_4(manu) ou *dtec_8(ser)*	0.46	0.50	0.40	0.49	0.60	0.49	0.89	0.31
area1	0.31	0.46	0.40	0.49	0.27	0.44	0.38	0.49
area2	0.21	0.41	0.18	0.38	0.22	0.41	0.19	0.39
area3	0.26	0.44	0.31	0.46	0.21	0.41	0.28	0.45
area4	0.23	0.42	0.11	0.32	0.31	0.46	0.15	0.36
N. obs	1 369 078		433 704		5 562 984		347 618	

Appendix 2. Variables' description

variable's name	type	description
lprod	*c*	labour productivity:value added to employees ratio (log)
occexp	*0/1*	1 if the firm is an occasional exporter (positive export value in some but not all the years)
persexp	*0/1*	1 if the firm is a persistent exporter (positive export value in each year)
export_int	c	export to sales ratio
d_hedu	*0/1*	1 if the share of employees with at least tertiary education (level 4 of ISCED) is higher than the 75th percentile of the statistical distribution in the reference sector
male/female	*c*	share of male/female workers on total employees
temporary/permanent	*c*	share of employees with a fixed-term/permanent contract
part_time/full_time	*c*	share of employees with a part-time/full-time contract
age_30-; age_30-49; age_50+	*c*	share of employees aged less than 30/between 30 and 49 years/more than 50 years
executives; white collars; blue collars	*c*	share of employees with managerial or middle management roles/office workers/blue collars on total employees
lage	*c*	firm's age: the number of years between its foundation and the date of observation (log)
size_10-; size_10-19; size_20-49; size_50-249; size_250+	*0/1*	one if the number of the firm's employees is within the classes indicated
k	*c*	capital intensity (log): fixed capital to employee ratio in the firm's reference domain. It is given by the following combination: NACE 2 digit sector*size class (5 classess)*macro region (4 areas). Average value over the period 2012-2014 (Source: Istat, the panel data on the balance sheets of corporations with employees, years 2001-2014). Available only for manufacturing firms.
dtec_1 - dtec_4	*0/1*	dummy variable assuming value 1 if the firm belongs to High/Medium-High/Medium-Low/Low technological manufacturing sector
dtec_5 - dtec_8	*0/1*	dummy variable assuming value 1 if the firm belongs to High-technology/Knowledge-intensive/Household/Other services sector
area1-area4	*0/1*	regional dummies: Northwest/Northeast/Center/South of Italy

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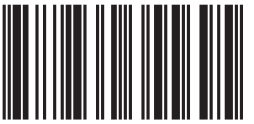
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