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DO INVESTMENT AND INNOVATION BOOST EXPORT? AN ANALYSIS ON EUROPEAN FIRMS

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Do Investment and Innovation Boost Export?

An Analysis on European Firms

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Abstract

It is widely recognized that innovative firms have an advantage in terms of competitiveness which allow them to successfully operate in global markets. Coincidently, entering and surviving in global markets require additional tangible assets aimed at the expansion of production capacity. This work investigates innovation activities and tangible investments as factors enhancing exporting propensities and performances by the firms. Particularly emphasis is given to product innovation, as it is directly related to the penetration of foreign markets. More in detail, we empirically study *a*) the relationship between product innovation and export intensity, and *b*) between tangible investment and export in a large sample of European firms. The analysis controls for internal and external structural characteristics, taking into account that innovative activities, resources devoted to the accumulation of tangible assets, and export intensity are simultaneously determined. The results suggest that both product innovation and tangible investment have a positive and significant impact on the export intensity of firms.

Introduction

A good export performance is commonly viewed as an indicator of competitiveness and success by the firm. At macro-level, export is considered as a prior factor promoting growth: the European Commission (2013) stated that "Trade has never been more important for the European Union's economy" and that "Boosting trade is one of the few ways to bolster economic growth".

Renewed trade policies by the European Union are built putting emphasis on the interrelation between three channels through which a firm's competitiveness may fuel economic growth and employment: export, investment, and innovation. On these grounds, we argue that it is extremely important to investigate innovation activities and tangible investments as factors enhancing exporting propensities and performances by the firms, in today's slow recovery from the crisis.

On one side, innovative activities may confer firms an advantage in terms of competitiveness which gives them an incentive to enter global markets (Harris and Li, 2009; Aw et al, 2011, among others). However, clear evidence on the effect of innovation on the propensity to export is still not found. One reason is attributed to the possible reverse relation from export to innovative capabilities by the firm. Other studies point to the simultaneity between innovation and exporting activity (Harris and Li, 2011), or support the idea that there is a self-selection mechanism of innovative firms into international trade (Aw et al, 2008, 2011). Studies which do not consider these econometric issues may end in misleading results.

On the other side, it has been argued that the propensity to export requires additional investment in order to increase and improve production capacity (Melitz, 2003; Rho and Rodrigue, 2016). An expanded production capacity requires new markets to sell products so that firms are pushed to invest in equipment and technology, in order to bring quality up to international standards of competition. Coincidentally, exports increase firms' expected profitability thus promoting investments, particularly if firms depend greatly on internal funds (Altomonte et al., 2013).

Following the large body of literature on the impact of firm-level decisions on export performance (Aw et al., 2011; Harris and Li, 2009, 2011; Rho and Rodrigue, 2016), this work investigates the relationship between innovation and export *(model 1)*, and between tangible investment and export (*model 2)* in a large sample of European firms. The analysis checks for internal and external structural characteristics, and takes into account that for each firm innovative activities, resources devoted to the accumulation of tangible assets, and export intensity may be simultaneously determined.

We study the first relationship (*model 1*) by estimating the effect of a measure of innovativeness (innovative products sales) on firms' export performance, considering that innovation intensity at the firm level, in its turn, depends on external and internal factors. Special emphasis is attributed to R&D efforts, which are identified as the main source of innovation in the literature (Griliches, 1979; Hall et al, 2010). When estimating the effect of tangible investment on export performance (*model 2*), we simultaneously allow investment to depend on several factors identified in the literature. Also in this case firms' R&D intensity received particular concern. The rationale is that additional investment in plant and equipment are undertaken by the firm for the implementation of R&D (Lach and Schankerman, 1989).

The analysis is based on a large and representative sample of European manufacturing firms, namely the EU-EFIGE/Bruegel Survey dataset carried out by leading academic institutions and coordinated by Bruegel. Data are cross-country comparative and are collected for seven countries: Austria, France, Germany, Hungary, Italy, Spain, and the UK. The existing empirical literature focusing on factors affecting export performance, which will be discussed in the next section, is mainly based on single country analysis, and rarely has investigated exporting activity by the firm simultaneously with other strategic decisions.

This work tries to fill the gap by using a large and unique, cross-country comparative sample of European manufacturing firms. Secondly, in this paper we study the simultaneous decision process regarding carrying out tangible investment behaviour, innovation and exporting performance, using a system of regression equations technique. This represents a novelty in the empirical literature.

The analysis confirms the hypothesis that (*i*) both firms' product innovation and tangible investment intensity are stimulated by the R&D activity performed by the firm and (*ii*) that export intensity, in its turn, is positively influenced by both innovative products sales and the accumulation of tangible assets. The innovative products sales variable shows an estimated impact on export intensity that is larger compared to the estimated effect of tangible investment in all specifications, corroborating the view that is a key factor for entering into and successfully operating in global markets.

Tests performed on the econometric model indicate the presence of unobservable factors that affect both export intensity, innovation and tangible investment, thus confirming the need of a system of regression equations approach.

The paper is organized as follows: Section 1 contains a brief review of the literature. Section 2 describes the data set. Section 3 describes the variables employed in the empirical analysis. Section 4 describes the econometric technique. Section 5 contains the estimates of the effect of tangible investment on export performance on one side, and, on the other, of innovation on export. Finally, section 6 summarises the conclusions.

1. Innovation, tangible investment, and export

The papers by Bernard and Jensen (1999) and Bernard et al. (2007) contributed to moving the attention of the international trade literature from macro-analysis to studies investigating firms' behaviour regarding export propensity and intensity, their causes and consequences in terms of survival in foreign markets, productivity growth, profits, and other industrial organization aspects.

A large body of firm-level studies followed, with a general consensus that a good export performance by firms is positively correlated with age (Wagner, 2015), size, availability of internal financial resources (Altomonte et al, 2016), productivity and human capital (Altomonte et al., 2013; Barba Navaretti et al., 2011; Harris and Li, 2011). Conversely such credit constraints are found to affect export performance negatively (Aristei and Franco, 2014).

While there is rich literature available on the link between innovation and export, only a few studies have empirically tested the effect of tangible assets accumulation on export performance. At the micro-level, the interaction between the innovative capacity by the firm and various measures of export performance has given rise to considerable interest in recent years, especially in a time of increasing global competition and slow recovery from the 2008 crisis.

Innovativeness may positively affect firms' propensity to export and to successfully perform exporting activity in a twin-track strategy. Innovation may confer to firms an advantage in terms of competitiveness, giving firms incentives to enter global markets or to consolidate their exporting status (Harris and Li, 2009; Aw et al, 2011, among others). Another branch of literature states that highly innovative firms find domestic markets limited in size, and expand abroad in search for returns on their investment in innovative activities (Kyläheiko et al., 2011).

A reverse relationship from export to innovation is also recognized. Competition in international markets enhances firms' innovativeness through technological spillovers or by the use of concepts such as “learning by exporting” (De Loecker, 2013, Carboni, 2013; Carboni and Russo, 2017). Harris and Li, (2011), among others, argue that the decision regarding innovative activities and whether to export are taken jointly by the firm, taking account of possible technological benefits from export, thus leading to simultaneity between measures of innovativeness and exporting activity.

Well-documented evidence supports the idea that those firms which carry out innovative activities self-select into exporting. Aw et al. (2008) build a model in which firms rationally decide to carry out innovative activities, along with other investments, aiming to compete in foreign markets. Employing a sample of Taiwanese firms, they find evidence of interactions between the firm’s choice to expand its innovativeness and export market participation.

Empirical studies also differ according to measurement of the firms' innovative activities employed. Innovation-led exports analysis is based on the assumption that it is the output from the innovative activity that matters in enhancing the propensity to enter into foreign markets and to succeed in international trade. In other words, innovations, in particular product innovations, patents, and other output measures of the firm's “knowledge production function” (Griliches, 1979) are directly related to the penetration of foreign markets, and thus foster exporting activity. In empirical studies, a positive impact of being a product innovator on the propensity to export has been found (Ganotakis and Love, 2011); however, no conclusive result is found on the innovation-export intensity relationship (Ganotakis and Love, 2011).

Input measures of the innovation activity, such as R&D, are also indirectly linked to exports. Process innovations and improved ability to internalise external knowledge[1] can positively affect firms' productivity and efficiency (Medda and Piga, 2014). As a result, firms with high productivity self-select into foreign markets where they can survive and gain profits (Aw et al. 2008; Wagner, 2007).

Competition in international markets may also require investments in tangible assets aimed at the enlargement of firms' production capacity and to bear high marginal costs of

[1]This “second face” of R&D concept was developed by Cohen and Levinthal (1989).

entering export markets. However, the relationship between tangible investment and export behaviour is neglected in the literature of international involvement with heterogeneous firms. Liu and Lu (2015) find a significant effect of firms' physical investment on the propensity to export in their empirical analysis of regional variation on Chinese firms. They found larger effects in more competitive industries. Rho and Rodrigue (2016) build a model with a fixed sunk cost for entering foreign markets where firm-level investments and export behaviour evolve simultaneously and additional tangible assets positively affect duration and revenue growth in export markets. Employing a sample of Indonesian manufacturing firms, they found that new investments enable young exporters to perform better in export markets. Finally, Peluffo (2016), tests empirically the hypothesis that, new physical investment favours entry into foreign markets and increases export intensity among firms that are already exporting, finding a significant causal relationship between investments and export behaviour.

Export destination may be another factor influencing the relationship between export performance and innovation on the one side, and fixed capital accumulation on the other. The level of technological advance of the destination countries, geographical proximity and other fixed and variable trade costs may make it more profitable to push on innovation to be successful in a foreign market, or it may require investment in tangible assets (Mayer et al., 2014).

Tangible investment decision, in its turn, depends on several factors and there is a large body of literature aimed at testing how financial constraints enter into the investment function (Hubbard, 1998, Carboni, 2017).

Conversely, only limited research is available on the interrelationship between R&D and tangible investment. In a dynamic factor analysis for firms in the US science-based industries in the 70's, Lach and Schankerman (1989) conclude that R&D has positive effects on tangible investment. Extending their analysis, Chiao (2001) found that the relationship between current R&D and current tangible investment is positively reciprocal, particularly in science-based industries. Using a panel of 185 UK firms for the period 1984–1992, Toivanen and Stoneman (1998) found that investment Granger causes R&D, while no evidence is found for the reverse. Finally, Carboni and Medda (2017) found a positive and highly significant effect of the decision to carry out R&D on investment behaviour for a sample of firms in seven European countries.

2. Data and descriptive statistics

Data used in this study are taken from the EU-EFIGE/Bruege Survey carried out by leading academic institutions and coordinated by Bruegel (Altomonte and Aquilante, 2012). The EFIGE survey provides information on the structure and the behaviour of 14,911 manufacturing firms across seven European countries and is representative at the country level for the manufacturing industry. About 3,000 firms are from France, Germany, Italy and Spain, 2,000 from the UK, and 500 from Austria and Hungary.

The data set, for the first time in Europe, contains qualitative and quantitative data on the characteristics and activities of firms. This results in a total of around 150 different variables, split into six different sections (proprietary structure of the firm; structure of the workforce; investment, technological innovation and R&D; internationalization; finance; market and pricing). This wide span of information has recently been used in a number of papers, as surveyed in Carboni and Medda (2017).

The firms included in the dataset were selected using a sampling design that stratifies companies by industries (11-NACE classification), regions (NUTS-1 level of aggregation) and size class (10-19; 20-49; 50-250; more than 250 employees). The reference population consists of firms with more than 10 employees. All the questions concerned 2008, with some questions asking information about 2009 and others expressed as average over the years 2007-2009. After some necessary cleaning, the final dataset includes 14,797 European firms (see Table 1). About 20.3 percent are from Italy, 20.1 percent from Germany, 19.8 percent from France, 19.1 percent from Spain and 14.2 from the UK; 3.2 percent of firms are from both Austria and Hungary.

Table 1
about here

Before describing our key variables regarding R&D, innovation, investments and export statistics, it might be useful pointing out what these variables represent. First of all, in line with conventional company accounts which treat R&D expenditures as current costs and not as an investment (Corrado et al., 2009), in the Efige survey tangible investments and spending in R&D activities are collected explicitly separated. This implies that R&D spending is not included in the investment variable.[2]

[2]In 2011, in France 88.1 percent of firms' R&D expenditure is classified as current costs; larger shares are

As a measure of R&D intensity, we use, as is common in literature, the R&D over sales ratio. We combine the Efige questionnaire question “Which percentage of the total turnover has the firm invested in R&D on average in the last three years (2007-2009)?” with the control question “In the last three years (2007-2009), the firm hasn't undertaken R&D activities”, using the percentage declared in the former question if the answer to the latter is “no”; otherwise, we input a missing value. In case the answer to the former question is “zero” and “yes” is the response to the control question, we use zero value; otherwise, again, we input a missing value.

Innovative products sales is our measure for innovation intensity. We use answers from the questionnaire question “Indicate the average percentage of turnover from innovative products sales on average in the last three years (2007-2009)” combined, similarly to the R&D intensity variable, with the control question “On average in the last three years (2007-2009), did the firm carry out any product innovation?”.

The tangible investment intensity variable is built using the Efige questionnaire question “What percentage of the annual turnover do the overall investments in plants, machines, equipment and ICT represent on average in the last three years (2007-2009)?”. Finally, as a measure of export activity we draw answers from the question “Which percentage of your 2008 annual turnover did the export activities represent?”, combined, as above, with the control question “Has the firm sold abroad some or all of its own products/services in 2008?”.

As shown in Table 1, about half of the firms in the sample carried out R&D (51.1%) with the largest share recorded in Italy (55.1%), while Hungarian firms show the lowest propensity to spend on R&D activities (27.1%). The reported statistics for R&D intensity, measured as R&D over sales, show that firms which carried out R&D (firms with R&D spending >0), have a mean value of R&D intensity of 7.01, with German companies spending more (7.79). Again, Hungary is at the bottom of the list, with a mean value for R&D intensity equal to 5.73.

An average share of 42.2% of firms have positive innovative products sales. On average, cross-country participation in R&D activities is positively associated with the share of firms which declare positive innovative products sales, despite France showing a very low share of innovative firms (35.9%), having an overall share of firms which spend on R&D in line with the sample average. The mean value for the innovation intensity ratio (innovative products

recorded in Germany (92.3 percent) and UK (94.2 percent). In these countries, labour costs represent at least half of current costs for R&D (Oecd, 2015).

sales over total turnover) is 20.43, with Spanish innovating firms at the top of the cross-country distribution (22.31).

About 88 percent of the firms have positive investments with a mean value for investment intensity (measured as a ratio of investments over sales) of 11.77. Cross-country comparisons show that Spanish firms are those with the greatest investment intensity (14.66 percent), while Germany is the country with the largest percentage of firms which invest (97.3 percent). In Italy, only 81.4 per cent of companies have positive investments with a mean value for investment intensity of 10.94 percent.

The last columns of Table 1 display statistics for the propensity to export and the intensity of export sales. Italian firms had the largest propensity to export in 2008: over 65% of them declare positive sales in foreign markets. Germany had the lowest share of exporting firms (44.6%), while the whole sample mean value is 53.2%. Looking at average exporting sales over total turnover, Hungarian exporting firms had the largest export intensity (46.56), while Spanish firms involved in international trade sold abroad, on average, 26.84% of their total turnover.

Table 2 may give some preliminary information about how R&D, innovative products sales, tangible investment, and export are connected. It provides cross-tabulations of firms' innovative products sales and export intensity, differentiating from those firms which carried out R&D from those which did not. It can be seen that 61.3% of R&D firms also obtained positive innovative sales, against 22.2% of non-R&D firms. Also, the innovative sales intensity is 22.34 for R&D firms, well above 12.33 which is the record for non-R&D firms. On the exporting sales side, Table 2 shows how export propensity and intensities are increasing according to having positive innovative sales and having undertaken R&D. Looking at extreme cases, non-R&D and non-innovative firms have an average propensity to export equal to 35.9% and an export/sales ratio equal to 25.98, while 71.5% of R&D-innovating firms sell their products abroad, with an average intensity equal to 36.21.

Table 3 tabulates the export activities depending on tangible investment decision, differentiating from R&D and non-R&D performing firms. Connections between the three variables are less evident, compared to the R&D-innovation-export relationship: on one side, if the share of firms carrying out tangible investment is larger among R&D firms (91.7%) compared to non-R&D ones (84.1%), the average investment intensity is larger among non-R&D performing firms (12.33 against 11.27). On the investment-export connection side, Table 3 shows that propensity to export is larger for investing firms, once R&D performing firms are selected-out. However, the average export intensity for these firms (25.67) is smaller compared to non-investing companies. Turning to R&D firms, the export propensity is larger among non-investing firms, while the export sales/total turnover ratio is not statistically different between investing and non-investing firms.

Table 2 and Table 3
about here

The correlation matrix displayed in Table 4 reveals positive and highly significant correlations between all intensity variables, although small in magnitudes, except for the tangible investment–export relationship where a negative correlation is found (-0.064). The strongest correlation is found between R&D and innovative product sales intensity (0.297), confirming R&D as a fundamental input in the firms' knowledge production function.

Table 4
about here

3 Estimation strategy and control variables

The empirical analysis follows the scheme presented in Figure 1. We estimate separately two models for the effect of innovation inside the firm on its export performance (1), and the effect of tangible investment on export behaviour (2), taking into account the role played by R&D, along with the control variables, in influencing innovation and tangible investment intensity. R&D is included as a factor determining innovative products success and stimulating the accumulation of tangible assets, but not directly related to export activities.

Both models are estimated considering the simultaneous behaviour of firms regarding export and, respectively innovation and investment in physical assets. Put in functional form, the first model is estimated as follows:

model 1

$$\textit{export intensity} = f(\textit{innovation intensity}, X) + u_1 \quad (1)$$

$$\textit{innovation intensity} = g(R\&D, X) + u_2 \quad (2)$$

where X is a vector of control variables, which will be described below, capturing firms' heterogeneity in internal and external factors. We estimate (1) and (2) jointly by the method of iterative seemingly unrelated regressions (SUR), assuming that unobservable characteristics may affect firms' export behaviour and also innovation through the knowledge production function. In other words, we assume that error terms are correlated:

$$E(u_1) = E(u_2) = 0; \qquad E[u_1 u_2] = \sigma_{12} \tag{3}$$

Similarly, the effect of tangible investment on export performance (eq. 4) is estimated jointly with an investment equation (eq. 5):

model 2

$$\textit{export intensity} = f\,(\textit{investment intensity}, X) + u_1 \tag{4}$$

$$\textit{investment intensity} = g\,(R\&D, X, Z) + u_2 \tag{5}$$

where X contains internal and external controls, as above, and vector Z includes a financial variable that may have an import role in firms' investment decision. Again, we assume non-zero correlation for the error terms, and apply a SUR procedure.

As discussed in the descriptive analysis, not all firms in the sample are engaged in investment activity, nor have product innovations or export sales, so a consistent number of observations are left censored. The problem of censored dependent variables in single equation models was first recognized by Tobin (1958), who introduce the notorious tobit model in order to encompass the biasedness and inconsistency of OLS.[3]

In a simultaneous equations context, the presence of ‘‘zero’’ observations makes the relationship between variables more complex than it is assumed to be by traditional SUR technique. We model the system of equations assuming that dependent intensity variables, (export, innovation and tangible investment) are censored by unobserved latent variables influencing, respectively, the propensity to sell abroad, the probability to have positive innovative products sales, and the propensity to undertake tangible investments. We apply a generalization of the Amemiya (1974) two-step estimator of multivariate censored models (drawing from Shonkwiler and Yen, 1999).

In the first step, we run probit models of dummy variables indicating whether (*i*) firms have exported, (*ii*) have positive innovative products sales, and (*iii*) have undertaken tangible

[3]See Carboni (2012) for an application of the Tobit censored dependent variable framework, adjusted to allow for heteroscedasticity and non-normality of error terms.

investment. This allows us to calculate the Inverse-Mills ratios for the left-censored variables.[4] In the second step, the Inverse-Mills ratios which incorporate the censoring latent variables are included as right-hand side variables in the corresponding intensity equations, to account for the censored nature of the data.

Vector *X* in equations (1), (2), (4), and (5), as said, contains variables capturing firms' internal factor and external controls. The internal factors are represented by a measure of firms' size, age, and dummies indicating past export behaviour and related to the belonging and position inside a group.

Size, expressed as the logarithm of the number of employees (*LOG_NUM_EMPL*) is considered in the model. The literature on industrial organization supplies several key facts about size distributions. Given the strong heterogeneity in the production system, size may be important for understanding the differences in the behaviour of firms (Hubbard, 1998). Firm size reflects a firm’s ability to absorb new technology, its organizational capacity, economies of scale and scope, and access to markets and resources. A firm's size is also a crucial factor in determining the intensity of export performance (Altomonte et al, 2016), of firms' innovativity (Hall et al, 2010), and access to financial resources devoted to physical investment (Schiantarelli, 1996).

The age of the firms, measured in (log of) years since their foundation, is also included in the model (*LOG_AGE*). Older firms may have accumulated valuable production and business experience that gives them a possible market advantage. If this is the case, young firms may be less efficient and grow more slowly than older ones. Nevertheless, the empirical evidence across different countries is mixed: Wagner (2015) finds that older German firms are more likely to export, while Love et al. (2016), in a sample of UK SME's find that experience in international trade, rather than age *per se*, is a factor affecting export success.

A dummy indicating whether the firm has exported before 2008 is included in the analysis (*EXP_PAST*). A key role for experience in international trade is widely recognized. Also, profits from good export performance can be used to finance investment in tangible and intangible assets, particularly if firms depend greatly on internal funds. In most cases, competing in international markets stimulates the incoming of knowledge spillovers, enhancing firms’ technological capabilities (Harris and Li, 2009).

Two dummy variables which are equal to one if the firm is part of a group (*D_GROUP*)

[4]The appendix reports estimates of simple probit estimates.

and if the firm is head a group (*D_HEADGROUP*) are also included. Being part of a group may mitigate financial constraints, both for innovative and traditional firms (Schiantarelli and Sembenelli, 2000). Firms in a group can also internalize externalities from R&D activities (Guzzini and Iacobucci, 2014).

The model includes country dummies, in order to account for unobserved country specific effects, and industry dummies (manufacturing sectors, defined by two digit NACE Rev. 1 codes) are employed to check for potential sectoral systematic differences in export and investment decisions. Differences in technological opportunity, appropriability conditions, which may also have effects on the innovation behaviour of individual establishments, and competence may be significant at cross-sectional levels [5].

The investment equation (eq. 5) describes the tangible investment behaviour of firms, depending on internal and external factors, among which is R&D. A considerable amount of the theoretical and empirical literature on firm-level investment has highlighted the role of financial factors and liquidity in investment decision (Hubbard, 1998; Hall et al., 2010). One issue of interest is thus whether firms facing a decrease in available funds will reduce their investment. The argument is that having access to internal resources facilitates investment, by limiting the risks that arise when firms use external sources of finance. This is particularly the case for potentially unproductive and unprofitable investments. Internal funds typically have low information costs (Hall et al., 2010) which in turn affect a firm's investment activity.

For all the above reasons, a vector *Z* of financial variables is added to eq. 5 among the regressors. *Z* includes the share of internally funded physical investments (*INT_FIN_INV*) and its squared term (*INT_FIN_INV_SQ*), and a dummy variable *D_INV_EXT_FIN* indicating whether the firm did recur to external credit in the period 2008-2009 to finance tangible investments.

Table 5 reports descriptive statistics for the control variables included in vectors *X* and *Z*.

Table 5
about here

[5]Atzeni and Carboni (2004) for instance, found substantial differences matching between human capital and ICT adoption in North and South of Italy.

4. Econometric results

Estimates of SUR models for the entire sample are displayed in Table 6. Column (1) reports estimates of model 1 (equations 1 and 2). The upper side shows a positive impact of R&D on innovative products sales intensity with a coefficient equal to 0.386. This is in line with the mainstream literature, where R&D is considered one of the main factors promoting innovation. From the results in the bottom side of column (1), it emerges that success in the innovation process, measured by innovative products sales, has a positive and significant impact on export sales. The coefficient is 0.697 with 1% level of significance. This result is in contrast to previous literature which did not find any significant effect of output measures of innovation on export intensity (Ganotakis and Love, 2011).

In the second column, estimation of model 2 (equations 4 and 5) corroborates the expected positive correlation between R&D and the tangible investment intensity, with a positive and highly significant coefficient (0.287). In its turn, tangible investment has a positive impact on export intensity. In the bottom side of Table 6 (column 2) a coefficient of 0.546 is reported, with at least 1% level of significance. This result is in line with what was found by Rho and Rodrigue (2016) and Peluffo (2016).

The Breusch-Pagan test for independence of errors between equations is significant for both models, revealing, as expected, the presence of simultaneity between export and (i) innovation inside the firm and (ii) physical assets investment.

Also, coefficients for Inverse Mills ratio in all equations are highly significant. These suggest the importance of controlling for the propensities of firms to engage in innovative activities, tangible investments and export. In particular, negative coefficients for inverse Mills ratio are estimated in both innovative sales and tangible investment equations (upper side of Table 6). In those cases, unobservable factors which positively (negatively) affect the probability to have positive innovative sales and tangible investments have a negative (positive) impact on the intensity of innovative sales and tangible investments. The export intensity equations (bottom side of Table 6) show positive estimates of coefficients for the inverse Mills ratio, indicating that unobservable factors affect in the same direction both propensity to and intensity of export engagement.

Note that first-stage probit models (in the appendix) from which we have computed Inverse Mills ratios are estimated following equations (1)-(2) and (4)-(5) with dummy variables as counterpart for R&D, innovative products sales, tangible investment, and exports.

Looking at control variables, Tables 6 reveals that the firm's size has a negative effect on both the innovative products and tangible investments intensities. On the export side, size exerts a positive impact on the share of sales abroad over total turnover. The belonging to a group variable shows an estimated coefficient in same vein. The age of firm variable has a negative coefficient in all equations. In contrast with Hall et al. (2010) and Schiantarelli (1996), it seems that large firms invest less in tangible assets and have a smaller gain from innovative activity. However, they benefit from their organizational capacity and their economies of scale and scope in international trade, a result found also by Altomonte et al. (2016).

Having exported in the past has a positive impact on current share of sales abroad. It also affects positively the innovative activities, following the idea of technological spillovers from international trade. However, its effect on tangible investment intensity is negative. This finding reveals the direction of the relationship between tangible investment and export performance according to which the former affects the latter. Also, the international crisis has mostly affected internationally exposed companies, as found by Kudlyak and Sanchez (2017), inducing the propagation of adverse shocks which may have dampened investments. Similarly, being at the head of a group shows a negative correlation with export sales, while firms which were part of a group have gained advantage from their position.

The analysis shows no significance for the variable which indicates the share of internal source of financing tangible investment, while its squared term has a negative impact on investment intensity. The use of external financial resources, captured by dummy indicating "increasing production scale through investments" as the main purpose of the use of external finance, show a negative coefficient.

The hypothesis that the coefficients of the industry dummies, as well as country dummies, are jointly zero can be safely rejected at one percent significance, confirming the presence of systematic heterogeneity between firms across manufacturing sectors and countries. The latter aspect will be analysed in the following analysis.

We then replicate estimation of models 1 and 2 focusing on three destinations of firms' export sales. This allows us to investigate whether operating in different foreign markets affects firms' decision to undertake innovative activities and tangible investments, and how such a decision impacts exporting performance. More in detail, we look for possible differences across firms with positive exporting sales in the following destinations: 15 UE countries, China and India, and USA and Canada. Table 7 collects the main results from the estimation of model 1 and 2 (estimated coefficients and statistics for control variables are omitted but they are available upon request).

In model 1, R&D intensity, as expected, exerts a positive effect on the innovative products sales intensity. The impact of the innovative products variable on export intensity, estimated in equation 2, is found to be significantly positive. The larger impact is found for export towards European Countries (0.249), while the smallest coefficient is related to export towards China and India (0.088). This can be partly explained by the general level of technological advance achieved by the different destination markets which may have different demand for innovative products, hence for the kind of goods they import from European firms[6]. In general, other fixed and variable trade costs may have a role in the export intensities of European firms towards different destinations.

Estimation of model 2 also shows differences across export destinations for the effect of tangible investment on export intensities. Again, the estimated effect of investments on the export intensity towards China and India, although positive and significant, is smaller than what is found for exports towards European Countries and USA and Canada.

For all three destinations, estimations of models 1 and 2 confirm the signs and significance of Inverse Mills Ratio coefficients, and the presence of correlation of error between the equations in the model.

Table 7
about here

4.1 Cross-country comparison

It is worth complementing the analysis on the entire sample of firms by studying the differences across countries. The country dummies included in estimates reported in Table 6 reveal that there are substantial fixed-effect cross-country differences in the sample. To further corroborate these results we also look at the relationship between innovative activities, tangible investment and export performance running single country model estimates.

[6]Eurostat (2017) data show that in 2007-2009 over 60% of exported goods from Europe to China were represented by machinery and transport equipment, confronted by 36.5% of intra-Euro exported goods; however, over 9% of exported goods to China were raw materials (3.3% tin intra-Europe trade, and 1.2% of export to the USA).

Results are reported in Table 8 and 9. In Table 8, estimates of the model relating R&D, innovative products sales, and export intensity are displayed, while in Table 9 we present estimates of the R&D–tangible investment–export intensity model. For each single country, evidence of the relationships in exam are confirmed, with different magnitudes.

R&D expenditures have, as expected, a positive impact on innovative products sales intensity in each country. The coefficients, all significant at the 1% level, vary from 0.289 in the UK to 0.577 in Spain (0.386 is the estimated coefficient for the whole sample). As Mate-Sanchez-Val and Harris (2014) argued, Spain and the UK are at different stages in the R&D and innovation development: note that although Spain has larger average intensities for both R&D expenditures and innovative products sales, a smaller share of firms engage in those activities, confronted by the UK (see Table 1). In Spain, innovation is spurred by R&D activities, while in the UK, as well as in the other countries in our sample, R&D has a positive and significant but smaller role in the innovation process.

The coefficient of the Inverse Mills Ratio is negative and highly significant, as in the whole sample analysis, for each Country.

Table 8
about here

Innovative products intensity has a positive and significant impact on export intensity for all countries, and UK firms take the larger advantage from innovation in their export performance with a coefficient equal to 1.024, well above the 0.697 estimated for the whole sample. Conversely, Spanish firms are those with a smaller coefficient for the effect of innovative products sales on export intensity (0.413). A positive and significant Inverse Mills Ratio is estimated in each country regression, suggesting the presence of a selection effect in the same direction both in the process of determining the propensity to export and of the export intensity.

In Table 9, the estimated impacts of R&D intensity on the tangible investment intensity are all significant at the 1% level, and vary from 0.110 in France and 0.429 in Spain (it is 0.287 for the whole sample). When the five countries are analysed separately, the Lach and Schankerman (1989) finding seems to be confirmed that R&D activities induce new accumulation of tangible assets. Again, the Inverse Mills ratio coefficients are significantly different from zero at the 1% level. The selection effect is positive for Germany (as in the whole sample), suggesting that unobservable factors affecting the propensity to carry out physical investment influence in the same direction the intensity of those investments, while they are negative for the other countries.

Finally, estimation of equation 2 in Table 9 shows a positive and significant impact of tangible investment on the export intensity for all countries, with the UK having the largest impact (0.867) and France having the smallest one (0.215). This result, as in the whole sample analysis, confirms for Europe what has been found in recent studies conducted on other Countries (Liu and Lu, 2015; Rho and Rodrigue, 2016; Peluffo, 2016).

Comparing estimates from model 1 and 2 it can be noted that R&D has a larger impact on innovative products sales compared to the effect on tangible investment in France, Italy and Spain, while for German firms the effect in promoting tangible investment is relatively larger. For UK firms there is no significant difference between the impact of R&D on innovation and on the accumulation of physical assets. Looking at the factors affecting export intensity, for all countries the larger impact is estimated for innovative product sales, confirming the basic idea that product innovation is a key factor for successful export performance.

For both the models in Table 8 and 9, the Breusch-Pagan test leads to the rejection of the hypothesis of zero correlation of the residuals in the two equations; that is, there are unobservable factors that affect both innovative products sales and export intensity (model 1), and tangible investment and export intensity (model 2). This corroborates our choice to use a system of regression equations estimation technique.

Table 9
about here

6. Conclusion

It is commonly recognised that exporting firms have different characteristics compared to non-exporters in terms of productivity, efficiency, employment and capital intensity. However, clear evidence on the effect of innovation and tangible investment on export performance in a cross-country perspective is still not found at firm or plant level.

In this paper we study the export behaviour in a large and representative sample of European manufacturing firms in Germany, France, Italy, Spain, the UK, Austria and Hungary, concentrating on the role played in fostering export performance by innovation and the accumulation of tangible assets. Developing innovative products gives firms an advantage in terms of competitiveness. This allows them to enter and successfully operate in global markets which, in turn, also requires additional tangible assets aimed at the expansion of production capacity.

We empirically investigate the behaviour of firms in terms of export, investment, and innovation by employing a system of regression equations. This allows the analysis to consider that firms may make different decisions simultaneously. It is an important task, considering the lack of clear evidence and in light of European Union's renewed trade policy which put emphasis on the interrelation between these three channels through which firms' competitiveness may fuel economic growth and employment.

The econometric strategy implies the use of a seemingly unrelated regression methodology and takes also into consideration that a significant number of firms in the sample do not export, do not have innovative products and do not undertake tangible investment.

The results show that for all countries both innovative products intensity and tangible investments have a positive and significant impact on export intensity. The larger impact is found for innovative product sales, confirming the basic idea that product innovation is a key factor for successful export performance.

Finally, the econometric technique employed in this paper is supported by tests performed on all the specification used, indicating the presence of unobservable factors that affect both export intensity, innovation inside the firm, and tangible investment.

References

Altomonte, C., and T. Aquilante (2012). *The EU-EFIGE/Bruegel-Unicredit dataset*. Bruegel Working paper, #753.

Altomonte, C., T. Aquilante, G. Békés, and G. Ottaviano (2013). "Internationalization and innovation of firms: evidence and policy." *Economic Policy* 28 (76): 663-700.

Altomonte, C., S. Gamba, M.L. Mancusi, and A. Vezzulli (2016). "R&D investments, financing constraints, exporting and productivity." *Economics of Innovation and New Technology* 25 (3): 283-303.

Amemiya, T. (1974). "Multivariate regression and simultaneous equation models when the dependent variables are truncated normal." *Econometrica* 42 (6): 999-1012.

Aristei, D. and C. Franco (2014). "The role of credit constraints on firms' exporting and importing activities." *Industrial and Corporate Change* 23 (6): 1493-1522.

Atzeni, G.E. and O.A. Carboni, (2004) ICT productivity and human capital: the Italian North-South duality, *Rivista Internazionale di Scienze Economiche e Commerciali* 51, 265-284.

Aw, B.Y., M.J. Roberts, and D.Y. Xu (2008). "R&D Investments, Exporting, and the Evolution of Firm Productivity." *American Economic Review* 98 (2): 451-56.

Barba Navaretti, G., D. Castellani, and F. Pieri (2014). "Age and firm growth: evidence from three European countries." *Small Business Economics* 43 (4): 823-837.

Bernard, A.B., and J. Bradford Jensen (1999). "Exceptional exporter performance: cause, effect, or both?." *Journal of International Economics* 47 (1): 1-25.

Bernard, A.B., J. Bradford Jensen, S.J. Redding, and P.K. Schott (2007). "Firms in International Trade." *Journal of Economic Perspectives*. 21 (3): 105-130.

Carboni O.A., (2012). "An empirical investigation of the determinants of R&D cooperation: An application of the inverse hyperbolic sine transformation." *Research in Economics* 66 (2): 131-141.

Carboni, O.A. (2013), "A spatial analysis of R&D: the role of industry proximity." *Economics of Innovation and New Technology* 22 (8): 820-839.

Carboni, O.A., and G. Medda (2017). "R&D, export and investment decision: evidence from European firms." *Applied Economics*, in press.

Carboni, O.A. and P. Russu (2017). "Complementarity in Innovation Decisions: Evidence from European Firms." *R&D Management,* in press.

Carboni, O.A. (2017). "The Effect of Public Support on Investment and R&D: An Empirical Evaluation on European Manufacturing Firms." *Technological Forecasting & Social Change* 117: 282 –295.

Chiao, C. (2001). "The relationship between R&D and physical investment of firms in science-based industries." *Applied Economics* 33 (1): 23-35.

Coe, D.T., and E. Helpman (1995). "International R&D spillovers." *European Economic Review* 39 (5): 859-887.

Cohen, W.M., and D.A. Levinthal (1990). "Absorptive capacity: a new perspective on learning and innovation." *Administrative Science Quarterly* 35 (1): 128-152.

Corrado, C., C. Hulten, and D. Sichel (2009). "Intangible Capital and U.S. Economic Growth." *Review of Income and Wealth* 55 (3): 661-685.

De Loecker, J. (2013). "Detecting Learning by Exporting." *American Economic Journal: Microeconomics* 5 (3): 1-21.

European Commission (2013). *Trade, Growth, and Jobs*, http://ec.europa.eu/trade/.

Eurostat (2017). *Extra-EU trade in goods*, http://ec.europa.eu/eurostat/web/international-trade-in-goods.

Ganotakis, P., and J.H. Love (2011). "R&D, product innovation, and exporting: evidence from UK new technology based firms." *Oxford Economic Papers* 63 (2): 279–306.

Griliches, Z. (1979). "Issues in Assessing the Contribution of Research and Development to Productivity Growth." *Bell Journal of Economics* 10 (1): 92-116.

Guzzini, E., and D. Iacobucci (2014). "Business Group Affiliation and R&D." *Industry and Innovation* 21 (1): 20-42.

Hall, B.H., J. Mairesse, and P. Mohnen (2010). "Measuring the returns to R&D." In *Handbook of the Economics of Innovation*," edited by B.H. Hall and N. Rosenberg . Amsterdam, Elsevier-North Holland.

Harris, R., and Q.C. Li. (2009). "Exporting, R&D, and absorptive capacity in UK establishments." *Oxford Economic Papers*, 61 (1): 74-103.

Harris, R., and Q.C. Li. (2011). "Participation in export markets and the role of R&D: establishment-level evidence from the UK Community Innovation Survey 2005." *Applied Economics* 43 (23): 3007-3020.

Hubbard, R.G. (1998). "Capital-market imperfections and investment." *Journal of Economic Literature* 36 (1): 193-225.

Kudlyak, M., and J.M. Sanchez (2017). "Revisiting the Behavior of Small and Large Firms during the 2008 Financial Crisis." *Journal of Economic Dynamics and Control* 77 (4): 48-69.

Kyläheiko, K., A. Jantunen, K. Puumalainen, S. Saarenketo, and A. Tuppura (2011). "Innovation and internationalization as growth strategies: The role of technological capabilities and appropriability." *International Business Review* 20 (5): 508-520.

Lach, S., and M. Schankerman (1989). "Dynamics of R&D and Investment in the Scientific Sector." *Journal of Political Economy* 97 (4): 880-904.

Liu, Q., and Y. Lu (2015). "Firm investment and exporting: Evidence from China's value-added tax reform." *Journal of International Economics* 97 (2): 392-403.

Love, J.H., S. Roper, and Y. Zhou (2016). "Experience, age and exporting performance in UK SMEs." *International Business Review* 25 (4): 806-819.

Mate-Sanchez-Val, M., and R. Harris (2014). "Differential empirical innovation factors for Spain and the UK." *Research Policy* 43 (2): 451-463.

Mayer, T., M.J. Melitz, and G.I.P. Ottaviano (2014). ""Market Size, Competition, and the Product Mix of Exporters." *American Economic Review* 104 (2): 495-–536.

Medda, G., and C. Piga (2014). "Technological spillovers and productivity in Italian manufacturing firms," *Journal of Productivity Analysis* 41 (3): 419-434.

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

OECD (2015), *STAN R&D: Research and development expenditure in industry - ISIC Rev. 4 (Edition 2015)*, STAN: OECD Structural Analysis Statistics (database).

Peluffo, A. (2016). "The role of investments in export growth." *Small Business Economics* 47 (1): 115-137.

Rho, Y., and J. Rodrigue (2016). "Firm-Level Investment and Export Dynamics.". *International Economics Review* 57 (1): 271-304.

Schiantarelli, F., and A. Sembenelli (2000). "Form of ownership and financial constraints: panel data evidence from flow of funds and investment equations." *Empirica* 27 (2): 175-192.

Shonkwiler, J.S., and S.T. Yen (1999). "Two-step estimation of a censored system of equations." *American Journal of Agricultural Economics* 81 (4): 972-82.

Tobin, J. (1958). "Estimation of Relationships for Limited Dependent Variables.", *Econometrica* 26 (1) 24–36.

Toivanen, O., and P. Stoneman (1998). "Dynamics of R&D and investment: UK evidence." *Economic Letters* 58 (1): 119-126.

Wagner, J. (2007). "Exports and Productivity: A Survey of the Evidence from Firm-Level Data." *World Economy* 30 (1): 60-82.

Wagner, J. (2015). "A note on firm age and the margins of imports: first evidence from Germany." *Applied Economics Letters* 22 (9): 679-682.

Figure 1 – Estimated models scheme

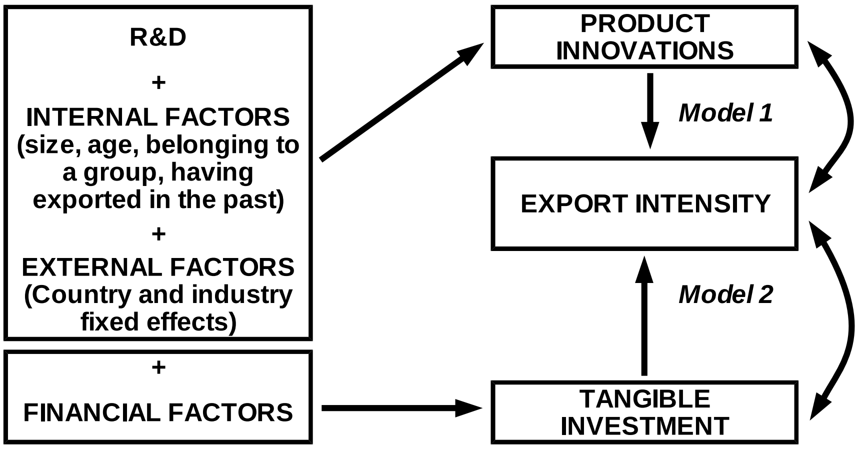

Table 1 – Dataset: country and industry composition

country		firms engaging in R&D		firms with positive innovative products sales		firms with positive tangible investments		firms with positive export sales	
	obs.	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
AUSTRIA	475	256	53.9%	243	51.2%	447	94.1%	271	57.1%
FRANCE	2,931	1,482	50.6%	1,053	35.9%	2,440	83.2%	1,420	48.4%
GERMANY	2,969	1,617	54.5%	1,369	46.1%	2,890	97.3%	1,324	44.6%
HUNGARY	479	130	27.1%	147	30.7%	410	85.6%	249	52.0%
ITALY	3,004	1,655	55.1%	1,354	45.1%	2,446	81.4%	1,962	65.3%
SPAIN	2,832	1,303	46.0%	1,117	39.4%	2,602	91.9%	1,425	50.3%
UK	2,107	1,119	53.1%	954	45.3%	1,791	85.0%	1,224	58.1%
Total	14,797	7,562	51.1%	6,237	42.2%	13,026	88.0%	7,875	53.2%
		R&D intensity		*Innovative sales intensity*		*Investment intensity*		*Export intensity*	
		mean	*s.d.*	*mean*	*s.d.*	*mean*	*s.d.*	*mean*	*s.d.*
AUSTRIA		6.29	9.78	21.00	19.36	12.02	14.17	42.24	34.65
FRANCE		6.24	9.67	18.21	17.75	9.91	13.22	29.59	27.02
GERMANY		7.79	9.14	19.73	16.60	12.16	13.32	31.29	24.35
HUNGARY		5.73	11.09	19.96	18.03	12.01	14.72	46.56	35.60
ITALY		7.26	8.91	22.22	19.14	10.94	11.64	35.93	28.55
SPAIN		7.04	9.25	22.31	18.53	14.66	16.07	26.84	26.40
UK		6.83	10.60	19.09	17.78	10.48	13.21	29.93	28.76
Total		7.01	9.51	20.43	18.10	11.77	13.77	31.98	28.12

intensities are expressed as percentages of total turnover

Table 2 – Cross-tabulations of firms by propensity to innovate and export

ENGAGED IN R&D	INNOVATIVE PRODUCTS SALES			EXPORTING SALES		
		obs	*average intensity*		*obs*	*average intensity*
No	**No**	77.8%	0	**No**	64.1%	0
				Yes	35.9%	25.98
	Yes	22.2%	12.33	**No**	52.9%	0
				Yes	47.1%	26.39
Yes	**No**	38.7%	0	**No**	39.0%	0
				Yes	61.0%	33.30
	Yes	61.3%	21.34	**No**	28.5%	0
				Yes	71.5%	36.21

Table 3 – Cross-tabulations of firms by propensity to invest and export

ENGAGED IN R&D	TANGIBLE INVESTMENTS			EXPORTING SALES		
		obs	*average intensity*		*obs*	*average intensity*
No	**No**	15.9%	0	**No**	63.4%	0
				Yes	36.6%	28.47
	Yes	84.1%	12.33	**No**	61.3%	0
				Yes	38.7%	25.67
Yes	**No**	8.3%	0	**No**	30.3%	0
				Yes	69.7%	35.04
	Yes	91.7%	11.27	**No**	32.8%	0
				Yes	67.2%	35.21

Table 4 – Correlation matrix for R&D, innovation, investment, and export

	R&D intensity	*Innovative sales intensity*	*Investment intensity*	*Export intensity*
R&D intensity	1			
Innovative sales intensity	0.297 ***	1		
Investment intensity	0.140 ***	0.048 ***	1	
Export intensity	0.163 ***	0.169 ***	-0.064 ***	1

*significance levels: * 0.1 ** 0.05 *** 0.01*

Table 5 – Descriptive statistics for control variables

variable		mean	std. dev.	vector
LOG_NUM_EMPL	*log of number of employees in 2008*	3.579	1.031	X
LOG_AGE	*log of years since firm's establishment*	3.205	0.863	X
EXP_PAST	*dummy indicating whether the firm has exported before 2008*	0.646	0.478	X
D_GROUP	*dummy indicating whether firm belong to a group*	0.220	0.414	X
D_HEADGROUP	*dummy indicating whether firm is head of the group*	0.036	0.187	X
INT_FIN_INV	*share of internal resources over total financing of tangible investments on average in 2007-2009*	46.783	43.009	Z
INT_FIN_INV_SQ	*square of INT_FIN_INV*	4,038.3	4,457.5	Z
D_INV_EXT_FIN	*dummy indicating investments as main purpose of increase of external finance in 2009*	0.429	0.495	Z

Table 6 – SUR models for export intensity

	Model (1)		Model (2)	
dependent variable:	*INNOVATIVE PRODUCTS SALES INTENSITY*		*TANGIBLE INVESTMENT INTENSITY*	
	Coef.	St. Err.	Coef.	St. Err.
R&D INTENSITY	.386 ***	.017	.287 ***	.013
LOG_NUM_EMPL	-.435 ***	.136	-.591 ***	.120
LOG_AGE	-.827 ***	.144	-.794 ***	.129
INT_FIN_INV			.017	.016
INT_FIN_INV_SQ			-.001 ***	.000
D_INV_EXT_FIN			-.630 **	.254
EXP_PAST	1.032 ***	.296	-2.069 ***	.235
D_GROUP	-.409	.341	-.993 ***	.307
D_HEADGROUP	.728	.683	.660	.609
D_AUT	1.485 **	.735	.981	.664
D_FRA	.176	.421	-1.353 ***	.378
D_GER	.455	.417	.565	.399
D_HUN	.473	.743	1.594 **	.658
D_ITA	1.068 ***	.411	-.478	.371
D_SPA	1.404 ***	.420	2.154 ***	.392
INV. MILLS RATIO	-8.564 ***	.420	-9.089 ***	.640
chi2	2,596.2 ***		1,632.3 ***	
R-sq	.141		.094	
dependent variable:	*EXPORT INTENSITY*			
	Coef.	St. Err.	Coef.	St. Err.
TANGIBLE INVESTMENT INTENSITY			.546 ***	.014
INNOVATIVE PRODUCTS SALES INTENSITY	.697 ***	.013		
LOG_NUM_EMPL	4.750 ***	.250	5.637 ***	.266
LOG_AGE	-.448 *	.238	-.872 ***	.241
EXP_PAST	68.774 ***	3.670	90.252 ***	4.429
D_GROUP	8.925 ***	.578	10.336 ***	.591
D_HEADGROUP	-4.770 ***	1.100	-4.634 ***	1.097
D_AUT	-2.960 **	1.263	-4.998 ***	1.294
D_FRA	-7.670 ***	.793	-10.272 ***	.851
D_GER	-15.012 ***	1.039	-19.772 ***	1.160
D_HUN	-2.337 *	1.259	-2.350 *	1.301
D_ITA	5.326 ***	.664	6.427 ***	.663
D_SPA	-6.321 ***	.733	-9.536 ***	.762
INV. MILLS RATIO	31.089 ***	2.259	41.951 ***	2.724
chi2	8,193.0 ***		6,988.8 ***	
R-sq	.213		.219	
Industry dummies and constant term included				
Test for all industry dummies = 0	421.4 ***		553.2 ***	
Test for all Country dummies = 0	556.6 ***		743.9 ***	
Number of obs	14,797		14,797	
Breusch-Pagan test of independence:	1,669.9 ***		1,442.0 ***	

*significance levels: * 0.1 ** 0.05 *** 0.01*

Table 7 – SUR models for export intensity by destination

Model 1	*export destinations:*		
	15 UE countries	*China and India*	*USA and Canada*
Equation 1	*dep. variable: INNOVATIVE PRODUCTS SALES INTENSITY*		
Inverse Mills Ratio	-8.465 ***	-8.031 ***	-8.246 ***
R&D INTENSITY	0.389 ***	0.405 ***	0.397 ***
Equation 2	*dependent variable: EXPORT INTENSITY*		
Inverse Mills Ratio	12.829 ***	1.723 **	2.878 ***
INNOVATIVE PRODUCTS INTENSITY	0.249 ***	0.088 ***	0.108 ***
Number of obs	14,797	14,797	14,797
Chi-sq 1st equation	2,468.5 ***	653.0 ***	2,499.9 ***
Chi-sq 2ndt equation	4,600.9 ***	1,419.9 ***	2,044.8 ***
Breusch-Pagan test of independence:	462.7 ***	954.5 ***	778.3 ***

Both equations include industry and Country dummies, a constant, and variables LOG_NUM_EMPL, LOG_AGE, EXP_PAST, D_GROUP, D_HEADGROUP

*significance levels: * 0.1 ** 0.05 *** 0.01*

Model 2	*export destinations:*		
	15 UE countries	*China and India*	*USA and Canada*
Equation 1	*dependent variable: TANGIBLE INVESTMENT INTENSITY*		
Inverse Mills Ratio	-9.574 ***	-9.085 ***	-9.119 ***
R&D INTENSITY	0.264 ***	0.278 ***	0.274 ***
Equation 2	*dependent variable: EXPORT INTENSITY*		
Inverse Mills Ratio	17.182 ***	12.286 ***	10.049 ***
TANGIBLE INVESTMENT INTENSITY	0.126 ***	0.079 ***	0.106 ***
Number of obs	14,797	14,797	14,797
Chi-sq 1st equation	1,563.2 ***	1,600.8 ***	1,610.8 ***
Chi-sq 2ndt equation	4,142.6 ***	1,577.9 ***	1,893.8 ***
Breusch-Pagan test of independence:	144.4 ***	784.2 ***	943.1 ***

Both equations include industry and Country dummies, a constant, and variables LOG_NUM_EMPL, LOG_AGE, EXP_PAST, D_GROUP, D_HEADGROUP
Equation 1 also includes variables: INT_FIN_INV, INT_FIN_INV_SQ, D_INV_EXT_FIN

*significance levels: * 0.1 ** 0.05 *** 0.01*

Table 8 – Single country analysis: innovation-export relationship

Model 1	*FRANCE*	*GERMANY*	*ITALY*	*SPAIN*	*UK*
Equation 1	*dependent variable: INNOVATIVE PRODUCTS SALES INTENSITY*				
Inverse Mills Ratio	-6.125 ***	-8.731 ***	-9.588 ***	-6.457 ***	-9.445 ***
R&D INTENSITY	0.321 ***	0.384 ***	0.394 ***	0.577 ***	0.289 ***
Equation 2	*dependent variable: EXPORT INTENSITY*				
Inverse Mills Ratio	40.100 ***	13.445 **	15.649 ***	13.099 ***	40.206 ***
INNOVATIVE PRODUCTS INTENSITY	0.762 ***	0.622 ***	0.632 ***	0.413 ***	1.024 ***
Number of obs	2,931	2,969	3,004	2,832	2,107
R-sq 1st equation	0.127	0.172	0.134	0.144	0.133
R-sq 2ndt equation	0.158	0.172	0.271	0.232	0.079
Chi-sq 1st equation	466.2 ***	653.0 ***	487.6 ***	494.7 ***	380.1 ***
Chi-sq 2ndt equation	1595.3 ***	1419.9 ***	1798.5 ***	1226.1 ***	1595.9 ***
Breusch-Pagan test of independence:	461.7 ***	306.2 ***	236.5 ***	154.2 ***	557.1 ***
Both equations include industry dummies and a constant, and variables LOG_NUM_EMPL, LOG_AGE, EXP_PAST, D_GROUP, D_HEADGROUP					

*significance levels: * 0.1 ** 0.05 *** 0.01*

Table 9 – Single country analysis: investment-export relationship

Model 2	*FRANCE*	*GERMANY*	*ITALY*	*SPAIN*	*UK*
Equation 1	*dependent variable: TANGIBLE INVESTMENT INTENSITY*				
Inverse Mills Ratio	-11.664 ***	43.973 ***	-7.927 ***	-8.213 ***	-10.971 ***
R&D INTENSITY	0.110 ***	0.424 ***	0.233 ***	0.429 ***	0.298 ***
Equation 2	*dependent variable: EXPORT INTENSITY*				
Inverse Mills Ratio	53.838 ***	58.658 ***	39.228 ***	23.487 ***	33.077 ***
TANGIBLE INVESTMENT INTENSITY	0.215 ***	0.573 ***	0.593 ***	0.270 ***	0.867 ***
Number of obs	2,931	2,969	3,004	2,832	2,107
R-sq 1st equation	0.069	0.071	0.112	0.088	0.109
R-sq 2ndt equation	0.278	0.130	0.261	0.229	0.133
Chi-sq 1st equation	218.8 ***	252.1 ***	398.7 ***	284.2 ***	302.9 ***
Chi-sq 2ndt equation	1196.9 ***	1265.4 ***	1480.9 ***	1109.6 ***	1204.1 ***
Breusch-Pagan test of independence:	30.2 ***	408.5 ***	229.8 ***	155.1 ***	430.1 ***

Both equations include industry dummies and a constant, and variables LOG_NUM_EMPL, LOG_AGE, EXP_PAST, D_GROUP, D_HEADGROUP

Equation 1 also includes variables: INT_FIN_INV, INT_FIN_INV_SQ, D_INV_EXT_FIN

*significance levels: * 0.1 ** 0.05 *** 0.01*

Appendix

Table A1 – Probit models for innovation, investment, and export propensities

	(1)		(2)		(3)		(4)	
dependent variable:	*DUMMY EXPORT*		*DUMMY EXPORT*		*DUMMY TANGIBLE INVESTMENT*		*DUMMY INNOVATIVE PRODUCTS SALES*	
	dp/dx	St. Err.	dp/dx	St. Err.	dp/dx	St. Err.	dp/dx	St. Err.
DUMMY TANGIBLE INVESTMENT	.059 ***	.016						
DUMMY INNOVATIVE PRODUCTS SALES			.091 ***	.011				
DUMMY R&D					.005 ***	.001	.352 ***	.008
LOG_NUM_EMPL	.043 ***	.006	.041 ***	.006	.004 ***	.001	.019 ***	.005
LOG_AGE	-.017 ***	.006	-.017 ***	.006	.001	.000	.002	.005
INT_FIN_INV					.003 ***	.000		
INT_FIN_INV_SQ					.000 ***	.000		
D_INV_EXT_FIN					.013 ***	.002		
EXP_PAST	.728 ***	.006	.723 ***	.006	-.002 **	.001	.105 ***	.010
D_GROUP	.068 ***	.015	.067 ***	.015	-.002	.001	-.017	.012
D_HEADGROUP	-.038	.030	-.042	.030	.003 *	.002	.067 ***	.025
*D_AUT**	-.145 ***	.029	-.144 ***	.029	.007 ***	.001	.059 **	.027
*D_FRA**	-.133 ***	.018	-.127 ***	.018	.006 ***	.001	-.075 ***	.015
*D_GER**	-.234 ***	.017	-.230 ***	.017	.015 ***	.002	-.002	.015
*D_HUN**	-.142 ***	.029	-.129 ***	.030	-.005	.004	-.063 **	.026
*D_ITA**	.033 *	.019	.033 *	.019	.004 ***	.001	-.010	.015
*D_SPA**	-.097 ***	.019	-.088 ***	.019	.010 ***	.002	-.031 **	.015
Industry dummies and constant term included								
Test for all industry dummies = 0	48.2 ***		36.2 ***		44.8 ***		172.7 ***	
Test for all Country dummies = 0	321.8 ***		311.3 ***		378.1 ***		54.7 ***	
Number of obs	14,797		14,797		14,797		14,797	
LR chi	8800.8 ***		8859.3 ***		4853.1 ***		2831.4 ***	
Pseudo-R-sq.	0.430		0.433		0.448		0.141	

*significance levels: * 0.1 ** 0.05 *** 0.01*

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