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ABSTRACT

Purpose

International sales are critical for the prosperity of Small and Medium Enterprises (SMEs), because of the limited size of their domestic market, but they can be difficult to attain for a number of reasons. This paper investigates this topic and uses a domain ambidexterity framework to analyse why the relationship between R&D investments and export initiatives generates managerial tensions in high and medium technology industries. In this paper, it is claimed that R&D investments and internationalization can be conflicting objectives that entail a diversity of routines and managerial approaches. This aspect is critical, especially when SMEs are in the early stages of their life cycle and are resource-constrained.

Design/methodology/approach

This issue is tested using multiple regressions on data collected through a survey that was conducted in 2014. The sample is composed of 221 SMEs operating in Italy in high and medium technology industries.

Findings

Our estimates show that combining contemporary high R&D investments and high export activities negatively affects the growth of revenues of SMEs. In detail, when exports over revenue are below 10%, R&D investments have a positive effect on revenue growth, whereas when exports over revenue are above 50%, the effect of R&D investments on revenue growth is negative. However, age acts as a moderator on this relationship, thus implying that the effect of combining these initiatives varies according to the lifecycle of a firm. In particular, combining R&D investments and export generates tensions that limit the growth of revenues in young SMEs (less than 10 years old). For firms aged between 10 and 25 years, the effect is positive, while the effect is positive but not statistically significant for mature firms (older than 25 years). These results demonstrate that the diversity of the organizational maturity in SMEs has an impact on their ability to combine activities that require different capabilities (technological vs. market).

Originality/value

This paper offers a theoretical contribution to the literature on domain ambidexterity, as it shows that combining contemporary innovation-related activities with international activities may constrain the performance of SMEs, according to the age of the firm. It extends the theoretical framework of domain ambidexterity to international studies and it reconciles previous mixed evidence about the combination of innovation and internationalization activities of SME's.

1. INTRODUCTION

International sales play a crucial role in Small and Medium Enterprises (SMEs) engaged in Research and Developments (R&D) programmes, especially when these firms operate on small domestic markets with a limited growth potential. This may be a common situation for SMEs operating in market niches in many European countries. Only a few business customers characterize the domestic market of SME's positioned in the upstream stages of value chains, and foreign customers represent an avenue of growth, but also pose new challenges for their product innovation programmes, given the diversity of the requirements of their markets and institutional environments (e.g. laws, norms and technical standards). Because of this necessity, internationalization can require changes in the competency base of SME's in both the technological and market domains (e.g., Branstetter, 2006; Golovko and Valentini, 2011).

Despite the benefits of international markets for firms involved in innovation, a contemporary engagement in innovation and internationalization may not have any positive effect on the growth of SMEs, due to their financial capital and managerial attention constraints (e.g. Filipescu et al., 2013; Kumar 2009), their tendency to centralize decision-making processes (Macri et al. 2002) and the lack of effective coordination between the sales, marketing and product development functions (Palmiè et al., 2016). For these reasons, exploration in both the market and the product domains can imply an overwhelming leaning process for an SME.

Irrespective of the sector, foreign sales require an intensive exploration phase aimed at finding prospective customers, analysing their needs, building relationships with local distributors and suppliers, understanding the local institutional and regulatory framework and implementing a supply chain management strategy to serve each local market. For an SME, such a market exploration may reduce the availability of the managerial and technical resources required for technological exploration and for R&D endeavours that have a long-term horizon, and can make the

coordination with the technical product function too complicated, especially when this function is engaged in the exploration of new technologies or new product architectures.

In this paper, we show that the simultaneous combination of high R&D investments and an important presence on international markets, in terms of high export intensity, has a negative effect on the growth of revenues in the short term, since R&D endeavours and exports belong to different knowledge and functional domains that SMEs cannot easily extend simultaneously. In this vein, we use a domain ambidexterity lens (Voss and Voss, 2013) to provide a theoretical contribution to the rich and consolidated literature on internationalization in SMEs. We also posit that the difficulties in reaching this domain ambidexterity may depend on the age of the SMEs, as age is associated with differences in routines and complementary assets that are relevant to an ambidexterity capability.

The empirical setting of this study is a survey on a sample of 221 high and medium technology SMEs located in North-West Italy that operate in manufacturing, software and engineering service industries. The focus on this setting is of a multi-industrial type, due to the fact that SMEs operating in manufacturing, software, engineering and R&D services face the same challenges when they try to reconcile market exploration abroad with technology exploration (Vasilchenko and Morrish, 2011). Moreover, Italian SMEs seem to be an interesting empirical setting to analyse the tension between R&D investments and market exploration, since the majority of these companies are family businesses, without the involvement of any external managers (Bugamelli et al., 2012). This managerial structure can weaken the capabilities of SMEs to conduct effective market and technological exploration, as the diversity of managerial experience and professional background available in a firm's management team can enrich its absorptive capacities (Lubatkin et al., 2006). As such, the lack of external managers may increase the tension that arises from the contemporary combination of R&D and internationalization endeavours.

With this paper, we contribute to the well-established literature on internationalization in SMEs in two ways. First, we advance a novel explanation of the dynamics of the growth of SMEs. While

past research has demonstrated the positive contribution of innovation and internationalization activities on SME performance by analysing them in isolation (e.g. Becchetti and Trovato, 2002), we explore whether their combination can have a negative effect on revenue growth, especially when firms are young and in the entrepreneurial stage of their life cycle. Second, in order to explain the negative consequence on firm growth, due to the combination of high export and a high intensity of R&D spending, we draw on domain ambidexterity arguments, and we show that situations of exploration in both the market and the product domains are likely to be detrimental for the revenue growth of SMEs, given their typical managerial traits. Under this perspective, we extend the seminal contribution on domain ambidexterity provided by Voss and Voss (2013) to a new empirical setting that is, of high and medium technology SMEs.

2. INTERNATIONALIZATION AND INNOVATION IN SMES

2.1. STATE OF THE ART AND OPEN POINTS

The involvement in research and development endeavours is a predictor of superior SMEs' performance (e.g. Garcia-Manjon and Romero-Merino, 2012; Leiponen, 2012), since large R&D spending is considered to be an avenue for technology exploration and for a superior product diversification ability in the medium-long term (Penrose, 1959). However, firms' economic and competitive success does not depend only on innovation but also on market access. For this reason, international market access acquires increasing importance for SMEs, especially when they operate in small niches and have a limited domestic market (Sapienza et al., 2006).

Despite the importance that innovation and internationalization activities have for SME growth, literature has begun only in the last few years to analyse their conjunct effect on performance (Love and Roper, 2015). There are several elements in favour of a complementary effect that internationalization and innovation can have on SME's growth. This complementarity finds origin in the fact that firms need to innovate in order to compete in foreign markets (Roper and Love,

2002), at least to refine their products to address foreign customers' needs. Becker and Egger (2013), for instance, show for German firms the significant role of product innovation in enhancing SME productivity which – in turns - affects export decision (Cassiman and Golovko, 2011). Moreover, an international market presence may lead to innovation as a result of a learning process which brings new knowledge into the firms and promotes the development of new innovation (Branstetter, 2006; Cassiman and Golovko, 2011; Golovko and Valentini, 2011).

However, a stream of other studies has found that the contemporary engagement of a SME in innovation and internationalization has a negative effect on performance (e.g. Booltink and Saka-Helmhout, 2018) due to constraints that small firms typically have in financial capital and managerial attention, or due to their lack of reputation (i.e. the liability of newness) to approach foreign markets with new products, whose innovativeness - compared to the state of the art - is not proved or tested due to the lack of a lead-user. Because of this reason, SMEs are unlikely to be contemporarily engaged in diversification on both the product and the market domain (e.g. Kumar, 2009). Apart from the constraints in resources and reputation, the other reason why internationalization and innovation can be hardly combined in SMEs can be related to the entrance mode in a foreign market. Specifically, SMEs are likely to use export contracts with local intermediaries, since they are the simplest and less risky way to increase market penetration abroad (Johanson and Vahlne, 1977),. However, the simplicity of export usually comes at the expense of a low appropriability for foreign sales (Johanson and Vahlne, 1977), limited learning opportunities on foreign markets and loss of strategic opportunities (Neirotti and Paolucci, 2015).

The debate on whether internationalization and innovation are complementary or substitute strategic decisions for SMEs in relation to their performance can be probably reconciled by considering the age of SMEs as a missing link. In the literature on the life cycle of organizations (Sørensen and Stuart, 2000), age is the main variable capturing the availability of the resources. The conventional wisdom (Kiss et al., 2017) proposes that SMEs may be more prone to internationalization when they have accumulated a great deal of financial resources, their domestic market have been

saturated, and new revenue opportunities can only come from entering new geographical markets. However, this type of reasoning and the greater availability of financial resources that can characterize an older and established SME exclude the fact that managing the duality between internationalization and innovation can be problematic even for SMEs in more mature stages of their life cycle and with more internal resources. Moreover, the other element coming from life cycle view of the organizations suggests that the greater maturity of management approaches and of organizational models make the combination of internationalization and innovation less problematic for more established and older SMEs. Such firms usually exhibit more formalized business processes and a more decentralized decision-making structure. These considerations pave the way to the fact that under certain organizational circumstances of "ambidexterity" (Raisch et al., 2009), companies can effectively combine conflicting goals and activities within the same organizational unit. However, these points are object of limited theoretical development and empirical exploration.

To bridge this gap, the paper uses an ambidexterity lens to analyse under which conditions of an SME's life cycle a great effort spend on internationalization and innovation can represent a conflicting activity. Our focus is on R&D spending and exports, as the two main indicators of such efforts. The next section explains why a high level of effort over these dimensions can generate tensions and resource allocation problems that are typically of interest to the ambidexterity literature.

2.2. EXPORT AND R&D SPENDING AS INDICATORS OF THE GROWTH TENSIONS OF SMES

Combining the international expansion of sales with radical product innovation falls into a situation of balancing resources on conflicting objectives, which is well documented in the rich literature on ambidexterity (e.g. He and Wong, 2006). In other words, the challenge of combining an expansion of sales overseas with R&D projects aimed at internalizing new technological competencies for an SME highlights a situation of ambidexterity across different functional domains (Voss and Voss, 2013; Lavie et al., 2011): the domain of applying "new" technologies to the products of the firm

through R&D projects, and the domain of marketing products in a new, unfamiliar market. Although these challenges are often intertwined in the strategic agenda of a firm, they generate tension on how to orchestrate and balance financial, technical and managerial resources in exploration on both the market domain and the product domain (Zhang et al., 2016). Situations in which firms experiment a product that embodies a new architecture and/or a new technology entail an intensive coordination - and thus geographical proximity - with a lead user along the entire innovation process (from the front-end to the validation). As such, firms conduct exploration on the product domain more easily in situations of exploitation of their established market relationships, which, for SMEs, corresponds to a prevalence of local sales on their domestic markets. In other words, product exploration projects that exploit the domestic markets of SMEs (shown in the upper-right hand quadrant in Figure 1) require fewer technical and managerial resources than radical innovation projects that target new markets for SMEs (upper-left quadrant).

Insert Figure 1 about here

Pursuing a high intensity of both export sales (i.e., a high ratio of exports over sales revenues) and R&D expenditures may reflect two distinct situations of tension that have to be faced by SMEs when managing the product and the market domains. The first situation is depicted in the cell [1] in Figure 1, i.e., developing a radically new product for a new geographical market (pure explorative strategy). The second situation may refer to being positioned contemporarily in two cells of the quadrant: developing a radically new product for the established local market (product development strategy - cell [2A]) and exploring new geographical markets with an established product or with incremental refinements of it (market development strategy - cell [2B]). Each of these cells depicts a situation of cross-functional ambidexterity (Voss and Voss, 2013). Whereas the first situation

requires managing an R&D project that is contemporarily complex as far as the technology and the market dimensions are concerned, the contemporary positioning of a project in cells 2A and 2B indicates a situation of complexity that pertains to managing a diversified R&D project portfolio, which includes both incremental and radical innovation projects that require a diversity of managerial and cultural approaches for the coordination with customers (Gibson and Birkinshaw, 2004).

3. HYPOTHESES DEVELOPMENT

3.1. THE TENSION BETWEEN R&D INVESTMENTS AND EXPORT

The contemporary exploration in the product and market domains represented in the combination of cells 2A and 2B or in the positioning of a firm in just cell 1 (Figure 1) is more critical in SMEs than in large firms. SMEs have a limited amount of managerial resources that can be used for the external search activities needed to explore the product and the market domains. Managers in SMEs generally spend a high percentage of their time on operational issues related to product refinement and production management, and a consequent limited time on the search and market intelligence activities that are needed for exploration (Volery et al., 2015).

SMEs with a broad market presence abroad may respond ineffectively to the need of innovation for their products, since they may have a limited ability to enact approaches of ambidexterity based on structural separation or on building contexts *á la* Birkinshaw and Gibson (2004), where employees are required to balance their efforts over multiple innovative projects. In this vein, separation, into distinct task forces, of the technological exploration for a new product that targets a foreign customer from the incremental innovation activities for the domestic market is not so feasible for an SME, due to the limited scale and the few resources available for the coordination between different R&D teams (Lee et al., 2001).

Contextual approaches can be sustainable, in terms of costs, since they do not entail any organizational separation of the teams that are engaged in different innovation projects. However, in a diversified R&D project portfolio situation (i.e. the contemporary position of a firm in the 2A and 2B cells), SMEs may make poor decisions on which projects they have to orchestrate their managerial attention as well as the time of their R&D and marketing teams. This occurs since the routines and systems used to prioritize and allocate efforts across different projects, such as stage-to-gate processes or agile project management in product development, are generally not common in SMEs (Hidalgo and Albors, 2008). The lack of prioritization may result in an "attention-allocation problem" (Koput, 1997) that leads firms to under-invest in each of their multiple innovation projects. In these situations, SMEs are likely to be slow in the time-to-market and in responding to customer's requests for change, especially when customers are geographically and culturally distant. For example, a firm could be ineffective in seizing the opportunity of revenue growth that stems from a radical product innovation on their domestic market when it is distracted by the need to introduce and market distinct incremental product refinements in order to adapt their established product to their multiple foreign markets (Chen and Nadkarni, 2016). The more markets are dynamic and competitive – such as in hi-tech sectors - the greater the risk of losing growth opportunities, due to an under-investment in R&D or marketing activities.

In short, the tension between large R&D investments and a high level of exports may manifest itself in SMEs in terms of a limited capability to seize the opportunity of revenue growth. Firms can thus fail to capitalize on the knowledge created at the front-end of their innovation projects to create new products and new lines of revenue. We thus posit what follows.

H1: *The interaction between R&D investments and export intensity negatively affects the short-term revenue growth of SMEs.*

3.2. AGE AND DOMAIN AMBIDEXTERITY

A firm's age influences the flexibility of the routines used for market and technological exploration, its reputation and the availability of the marketing assets needed to bring product innovation onto the market, as well as the complexity of the management systems deployed to govern a diversified portfolio of innovation projects. In their seminal contribution to domain ambidexterity, Voss and Voss (2013) acknowledged the moderating role of age in influencing the relationship between ambidexterity approaches and performance. Analogously, multiple arguments have been put forward that may explain why the effect on revenue growth, due to combining high expenditures in R&D and high levels of export, may change according to an SME's age.

Young firms are more amenable to responding ineffectively to the tension generated by high export intensity and R&D intensity. This may happen in situations in which they have to manage a radical innovation project for a foreign market (positioning in cell 1) or when they have to manage, at the same time, a radical innovative project for their domestic market and some incremental product refinements abroad (contemporary position in cells 2A and 2B). In the first situation, the presence of a large customer abroad that requires radical innovation is likely to lead young firms to overlook growth options on their domestic market, as all the resources tend to be committed to the foreign customer. Moreover, as explorative innovation often needs the project times, costs and product functionalities to be revisited, due to the higher uncertainty, young firms – given their weaker reputation - may be more vulnerable to the more intense coordination and re-bargaining that an explorative innovation project requires with a customer, especially in situations of size asymmetry and cultural and geographical distance from the counterpart. In the latter situation, the lack of formalization in the control and decision-making processes of innovation projects may lead to a poor implementation of contextual approaches to govern ambidexterity. In the words of Gibson and Birkinshaw (2004), young firms may thus have a lack of the "discipline" that is needed in the orchestration of time across multiple innovative projects. This is due to the long time and

experience necessary to develop the complex management systems and processes required to foster system wide orientation toward exploration and exploitation (March, 1991). Moreover, obtaining subsequent benefits from financial performance requires an extended time frame, even after the contextual capabilities necessary for pursuing ambidexterity have been developed (Van Looy et al., 2005).

According to Voss and Voss (2013), larger and more mature firms are more likely to respond effectively to the tension triggered by domain ambidexterity, since they possess the knowledge, experience and time frame required to implement and benefit from contextual management approaches. Drawing on this insight, we may expect more mature firms to be more likely to respond effectively to the tension posed by high export intensity and high budgets spent on R&D programs. However, when age is taken into account in the case of SMEs, there can be a self-selection bias associated with older SMEs. In other words, these firms are more likely to be oriented towards and more capable of pursuing efficiency and stability - rather than business growth - otherwise they would already have become large enterprises over time. As such, older SMEs may employ more rigid and crystallized routines and may be less able to effectively conduct product and market exploration initiatives.

Following the same arguments, adolescent firms - i.e., those that have survived the initial critical years, but have not yet reached a mature phase where they feature well-established firms (Biggadike, 1979) - can exhibit the more favourable combination of contextual management systems, slack resources and flexibility in routines that is needed to pursue domain ambidexterity and which can express a high potential for revenue growth. For example, once these firms have overcome the high pressure of cost compression and risk minimization associated with the earlier years of their life, the obtained mitigation in resource constraints allows them to hire new personnel that can then be involved in exploration. For example, the hiring of an experienced person in the managerial team or in the technical and marketing function can lead to a mechanism of “learning by grafting” (Huber, 1991), which can sustain exploration dynamics in adolescent firms.

In short, an ambidexterity capability in SMEs to combine international presence, through export activities, and exploratory R&D investments, can be more evident in firms of an intermediate age (namely that are in the adolescence phase). Thus we posit what follows:

H2: *The age of SMEs moderates the negative interaction between R&D investments and export intensity on revenue growth in such a way that the negative interaction is less salient for adolescent SMEs.*

4. RESEARCH METHODOLOGY

4.1. SAMPLE AND DATA COLLECTION

The empirical analysis is based on a survey that was administered in June and July 2014 on high and medium tech SMEs in the Piedmont region (Italy). Over the last decade, the European Innovation Scoreboard and the Regional Innovation Scoreboard have classified the Piedmont region as being a "Strong Innovator"[1] in relation to various measures pertaining to firms' investments in R&D and to initiatives of the local institutions to support innovation and internationalization activities. Such institutional measures involve elements of the innovation ecosystem that encompasses the collaboration attitude of local universities and research centres with firms, the role that banks and venture capitalists have in providing financial capital for R&D initiatives, and the availability of qualified managers as a result of the offer of executive managerial education programs, etc. The "Strong Innovator" category is the most common throughout European regions. Some examples of these regions are the Bremen region in Germany, the Groningen region in The Netherlands and the East and West Midlands in the United Kingdom. Thus, the results obtained in this survey are potentially generalizable to many other European areas that fall into the "Strong Innovator" category, where firms are confronted with similar innovation ecosystems and thus with

[1] A complete discussion on the innovation categories through which the European Union classifies regions can be found in Hollanders et al., (2012).

comparable conditions of access to the relevant production factors (i.e. human capital with managerial or technical competencies, financial capital and knowledge) for innovation endeavours.

The firms that have been analysed all belong to medium or hi-tech industries, as defined by OECD (2009). Automotive, aerospace, telecommunication, medical instrument, machinery and pharmaceutical industries have been included in the sample frame. Software, engineering and R&D services have also been added to these sectors, since – despite the intangible nature of what the firms in these sectors sell - their technology and market exploration dynamics are similar to those of the manufacturing sectors with high technological intensity. More specifically, internationalization in the software sector, especially in the case of a firm's positioning on B2B markets, requires the firm to be present on the foreign market in order to effectively conduct analyses of the customers' needs, to test products and to coordinate with customers in these phases. The same type of presence is needed for firms in the engineering and R&D service sectors.

As the aim of the present research was to explore the effectiveness of the ambidextrous strategies adopted by SMEs, the selection criteria were chosen in order to capture a convenient sample made up of SMEs with a certain level of expected involvement in technological and market exploration endeavours. This condition is generally rare among SMEs, as their innovation focus is usually on endeavours with just an incremental innovation nature (Oke et al., 2007; De Massis et al., 2012). Therefore, to exclude firms that are only involved in particularly incremental and exploitative technology or market expansion projects, the firms included in the population frame had to have accomplished at least one of the following tasks that denote a certain level of technology or market exploration in the three years preceding the survey: i) R&D projects funded by European, national or regional public initiatives, ii) at least one patent filled, iii) their inclusion in local incubators or science parks; iv) the inclusion in special acceleration programs sustained by the local Chamber of Commerce and dedicated to entering new foreign markets. The architecture of the survey followed the framework used in the Community Innovation Survey (CIS), which has been used in several academic studies on innovation (e.g. Laursen and Salter, 2006).

The respondents were CEOs, and they were all contacted telephonically. Two rounds of recalls were conducted to avoid non response bias. We invited 1,203 firms to participate in the survey, and we collected answers from 364 SMEs (response rate: 30.26%). The survey data were integrated with financial data from the Aida database (published by Bureau Van Dijk), which includes the financial reports of all Italian firms. We obtained 221 observations with complete data for these analyses. The here analysed sample of 221 firms is composed of firms with fewer than 100 employees. Moreover, 43% of the firms included in the final sample belong to manufacturing industries, 33% are software firms operating on B2B markets through standard software packages, while 24% are firms that provide advanced services related to engineering design or other R&D activities. All the firms in the sample operate Business-to-Business, and none of them sells products or services through e-commerce channels. We thus obtained a sample in which the contextual conditions imposed that the firms had to face market or technology exploration activities, with similar challenges at a managerial and organizational level. This implies having a sample made up of firms with comparable situations, in terms of ambidexterity capabilities

4.2. MEASURES

Dependent variable. The revenue growth rate was measured in logarithmic terms and was computed between 2008 and 2013. The firm growth rate was adjusted to the growth rate of the overall sales revenues at the industry level, where industry was operationalized at the SIC second-digit level. In this manner, we measured the differential of growth compared to the overall trend of the industry and we were thus able to measure industry-specific effects.

Independent variables. R&D investments were measured as the ratio between R&D expenditures in 2013 and the total revenues of the firm in the same year. Exports were measured as the ratio between exports and sales revenues in 2013. Firm's age was included as the logarithmic value of the years since firm has been incorporated.

Control variables. Size effects related to revenues and to the number of employees were incorporated as control variables. Moreover, we also incorporated a dummy variable to take into account whether the firm belongs to a high or medium tech industry. We also controlled for how respondents perceived a munificence and competition situation in their competitive environment. The perceived market environment can influence a firm's options of market growth, and/as well as the marketing and R&D initiatives enacted to pursue growth (Sutcliffe and Huber, 1998). For the same reason, we also looked at vertical forces of competition in the industry, by controlling for the position of the firm in their industry's vertical chain. We asked firms to state the percentage of their firms' sales dedicated to the manufacturers of components or subassemblies and the percentage related to the final customers or distributors.

Finally, consistently with the idea that family firms with no external managers deploy less effective managerial practices in innovation endeavours, we used a dummy variable to control for managerial teams that were made up of just family members of the main shareholders.

4.3. STATISTICAL MODELLING

We use the following regression specification (1) to test our hypothesis H1:

$$Rev.growth_i = \beta_0 + \beta_1 R\&D_i + \beta_2\, export_i + \beta_3 R\&D_i * Export_i + \beta_4 W_i + \varepsilon_i \qquad (1)$$

where W_i is a vector including all the control variables specified above and a set of industry dummies.

To test our hypothesis H2, we use instead the regression specification (2) which is analogue to Model 1 (1), but which includes a third level interaction between R&D investments, revenues from export, firm's age, as well as all the second level interactions between R&D investments and age, and revenues from export and age.

$$Rev.growth_i = \beta_0 + \beta_1 R\&D_i + \beta_2 export_i + \beta_3 age_i + \beta_4 R\&D_i * export_i + \beta_5 R\&D_i * age_i + \beta_6 export_i * age_i + \beta_7 R\&D_i * export_i * age_i + \beta_7 W_i + \varepsilon_i \qquad (2)$$

We employed multiple regressions with robust standard errors to test hypotheses. A common problem in using empirical data is represented by non-normality of residuals which may violate the basic assumptions of OLS. Then, we tested against non-normality of residuals using the Shapiro-Wilk W test and obtaining that we cannot reject the null hypothesis that our residuals are non-normally distributed (p=0.210). Another problem in empirical data may be represented by heteroskedasticity. Therefore, we tested against this possible concern using the White/Koenker test and we find that we cannot reject the null hypothesis of homoscedasticity ($\chi 2$=214.92; p-value=0.221). Finally we also checked for multicollinearity. Our results indicate that the VIF among our covariates has at most the value of 4.42, so all variables have a VIF largely below the critical threshold of 10.

5. FINDINGS

5.1. DESCRIPTIVE STATISTICS

The firms in the sample (see Table 1) show an average and a median number of 22 and 15 employees, respectively. The small number of employees is related to the fact that about 25% of the firms in the sample are less than 10 years old. The first and the third quartile, in terms of age, are 11 and 37 years, respectively. Firms that are more than 50 years old make up about 12% of the sample.

Despite the limited size of the sample, export was found to be common to 163 of the firms, and it occupies a non-marginal part of their revenue (on average, about 25% of revenues), due to the overall limited revenues. Specifically, for 15% of the sample, 80% of the revenues come from exports. The average expenditure in R&D is just below 10% of the sales revenues, and half of the sample invested about 5% of their revenues in R&D activities.

Insert Table 1 about here

5.2. REGRESSION RESULTS

5.2.1 THE INTERACTION BETWEEN R&D INVESTMENTS AND EXPORT

In Hypothesis 1, we posited that there is a negative effect on the performance of SMEs when these firms combine high spending in R&D with a strong foreign market presence through exports. As can be observed in Table 2, Model 1 exhibits positive and significant first-order effects of both R&D investments (β_1=1.887, p<0.05) and export intensity (β_2= 0.762, p<0.05) on revenue growth. These effects represent conditional effects that describe the effect of one predictor (e.g., R&D spending) on the dependent variable (i.e., revenue growth) under the condition in which the other predictor (e.g., export) equals zero (Aiken et al., 1991). This means that in situations in which firms are only engaged in R&D activities or only in export activities, they benefit from such activities, since they exert a positive effect on revenue growth. However, as the R&D*Exports interaction term reported a negative and significant value (β_3=-7.239, p<0.05), revenue growth is lower when R&D activities and export are performed at the same time. In other words, the coefficient of the interaction term indicates the amount of change in the regression slope of the logarithmic value of revenue growth on R&D spending resulting from a one-unit change in the export activities (Dawson, 2014). The high relevance of this implication is also highlighted by the partial ω^2 we computed for model 1. More specifically, the quota of variance of revenue growth accounted by R&D spending is superior to the quota of exports (0.058 vs. 0.025), but they are both lower than the second-level interaction (R&D spending*Revenues from export), which explains more variance (0.069). This insight supports the idea that contemporary R&D and export activities are very relevant in explaining the revenue growth of SMEs.

Insert Table 2 about here

To facilitate the interpretation of this result, we use two complementary approaches. First, we test the effect of the interaction between R&D activities and export through an analysis of the marginal effect that R&D activities have on revenue growth at different levels of exports. Second, we perform a simple slope analysis (Aiken et al., 1991) to check the effect at high and low levels of R&D investments and export activities on revenue growth. Both the analyses we perform support the idea that pursuing strategies encompassing contemporary innovation and internationalization activities are detrimental to SMEs' revenue growth.

Studying the marginal effect that R&D investments have on revenue growth at different levels of export corresponds to estimate the partial derivative of Model 1 (1) with respect to R&D investments and to analyse the response function at different level of export intensity. Therefore, following the notation expressed in Model 1 (1) the marginal effect is:

$$\frac{\partial(Rev.growth_i(1))}{\partial(R\&D)} = \beta_1 + \beta_3 export_i = 1.887 - 7.239 * export_i \qquad (3)$$

Insert Figure 2 about here

Figure 2 reports the estimated marginal effect of R&D investments at different levels of revenue from exports. It clearly emerges that R&D investments have decreasing marginal returns on revenue growth the more the revenues from export grow. From Figure 2, we can assess that at low values of exports ($\%\ of\ revenue\ from\ exports < 10\%$) R&D investments have a positive and significant marginal effect on revenue growth (p-value <0.1), while at higher levels of exports ($\%\ of\ revenue\ from\ exports > 50\%$) R&D investments have a negative and significant marginal effect (p-value <0.1), implying lower revenue growth.

Figure 3 offers an alternative graphical representation of the negative interaction effect between R&D investments and exports following the approach suggested by Aiken et al. (1991). In detail, we plotted revenue grow rates - as estimated by the regression model - at high and low values of

R&D spending and revenue from exports (i.e., one standard deviation above and below the mean). This plot indicates that SMEs report superior growth in situations of high spending in R&D projects combined with a sales concentration on the domestic market, or when their spending in R&D is limited and their sales from exports are high. Conversely, a lower performance emerges for firms that contemporary combine high R&D spending with high revenues from exports. In sum, from these results we find support to our hypothesis H1 according to which combining high R&D investments with a high level of activities abroad hampers the growth of revenues.

Insert Figure 3 about here

5.2.2 AGE MODERATION ON THE TENSION BETWEEN R&D AND EXPORT

In Hypothesis 2, we posited that age can be a moderator of the negative interplay between R&D spending and export intensity, and that the organizational tension, due to the balancing of these actions, can be less evident for firms that are neither too young nor too old. Model 2 reports that the interaction term between R&D spending, export intensity and age is positive and significant (β_7= 9.845, $p < 0.01$), thus suggesting that age may act as a moderator of the relationship that exists between R&D and export activities. Similarly to Hypotheses 1, we checked for the size effect of the independent variables of Model 2 with respect to SMEs' revenue growth rate. Such results are reported in the column "Partial ω^2 " and highlight that the third level interaction between R&D activities, revenues from export and age explains the 0.084 of the variance of the revenue growth rate, i.e. a medium large part of its variance (Miles and Shevlin, 2001). To understand the form of the interaction, we performed again simple slope analysis (Aiken et al., 1991). The regression lines for high and low values of R&D spending, export intensity and age are plotted in Figure 4. This figure clearly describes the nature of the moderation effect played by age. The plot shows that

higher revenue growth is attained by the younger SMEs that engage in high R&D spending and which are focused on their domestic market (low export intensity). Increasing export intensity has a detrimental effect on revenue growth for younger firms with high R&D spending. A marginal negative effect on revenue growth emerges for such firms, due to increasing exports. The revenue growth rates are higher for older SMEs with high spending in R&D initiatives, when these firms engage in more exports than in the case of limited export intensity. Thus, we find support for the fact that older firms with high spending in R&D experience superior growth when they can access international markets. However, the interaction plot also shows that such firms report similar revenue growth rates to the ones of a comparable age that are focused on more incremental R&D initiatives and on local sales.

Insert Figure 4 about here

In order to identify the age group that benefits the most from combining R&D and export initiatives, we compared the effect on the revenue growth rate of the contemporary engagement of firms in R&D endeavours and export activities for three age groups. To do so, we re-estimated the regression models using dummy variables for age categories rather than expressing age in logarithmic form. Consistently with past research on age as a factor of influence on the conduct of SMEs (e.g. Carr et al., 2010; Zhou and Wu, 2014), we defined two cut off points in the SMEs' age: 10 and 25 years.

Insert Table 3 about here

We chose the two cut-off points, because of the general lack of consensus in literature about how to define age classes for firms, considering three rules. First, we adopted cut-offs that had been employed in past studies. For example, a 10-year cut-off has been used to identify the difference in behaviour of "early youth" SMEs and "adolescence" ones over their life cycle in relation to their strategies on accessing new financial capital (e.g. La Rocca et al, 2009). In a similar vein, the 25-year cut-off was used in previous literature to identify firms with a more established presence on the markets (e.g., Berger and Udell, 1998). The three classes also reflect the tendency of firms to show different innovation behaviours and to develop different innovation capabilities throughout their life (Branzei and Vertinsky, 2006), as well as to adopt different internationalization pathways (Kuivalinen et al., 2012). Although SMEs may begin to lower product innovation endeavours after about ten years and begin focussing on efficiency and process innovation activities (Klepper, 1996), those firms that have survived competition after about 25 years attempt to maintain and establish their product-market position less through the innovativeness of their product and more through their efficiency in producing and selling it. At the same time, international activities also change according to the lifecycle of the firm. In the very first years, firms rely on intermediaries in their international activities (Neirotti and Paolucci, 2015). However, after 25 years, firms may begin to have a consistent market presence abroad or international experience, and they may rely on their own capabilities to address foreign markets (Johanson and Vahlne, 2009). Second, the creation of the three groups has allowed us to test our second hypothesis on three well-balanced sub-samples, in terms of number of observations. This reduces the risk of capitalization of chance that may incur when results obtained from small sub-samples are considered. Third, in order to check the consistency of the two cut-offs, we employed the Chow test (Chow, 1961) as a robustness test to confirm the existence of structural breaks in the sample with reference to age. Model 3 in Table 3 reports the results of the analysis in which we used three dummy variables to express the two cut-off levels. In general, the model reports a significant discontinuity in the effect given by the combination of R&D endeavours and export activities on the growth of revenues for SMEs for the

two age thresholds. In fact, the interaction terms between the three variables and the dummy variable that discriminates firms with less than 10 years and firms between 10 and 24 years are significant. Chow's test confirmed the differences indicated when considering the two thresholds.

At this point, in order to gather more evidence on the age moderation factor, we estimated the two-way interaction effect on the three different subsamples (models 4, 5 and 6; Table 3) identified when considering the two different firm age thresholds. Considering the interaction results, it is possible to see that a significative negative interaction effect only exists for firms with less than 10 years (β_3=-14.404, $p<0.01$), and that revenue from exports are not significantly correlated to revenue growth for this group of firms, while R&D investments are positively correlated (β_3=4.004, $p<0.05$). Conversely, the revenue growth rates of adolescent firms are positively correlated to the contemporary presence of R&D investments and exports (β_3=13.773, $p<0.01$), but suffer from R&D expenditures, since it can be observed that they lowered the growth rate (β_3=-4.237, $p<0.05$). Finally, firms older than 25 years do not show any significant effect of R&D investments, exports or their interaction. Overall, these evidence support our Hypothesis H2, which posits that the detrimental effect on revenue growth, due to the attempt of SMEs to combine or balance R&D endeavours with internationalization, may tend to vanish when these firms become adolescent, that is, when they reach an intermediate age at which they are likely to be better organized.

6. DISCUSSION AND CONCLUSIONS

In this paper, we have analysed the impact of R&D investments and exports on the revenue growth of SMEs. By developing two hypotheses, rooted in the theoretical framework of domain ambidexterity (e.g. Voss and Voss, 2013; Zhang et al., 2016), we have shown that although R&D investments and export intensity have a positive impact on the revenue growth of SMEs, their contemporary combination may be detrimental to revenue growth. In detail our estimates show that when exports over revenue are below 10%, R&D investments have a positive effect on revenue

growth. By contrast, when exports over revenue are above 50%, the effect of R&D investments on revenue growth is negative. We have found that the tension on revenue growth between R&D and export intensity particularly occurs in young firms, due to their lack of resources and the difficulties they encounter in building or obtaining returns from contextual management approaches to ambidexterity. Therefore, SMEs – and in particular the younger ones - should focus their investments on either high R&D investments or on the internationalization of their sales.

These results have a theoretical background in the emerging view of domain ambidexterity. We started the research by assuming that high R&D investments and high exports may occur in two different situations: when firms undertake a pure exploration strategy (Voss and Voss, 2013), in which they develop radical new technologies to address a new foreign market; or when firms undertake two different strategies contemporarily, namely, developing a radical new technology to address the needs of a local market and contemporarily refining a technology on which the SMEs are specialized to enter a new foreign market. Both of these situations denote a domain ambidexterity situation, namely an explorative position undertaken in both the technological/product and market domains.

Our results are different from those obtained by Voss and Voss (2013), who found a pure explorative strategy (i.e. high levels of product and market exploration) as being beneficial to the growth of sales. The results of our study are akin to those of Zhang et al. (2016), who found that strategies that are exploitative in a domain and exploitative in another domain are beneficial to performance. In this vein, our focus on age as a moderator of a firm's domain ambidexterity capability extends previous results (Voss and Voss, 2013) by showing that, in the case of SMEs, mature organizations are not able to take advantage (in terms of revenue growth) of domain ambidexterity strategies. Our results suggest that 10 to 25 year old firms are able to take advantage of being ambidextrous across domains. The reasons why young and mature SMEs may be unable to take advantage of domain ambidexterity strategies are likely to be different. We have concluded that young firms are unable to set contextual management approaches to domain ambidexterity, due

to their limited resources and the complexity of such approaches, whereas more mature firms probably have more rigid organizational routines and strategic myopia to effectively undertake exploration paths, especially on the technological domain.

According to these results, our research contributes to domain ambidexterity literature in two other ways. First, to the best of our knowledge, this study represents the first attempt that has been made to apply the domain ambidexterity framework to international studies. Second, the framework has been adapted to the context of small and medium enterprises operating in sectors with medium or high technological intensity in manufacturing and services industries, unlike Voss and Voss (2013), who developed their study in the non-profit organisation context, or Zhang et al. (2016), who developed their work to analyse product and market innovation in the Chinese high-tech firm context. The adoption of this framework has allowed us to unravel product and market activities and to categorize them as explorative or exploitative (March, 1991). The use of this feature can be very relevant, especially in the SME context, where exploration and exploitation activities are often difficult to distinguish and where the management of product and market activities often overlap, due to the intrinsic nature of SMEs. In this vein, we believe this work is valuable as it represents a further step towards depicting the way in which international activities are integrated with innovation activities within SME functions: while this aspect has been studied extensively for multinational enterprises (e.g. Hitt et al., 1997), the interaction between these two activities has been treated as a sort of black-box in the SME context, due to the social complexity that is related to the resources that are associated with the two operations. In this vein, our study also responds to the call for research on ambidexterity across domains in business (Lavie and Rosenkopf, 2006; Lavie et al., 2011).

Finally, this study offers further clarification about the complementarity that exists between innovation and internationalization in SMEs. While previous studies found mixed results about the effective existence of a complementary effect, with some studies pointing to complementarity, others to substitution and still others to no effects (e.g. Golovko and Valentini, 2011; Kumar, 2009;

Filatochev and Piesse, 2009), our study argues that the complementarity between internationalization through exports and innovation activities may change according to the age of the firm, since the capabilities of managing the two activities vary according to the experience, the availability of resources and the inertia of the enterprise. In this vein, we reconcile the three different views and sustain that a complementary effect exists, does not exist or is irrelevant to SME performance, according to the age of a firm.

This work offers managers several implications. First, our results directly indicate that during the first years of SME's life, firms should be focused on pursuing exploration on just one domain among innovation in the product and in the geographical market. Since our results indicate that SMEs may deal with an overload of R&D and information requirements, the practical implication for managers is - therefore – to first develop the routines and the approaches in the R&D process to balance different projects, also with differences in the attributes of market and product exploration. In practice, this means that small firms should first develop the asset orchestration capabilities (Teece, 2014) that are needed to manage a large and diversified portfolio of innovation. Especially in the research and product development areas, such firms need to implant contextual management practices that put human resources in the condition to balance their cognitive effort and attention on different innovation projects.

Second, our results raise questions about how SMEs may benefit from the combination of international operations and R&D endeavours. The fact that age positively moderates the negative interaction between R&D endeavours and export may imply that experience and learning are two mechanisms in place in shaping growth through internationalization and innovation. In this vein, our results advice managers that they may benefit from accumulated experience in international markets. Due to the limited time to develop such experience, however, young SMEs could rely on vicarious learning by hiring managers with a previous experience of developing foreign markets in contexts of innovative products (Child et al., 2017). Other viable mechanisms could be the use of

temporary managers or training programs that involve young managerial roles and aim to give them an experience in managing international operations and product development.

More relevant contributions to managerial practice and theory may emerge in the future, in which the missing links in the moderation effect played by firm age on SME growth of combining high intensity in exports and revenue may be captured. For example, a missing link that could help to explain the superior ambidextrous capability of adolescent SMEs in combining R&D investments and exports may depend on the managerial routines of more mature firms. With reference to traditional studies on SMEs, it is possible to advocate that these firms may count on more structured management teams (Lubatkin et al., 2006; O'Reilly and Tushman 2013).

Future studies could also overcome some of this study's limitations. First, our study was not based on panel data. Moreover, our measurement of the SME growth rate took into account a period of six years, while the measurements of R&D expenditures and export intensity were punctual and refer to a single year (2013). Thus, there might be a problem of reverse causality that could have conditioned our findings, and for which we were limited in implementing more robust analyses. This problem was partially mitigated by the fact that R&D and export intensity are not isolated activities, but they reflect long-term attitudes and exhibit certain stability over time. Finally, our study has focused on SMEs operating in a region that has been categorized as a "Strong Innovator" by the European Union. Therefore, while our results are generalizable to regions with a similar innovation ecosystem structure, we have not been able to test the consistency of our predictions for firms operating in more innovative regions (i.e., firms in "innovation leader" regions). Institutional factors may play a significant role in supporting SMEs in combining innovation and internationalization activities (Yi et al., 2013). For example, in ecosystems such as the Silicon Valley, the well-rooted local presence of actors, for example, venture capitalists, technical universities with technological transfer programs toward SMEs and management programs for entrepreneurs, may help mitigate the tensions SMEs face in their attempts to combine technological and market exploration. Therefore, future research could test the same problem in a more innovative

context than the one we have focused on, and could also explore the institutional factors that enable successful combinations of innovation and internationalization activities by studying different ecosystems.

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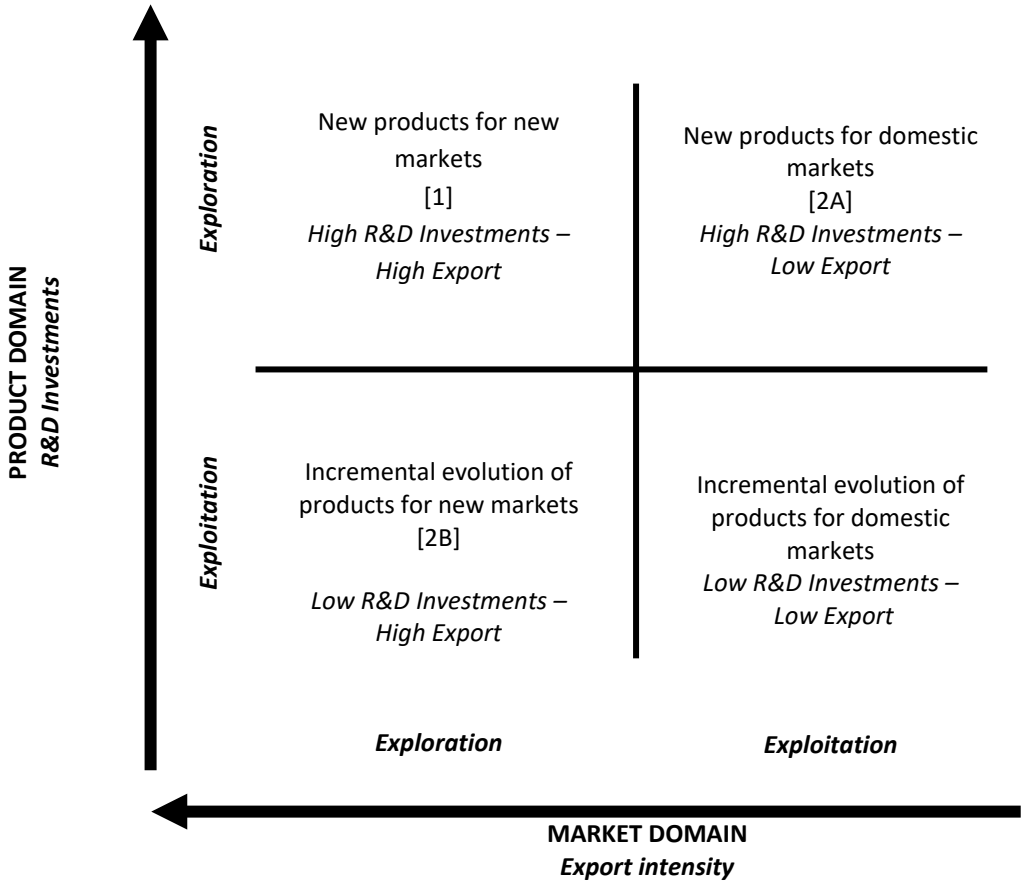

Figure 1 – Exploration and exploitation in product and market domains

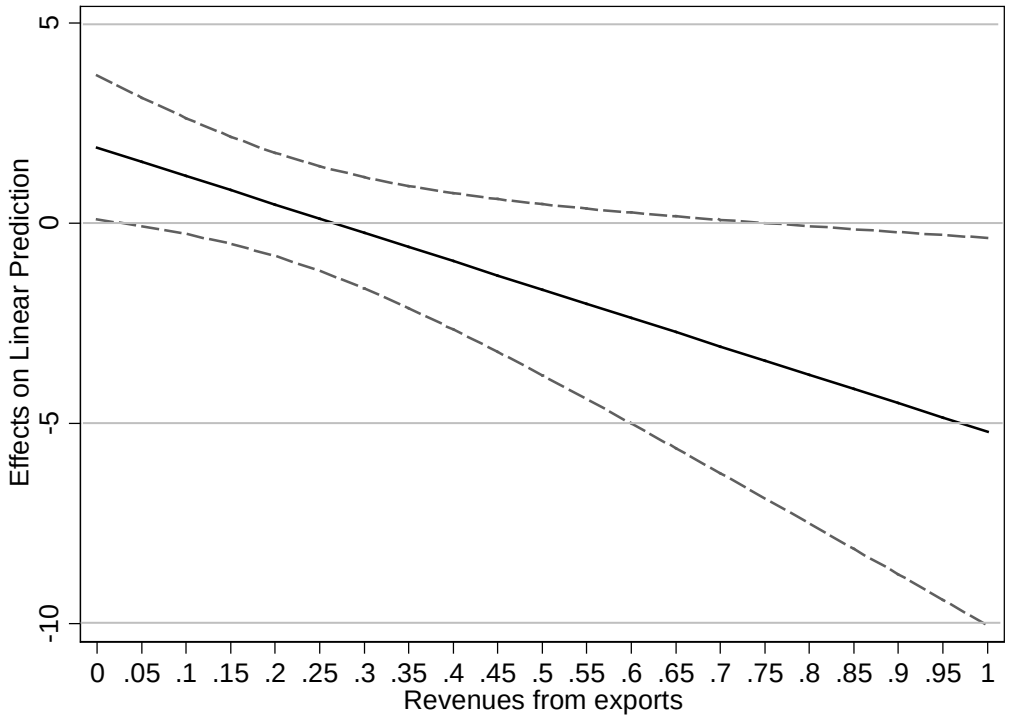

Figure 2 – Average marginal effects of R&D investments over revenue growth with 95% CIs

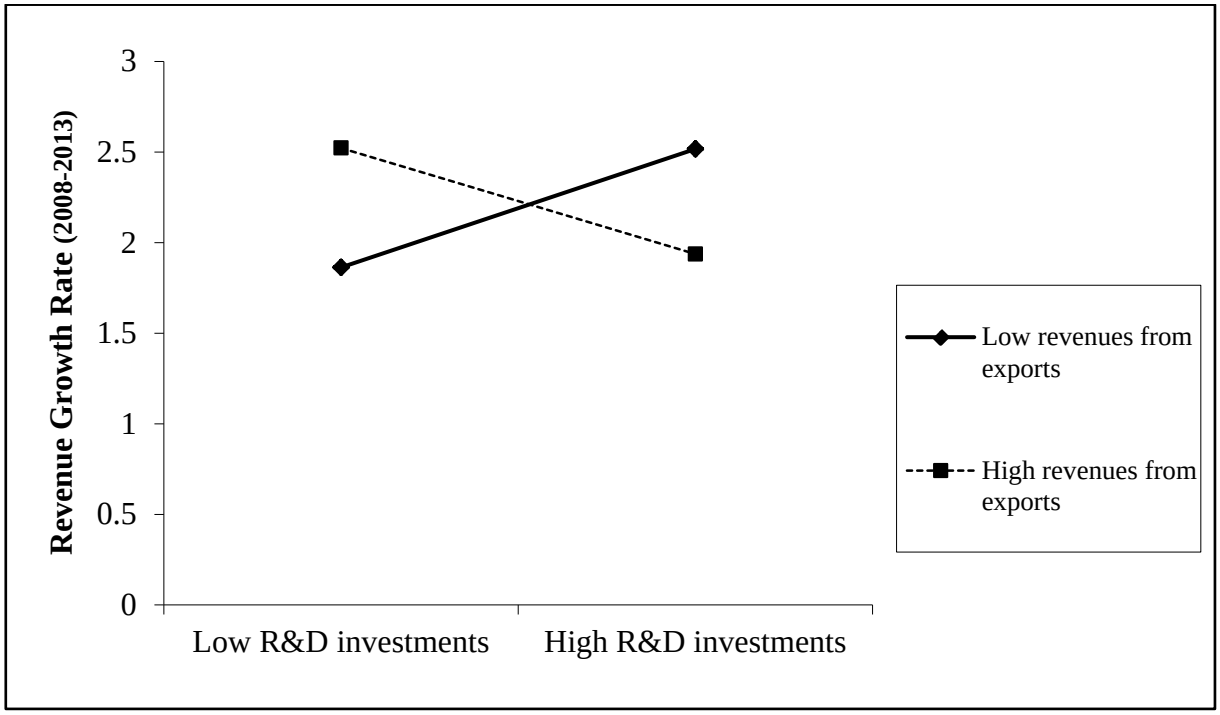

Figure 3 - Two-way interaction between Exports and R&D investments

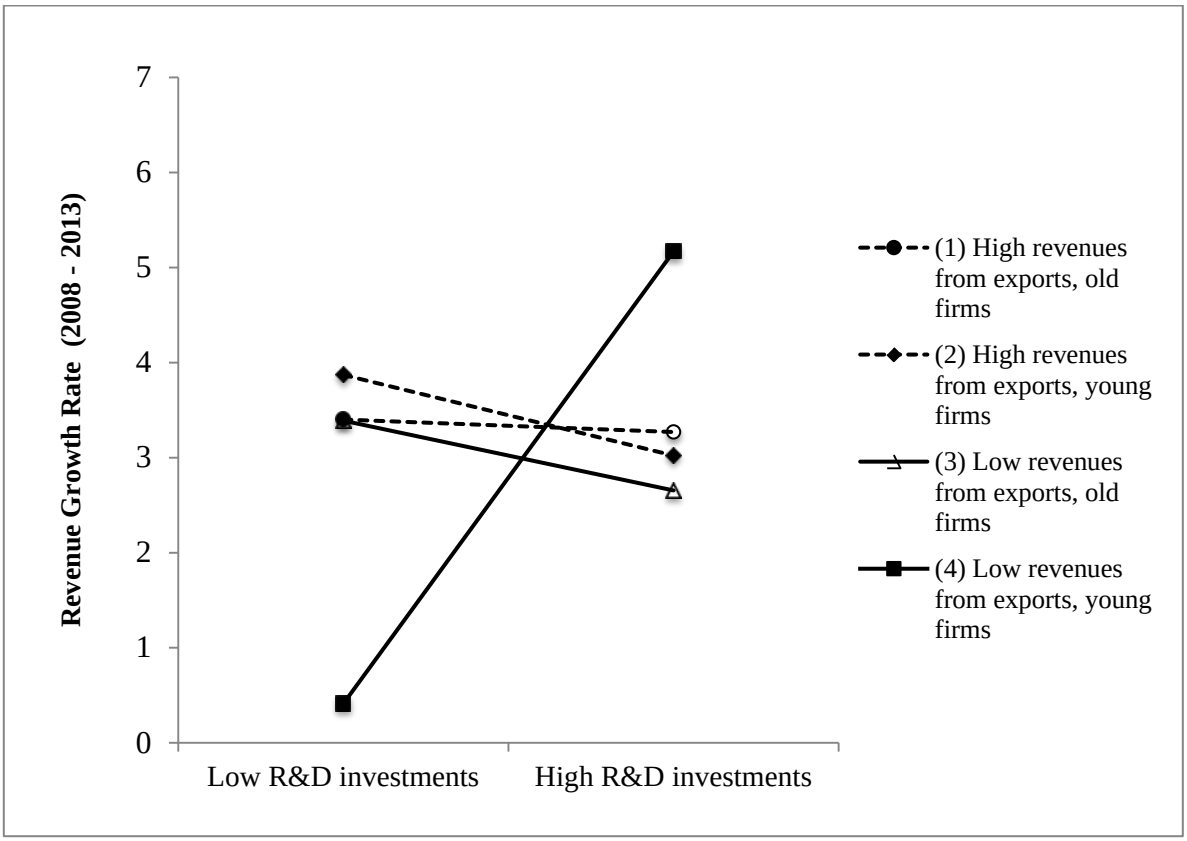

Figure 4 – The moderation effect of age on the effect of R&D investments and exports on revenue growth

		1	2	3	4	5	6	7	8	9	10	11	12
1	Revenue Growth Rate (ln)	1											
2	R&D investments	0.222***	1										
3	Exports	-0.060	-0.118*	1									
4	Employees (ln)	-0.095	-0.223***	0.339***	1								
5	Hi-tech – Medium tech Industry	0.063	0.249***	-0.181**	-0.163**	1							
6	Age	-0.334***	-0.362***	0.294***	0.518***	-0.293***	1						
7	Munificence	0.134*	0.236***	0.146**	-0.008	0.200***	-0.136*	1					
8	Competition	-0.0499	0.003**	0.1576*	0.066	0.010	0.032	0.454***	1				
9	Component Sales	0.025	-0-0.108	0.066	0.021	-0.173**	0.122*	-0.029	-0.010	1			
10	End User Sales	0.083	-0	-0.022	0.080	0.020	0.117**	0.013	-0.020	-0.037***	1		
11	Family	-0.075	0.089	-0.042	-0.005	-0.033	-0.064	0.035	0.031	0.074	-0.014	1	
12	Revenues in 2013	-0.108**	-0.169**	0.097	0.361***	0.043	0.244***	-0.000	0.031	0.004	-0.045	-0.012	1
	Median	-0.11	0.045	0.15	2.71	1	22	1	1.11	0	0	0	1850
	Mean	0.045	0.098	0.251	2.74	0.760	26.43	1.002	1.094	0.148	0.202	0.167	4159
	Standard Deviation	0.966	0.152	0.286	0.949	0.428	23.50	0.216	0.265	0.290	0.318	0.374	7087

****p-value < 0.1%; ** p < 1%; * p < 5%*

Table 1 – Correlation matrix and descriptive statistics

	Model 1 Two – way Interaction		**Model 2** Three – way interaction	
.	β (s.e.)	Partial ω^2	β (s.e.)	Partial ω^2
R&D Spending	1.887* (0.89)	0.053	10.616** (3.86)	0.097
% of revenues from exports	0.762* (0.35)	0.025	1.776 (1.54)	0.015
R&D * Exports	-7.239* (3.10)	0.069	-28.243** (8.97)	0.122
Age * R&D	-	-	-4.045* (1.58)	0.072
Age * Exports	-	-	-0.466 (0.44)	0.009
Age * R&D * Exports	-	-	9.845** (3.37)	0.084
Employees (ln)	0.067 (0.07)	0	0.039 (0.07)	0
Hi-tech. – Medium tech. Industry	-0.035 (0.16)	0	-0.003 (0.16)	0
Revenues(t-1)	-0.109* (0.05)	0.028	-0.102* (0.05)	0.027
Age	-0.297** (0.10)	0.029	-0.023 (0.19)	0
Munificence	0.055 (0.33)	0	-0.175 (0.35)	0
Competition	-0.404 (0.28)	0.005	-0.303 (0.27)	0.001
Component sales	-0.001 (0.25)	0	-0.030 (0.23)	0
End User sales	-0.455* (0.21)	0.02	-0.399* (0.20)	0.016
Family	-0.300 (0.18)	0.001	-0.249 (0.17)	0
Constant	2.008* (0.75)	-	1.550† (0.87)	-
Adj. R-squared	0.187		0.249	
N	221		221	

Dependent Variable: Logarithmic growth rate of revenues

****p-value < 0.1%; ** p < 1%; * p < 5%; † p < 10% (robust standard errors in parentheses).*

Industry effects controlled at the second digit of the SIC code for each model.

Partial ω^2 is the variance in the DV accounted for by one particular IV, with the effects of the other IVs partialed out.

Table 2 –Regression results

	Model 3 Chow's Test	**Model 4** Subgroup with age <10	**Model 5** Subgroup with 10 ≤ age > 25	**Model 6** Subgroup with age ≥ 25
.	β (s.e.)	β (s.e.)	β (s.e.)	β (s.e.)
R&D Spending		4.004*	-4.237*	-0.987
		(1.55)	(1.78)	(1.56)
% of revenues from exports		1.107	0.610	0.244
		(0.90)	(0.38)	(0.27)
R&D * Exports		-14.404**	13.773**	0.758
		(5.24)	(5.34)	(3.67)
Employees (ln)	0.043	-0.334	0.154	-0.038
	(0.07)	(0.31)	(0.10)	(0.07)
Hi-tech. – Medium tech. Industry	0.022	1.076†	-0.052	0.071
	(0.16)	(0.60)	(0.28)	(0.16)
Revenues(t-1)	-0.097†	-0.299**	-0.141*	0.016
	(0.05)	(0.11)	(0.07)	(0.04)
Age		0.760	-1.098**	0.002
		(0.60)	(0.41)	(0.20)
Munificence	-0.125	-2.086	-0.199	-0.291
	(0.36)	(1.81)	(0.38)	(0.39)
Competition	-0.206	-2.086	-0.102	0.202
	(0.25)	(1.81)	(0.24)	(0.35)
Component sales	0.073	2.199	-0.223	0.093
	(0.24)	(1.61)	(0.48)	(0.19)
End User sales	-0.330†	-0.289	-0.063	0.063
	(0.20)	(0.99)	(0.32)	(0.18)
Family	-0.309	-0.551	-0.149	-0.058
	(0.18)	(0.57)	(0.23)	(0.11)
Under 10 * R&D	2.114 †			
	(1.23)			
Under 10 * Export	0.362*			
	(1.13)			
Under 10 * R&D * Exports	-8.529*			
	(4.15)			
Intermediate * R&D	-2.772 †			
	(1.56)			
Intermediate * Exports	-0.025			
	(0.45)			
Intermediate * R&D X Exports	15.610*			
	(7.46)			
Over 24 * R&D	-0.485			
	(1.79)			
Over 24 * Exports	0.381			
	(0.28)			
Over 24 * R&D * Exports	-0.135			
	(3.59)			
Under 10	1.621*			
	(0.72)			
Intermediate	1.363 †			
	(0.76)			
Over 24	-1.014			
	(0.79)			
Constant		4.780*	1.934	0.194
		(2.17)	(1.41)	(0.83)

Adj. R-squared		0.144	0.483	0.138
ω^2		0.145	0.394	0.166
N	221	54	68	99

Dependent Variable: Logarithmic growth rate of revenues
****p-value < 0.1%; ** p < 1%; * p < 5%; † p < 10% (robust standard errors in parentheses).*
Industry effects controlled at the second digit of the SIC code for each model.

Chow's Test

β [Under 10 * R&D] = β [Intermediate * R&D] = β [Over 24 * R&D]
β [Under 10 * Export] = β [Intermediate * Exports] = β [Over 24 * Exports]
β [Under 10 * R&D * Exports] = β [Intermediate * R&D * Exports] = β [Over 24 * R&D * Exports]
β [Under 10] = β [Intermediate] = β [Age≥25]

(1) Under 10 * R&D – Intermediate * R&D = 0
(2) Under 10 * R&D - Over 24* R&D = 0
(3) Under 10 * Export – Intermediate * Exports = 0
(4) Under 10 * Exports - Over 24* Export = 0
(5) Under 10 * R&D * Exports – Intermediate * R&D * Exports = 0
(6) Under 10 * R&D * Exports - Over 24 * R&D * Exports = 0
(7) Under 10- Intermediate= 0
(8) Under 10- Over 24= 0

F (8, 169) = 3.60
Prob > F = 0.0007

Table 3 –Chow's test and split sample analysis