Technological resources, external research partners and export performance: a study of Italian high tech SMEs.

Alfredo D'Angelo[*]

Dipartimento Ricerche Aziendali, Facoltà di Economia,
Università di Pavia,
Via S. Felice, 5 - 27100 Pavia, Italy

Abstract

The objective of the paper is to examine the influence of technological resources and external research partners on the export performance of Italian high-technology small and medium firms. In fact, despite a growing number of empirical studies, the question of the relationship between these variables is not clearly established. Drawing on the Resource Based View of the firm, we used a sample of Italian firms operating into the high tech setting within the manufacturing industry to run a linear regression model. Our empirical results revealed that: (1) the use of output rather than input measures of innovation better captures the contribution of technological resources on export intensity of firms in our sample; (2) product innovations positively and significantly affect the export intensity of technology intensive small firms; (3) among external research partners, universities provide positive spillover effects on their export performance.

Keywords: Internationalization, Innovation, R&D, High technology small firms.

[*] Corresponding author. Tel.: +39 0382 986457; fax: +39 0382 986228.
E-mail address: a_dangelo@eco.unipv.it (A. D'Angelo)

1. Introduction

The purpose of this study is to analyze the relationship between innovation and internationalization at micro-level with particular emphasis on examining the influence of technological resources and external research partners on the export performance of Italian high-technology small and medium firms (HTSMEs).

Internationalization and innovation of the firms have been considered strictly related concepts (Vila & Kuster 2007). Internationalization is a concept that does not have a comprehensive definition (Andersen 1997) and it is a multidimentional construct (Ramaswamy et al. 1996). According to Calof & Beamish (1995), internationalization is a process of adapting firm's operations to the international environment and it can involve both outward movements (Welch & Luostarinen 1988) and inward cross border operations (Jones 1999). Among the outward movements, internationalization can range from exports to inter-firm equity and non-equity agreements and to foreign direct investment (Majocchi & Zucchella 2003). Innovation can also be considered as a multidimentional construct. The recent definition provided by the OECD (2005) describes innovation as the implementation of a new or significantly improved product (good or service), or process or business function such as marketing methods and organization changes or external relations (Olso Manual 2005). This description not only encompasses the entrepreneurial venture endeavours of Schumpeterian origin (1934), but it also emphasises the fact that the actual implementation of innovations in the form of products, services, organization and marketing processes derives from the enterprises sector (ENSR 2002). Moreover, the above definition underlines the importance of the linkages between innovation activities and collaborations with external partners, the so called 'collaborative innovation', which has found increasing consensus in export literature (Coviello & Munro, 1997; Dimitratos & Jones, 2005; Mort & Weerawardena, 2006).

The interrelation between internationalization and innovation has been widely studied. In particular, the impact of innovation indicators on the export performance has received a lot of attention by previous research (Sterlacchini 1999). Theoretical and empirical works have been produced at both macro and micro level. At macro level, there are two main theoretical approaches explaining the relationship between innovation and exports. The first approach to international trade theory produced two streams namely the technology-gap theory (Posner 1961) and the life-cycle approach (Vernon 1966) which argued that innovation represents the driving force behind exports. These streams stress the exogenous nature of innovation in influencing exports (Lachenmaier &

Wossmann 2006). Another theoretical approach of international trade theory argued that causality runs in the opposite direction, i.e. from undertaking internationalization to innovation. These growth models (Aghion & Howitt 1998; Alvarez & Lopez 2005; Grossman & Helpman 1991) recognized the 'learn by exporting' effect and stressed the endogenous nature of innovation; therefore, innovation is not the cause, but the effect of the internationalization process (Harris & Li 2009; Lachenmaier & Wossmann 2006). Similar conclusions as regard the direction of causality have been reached at micro-level research, simply because the decision to carry out innovative activities is taken at firm level (Sterlacchini 1999; Wakelin 1998). On one side, the 'learn by exporting' stand argues that exporting should allow firms to acquire new and diverse knowledge from acting in foreign markets (Lachenmaier & Wossmann 2006). In other words, exporting firms could enhance their competency base through the learning process occurring when dealing with international markets. Taking advantage of these, they can foster innovation within firms (Harris & Li 2009). In this context, the direction of causality runs from internationalization to undertaking innovation activities. On the other side, innovating firms have incentives to expand their activities into other markets so they can earn higher returns from their investments (Teece 1996). This perspective of firm's differentiation sustains the innovation-led exports argument which claims that causality runs from undertaking innovation activities to internationalization (Harris & Li 2009). In this context, internationalization may represent an area of exploitation of innovations from which derives the economic performance of a firm (Onetti & Zucchella 2008). The present paper follows the latter theoretical approach.

Despite the fact that export performance represents a typical measure of the degree of internationalization of small and medium firms (SMEs) (Leonidou & Katsikeas 1996; Majocchi & Zucchella 2003; Ramaswamy et al. 1996; Young et al. 1989), the research conducted at micro level on the topic concerning the relation between innovation and export performance has reserved very little attention to smaller firms (Lefebvre et al 1998; Nassimbeni 2001; Sterlacchini 1999). From a practical point of view, the lack of firm-level data have hampered investigation on these issues (Wignaraja 2007). From a theoretical pont of view, two other explanations of why very few studies have focussed specifically on small firms can be considered. On one side, the 'conventional vision' of innovation have tended to assign only to larger firms the ability to carry out innovative activities, considering SMEs to have a deficit in knowledge assets and critical resources needed to manage the level of uncertainty which characterize any innovation process (Acs & Audretsch 1990; Henderson & Clark 1990). On the other side, but for the same reasons, traditional theories of internationalisation have considered SMEs characterized by insufficient resources to expand their

business abroad (McDougall et al. 1994). Therefore, most of the attention in both innovation and internationalization streams of research was given to larger corporations. However, the relation between firm's dimension and innovative ability, on one side, and firm's dimension and internationalisation behaviour, on the other side, has always been a controversial issue in both streams of literature (Zucchella 2004). Previous research has revealed that bigger firms can often be locked in their organizational routines (Abernathy & Thushman 1978; Anderson & Thushman 1990) and bureaucratic constraints (Link & Bozeman 1991) that produce inertia regarding the undertaking approach of innovative activities (Scherer 1991). Whereas, smaller firms with little routines and less bureaucratic resistance have the ability to interpret and to adapt to environmental changes more easily which makes them more prone to provide technological innovations compared to their larger counterparts (Foster 1986; Christensen & Rosenbloom 1995; Scherer 1991; Tether 1998). In the recent years, we have also witnessed to an increasing presence of small firms on the international scene as a result of their ability to respond to market forces more rapidly thanks to their flexibility (Miesenbock 1988). The advent of the rapid internationalisation phenomenon (Oviatt & McDougall 1994) has, furthermore, confirmed that SMEs are able to overcome resource constraints and the liabilities of smallness (Zahra & George 2002). In other words, SMEs are endowed with particular mechanisms thanks to which they are able to operate abroad managing situations of greater complexity, despite the difficulties inherent to their reduced dimension (Nassimbeni 2001). These phenomena have given, in some way, a new vigour to the research concerned with the relevance of the 'firm's internal forces' on the internationalization process of firms (Cavusgil & Zou 1994:3). According to Sousa et al. (2008), the Resource Based View (RBV) is the school of thought that has focussed its attention on firm's internal factors in order to explain the entire spectrum of firm's dynamics.

The RBV perspective is considered one of the most influential streams in the strategic management literature (Mahoney & Pandian 1992) and it has been increasingly used to explain the differences of firms performance when operating in international markets (Ibeh & Wheeler 2005). According to the RBV scholars, intangible resources are the most likely sources of sustainable competitive advantage to achieve higher firm's performance (Barney 1991; Collis & Montgomery 1995; Hitt et al. 2001). Among intangible resources, technological resources have often been mentioned for their particular importance in helping firms to gain access to international markets (Lopez-Rodriguez & Garcia-Rodriguez 2005). Previous studies have claimed that technology represents an important factor in a firm's product mobility across national boundaries (Buckley & Casson 1998). According to Guan & Ma (2003), competitive advantages in the global market derive from the ability to

promote and facilitate the creation and dissemination of technological innovations. Although former research on the determinants of firm's export performance has covered a wide spectrum of aspects, the technological issues have received little attention (Lefebvre et al. 1998; Nassimbeni 2001). Scarse attention has also been reserved to the role played by external research partners. However, as Stuart et al. (2007) noted, the topic of inter-corporate partenership is the nexus of strategic management, organizational theory and organizational economics, and it is particularly relevant when studying high tech firms. As the unit of analysis of this study is placed at firm level, we concentare our attention on studying SMEs operating in the high technology sector.

According to Bernardino & Jones (2008), when studying efforts related to technological resources, high tech firms play a major role in industrialized economies and their relevance has often been neglected in the previous studies. Traditionally, research has tended to examine SMEs homogeneously without distinguishing among business sectors. This is confirmed by Sousa et al. (2008) and Wheeler et al. (2008) who reported that very few research has concentrated on single business sectors when studying SMEs internationalization. However, Rumelt (1987) noted that variation among firms' economic rents was mainly business specific. Empirical evidences show that firms' performance differs in relation to the business sector they are in and that the role of technology and its impact on firm performance can be very different across sectors (Dosi, Pavitt, & Soete 1990; Lee et al. 2001). Previous studies on export performance (Guan & Ma 2003; Lopez Rodrıguez & Garcıa Rodrıguez 2005; Verspagen & Wakelin 1993) have also shown that technology intensive sectors export a higher proportion of their output than other sectors. However, empirical evidences validating this assumption for SMEs are missing. Earlier studies on the internationalization of small firms operating in high-tech sector (Autio & Yli-Renko, 1998; Bell 1997; Coviello & Munro 1997; Crick & Jones 2000; Crick & Spencer 2005; Jones 1999, 2001; Keeble et al. 1998; Knight & Cavusgil 2004; Spencer & Crick 2006; Bernardino & Jones 2008) did not focus their attention on the influence of technological resources and external research partners. Moreover, previous research is mainly focused on UK and US samples. Empirical evidence from other countries and different economic contexts may be useful to extend the existing body of knowledge in this area of research. Our study aims at examining the differences between HTSMEs and SMEs when they internationalize their business activity via exporting. Thus, the focus is on technological resources and external research partners and how those contribute to the export performance of HTSMEs settled into the Italian manufacturing setting. In doing so, we invoke the guidance of the Resource-based view (RBV) as a firm level theory particularly appropriate for the study of export performance (Morgan et al. 2004; Zou et al. 2003) in order to answer the following

research question: do HTSMEs differ from SMEs in terms of technological resources and external research partners, along with their export intensity when they expand internationally via exporting? We also addressed a secondary question: which technological resources and external research partners best discriminate the export intensity of Italian HTSMEs?

We believe to respond to Barney & Clark's (2007) recommendation who stated that despite the assertion identifying in technological resources a possible source of sustainable competitive advantage, the area remains underdeveloped. Particularly the relationships between export performance and technological resources need further clarification (Lopez-Rodriguez & Garcia-Rodriguez, 2005), even more in the case of smaller firms. Moreover, examining the influence of external research partners, we also believe to contribute in espanding the determinants of export performance defined by Zou & Stan (1998) as an area of study where the knowledge base is still limited.

The rest of the paper is organised as follows. In Section 2 we report a general overview of the Resource Based View and its application as theoretical framework for studying the export performance of firms. In Section 3, we developed a series of hypotheses on the basis of the relevant literature on the impact of technological resources and external research partners on the export behaviour of firms. Section 4 presents the description of the dataset used in this study and the methodology selected for the statistical analysis. In Section 5 we summarize the main research findings and report the discussion of the most significant empirical evidences. In Section 6, we outline conclusions, limitations and possible suggestions for future research.

2. Literature Review

The Resource Based View and Export performance

The earliest acknowledgement of the potential importance of firm-specific resources on the growth of the firms is found in Penrose's seminal work (1959). Grounded on the pioneering work of Penrose, the Resource Based View (RBV) of the firm has emerged as a strategic management approach theorizing that growth, success and performance of the firm are determined by the firm's unique and heterogeneous bundle of resources (Barney 1991; Peteraf 1993; Wernerfelt 1984). However, those resources must have specific characteristics and key attributes to allow the firm to create a sustainable competitive advantage. Assuming resource market imperfections and the existence of asymmetries, Barney (1991) proposed that resources must meet four conditions,

namely, value, rareness, inimitability and non-substitutability in order to achieve a sustainable competitive advantage (SCA) and turn it into above-average returns. According to Amit and Schoemaker (1993), the RBV stresses the importance of sustainability, uniqueness and costly to imitate features of firm's resources as source of their economic rents.

Although the relation between resources, sustainable competitive advantage (SCA) and firm performance is clear in the RBV argument, not all resources are considered equally valuable to a firm. Foss (1997) argued that tangible resources can allow firms to achieve a superior position in to the market compared to its competitors. Others RBV scholars (Barney 1991; Collis & Montgomery 1995; Hitt et al. 2001) have tended to favour intangible resources as the most likely sources of sustainable competitive advantage to achieve higher firm's performance. Among intangible resources, great importance is placed on technology as an idiosyncratic resource of the firm which determine sustaining a competitive advantage (Gallende 2006). Technological resources are indeed knowledge-based resources where complexity and causal ambiguity are more likely to occur. These types of resources are more likely to be idiosyncratic to the firm in which they reside (Barney 1991; Mahoney & Pandian 1992; Peteraf 1993) and this makes technological resources able to provide a superior performance to the firms (Fahy 2002; Acquaah & Chi 2007).

The RBV school of though is considered one of the most influential streams in the strategic management literature (Mahoney & Pandian 1992). However, only recently it has found advocates for the study of the internationalization (Barney et al. 2001; Peng 2001). In general terms, the international expansion of a firm can be considered one of several aspects of corporate growth (Casson 1992). According to Buckley & Ghauri (1999), when the internationalization is interpreted as a direction of firm's growth, the role of resource becomes crucial. In line with Andersen & Kheam's (1998) study, who stressed the usefulness of firms' resources for predicting their international growth ambitions and strategy, other studies have increasingly used the RBV perspective to explain firm-level performance differences in international markets (Ibeh & Wheeler 2005). Many studies have applied the RBV as theoretical framework to test their export models (Dhanaraj & Beamish 2003; Fahy 2002; Guan & Ma 2003; Lopez-Rodriguez & Garcia-Rodriguez 2005; Westhead et al. 2001; Wolff & Pett 2004 among others) and empirical evidences support that firm-specific resources endowment plays an important role in determining performance heterogeneity in the global environment. Rialp et al. (2005), highlighted the importance that a firm's intangible resource endowment plays in generating firm's internationalization capability. Dhanaraj & Beamish (2003), who applied the RBV framework in order to identify intangible assets

that define the competitive position of firms in export markets, concluded that technological intensity is a good predictor of export strategy, and export strategy has been shown to influence positively firm's performance. Basile (2001) argued that technology and innovation determine the level of firm's heterogeneity and innovating firms are able to sustain their competitive advantage not only in the domestic market but also in foreign markets. In RBV school of thought, technological resources represent the basis of a firm's sustainable competitive advantage, even more central in high-technology firms (Lee et al. 2001). However, although technological resources are frequently mentioned in the literature as important assets to deal with foreign market (Aaby & Slater 1989; Dhanaraj & Beamish 2003; Lopez-Rodriguez & Garcia-Rodriguez 2005; Westhead et al. 2001), the relationship between technological resources and export performance remains uncertain (Gun & Ma 2003). According to Harris & Li (2009), evidence at this micro level does not seem to be conclusive. Findings are not consistent and the effect of the technological intensity of the firm on export performance is mixed (Aaby & Slater 1989; Zou & Stan 1998; Wheeler et al. 2008).

Among international business scholars, the internationalisation of firms seems to be generally accepted as a process of value creation that consists of developing heterogenic resources to overcome limitations and liability of foreignness when dealing with international markets (Barney et al. 2001). Ahokangas (1998) argued that SMEs, in particular, are dependent on the development of internal and external resources. Leveraging external assets into the markets through interfirm collaborations or other external linkages (Chetty & Wilson 2003; Srivastava et al. 1998) seems to shift the attention away from the internal view of the firm typical of the RBV theory. Although part of the firm's value chain depend on their environment (Pfeffer & Salancik 1978), the focus on external resources to complete the missing parts of the firm's value chain is coherent with the RBV theoretical approach as the access to 'market-based assets' is an important complementary part of the RBV (Srivastava et al. 1998). According to Foss (1997), the fact that RBV focus on resource-side of the firm does not imply lack of regard for the external environment. In internationalization field of research, the external resources are considered part of the network theory (Johanson & Mattson 1998). However, the development of resource based theory and the network perspective seems to go on parallel tracks as the total set of resources available to the firm includes both, internal and external resources. Internal and external resources are, as Westhead et al. 2001 sugggested, the resources basis of the firm. According to several authors (Bell & Young 1998; Bell et al. 2003; Peng 2001) a more holist view of the firm and an integrative perspective exploring and exploiting the complementarities among RBV and other relevant theoretical perspectives is

desirable, as it could generate a greater understanding of firm's dynamics, including the internationalization process of firms.

Assuming a holistic approach to the internationalization process of firms, in the next section we discuss the main findings of empirical literature in order to develop a series of hypothesis to measure the influence of technological resources and external research partners on the export performance of high-technology small firms (HTSMEs).

3. Hypothesis development

Technological resources, external research partners and export performance

In previous research concerning the relation between innovation and export performance, exporting behaviour has been analyzed from a dual perspective, i.e. as a probability for a firm to export (export propensity) and as the intensity of the firm's export activity (export performance). In analyzing the impact of technological resources on export, the majority of the studies at firm level have used the terms 'technological resources' and 'innovation' interchangeably and have employed R&D expenditure as a proxy to measure firm's technology resource capacity (Lopez-Rodriguez & Garcia-Rodriguez 2005; Nassimbeni 2001). Hirsch & Bijaoui (1985), in their study on the export behaviour of 111 Israeli firms, found out that R&D expenditure (measured as the number of R&D employees) is an important determinant of export propensity and it has a positive and significant effect on their export growth. Conversely, Willmore (1992) found no R&D effect on exports of Brazilian multinational firms. Using the ratio of R&D expenditure to sales, Ito & Pucik (1993) also found no evidence of the significant effect of R&D on the export performance of Japanese manufacturing firms. However, they concluded that R&D expenditure was a significant determinant of export performance when the size indicator was excluded from the equation. Kumar & Siddhartan (1994), considering 640 Indian firms, concluded that R&D intensity was a significant determinant for low and medium technology industries. Zhao & Li (1997), using data for Chinese firms, found that R&D intensity was positively associated with both export propensity and growth. Kalafsky & MacPherson (2001) examining the export characteristics of US companies in the machine tool industry, found that export performance correlates strongly with applied research and development (R&D) activity. Roper & Love (2002), studying the differences between the determinants of export performance among the UK and German manufacturing plants, reported that R&D intensity influences export performance. Hasan & Raturi (2003) using data for Indian manufacturing firms, showed that the role played by technology does have a positive influence on

the entry mode of firms, but only limited influence on the export volume. In his study, Rasiah (2003) found that the R&D intensity has a positive effect on the export performance of electronic firms in Malaysia and Thailand. Ozcelik & Taymaz (2004) confirmed the positive effect of R&D intensity on the export performance of Turkish firms working in the manufacturing industries. In their study, Gourlay & Seaton (2004) concluded that both the probability of exporting and firm export performance are positively influenced by R&D expenditures. More recently, Lopez-Rodriguez & Garcia-Rodriguez (2005) found that R&D spending intensity was significant in affecting export intensity, but not significant in the decision to export. In their study for the UK, Harris & Li (2009) reported that R&D plays an important role for firms to overcome barriers to internationalisation, but R&D does not increase export intensity. In studies specifically dealing with SMEs, Lefebvre et al. (1998) found no evidence with respect to the contribution of the level of R&D investments to the export dynamics of 101 Canadian small firms. The same results were found by Sterlacchini (1998) and Nassimbeni (2001) on Italian samples of small firms. Our research focuses on a specific type of SMEs, i.e. high tech SMEs, where the relevance of technological resources should be the *raison d'etre* and constitute the basis for their competitive advantage not only in the domestic market but also in foreign markets. Therefore, considering the most common indicators used in literature to measure the inputs into the innovative process, we hypothesizes that:

H1a: The higher the R&D expenditure, the higher the export performance of HTSMEs.

H1b: The higher the number of R&D employees, the higher the export performance of HTSMEs.

However, limitations in using R&D expenses and R&D employees as proxies to measure for technological resources do exist. Both the R&D figures mentioned above do reflect the resources devoted to producing innovative output, but only weakly represent the amount of innovative activity actually realized at firm level (Lachenmaier & Wossmann 2006). Previous research on small firms (Lefebvre et al. 1998; Nassimbeni 2001; Sterlacchini 1998) revealed that R&D statistics can be misleading in the case of small firms as R&D process is rarely accounted in those firms. Evidences show that even accounting standards lack the ability to accurately reflect innovative activities of firms (Canibano et al. 2000). Hoffman et al. (1998) invited researchers to link innovative inputs to innovative outputs in order to represent the actual innovative activity that takes part within firms. Regarding the direct measures of the innovative outputs, previous research using both large and small firms' samples gave more relevance to product innovations rather than process innovations in

producing positive effects on the export behaviour of firms (Sterlacchini 2001; Roper & Love 2002). Other authors (Basile 2001; Ozcelik & Taymaz 2004; Lopez Rodrıguez & Garcıa Rodrıguez 2005) found that both product and/or process innovations are significant determinants of the export performance. Contradicting results have been produced by Alvarez (2004) who stressed the relevance of process innovation only in positively contributing to the export performance. However, previous studies have missed to consider a direct measure of the innovative output of firms. Hence, we hypothesize that:

H2a: Product and process innovations have a positive effect on the export performance of HTSMEs.

H2b: The higher the percentage of turnover derived from innovative activities, the higher the export performance of HTSMEs.

An area of particular interest in determining the firm's innovative profile is the role of external partners as complementary sources of knowledge (Sobrero 2000) and their impact on the firm's innovation performance and export behaviour (Lefebvre et al. 1998). Basile (2001) argued that small firms innovate through acquiring knowledge embodied in external sources and external collaborations. Insufficient attention has been paid to the role played by different forms of cooperation with external partners which are considered crucial for the small firm's innovation performance and access to foreign markets (Guan & Ma 2003; Nassimbeni 2001). We concentrate our attention on the collaboration between external research partners (universities, research centres, other companies, other organizations) and firms in our sample in order to carry out innovative activities and how they influence the export performance of high-technology small firms (HTSMEs). The complexity of technology and its costs and uncertainty motive firms' for cooperative R&D (Bayona, Garcia-Marco & Huelta 2000). The collaboration with universities and research institutes should provide a mean of developing technological knowledge (Lee et al. 2001) and opportunities for growth due to their increasing commercialization effort to exploit academic knowledge to generate revenues (Shane & Stuart 2002; Grimaldi 2005). However, empirical findings reported that the cooperation and knowledge exchange between high-tech firms, the small ones in particular, and universities remains underdeveloped (ENSR 2002). Strategic collaborations with other companies and/or organizations should assist firms with complementary resources (Cohen & Levinthal 1990). According to Gulati et al. (2000), firm alliances and strategic networks potentially provide a firm with access to information, resources, markets and technologies.

Technology-based firms generally seek technical, managerial, and financial resources through alliances as to enhance legitimacy and increase the chance of harvesting investments in the firms (Lee et al. 2001). Stuart et al. (2007) positioned high tech firms as intermeidiaries along a tripartite value chain which entails upstream alliances with universities and downstream deals with established firms. They argued that high tech firms prefer vertical collaborations, rather than horizontal linkages among firms engaged in similar activities in order to exploit complementary assets in terms of expertises in different fields of knowledge from their own. Generally, collaborations have been considered particularly important, not only for their role in helping to overcome resource constraints providing additional competences (Mort & Weerawardena 2006), but also in term of additional information enabling identification of new market trends and exploitation of entrepreneurial opportunities (Burt 1992; Dimitratos & Jones 2005). For international firms, collaborations represented the principal source of external physical, organisation, technical and reputational resources (Chetty & Wilson 2002). According to Lu & Beamish (2001), alliances and cooperative agreements can improve the international performance of small firms by providing resources and mitigating the uncertainty of the internationalisation process. Empirical evidences in export literature, to which this study belongs, reveals that collaborations with external partners is quite common among high-tech companies as it enables firms to accelerate their international growth (Coviello & Munro 1997). However, prvious research have scarsely consider the influence of collaboration with external reseach partners. Hence, we hypothesize that:

H3: The larger the collaboration with external research partners (universities, research centres, other companies and other organizations) the higher the export performance of HTSMEs.

4. Data and Methodology

4.1 Definition of the sample and strategy for casual effect

The present study is based on secondary data of Italian firms operating in the manufacturing industry collected through a National Survey carried out by the research department of Capitalia (a large Italian bank) at the end of 2003. The database accounted 3452 observations with a large set of variables including both quantitative data and qualitative information. According to the Survey of manufacturing enterprises (Capitalia 2003), the sample represents 11.3% of the total manufacturing industry in Italy. The data in this source are based on responses to questionnaires sent every three

years by the bank to its clients. These responses are matched with firms' balance sheets data available to the bank. The joint use of both sources of information (i.e. balace sheets and surveys) is allows to overcome the methodological limitations affecting innovation studies based on only one source of information (Canibano et al. 2000). The dataset provides detailed information on: a) general information on activity, sector, ownership, b) employment; c) innovation and investments; d) internationalization; e) market and competition; f) finance and relationships with banks. The direct participation of Capitalia in the collecting data makes the reliability not an issue for this dataset due the very reliable source of information. The Table 1 reported provides a brief summary of the secondary data source used in this study.

Table 1 – Summary of the secondary data source

Title	Data set	Topics covered
Capitalia 'IX Indagine sulle imprese manufatturiere italiane'	Data are for the years 2001-2003 and they refer to Italian manufacturing firms. The original dataset counts 3452 observations and 1016 variables including both quantitative data, drawn from the annual reports, and qualitative information obtained through the submission of a questionnaire.	Data gathered through the questionnaire cover the following topics: a) general information on activity, sector, ownership; b) employment; c) innovation and investments; d) internationalization; e) market and competition; f) finance and relationships with banks.

Moving from the original dataset and following the EU Recommendation (2003), we selected SMEs only according to their number of employees (>10 and <250) and total turnover (< 50 million euro). The decision to concentrate on SMEs resides on the fact that they represent almost 99 percent of all enterprises in the EU, providing around 100 million jobs or 67% of the total employment in Europe (European Commission, 2003). According to OECD (2005), SMEs are socially and economically important since they contribute strongly to the innovation and technological advances, fostering economic growth and social development and increasing well-being and employment in the old continent. Having restricted our unit of analysis to small firms only within the manufacturing industry we used the classification adopted by EU Commission (ENSR 2002) to further reduce our unit of analysis to small firms operating in the high technology setting only. Although, a broadly accepted definition for high-tech SMEs does not exist in literature, the use of an EU classification should allow comparison of high-tech SMEs across countries, at least in Europe. This approach is in line with Storey & Thether's (1998) reccommendation. However, when applying the two digit statistical classification of economic activities provided by the EU Commission (Table 2), 'Computers and related activities' and 'Research and Development' are considered service

activities. Data collected in the Survey did not report information about the service activities. As previous scholars (Bernardino & Jones, 2008), we concentrated the analysis on the remaining six high tech activities which belong to the manufacturing industry. The adjustments described above lead us to have 2749 small firms (689 of which were high tech small firms) for our empirical analysis.

Table 2 – EU High Technology Statistical Classification of Economic Activities

Nace Code	Description
24	MANUFACTURE OF CHEMICALS,CHEMICAL PRODUCTS AND MAN-MADE FIBRES
29	MANUFACTURE OF MACHINERY AND EQUIPMENT
30	MANUFACTURE OF OFFICE MACHINE AND COMPUTERS
31	MANUFACTURE OF ELECTRICAL MACHINERY
32	MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT
33	MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS
72	COMPUTERS AND RELATED ACTIVITIES
73	RESEARCH AND DEVELOPMENT

Source: European Commission (2002) 'High technology SMEs in Europe', Observatory of European SME's, No.6

The main research purpose of this study is to analyze the relation between internationalization and innovation. From a methodological perspective, the *mutual causation* of innovation and internationalization represents an important issue predicted by trade and economic growth theories which may raise problems for empirical analysis (Lachenmaier & Wossmann 2006). Nassimbeni (2001) noted that a bi-directional relationship exists not only between the measure of innovation and internationalization, but also between the firm's export activity (intensity) and other firm's characteristics. Therefore, he concluded that '*given the twofold valence of many of the factors which can be hypothesised to be both a cause and an effect of the export choice, the model we verify is not a causal model, that is, it does not explain the export (intensity) of small units. It simply identifies which factors best characterise their export activity*' (Nassimbeni 2001:249). This is in line with our research aim of examining among the influence of technological resources and external research partners on the export performance of high tech SMEs. In order to deal with the problems of causality due to the possible endogenous nature of the variables, the use of lagged rather than contemporaneous strategy variables allows to alleviate the possibility that indipendet variables and the dependent variable are jointly determined (Spanos et al. 2004). In other words, the independent variables concerning the firm's technological resources and external research partners will be measured with a lag time period compared to our target variable, i.e export performance. The OECD (2005) recommends to take into account three years periods since innovation is a path

dependent process which may take some time to have an effect on the firms' activities. Recent studies on export performance (Lopez-Rodriguez & Garcia-Rodriguez 2005) applied this approach in order to overcome the causal effect problem. However, the data allowed them to apply only a one year lag time period. The data collected through the Capitalia Survey (2003) provides us with information which made possible the use of a lag time period of three years, in line with the OECD recommendation. This should allow us to realize a more realistic analysis of the influence of technological resources and external research partners on the export performance of high tech SMEs.

4.2 Dependent Variable

As previously noted, research concerning the relation between innovation and export performance of firms has often analyzed the probability for a firm to export (i.e. export propensity) and/or the intensity of the firm's export activity (export performance). We decided to concentrate on the latter only as it represents the economic indicator which better represents the performance of SME which extended their business activities internationally via exporting. Exporting is actually the most common strategy adopted by SMEs to internationalise their activity (Wolff & Pett 2000). Ramaswamy et al. (1996) described export performance or export intensity as the typical measure of the degree of internationalization. However, there is not a general accepted conceptualization and operationalization of export performance in the literature (Aaby & Slater 1989; Cavusgil & Zou 1994; Chetty & Wilson 2003; Majocchi et al. 2005; Zou & Stan 1998). According to Katzikeas et al. (2000), export performance is a multifaceted phenomenon and none of the individual measures of performance can be considered inherently superior to others. However, Cavusgil (1980) argued that the percentage of export sales to total sales better assesses the process of internationalization. This measure has already been applied in many previous studies (Gemunden 1991). Hence, in line with our research aim of examining the factors best characterise the performance of Italian high technology SMEs, we measured export performance as the percentage of total turnover exported (EXPINT).

4.3 Independent variables

Exploration into the determinants of export performance still represents an area of study where the knowledge base is limited and findings are fragmented and it is still lacking a solid conceptual framework (Zou & Stan 1998). Those considerations make the topic of export performance and the factors determining firms' export success particularly amenable for investigation (Cavusgil & Zou 1994). Gemunden (1991) argued that there are over 700 explanatory variables used as determinants

of export performance in the literature. Although numerous empirical researches on the determinants of export performance have covered a wide spectrum of problems, technological and innovation-related issues have received much less attention than other factors (Nassimbeni 2001). Measuring innovation is a complex operation, and not commonly agreed methods and measures exist representing exhaustively all the manifestation of innovation. However, measures of innovation exist in literature to guide the approximation of the value of innovation: (1) R&D expenditures and/or the share of employees involved in R&D activities are applied as measures of the inputs into the innovative process; (2) the number of patented inventions is used an intermediate output; (3) product and process innovations are usually used as a direct measure of innovative outputs.

In line with previous studies we used the total amount R&D spending (R&D INT) and the number of R&D employees (R&D EMP) as proxies to measure firms' technological resource capacity (Hirsch & Bijaoui 1985; Lopez Rodrıguez & Garcıa Rodrıguez 2005; Nassimbeni 2001). Lefebvre et al. (1988) argued that, besides those R&D measures, other innovation measures must be taken into account. In order to avoid to reflect only a partial aspect of the technological profile of the firms (Lopez Rodrıguez & Garcıa Rodrıguez 2005), we also included variables measuring whether the firms have undertaken product or process innovations (INNO). Those variables reflect the output side of the innovation process. Finally, we consider the percentage of turnover derived from firm's innovative activities (TURINNO) in order to widen the measure of innovation outputs as we believe it captures not only the magnitude of the technological profile (Lopez Rodrıguez & Garcıa Rodrıguez 2005) of Italian high tech SMEs, but also the amount derived from their innovative effort. However, Lachenmaier and Wossmann (2006) argued that innovation is not possible in isolation. The role of the external environment in terms of partnership and interorganizational collaboration is considerably important (Nassimbeni 2001). Firms are linked to a diversified set of agents through networks of collaboration and exchange of information. Those sources of information are external to the firm: customers, suppliers, other firms, government agencies, research centres, universities, financial institutions, venture capitalists, etc. This represents a 'system of innovation' where intense interactions between firms and external sources of information increase the benefits in terms of new knowledge and knowledge sharing (Lorenzoni & Lipparini 1999; Lundvall 1993; Nooteboom 2000; Powel 1990, 1998; Rothwell 1992). Moreover, this reduces uncertainty in innovation processes and technological complexity, time frame, knowledge gaps and financial constrains of the firms (Kuppers 2002). In our analysis we considered the use of external research partners (R&D NET) made by firms in our sample in terms of

percentage of external research they commit to universities, research centres, other companies and other organizations. Table 3 summarises the variables included in the empirical analysis.

4.4 Control variables

The technological profile of firms and its innovation capability can be related to firms' characteristics. Following Lopez Rodrıguez & Garcıa Rodrıguez (2005), we included four control variables that previous research has demonstrated can affect the firm's export performance. Such variables are: firm size, firm age, home location industrial environment and economic activities of firms belonging to the high tech sector.

Table 3 – Variables included in the analysis

Variables	Description
Dependent	
Export Intensity (EXPINT)	Percentage of total turnover exported in 2003
Independent	
R&D expenditure (R&D INT)	Total amount spent for R&D in 2001
R&D employees (R&D EMP)	Total number of employees who take part to R&D activities in 2001
Type of innovations (INNO):	Type of innovations realized during the period 2001-2003:
• Product • Process	Dichotomous variable taking the value 1 if firm innovates in products Dichotomous variable taking the value 1 if firm innovates in process
Turnover derived from for innovations (TURINNO)	Percentage of turnover derived from innovations during the period 2001-2003
External research partners (R&D NET)	Percentage of external research done by: Universities, Research centres, Other companies, Other organizations during the period 2001-2003
Control	
Size (EMP)	Number of Employees in 2001
Business experience (AGE)	Years since founding
Home country location (LOC)	Dummy variables for firms located in: N. West; N. East; Centre and South of Italy
High tech economic activities (ACT)	Dummy variables for the six high tech activities specified in Table 2: MANUFACTURE OF CHEMICALS,CHEMICAL PRODUCTS AND MAN-MADE FIBRES; MANUFACTURE OF MACHINERY AND EQUIPMENT; MANUFACTURE OF OFFICE MACHINE AND COMPUTERS; MANUFACTURE OF ELECTRICAL MACHINERY; MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT; MANUFACTURE OF MEDICAL,PRECISION AND OPTICAL INSTRUMENTS

The first two variables are internal to the firms. Although progress has been made in understanding the effect of a firm's internal resources on export performance, knowledge of the internal determinants is still contradictory (Pla-Barber & Alegre 2007). The most contradictory results in the literature have been reported for the analysis of the relationship between firm size and export intensity. According to Zou & Stan (1998), empirical findings have produced mixed results detecting several inconsistencies in the current knowledge base. Some scholars report a positive relationship between the two variables (Dhanaraj & Beamish 2003; Majocchi et al. 2005; Reid 1982; Wagner 1995), while others report a negative relationship (Wolff & Pett 2000). Some authors found no relationship (Bonaccorsi 1992) or a medium positive effect (Chetty & Hamilton 1993). According to Baldauf et al. (2000) these inconsistencies may be grounded in the use of non uniform measures. Zou & Stan (1998) stated that the most common hypothesis is a positive relationship, based on the Reid's concept (1982) of size advantage. However, Kaynak & Kuan (1993) found out that when size is measured by number of employees negative effects especially on export profit are more frequent. This negative effect has been well explained by Harris & Li (2009) who argued that as firms grow bigger they may prefer an alternative foreign entry mode such as FDI because more convenient than export. In line with other studies (Dhanaraj & Beamish 2003; Mittelstaedt et al. 2003), the number of total employees (EMP) as a proxy for the firm size will be used in our research in order to control the effects of firm size on the export performance of high tech small firms.

The relationship between firms' age and export performance has also been studied widely in recent years. Firm's age, expressed as number of years in business, has been previously used as a proxy of business experience in other internationalisation studies (Chen & Martin 2001; Majocchi et al. 2005). Some research has shown that experience is a key factor in international development, reporting a positive and robust relationship (Majocchi et al. 2005); other studies considered experience an unimportant variable for internationalization (Oviatt & McDougall 1994). Zou & Stan (1998) stated that, among others, firm's age, expressed as number of years in business, have only limited explanatory power in explaining export performance and the relationship between firm's age had either a negative effect (Zou & Stan 1998; Baldauf et al. 2000; Brouthers & Nakos 2005; Sousa et al. 2008) or an insignificant effect. In this study we include a variable to control for firm age, defined as the number of years in since foundation (AGE).

Where the company is placed and its surrounding industrial environments have been scarsely investigated in previous research (Aaby & Slater 1989; Zou & Stan 1998). Miesenbock (1988:44)

stated that 'the home country of the firm also determines the performed export behaviour'. Infrastructures, legal systems and government support are all measures of the domestic geographic environment (Leonidou & Katzikeas 1996). According to Dunning (1997), the locational advantage which includes knowledge-based assets, infrastructure and technology, shapes the firm competitiveness. Robertson & Chetty (2000) suggested that firms generally perform better when they face a benign domestic environment. Differences about the North, Centre and South of Italy have been reported in the term of infrastructure endowment, public expenditure, corruption and economic growth (Del Monte & Papagni 2001). Hence, we also decided to control for the home country location effect (LOC).

Finally we include a control variable for the six economic activities of the high tech sector. Previous studies revealed that the intensity of exporting activity and may vary considerably across industries (Cavusgil & Zou 1994; Harris & Li 2009) and that firms in more complex and technologically oriented industries may have a better export performance (Zou & Stan 1998). However, as noted by Basile (2001), studies at the sector level abstract from variation among firms.Within the high tech sector there are different activities with different types of firms which might have different export intensity. Although we limit our analysis to the high tech sector within the manufacturing industry only, we included dummy variables for the six economic activities of the high tech sector specified in Table 2 in order to consider the various dimensions occurring within the high tech sector so to control for the 'firm's economic activity effect' on the export intensity (ACT).

4.5 Methodology of analysis

The analysis of data is carried out in two steps. The first step of our empirical investigation is to consider SMEs and HTSMEs when they internationalize their business activity via exporting. The focus is placed on the differences between the two groups of firms in terms of technological resources, external research partners and export performance. From a methodological perspective, we moved from the original dataset counting 3452 observations to a smaller sample of 2749 small firms (689 of which were high tech small firms). The criteria adopted to differentiate HTSMEs from SMEs was already discussed in section 4.1 of this paper. This lead us to have 2060 SMEs (60% of the total firms in the dataset) and 689 HTSMEs (20% of the total firms in the dataset). From here we selected only exporting firms leading us to have 1430 exporters SMEs (41% of the total firms in the dataset) and 576 exporters HTSMEs (17% of the total firms in the dataset) for our empirical analysis. As we will be dealing with hypothesis tests for equality of means and proportions with two samples, we tested for equality of variances between the two samples before to use the appropriate

formula for equal or unequal variance. Descriptive and hypothesis test are used for comparative analysis. In the second step of our investigation, we selected only exporters high tech manufacturing small firms (HTSMEs). At ths point of our empirical investigation, we had to deal with missing values presence. For such kind of problem we decided to rely on the SPSS Missing Values Analysis (MVA) which employs the expectation maximization (EM) approach to handle missing data. This approach which is documented in Little & Rubin (1987) allowed us to proceed further and to substitute missing values with the mean values provided by the SPSS output. The EM method was preferred to other approaches for handling incomplete data such as listwise, pairwise deletion and mean substation as it should provides parameter estimates which are unbiased (Little & Rubin 1987). This allowed us to have 576 firms for our hierarchical regression analysis. A test for the association between technological resources, external research partners and export performance is provided. Given the nature of our dependent variable (a percentage variable, limited at a minimum value of 0 and maximum of 1, or 100% of total sales), the linear regression technique (OLS) is appropriate, since the adjusted values of a linear regression are restricted to lie between 0 and 100. Previous studies (Ito & Pucik 1993; Nassimbeni 2001; Guan & Ma 2003; Majocchi et al. 2005) also relied on OLS estimates for a similar dependent variable.

5 Empirical results

5.1 Descriptive analysis and Hypothesis tests

Before proceeding to test the hypotheses previously proposed with the regression analysis, it is important to provide the general descriptive statistics of this study's sample data. Our empirical analysis encompasses two research questions. Firstly, we aim at assessing whether HTSMEs differ from SMEs in terms of technological resources and external research partners, along their export performance when they expand their business activity abroad via exporting. Secondly, considering HTSMEs exporting firms only, we aim at determining which technological resources and external research partners are the strongest discriminants of export intensity.

To examine whether exporters HTSMEs differ from exporters SMEs in terms of technological resources, external research partners and export intensity, we conducted a *Student's t test* for two independent samples. The *Levene's test* was executed first in order to verify that data does accomplish or it does not to the assumption of homogeneity of variances. From the *F-distribution* critical value and the related *p-value* associated with a significance level reported in the Levene's test, we reject the null hypothesis of equal variances if the p-value was lower than 0.05.

Consequently, the appropriate hypothesis test for unequal means is applied. Conversely, if the p-value is higher than 0.05, we accept the null hypothesis of equal variances and we apply the appropriate hypothesis test for equal means. The hypothesis tests are executed using SPSS macros. In the following Tables 4, we provide the descriptive statistics and we show the results obtained from the hypothesis tests for equality of means and/or proportions. Lower and upper tailed tests are reported were appropriate as a result of the hypotheses formulated observing the descriptive mean/proportion values.

*****Insert Table 4*****

The analysis of the mean values for technological resources and external research partners along with export performance in the two groups of firms (HTSMEs vs SMEs) reveals that exporters HTSMEs have an higher level of export performance compared to exporters SMEs. With this finding we extend to SMEs area of research, the argument that claims that technology intensive firms export a higher proportion of their output than other firms (Dosi, Pavitt, & Soete 1990; Guan & Ma 2003; Lopez Rodrıguez & Garcıa Rodrıguez 2005; Verspagen & Wakelin 1993). Empirical evidences also revealed that exporters HTSMEs have an higher level of R&D expenditure and they employ an higher number of people in R&D compared to exporters SMEs. Although, this finding is not new in the literature, it confirms that to invest in technological resources, in terms of both measures of innovation inputs, is the *raison d'etre* for technology intensive firms, even for small enterprises (Hoffman et al. 1998). Among the different type of innovations, exporters HTSMEs have an higher number of product innovations compared to exporters SMEs. This finding show a more *product orientated profile* of exporters HTSMEs compared to exporters SMEs. This is confirmed by the higher level of turnover derived from innovations achieved by exporters HTSMEs compared to exporters SMEs. Technology intensive small firms, which spend more in terms of innovation inputs, derive also more innovative outputs in terms of product innovations which are sold on the export markets to address the heterogeneity of consumer tastes across coutries rising the level of the turnover derived from their innovative activities. *Technology push* and *demand pull* factors seem to explain the higher innovativeness of exporters, on one side, and the higher level of export intensity, on the other side.

Data have also shown that exporters HTSMEs spent an higher amount of money in internal R&D research, whereas exporters SMEs spent an higher amount of money in external R&D research. There seems to be no differences between the two group of firms in terms of external R&D research

done by Research centres, Other companies and Other organizations. However, among the external R&D research options, exporters HTSMEs have an higher proportion of external R&D research done by Universities compared to exporters SMEs. This finding do not support previous empirical research that reported that the cooperation and knowledge exchange between the small high-tech firms and universities is underdeveloped (ENSR, 2002). Results also show that exporters HTSMEs, whose competitive advantage depends upon sensible information, prefer to rely on internal R&D research, rather than external R&D research. Our finding provides a new insight into the fact that the firm's management might tend to prefer internal R&D research to conduct R&D projects because opening to orizontal collaborations with other market's actors such as other firms for example, would have meant to lose information and the possibility to convert innovations into a source of competitive advantage. When exporters HTSMEs make use of external R&D partners, Universities are their preferred partners. This finding confirms previous research that claimed that the collaboration with universities provides a mean of developing new technological knowledge (Lee et al. 2001), but it also provides support to previous studies (Stuart et al. 2007) which positioned high tech firms as intermeidiaries between upstream alliances with universities and downstream deals with established firms. The preference for vertical collaborations with Universities, in our case, support previous evidence that high tech firms are more prone to engage in disimilar activities in order to exploit the complementary assets in terms of different expertises, rather than the orizontal collaborations with a similar set of knowledge.

5.2 Econometric analysis

We employed ordinary least squares (OLS) regression to analyze which technological resources and external research partners best influence the export intensity of HTSMEs. Following Lee et al. (2001) approach, we ran various models for each set of independent variables in order to test the additive effects of different variables in explaining the export intensity of HTSMEs. In the first model we used only control variables in order to have a benchmark against which to test the effects of technological resources and external research partners on export performance. The second model has both control variables and technological resources measured as input measures in the innovation process such as the total amount R&D spending (R&D INT) and the number of R&D employees (R&D EMP) in order to test the effects of technological resources in comparison to the first model. The third adds the variables measuring the output side of the innovation process i.e. the variables measuring whether the firms have undertaken product or process innovations (INNO) and the percentage of turnover derived from innovative outputs (TURINNO). The last model adds external research partners (R&D NET) to measure the effect of access to external knowledge on the export

performance of HTSMEs. Before proceeding with the regression analysis, it is worth examining correlation coefficients of all the independent variables used in this study. Table 5 shows several positive and statistically significant correlations between export performance of HTSMEs and some of the determinants chosen for our regression model. Examining the significance of correlation coefficients allows checking for multicollinearity problems, given that correlations between predictor variables could lead to unreliable regression estimates (Pryce, 2006). From the correlation matrix (Table 5), the correlations are quite low, thereby suggesting that multicollinearity is not a problem. Other diagnostic tests for multicollinearity such as the Tolerance test and the Variance Inflation Factor have been executed and no multicollinearity problems were found.

*****Insert Table 5*****

Table 6 reports the results of various regression models explaining export performance of HTSMEs. We conducted a series of tests comparing successive models by using Incremental *F*-test as shown at the bottom of Table 6. The use of hierarchical regression allowed determining the unique contribution of predictors (independent) in explaining the dependent variable into the equation of a regression model through observing the effect of entering sets of variables on Incremental *F*-test (Hair et al. 2006).

The first test reported in Table 6 indicates that Model 1, which includes only control variables explains 10.3% of the variation in the export performance of HTSMEs. Model 2 which includes the input measures of the innovative process of firms (i.e the total amount R&D spending and the number of R&D employees) as well as control variables, did not explain better the variation in export performance of HTSMEs than Model 1. In other words, the addition of the input measures of the innovative process of firms did not substantially change the main effect of the control variable indicators on the export performance of HTSMEs. The test indicates that Model 3, which includes the outputs measures of the innovative process of firms (i.e. the variables measuring whether firms have undertaken product or process innovations and the turnover derived from innovative activities), explains the dependent variables slightly better than Model 1 ($p < 0.10$). Model 4 which includes the external research partners variables explains the variation in export performance of HTSMEs significantly better than Model 1 ($p < 0.05$). In Model 5, which can be considered an alternative model to Model 4, we included all the variables used in Model 4, but we did not report the variable TURINNO. We did this not for technical calculations but for theoretical reasons and we find that Product innovations is a significant determinant of the export performance of of HTSMEs.

On the basis of Model 4, we did not find evidence to support our *H1a* and *H1b* which predict a positive relationship between R&D expenditure, R&D employees and export performance of HTSMEs. However, this is in line with previous findings of studies specifically dealing with SMEs (Lefebvre et al. 1998; Nassimbeni 2001; Sterlacchini 1998). The use of R&D expenses and R&D employees as proxies to measure for technological resources might present limitations in accounting for the innovative activity actually realized at small firm level. In turn, this do not seem to constitute the basis for their competitive advantage in export markets.

Hypothesies 2a and *2b* predict a positive relationship between the inputs measures of the innovative process (i.e. product, process innovations and the level of turnover derived from innovative activities) and small high tech export firms' returns. Our models 4 and 5 seem to confirm this positive relationship. We found that the level of turnover derived from innovative activities is a significant determinant of export performance of HTSMEs. We also found that Product innovations is a significant determinant of export performance of HTSMEs when the turnover derived from innovative activities indicator is excluded from the equation. Here it is fairly clear that the turnover derived from innovative activities comes from product innovations more than process innovations. Therefore, the competitive advantages of HTSMEs when dealing with international markets via exporting is based on product differentiation whose technology is one of the main driver (Lopez-Rodriguez & Garcia-Rodriguez 2005; Teece, 1986). Thus, technology drives product innovations and HTSMEs differantiation which founds in international markets the area of exploitation from which derive higher economic performance (Onetti & Zucchella 2008). Overall, the results show a preminent prevalence of the output over the input measures of the innovative process of firms in expaining the export performance of HTSMEs.

Model 4 was introduced in order to test *hypothesis 3*. According to this hypothesis, the larger the collaboration with external research partners (universities, research centres, other companies and other organizations) the higher the export performance of HTSMEs. This is in line with the view that assign to a 'system of innovation' the benefits in terms of knowledge sharing (Lorenzoni & Lipparini 1999; Lundvall 1993; Nooteboom 2000; Powell 1990, 1998; Rothwell 1992). Reduction of uncertainty and technological complexity, time frame, knowledge gaps and financial constrains (Kuppers 2002) should allow firms to accelerate their international growth in foreign markets (Coviello & Munro 1997; Dimitratos & Jones 2005; Mort & Weerawardena 2006). Our results show that the use of Universities as external R&D partners has a positive influence on the export performance of HTSMEs. This result is in line with previous research (Shane & Stuart 2002;

Grimaldi 2005) which claimed that the increasing effort of universities in commercialization of academic knowledge might brings spillover effects to the growth opportunities of firms collaborating with the universities.

*****Insert Table 6*****

As far as the control variables are concerned, firm size, home country location and economic activities of technology-intensive sector positively and significantly affect the export intensity of exporters HTSMEs. With regards the first, the positive relationship firm size and the degree of internationalization of HTSMEs measured in terms of total turnover exported is consistent with the Reid's concept (1982) of size advantage and economies of scale to overcome the perception of risk in dealing with foreign markets. Our finding is in line the majority of the studies in the export literature (Zou & Stan 1998).

In an age of information and communication technologies geographic and industrial setting location should be less a constrain, especially for exporters. However, our results show that the surrounding industrial environments and the domestic geographic location of firms are still important determinants of export performance. This result confirms previous research which underlined the importance of locational assets in determining firm competitiveness (Dunning 1997; Leonidou & Katzikeas 1996; Robertson & Chetty 2000). The existance of differences between the North, Centre and South of Italy in the term of infrastructure endowment, public expenditure, corruption and economic growth (Del Monte & Papagni 2001) seem to negatively affect the export performance of Italian HTSMEs.

With regards performing a specific economic activity within the technology-intensive sector, the results indicate that the effect is negative and significant on the export performance. This might suggest that some firms performing specific economic activities might lack capacity to compete in foreign markets although belonging to the technology-intensive sector. The intensity of exporting activity vary considerably not only across industries (Cavusgil & Zou 1994; Harris & Li 2009), but also across sectors and within sectors. Our result show that different firms performing different economic activities within the same sector differ in terms of their export intensity.

Finally, the limited explanatory power of the variable age in explaining export performance ofHTSMEs reported in our study is in line with previous research which argued that experience is an unimportant variable for internationalization (Oviatt and McDougall, 1994; Zou and Stan, 1998).

6 Conclusions

Drawing on the Resource Based View (RBV) of the firm as theoretical framework and assuming a holistic approach to the internationalization process of firms, this study investigated the influence of technological resources and external resarch partners on the export performance of HTSMEs. The analysis was carried out in two steps. Firstly, we assessed whether HTSMEs differ from SMEs in terms of technological resources and external research partners, along their export performance when they expand their business activity abroad via exporting. Secondly, considering only HTSMEs exporting firms, we tried to determine which technological resources and external research partners are the strongest discriminants of their export intensity. The technological resources of firms were measured in multiple way, employing both input and output measures of innovation in order to capture the Italian high tech SMEs' innovative effort. Moreover, we concentrate our attention on measuring the influence of external research partners on the export performance of high-technology small firms (HTSMEs), as a topic to which previous research dedicated little attention. With regards to the empirical analysis, we measured the firm's technological resources and external research partners with a lag time period of three years in order to deal with the problems of causality due to the possible endogenous nature of our variables. Our investigation revealed some interesting results.

First, while age of the firms do not account for significant differences, size, geographic home location and economic activities of the firms act as important control variables. With regards to the latter, our result suggests that different firms performing different economic activities within the same sector differ in terms of their export intensity questioning wheather studying SMEs heterogeneously rather than homogeneously could offer a more insight into the firms' dynamics. In this regards, future studies dealing with high tech sector should examine firms belonging to singular economic activities in order to achieve a deeper understanding of their intenationalization behaviour.

Second, our analysis suggest that R&D expenses and R&D employees are essential indicators of technological innovation. However, no evidence is found with respect to their contribution to the export performance of our firms. Investment in R&D may be necessary, but not sufficient. The use of output measures of the innovative process of firms seems to better explain the export performance of Italian HTSMEs. This underlines the limitations in the use of input measures of innovations in accounting for the innovative activity realized at small firm level. The development of measures focusing on innovative output seems to better capture the vital contribution of small

enterprises as an engine of innovative activity which, in turn, influence their export performance, at least in some industry contexts. High technology SMEs should direct their innovative effort towards product innovations rather than process innovations if they want to perform in international markets. Product innovations represent the materialization of the technological resources of high technology SMEs which allows them to focus on product differentiation to achieve a competitive advantage on export markets. As for future research in this area of study, researchers are called to expand the scope of this study by focussing on other measures of innovation which may influence the internationalization of high technology SMEs such as organizational and marketing innovations.

Third, the positive influence of Universities as external research partners on the export performance of Italian HTSMEs support the existence of cooperation development and knowledge exchange between the small high-tech firms and universities, on one side; and, on the other side, it implies that the exploitation of complementary innovation assets not only make it possible for core innovation resources to operate effectively, but they also become relevant for achieving success in foreign markets. Therefore, Italian HTSMEs should consider other complementary innovation assets along with their internal technological resources to enhance their export competitiveness. Universities, in our case, seem to provide positive spillover effects on the export performance of technology intensive small firms.

Some weaknesses concerning the results of this study should also be stressed. Although the application of EU classification to define our sample of HTSMEs, the use of data from the Italian setting makes the generalizability of the findings questionable to other countries. Thus, studies with comparative samples from other studies are called to extend the generalizability of the results of this study. Although the limitations outlined above, we believe that this study makes three contributions to the existent knowledge. First, it provides the heterogenic perspective of the high tech sector when attempting to explain the influence of technological resources and external research partners on the export performance of SMEs. Second, the study expands the traditional measures used in the literature for firm's technological resources and it comprehensively links innovative inputs to innovative outputs while exploring whether innovative efforts have had a measurable effect on the export performance of high tech SMEs. Finally, the use of a lag time period of three years provide more accurate results while measuring this impact.

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Table 4 - Descriptive statistics, mean and proportion comparison tests between two groups of exporters (SMEs vs HTSMEs)

Variable	Type of exporters	Valid	Missing	Mean	STD	Min	Max	Levene's Test for Equality of Variances *F*	*Sig*	P-value*
EXPINT	SMEs	1426	4	36,42	28,58	0	100	1,11715	,05433	,000000(u)
	HTSMEs	572	4	44,96	27,04	1	100			
R&D INT	SMEs	575	855	154989,15	317411,66	0	4505000	1,60062	,00000	,002205(u)
	HTSMEs	349	227	227338,57	401575,08	0	3321000			
R&D EMP	SMEs	1414	16	1,90	4,32	0	65	1,56250	,00000	,000000(u)
	HTSMEs	573	3	3,50	5,40	0	50			
Type of innovations(INNO)										
Product innovations (%)	SMEs	1419	11	42,3	N/A	N/A	N/A	N/A	N/A	,00000(u)
	HTSMEs	573	3	57,6						
Process innovations (%)	SMEs	1419	11	18,7	N/A	N/A	N/A	N/A	N/A	,0135(l)
	HTSMEs	573	3	13,2						
TURINNO	SMEs	1320	110	10,08	19,27	0	100	1,02109	,39280	,00679(u)
	HTSMEs	513	63	12,55	19,07	0	100			
External R&D partners										
Amount spent in R&D in internal research	SMEs	645	785	79,21	32,17	0	100	1,42808	,00006	,016043(u)
	HTSMEs	391	185	83,21	26,92	0	100			
Amount spent in R&D in external research	SMEs	645	785	20,78	32,17	0	100	1,42808	,00006	,016043(l)
	HTSMEs	391	185	16,78	26,92	0	100			
University	SMEs	278	1152	12,16	28,73	0	100	1,37836	,00798	,031478(u)
	HTSMEs	184	392	17,82	33,73	0	100			
Research centres	SMEs	278	1152	16,78	34,86	0	100	1,15619	,14431	,24368(l)
	HTSMEs	184	392	14,54	32,42	0	100			
Other companies	SMEs	278	1152	45,76	47,61	0	100	1,04292	,38134	,38950(l)
	HTSMEs	184	392	44,50	46,62	0	100			
Other organizations	SMEs	278	1152	25,28	41,61	0	100	1,04727	,36966	,29089(l)
	HTSMEs	184	392	23,12	40,66	0	100			

Note 1 - * p<0,05
Note 2 - (u) upper tail ed test; (l) lower tailed test; 2t (two-tailed test)
Note 3 - N/A = Not Applicable

Table 5 - Correlations Matrix (*N* = 576)

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. EXPINT	1																			
2. R&D INT	,094(*)	1																		
3. R&D EMP	,107(*)	,649(**)	1																	
4.Product Innovation	,126(**)	,187(**)	,282(**)	1																
5. Process Innovation	-,052	-,103(*)	-,082(*)	-,453(**)	1															
6. TURINNO	,104(*)	,081	,147(**)	,384(**)	-,143(**)	1														
7. University	,085(*)	,157(**)	,181(**)	,066	-,039	-,024	1													
8. Research centres	,008	,125(**)	,114(**)	,036	,045	,034	,017	1												
9. Other companies	-,009	,063	,138(**)	,139(**)	-,037	,063	-,254(**)	-,257(**)	1											
10. Other organizations	-,004	-,017	,039	,125(**)	-,063	,052	-,044	-,060	-,345(**)	1										
11. EMP	,220(**)	,356(**)	,382(**)	,108(**)	,003	,022	,094(*)	,132(**)	,029	-,042	1									
12. AGE	-,013	-,022	-,042	-,019	-,012	,007	-,019	-,025	-,073	,075	-,099(*)	1								
13. N.West vs N. East	,096(*)	,036	,042	,066	,027	,046	-,077	,049	,019	,120(**)	,039	,079	1							
14. N. West vs Centre	-,063	,005	,039	-,039	-,036	,005	,092(*)	,027	-,091(*)	,013	-,007	,067	-,245(**)	1						
15. N. West vs South and Islands	-,096(*)	-,019	-,070	-,138(**)	,083(*)	-,056	-,047	-,069	-,020	-,032	-,019	,132(**)	-,219(**)	-,092(*)	1					
16. 24	-,187(**)	,009	-,033	-,107(*)	,054	-,113(**)	,102(*)	,042	-,087(*)	-,049	-,043	-,075	-,122(**)	,015	,148(**)	1				
17 30	-,016	,069	,005	,050	-,023	-,030	-,016	-,014	-,010	-,017	,048	,048	-,045	-,019	-,017	-,028	1			
18. 31	-,025	-,022	-,037	,012	-,023	,001	-,022	-,032	,014	-,012	-,031	,090(*)	-,007	-,027	,015	-,193(**)	-,024	1		
19. 32	-,130(**)	,095(*)	,103(*)	-,046	,045	-,001	-,015	-,017	,023	-,039	-,031	,043	-,054	-,050	,018	-,114(**)	-,014	-,096(*)	1	
20. 33	,050	,087(*)	,066	,095(*)	-,038	,061	,021	,022	,029	,035	,033	-,067	,007	,013	-,049	-,125(**)	-,015	-,106(*)	-,062	1

Note 1 - $*p < 0.05$; $**p < 0.01$ (two-tailed test)

Note 2 - NACE statistical classification of economic activities: 24 - MANUFACTURE OF CHEMICALS,CHEMICAL PRODUCTS AND MAN-MADE FIBRES; 29 - MANUFACTURE OF MACHINERY AND EQUIPMENT; 30 -MANUFACTURE OF OFFICE MACHINE AND COMPUTERS; 31 - MANUFACTURE OF ELECTRICAL MACHINERY; 32 - MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT; 33 - MANUFACTURE OF MEDICAL,PRECISION AND OPTICAL INSTRUMENTS.

Note 3 - The economic activities coded as 29 - MANUFACTURE OF MACHINERY AND EQUIPMENT – is used as baseline for comparison.

Table 6 - Results of OLS models: export performance of exporters HTSMEs (*N* = 576)

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	42,402*** (2,103)	42,346*** (2,107)	40,955*** (2,224)	40,801*** (2,217)	40,232*** 2,408
Control					
EMP	,123*** (,024)	,110*** (,026)	,122*** (,024)	,117*** (,024)	,114*** ,024
AGE	,032 (,065)	,031 (,065)	,030 (,065)	,027 (,065)	,027 (,065)
N.West vs N. East	1,101 (2,404)	,986 (2,408)	,917 (2,404)	1,572 (2,427)	1,610 (2,428)
N. West vs Centre	-6,348* (3,656)	-6,512* (3,664)	-6,388* (3,647)	-7,183** (3,648)	-6,840* 3,656
N. West vs South and Islands	-6,540 (4,264)	-6,395 (4,275)	-6,213 (4,269)	-5,473 (4,306)	-5,409 (4,310)
29_vs_24	-14,6576*** (2,818)	-14,618*** (2,824)	-13,929*** (2,830)	-14,609*** (2,833)	-14,685*** 2,837
29_vs_30	-17,580 (18,226)	-18,327 (18,306)	-17,319 (18,283)	-18,557 (18,321)	-19,904 (18,311)
29_vs_31	-5,951** (3,147)	-5,933** (3,149)	-5,812* (3,140)	-5,844* (3,127)	-5,913* 3,130
29_vs_32	-18,874*** (4,791)	-19,635** (4,838)	-18,728*** (4,780)	-18,788*** (4,761)	-18,456*** 4,773
29_vs_33	-,058 (4,448)	-19,396 (-19,396)	-,784 (4,469)	-,931 (4,472)	-,842 (4,475)
Indipendent					
R&D INT		2,10E-006 (,000)	2,64E-006 (,000)	2,53E-006 (,000)	1,99E-006 (,000)
R&D EMP		,155 (,267)	,054 (,270)	,028 (,282)	048 (,281)
Product Innovation			2,192 (2,715)	2,709 (2,763)	3,730* 2,177
Process Innovation			-,547 (3,587)	-,237 (3,589)	-,061 (3,589)
TURINNO			,115* (,059)	,117** (,059)	
University				,122** (,052)	,114** ,052
Research centres				-,058 (,059)	-,057 (,060)
Other companies				-,057 (,049)	-,058 (,049)
Other organizations				-,050 (,048)	-,051 (,048)
Adj. R^2	,103	,102	,107	,114	,113
Incremental *F*-test	-	,676	3,815*	5,572**	4,829**

Note 1 - Standard errors are in parentheses.
Note 2 - *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$ (two-tailed test)
Note 3 - NACE statistical classification of economic activities: 24 - MANUFACTURE OF CHEMICALS,CHEMICAL PRODUCTS AND MAN-MADE FIBRES; 29 - MANUFACTURE OF MACHINERY AND EQUIPMENT; 30 -MANUFACTURE OF OFFICE MACHINE AND COMPUTERS; 31 - MANUFACTURE OF ELECTRICAL MACHINERY; 32 - MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT; 33 - MANUFACTURE OF MEDICAL,PRECISION AND OPTICAL INSTRUMENTS.
Note 4 - The economic activities coded as 29 - MANUFACTURE OF MACHINERY AND EQUIPMENT – is used as baseline for comparison.