QUADERNI DEL DIPARTIMENTO DI SCIENZE DELL'ECONOMIA

UNIVERSITÀ DEL SALENTO

Export, R&D and firm growth in SMEs: Empirical evidence from Italy

Marco DI CINTIO
Sucharita GHOSH
Emanuele GRASSI

Numero E/11

DIPARTIMENTO DI SCIENZE DELL'ECONOMIA
FACOLTÀ DI ECONOMIA
UNIVERSITÀ DEL SALENTO - LECCE
ISSN 2284-0818

Quaderni del Dipartimento di Scienze dell'Economia

I Quaderni intendono favorire la circolazione di studi in versione preliminare, al fine di accelerarne la diffusione e per sollecitare suggerimenti e critiche.

Vengono considerati per la pubblicazione sui Quaderni del Dipartimento solo lavori non ancora pubblicati in versione definitiva su libri o su rivista. Possono proporre lavori per la pubblicazione membri del Dipartimento (anche in collaborazione con studiosi esterni) o studiosi che abbiano presentato il lavoro in oggetto nell'ambito di conferenze o seminari svolti nell'ambito delle attività dipartimentali.

I quaderni si articolano in quattro sezioni: Aziendale, Economica, Giuridica, Matematico Statistica.
I quaderni vengono regolarmente inviati a Istituti, Dipartimenti e Biblioteche a carattere economico e sono inclusi nella serie Research Papers in Economics (REPEC).

L'accesso ai Quaderni è approvato dal Coordinatore scientifico della sezione.

Editore:

Dipartimento di Scienze dell'Economia
Indirizzo mail: direzione.dipeconomia@unisalento.it
Ecotekne - via Monteroni
73100 Lecce

Codice ISSN: 2284-0818

Export, R&D and firm growth in SMEs: Empirical evidence from Italy

Marco Di Cintio
Sucharita Ghosh
Emanuele Grassi

Abstract

This paper studies the firms' decisions to export and invest in R&D and their effects on employment growth and labor flows for a sample of Italian SMEs operating in the manufacturing industry. By first accounting for under-reporting of R&D in SMEs, our quantile regressions reveal that: a) R&D is associated to higher growth rates, higher hiring rates and lower separation rates; b) R&D-induced export is negatively related to growth and accessions and positively related to separations; c) pure export is not a driver of growth and labor flows.

1 Introduction

This paper examines the firms' decisions to export and invest in R&D and their effects on employment growth and labor flows for a sample of SMEs belonging to the Italian manufacturing industry. A large and growing body of the literature deal with the growth-innovation relationship, and there is now ample, yet not conclusive, empirical evidence on the role of innovation for firm growth. Surprisingly, among these studies, the degree of openness to foreign market has so far received little systematic attention, though foreign trade can be easily thought of as a key determinant of firm size. Recently, indeed, Sousa et al. (2012) have documented that the exports of goods and services from the EU to the rest of the world supported around 25 million jobs in Europe, suggesting the importance of external trade for job creation and, thus, firm growth. As a result, export oriented firms may exhibit different growth patterns compared to non exporters.

Furthermore, a large body of theoretical and empirical research debates around the nature of the relationship between export and innovative investments. This paper, thus, represents a bridge between the innovation-growth and the innovation-export research and literature and aims at making the following contributions. First, it explores the nature of the export-innovation relationship for the Italian case. Second, it assesses the implications of export and R&D choices for firms' growth and labor flows.

Our empirical analysis differs from related research in several ways. The first departure from previous literature is that we use R&D intensity and export intensity as measures of innovation and openness, while previous research has mainly focus on binary indicators of R&D and export status. Thus, our approach has the advantage of exploiting finer information on firms' behavior. Secondly, to our knowledge, the findings of this paper are the first one that incorporate export activities in an empirical model of firm growth. Third, differently from previous research, we shed light on the impact of export and innovation activities on labor flows at the firm level.

The rest of the paper is organized as follows. Section 2 underpins the research hypotheses and places the paper in the related literature. Section 3 provides a brief description of data and research methods. Results are presented in section 4. Section 5 concludes.

2 Background

This paper relates to two strands of the literature. The first one is concerned with the impact of innovation on firm growth, while the second explores the interrelationship between export and R&D decisions. From the first point of view, theoretical contributions suggest that both the kind and strength of innovation strategies are likely to produce different outcomes in terms of changes in firm size and labor flows, with an overall effect of innovation on employment that still remains unclear[1] (Van Reenen, 1997). Studies based on output measures of innovation investigate the impact of product and process innovations. While product innovation is often found to have a positive impact on growth (Lachenmaier & Rottmann, 2011; Hall, Lotti, & Mairesse, 2008; Dachs & Peters, 2014), process innovation has been associated not only to employment growth (Lachenmaier & Rottmann, 2011), but also to employment reductions (Dachs & Peters, 2014) and employment stability (Hall et al., 2008).

Other studies, instead, concentrate on the effects of input measures of innovations, mostly R&D activities, on employment changes. From this standpoint, both Yasuda (2005) and Falk (2012) finds that R&D has a positive impact on growth, while Brouwer, Kleinknecht, & Reijnen (1993) report a negative relationship between R&D expenditures and employment, but when the authors refine their R&D measure as the percentage of R&D dedicated to product development, they find a positive impact on employment growth. Differently, Klette & Førre (1998) do not find any clear-cut relationship between job creation and R&D intensity.

In spite of the interest in the role of innovation-driven growth, very little attention has been paid to export activities and their linkage to R&D. To the best of our knowledge, export indicators have been only used as simple control variables in growth equations. Goedhuys & Sleuwaegen (2010) discuss the growth performance of a sample of Sub-Saharan African entrepreneurial firms. To account for export activities, the authors include a dummy for exporters and find that it is not statistically relevant. Also Czarnitzki & Delanote (2012) use a dichotomous indicator for export status in a study of young innovative companies in Flanders, and they find a negative

---

[1] Surveying the literature, a key distinction is always made between product and process innovation. The former fosters employment as more labour is needed to produce new goods or improve the quality of existing ones. On the other hand, firms introduce new and/or more differentiated products in the attempt to strengthen their market power and set higher prices, leading to output and employment contractions. Process innovation modifies the relative productivity of production factors and, to the extent that such innovation is of a labour-saving kind, it reduces employment. At the same time, when process innovation is associated with lower production costs, firms tend to increase production and their workforce via price reductions and increased demand.

and statistically significant impact of export on firm growth. Hölzl (2009) uses the export to sales ratio and concludes that export is important for high-growth firms. This paper suggests that export and R&D are interconnected in a more complex way and explores this relationship further to disentangle the effects on firm growth.

This paper is also related to the literature on the link between export and innovation. In this strand of the literature, a major concern is to fully understand the causality direction between them. A firm's decision to invest in R&D and to innovate may yield a productivity premium that (partially) explains firms' export behavior (self-selection hypothesis) (Clerides, Lach, & Tybout, 1998). Stemming from the idea that only the more productive firms enter foreign markets - as they can bear the fixed costs of trade barriers (Melitz, 2003), innovation is regarded as an explanatory factor of productivity premiums. In the opposite direction, being engaged in export activities increases the ability to assimilate knowledge more effectively, pushing firms to intensify their innovative efforts (learning-by-exporting hypothesis). Up to now, though, the literature has been able to assess the importance of the learning-by-exporting mechanism only for export starters (i.e. firms that enter foreign markets for the first time) and for firms in low-income countries selling their goods in high-income countries (where buyers demand higher quality products, Atkin, Khandelwal, & Osman, 2014). In other words, firms either start producing high-quality products when they first enter a new market and develop steeper learning curves, or they benefit from the transfer of knowledge when dealing with foreign buyers.

3 Data and methods

3.1 The Survey of Italian Manufacturing Firms

We use establishment-level, cross-section data drawn from three waves of the ''Survey of Italian Manufacturing Firms'' conducted by Mediocredito-Capitalia from 1998 to 2006. The survey has been carried out from 1992 to 2007 every three years and delivers information on the three years prior to the interview. Each wave includes both a stratified sample[2] of firms with more than 11 workers and up to 500 workers and all firms above this threshold. Even if each wave contains around 9000 records, exploiting the panel dimension of the data is arguable, since the sample overlapping across waves is extremely small[3].

Firms that participate in the survey were asked to fill out a questionnaire eliciting information on labor force, innovation activities, export and finance. In particular, we exploit data on annual hires and separations, as well as employment stocks, the share of exports in total sales (export intensity) and R&D investments.

We merge the data from the three waves, and exclude firms with inconsistent or missing information. Since our focus is confined to SMEs, we also use the threshold of 250 employees to select the estimation sample.

3.2 Variables and summary statistics

[2] Stratification is based on industry, geographic area and firm size.

[3] By merging the second and third waves, (Piva & Vivarelli, 2005) are able to build a panel of 575 manufacturing firms.

To depict employment dynamics, we implement the empirical model on three key dependent variables, i.e. the growth, hiring and separation rates. Specifically, the growth rate is defined as the yearly net employment change over initial employment. Hiring and separation rates are defined, respectively, as the yearly number of hires (H) and separations (S), divided by total employment.

The explanatory variables of main interest are those related to export and R&D. In our data, while the R&D expenditure has been reported on a yearly basis, both export status and export intensity are recorded only for the last year of each survey. This data limitation leads us to focus only on exploitable information.

Tables 1 to 3 shows summary statistics of growth, hiring and separation rates by export and R&D status. According to these unconditional figures, firms that engage in R&D activities but do not trade internationally have the highest growth rates. It seems that innovating firms are able to grow faster if they choose to sell their goods in national markets. This could be in line with the idea of a limited competitive pressure in national markets compared to the competitive pressure faced in international markets. R&D can be the source of market power, which becomes stronger when the size of the market is limited. The same tables reveal that the growth and labor flow rates of non-innovative firms do not differ substantially when comparing exporters and non-exporters. In contrast, the growth and labor flow rates of exporters tend to be higher for non-innovating firms.

Another interesting fact is that the standard deviations of the growth, hiring and separation rates of exporting firms are about twice as much as those of non-exporters. This large variability, however, might be related to differences in other firm dimensions, such as industry or regional characteristics that our multivariate analysis will account for.

3.3 Empirical model

The empirical model is made up of three blocks. In the first one, we estimate an R&D intensity equation to account for informal innovation activities. As suggested by Kleinknecht (1987) and confirmed by Santarelli & Sterlacchini (1990), official R&D measures for SMEs may severely underestimate their innovation activities. The presence of informal activities, the type of R&D being undertaken or the way it is organized are all likely to be factors influencing the declared R&D effort (Roper, 1999) and are more likely to be more relevant when moving to the left tail of the firm size distribution. Thus, self-reported R&D expenditure often fails to adequately describe the innovative effort undertaken by SMEs[4]. The estimates of the R&D intensity equation is thus a necessary step to obtain a better proxy of the innovative activities carried out by firms in our sample.

It is worth noting that in this step, we also control for self-selection of firms into R&D through a 2SLS model and, similarly to Hall, Lotti, & Mairesse (2009) *on the same data*, we reject the hypothesis of self-selection. Consequently, we estimate the R&D equation by a Tobit regression without the inclusion of a correction term for selectivity.

---

[4] A similar approach can be found in (Crépon, Duguet, & Mairessec, 1998) and (Hall, Lotti, & Mairesse, 2009).

In the second block we dig into the relationship between R&D intensity and export intensity. First, we run a tobit model in which we regress export intensity on the estimated R&D and find that R&D intensity is a good predictor of export intensity. Suspected endogeneity is then checked and rejected both with the Smith & Blundell (1986) procedure and with an IV strategy based on government subsidies. Sensitivity of the estimated coefficients of the export-innovation relationship is then validated with two alternative models, OLS and truncated regression. Finally, we check if reverse causality is an issue in our data. In this respect, we estimate an innovation to export relationship and perform endogeneity check of the export variable. We do not find evidence of a causal link from export to innovation. Thus, we use the results of the tobit estimates of export intensity on R&D to obtain predicted values, which describe the amount of export intensity due to the R&D effort. Given the predicted values we also compute the residual amount of export intensity not explained by R&D.

Then, we proceed to the third block of the empirical model in which we study the impact of export and R&D on firm growth and its components, namely hiring and separation rates. To capture the direct effect of R&D we include the estimated R&D values from the first block. The indirect effect of R&D through export is captured by the estimated export intensity. While the residuals obtained in the second block capture the direct impact of export on firm growth and labor flows.

Coefficients are obtained through quantile regressions. Quantile regressions have increasingly gained the attention of scholars in the literature based on the growth-innovation relationship, allowing numerous authors to find that, at a micro level, the effects of innovation vary substantially along the conditional distribution of the employment growth[5]. In the present study, we adopt this methodology to identify the impact of R&D and export on firm growth, hiring rate and separation rate. In particular, we estimate a model[6] of the form specified as

$$y_i = x_i'\beta_\theta + u_{\theta i} \;\; with \;\; Quant_\theta(y_i|x_i) = x_i'\beta_\theta \qquad \text{(i=1,...,n)}, \quad (1)$$

where $Quant_\theta(y_i|x_i)$ denotes the quantile of y_i, conditional on the set of regressors x_i, θ indicates the quantiles, n is the sample size, β_θ is the vector of coefficient to be estimated and $u_{\theta i}$ is the error component. In particular, the estimator for β_θ solves the problem

$$\min_\beta \frac{1}{n}\left\{\sum_{i:y_i\geq x_i'\beta_\theta} \theta|y_i - x_i'\beta_\theta| + \sum_{i:y_i<x_i'\beta_\theta}(1-\theta)|y_i - x_i'\beta_\theta|\right\}. \quad (2)$$

Several advantages make us prefer this methodology against alternative strategies. First, it can be used to characterize the overall distribution of a dependent variable given a set of regressor. This means that it allows quantifying the effects of a variable in a more accurate way than standard linear regression techniques based on conditional mean functions. Second, quantile regression techniques have been proved

---

[5] See, among others, Goedhuys & Sleuwaegen (2010) and Falk (2012).
[6] See Koenker & Bassett Jr (1978), Koenker & Hallock (2001) and Buchinsky (1998).

to be robust in the presence of heteroskedastic and non-normally distributed errors. Finally, the quantile regression objective function is a weighted sum of absolute deviations, so that the estimated coefficients are not sensitive to outliers.

4 Results

4.1 Accounting for under-reporting of R&D in SMEs

Table 4 reports the estimated coefficients of the R&D equation (block 1). Before running the regressions, we checked for self-selection into R&D with a 2SLS model. The first step is a selection equation estimated via probit. Then we compute the inverse mills ratio, which is then included in the tobit equation. The estimated coefficient of the selectivity term is not significant in our model specification, thus, similarly to what found by Hall et al. (2008), we conclude that self-selection is not relevant in our data.

We then estimate a Tobit model on a rich set of variables aimed at capturing observable differences in R&D intensity. We include the log of turnover, initial size and age indicators. We use geographical dummies to capture disparities in local markets. We also include a dummy variable which is equal to one when firms report that their main competitors are from foreign countries and a dummy equals to one when the firm belong to a group. We also add 29 industry dummies, year dummies and wave dummies. Standard errors are bootstrapped with 399 replications, the number of observations is 18222.

We use the predicted values from this first block to study the export-innovation relationship and, further, the impact of R&D and export activities on growth, hiring and separation rates.

4.2 Export-innovation relationship

We now turn to the estimation of the export-innovation relationship[7]. Estimates are reported in table 5 and show that the R&D intensity has a positive and significant impact on the export intensity. This result is not surprising, since most of the literature has already highlighted the importance of innovation for international trade. Successful exporters are often innovators because innovation helps firms face the more intense competition in international markets. Despite we control for several confounding factors, in the absence of an exogenous variation in the R&D behavior, our estimates should be interpreted with cautiousness. Nevertheless, we control for potential endogeneity of R&D intensity with the Smith & Blundell (1986) procedure and an IV strategy. Both methods fails to reject exogeneity (tables are available upon request).

From this step, we compute predicted values and residuals that are later used to understand the impact of export on growth and labor flows. Predicted values tell us the share of export intensity explained by R&D intensity and other control variables,

---

[7] As before, we first assess self-selection into export with a two-stage procedure. We first estimate a selection into export equation and recover the inverse Mills ratio. Then, we include this ratio in a second stage tobit regression and control the significance of the selection term. Since the Mills ratio is not significant at conventional levels, we do not correct for selection in our estimates of export intensity.

thus we use them in the next estimation step to account for any indirect effect of R&D on our dependent variables. Instead, we use residuals as the component of export intensity that is not explained by R&D.

4.3 The effect of export and innovation on firm growth and labor flows

Quantile regression results for the growth, hiring and separation rates are given in table 6. The main independent variables are the R&D intensity, the R&D-induced export intensity and the non-R&D-induced export intensity. In this way, we aim at capturing separately the direct impact of R&D, the indirect impact of R&D (through export) and a pure export effect on growth and labor flows.

Focusing first on the growth rate (panel a), it can be seen that an increase in R&D intensity is associated with a significantly higher growth. Moreover, the magnitude of the estimated coefficients is more pronounced when moving to the tails of the growth distribution. At the same time, the share of export intensity explained by R&D is negatively correlated to growth. Nevertheless, the first effect dominates the second, thus the R&D intensity produces an overall improvement in the growth performance of SMEs. The coefficients related to the pure export effect are also negative, but are never significant at conventional levels. As pointed out in section 2, previous research has only marginally tackled the export-innovation relationship when estimating equations of firm growth. Our empirical evidence suggests that to fully understand the export-driven growth of firms, it is first necessary to clarify to what extent export success is explained by R&D efforts.

To explore more in depth the results, we investigate whether the higher growth rates induced by R&D activities are compatible with the responses of accession and separation rates to R&D. The estimated coefficients in panels (b) and (c) are clearly coherent with those presented in panel (a). Specifically, the positive effect of R&D on growth finds its counterparts in increasing accessions and reduced separations. In other words, R&D companies grow faster because of increasing hiring and decreasing separations. SMEs that choose to invest in R&D tend to stabilize their workforce (lower separations) and are able to create opportunities for new jobs.

We also find coherence between the negative effect of the R&D-induced export on growth and the signs of the effects on accessions and separations. Indeed, results show that R&D-induced export affects negatively accessions and positively separations. Moreover, in line with the results in panel a, we find that there is no effect of pure export on both hiring and separation rates.

4.4 Robustness and extensions

To check the robustness of our results, we rerun the quantile regressions excluding the pure export effect. Results are shown in table 7 and confirm what previously found. The exclusion of the export effect does not alter the point estimates and their statistical significance. Again, the results for the hiring and separation rates corroborate both the positive impact of R&D and the negative effect of the R&D-induced export on growth. This suggests that companies that actively engage in R&D activities outperform non-innovating companies in terms of employment growth, but this effect is slightly mitigated by the increased propensity to export once R&D is carried out.

Up to now, we have ignored the fact that most Italian companies export inside the EU. Since our data allow us to identify intra-UE export, we restrict the analysis by excluding those companies that trade outside the EU. Results are reported in table 8. Once again, the signs and the magnitude of the estimated coefficients point toward a positive impact of R&D intensity on employment growth and a negative impact of R&D-induced export on growth. Also the components of the growth rate react in the expected way to increasing R&D and R&D-induced export. Finally, export *per se* does not seem to play a specific role for firms' growth.

5 Conclusion

This paper has explored how employment growth and labor flows are related to firms' R&D activities and export involvement. While previous research has relied on export indicators as simple control variables in growth equations, this study has explored the R&D-export relationship more in depth to better understand its impact on firm performance.

By using establishment-level, cross-section data drawn from three waves of the ''Survey of Italian Manufacturing Firms'', our quantile regressions reveal that: a) R&D is associated to higher growth rates, higher hiring rates and lower separation rates; b) R&D-induced export is negatively related to growth and accessions and positively related to separations; c) pure export is not a driver of growth and labor flows.

References

Atkin, D., Khandelwal, A. K., & Osman, A. (2014). *Exporting and Firm Performance: Evidence from a Randomized Trial*. National Bureau of Economic Research.

Brouwer, E., Kleinknecht, A., & Reijnen, J. O. (1993). Employment growth and innovation at the firm level. *Journal of Evolutionary Economics*, *3*(2), 153–159.

Buchinsky, M. (1998). Recent advances in quantile regression models: a practical guideline for empirical research. *Journal of Human Resources*, 88–126.

Clerides, S. K., Lach, S., & Tybout, J. R. (1998). Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. *Quarterly Journal of Economics*, 903–947.

Crépon, B., Duguet, E., & Mairessec, J. (1998). Research, Innovation And Productivity: An Econometric Analysis At The Firm Level. *Economics of Innovation and New Technology*, *7*(2), 115–158.

Czarnitzki, D., & Delanote, J. (2012). Young Innovative Companies: the new high-growth firms? *Industrial and Corporate Change*, dts039.

Dachs, B., & Peters, B. (2014). Innovation, employment growth and foreign ownership of firms. *Research Policy*, *43*, 214–232.

Falk, M. (2012). Quantile estimates of the impact of R&D intensity on firm performance. *Small Business Economics*, *39*(1), 19–37.

Goedhuys, M., & Sleuwaegen, L. (2010). High-growth entrepreneurial firms in Africa: a quantile regression approach. *Small Business Economics*, *34*(1), 31–51.

Hall, B. H., Lotti, F., & Mairesse, J. (2008). Employment, innovation, and productivity: evidence from Italian microdata. *Industrial and Corporate Change*, *17*(4), 813–839.

Hall, B. H., Lotti, F., & Mairesse, J. (2009). Innovation and productivity in SMEs: empirical evidence for Italy. *Small Business Economics*, *33*(1), 13–33.

Hölzl, W. (2009). Is the R&D behaviour of fast-growing SMEs different? Evidence from CIS III data for 16 countries. *Small Business Economics*, *33*(1), 59–75.

Kleinknecht, A. (1987). Measuring R & D in small firms: How much are we missing? *The Journal of Industrial Economics*, 253–256.

Klette, J., & Førre, S. E. (1998). Innovation And Job Creation In A Smallopen Economy-Evidence From Norwegian Manufacturing Plants 1982–92. *Economics of Innovation and New Technology*, *5*(2-4), 247–272.

Koenker, R., & Bassett Jr, G. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society*, 33–50.

Koenker, R., & Hallock, K. (2001). Quantile regression: An introduction. *Journal of Economic Perspectives*, *15*(4), 43–56.

Lachenmaier, S., & Rottmann, H. (2011). Effects of innovation on employment: A dynamic panel analysis. *International Journal of Industrial Organization*, *29*(2), 210–220.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725.

Piva, M., & Vivarelli, M. (2005). Innovation and employment: evidence from Italian microdata. *Journal of Economics*, *86*(1), 65–83.

Roper, S. (1999). Under-reporting of R&D in small firms: The impact on international R&D comparisons. *Small Business Economics*, *12*(2), 131–135.

Santarelli, E., & Sterlacchini, A. (1990). Innovation, formal vs. informal R&D, and firm size: some evidence from Italian manufacturing firms. *Small Business Economics*, *2*(3), 223–228.

Smith, R. J., & Blundell, R. W. (1986). An exogeneity test for a simultaneous equation Tobit model with an application to labor supply. *Econometrica*, *54*(3), 679–685.

Sousa, N., Rueda-Cantouche, J., Arto, I., & Andreoni, V. (2012). Extra-EU Exports and Employment. *European Commission, DG Trade Chief Economist Note*.

Van Reenen, J. (1997). Employment and technological innovation: evidence from UK manufacturing firms. *Journal of Labor Economics*, 255–284.

Yasuda, T. (2005). Firm growth, size, age and behavior in Japanese manufacturing. *Small Business Economics*, *24*(1), 1–15.

Table 1: Growth rates by R&D and export status

		Growth rate		
		Non exporters	Exporters	Total
Non-R&D companies	Mean	0.0334	0.0378	0.0358
	SD	0.3766	0.6865	0.5626
	Frequencies	1829	2068	3897
R&D companies	Mean	0.0472	0.0259	0.0307
	SD	0.2069	0.4527	0.4103
	Frequencies	549	1882	2431
Total	Mean	0.0366	0.0321	0.0338
	SD	0.3449	0.5868	0.5095
	Frequencies	2378	3950	6328

Table 2: Hiring rates by R&D and export status

		Hiring rate		
		Non exporters	Exporters	Total
Non-R&D companies	Mean	0.1298	0.1320	0.1310
	SD	0.4132	0.7638	0.6242
	Frequencies	1829	2068	3897
R&D companies	Mean	0.1291	0.1036	0.1094
	SD	0.2099	0.4820	0.4357
	Frequencies	549	1882	2431
Total	Mean	0.1296	0.1185	0.1227
	SD	0.3761	0.6451	0.5594
	Frequencies	2378	3950	6328

Table 3: Separation rates by R&D and export status

		Separation rate		
		Non exporters	Exporters	Total
Non-R&D companies	Mean	0.0964	0.0941	0.0952
	SD	0.1944	0.3090	0.2615
	Frequencies	1829	2068	3897
R&D companies	Mean	0.0819	0.0778	0.0787
	SD	0.0875	0.1144	0.1089
	Frequencies	549	1882	2431
Total	Mean	0.0931	0.0863	0.0889
	SD	0.1756	0.2372	0.2161
	Frequencies	2378	3950	6328

Table 4: Accounting for under-reporting of R&D in SMEs

Dependent variable: log R&D intensity	
log turnover	-0.0184**
	(0.00778)
size	0.00127***
	(0.000341)
size2	-0.00000345***
	(0.000000966)
age (0 - 15)	-0.00145
	(0.00248)
age (16-25)	0.00220
	(0.00258)
NW	0.0159***
	(0.00505)
NE	0.0259***
	(0.00739)
C	0.0272***
	(0.00670)
foreign competitors	0.0382***
	(0.00762)
group	0.0179***
	(0.00505)
Pseudo R-squared	0.8015

Notes: the model includes industry dummies, year dummies and wave dummies. Standard errors are in parentheses and are bootstrapped with 399 replications. N=18222.

Table 5: Export intensity

Dependent variable: log export intensity	
log R&D intensity	5.627***
	(0.724)
log turnover	0.0994***
	(0.00929)
size	-0.000885*
	(0.000458)
size2	0.00000154
	(0.00000154)
age (0 - 15)	-0.0116
	(0.0107)
age (16-25)	0.0120
	(0.00890)
NW	0.0928***
	(0.0138)
NE	0.0628***
	(0.0143)
C	0.0611***
	(0.0154)
foreign competitors	0.182***
	(0.0131)
group	-0.0543***
	(0.0121)
Pseudo R-squared	0.3515

Notes: the model includes industry dummies, year dummies, wave dummies. Standard errors are in parentheses and are bootstrapped with 399 replications. N=8762.

Table 6: Direct, indirect and export effects

Main regressors	p10	p20	p30	p40	p50	p60	p70	p80	p90
Growth rate (a)									
R&D intensity	4.903***	2.905***	1.031***	-2.39e-12	0.519***	1.657***	2.105***	2.453***	3.939***
	(0.542)	(0.313)	(0.152)	(0.0798)	(0.0971)	(0.224)	(0.279)	(0.566)	(0.651)
R&D ind effect	-0.381***	-0.231***	-0.0782***	1.18e-13	-0.0295***	-0.105***	-0.128***	-0.158***	-0.286***
	(0.0516)	(0.0304)	(0.0130)	(0.00704)	(0.00733)	(0.0158)	(0.0238)	(0.0455)	(0.0604)
exp effect	-0.00363	-0.00529	0.000149	-3.18e-15	-0.000267	-0.000375	-0.00250	-0.00646	-0.00795
	(0.00871)	(0.00672)	(0.00176)	(0.00129)	(0.00124)	(0.00253)	(0.00445)	(0.00595)	(0.0106)
Hiring rate (b)									
R&D intensity	9.85e-14	0.796***	0.743***	0.715***	0.760***	0.980***	1.983***	2.253***	4.089***
	(0.127)	(0.150)	(0.178)	(0.212)	(0.249)	(0.249)	(0.383)	(0.563)	(1.101)
R&D ind effect	-4.75e-15	-0.0458***	-0.0382**	-0.0399**	-0.0364	-0.0315	-0.0966***	-0.134**	-0.191**
	(0.0117)	(0.0122)	(0.0163)	(0.0193)	(0.0224)	(0.0245)	(0.0366)	(0.0543)	(0.0852)
exp effect	3.57e-17	-0.00352	-0.00559	-0.00288	-0.00195	-0.00386	-0.00389	-0.00192	-0.000410
	(0.00224)	(0.00232)	(0.00362)	(0.00387)	(0.00437)	(0.00497)	(0.00753)	(0.00994)	(0.0235)
Separation rate (c)									
R&D intensity	2.48e-12	-0.234**	-0.969***	-1.347***	-1.559***	-1.643***	-2.075***	-2.306***	-2.545***
	(0.109)	(0.108)	(0.159)	(0.159)	(0.172)	(0.266)	(0.255)	(0.414)	(0.885)
R&D ind effect	-1.23e-13	0.0109	0.0756***	0.104***	0.138***	0.153***	0.191***	0.229***	0.252***
	(0.0105)	(0.0109)	(0.0165)	(0.0159)	(0.0196)	(0.0241)	(0.0271)	(0.0439)	(0.0723)
exp effect	7.95e-16	0.00198	0.00345	0.00194	0.00282	0.00196	0.00408	0.0167**	0.0171
	(0.00204)	(0.00213)	(0.00316)	(0.00351)	(0.00371)	(0.00456)	(0.00524)	(0.00801)	(0.0151)
N=6328.									

Table 7: Direct and indirect effects

	p10	p20	p30	p40	p50	p60	p70	p80	p90
Growth rate									
R&D intensity	4.877***	2.999***	1.031***	-2.77e-12	0.518***	1.660***	2.098***	2.500***	3.920***
	(0.471)	(0.300)	(0.153)	(0.0798)	(0.0968)	(0.227)	(0.283)	(0.571)	(0.606)
R&D ind effect	-0.379***	-0.235***	-0.0781***	1.34e-13	-0.0295***	-0.106***	-0.127***	-0.160***	-0.279***
	(0.0480)	(0.0326)	(0.0131)	(0.00704)	(0.00732)	(0.0158)	(0.0242)	(0.0463)	(0.0562)
Hiring rate									
R&D intensity	1.07e-13	0.786***	0.734***	0.689***	0.704***	0.998***	1.919***	2.279***	4.087***
	(0.127)	(0.148)	(0.183)	(0.209)	(0.238)	(0.258)	(0.359)	(0.547)	(1.099)
R&D ind effect	-4.91e-15	-0.0456***	-0.0389**	-0.0357*	-0.0316	-0.0338	-0.0895**	-0.136**	-0.190**
	(0.0117)	(0.0122)	(0.0166)	(0.0191)	(0.0223)	(0.0254)	(0.0348)	(0.0552)	(0.0835)
Separation rate									
R&D intensity	2.00e-12	-0.211*	-0.961***	-1.350***	-1.594***	-1.682***	-2.002***	-2.273***	-2.372***
	(0.109)	(0.110)	(0.160)	(0.159)	(0.176)	(0.258)	(0.248)	(0.448)	(0.522)
R&D ind effect	-9.02e-14	0.00917	0.0750***	0.105***	0.139***	0.156***	0.185***	0.224***	0.247***
	(0.0105)	(0.0110)	(0.0162)	(0.0158)	(0.0194)	(0.0238)	(0.0268)	(0.0479)	(0.0642)

N=6328.

Table 8: Direct, indirect and export effects (EU exporters and non exporters)

Main regressors	p10	p20	p30	p40	p50	p60	p70	p80	p90
Growth rate									
R&D intensity	4.859***	3.066***	0.667**	-4.53e-15	-5.31e-14	2.101***	2.428***	4.018***	5.114***
	(0.792)	(0.734)	(0.293)	(0.197)	(0.206)	(0.577)	(0.781)	(1.533)	(1.582)
R&D ind effect	-0.629***	-0.316***	-0.0888***	4.68e-16	4.13e-15	-0.134***	-0.155**	-0.280**	-0.374**
	(0.104)	(0.0772)	(0.0337)	(0.0219)	(0.0222)	(0.0396)	(0.0638)	(0.131)	(0.147)
exp effect	-0.101	-0.0675**	-0.0313	-8.89e-18	-1.59e-16	-0.0109	-0.0162	-0.0403*	-0.0952***
	(0.0777)	(0.0279)	(0.0256)	(0.00811)	(0.00824)	(0.0119)	(0.0150)	(0.0216)	(0.0240)
Hiring rate									
R&D intensity	6.12e-14	1.231***	1.718***	1.309***	1.033**	1.201	1.948**	4.216***	5.373***
	(0.343)	(0.297)	(0.313)	(0.422)	(0.409)	(0.806)	(0.859)	(1.564)	(2.030)
R&D ind effect	-4.69e-15	-0.0660**	-0.0992***	-0.108***	-0.0750	-0.0465	-0.111	-0.170	-0.0748
	(0.0354)	(0.0279)	(0.0296)	(0.0395)	(0.0488)	(0.0768)	(0.0909)	(0.128)	(0.226)
exp effect	2.64e-16	0.00479	0.0123	-0.00224	-0.00801	-0.0143	-0.0242	-0.0121	-0.0537
	(0.0112)	(0.0105)	(0.00922)	(0.00995)	(0.0123)	(0.0175)	(0.0233)	(0.0430)	(0.0540)
Separation rate									
R&D intensity	1.39e-14	-0.0339	-0.921***	-1.466***	-1.550***	-1.729***	-1.972***	-1.958**	-1.819
	(0.297)	(0.283)	(0.339)	(0.366)	(0.392)	(0.465)	(0.497)	(0.903)	(1.467)
R&D ind effect	-1.11e-15	0.00168	0.0780**	0.111**	0.187***	0.226***	0.312***	0.332***	0.416***
	(0.0351)	(0.0374)	(0.0385)	(0.0486)	(0.0497)	(0.0609)	(0.0671)	(0.106)	(0.161)
exp effect	-1.86e-16	0.000108	0.0213**	0.0203	0.0343	0.0592*	0.0627***	0.0619	0.164***
	(0.0126)	(0.0140)	(0.0105)	(0.0133)	(0.0252)	(0.0309)	(0.0157)	(0.0386)	(0.0380)

N=2519.