2016

E-commerce adoption within an entrepreneurial context

Panagiotis Ganotakis
Birmingham University, University of Wollongong in Dubai (UOWD), pganotak@uow.edu.au

V Lindsay
University of Wollongong in Dubai (UOWD)

Publication Details

Ganotakis, P. & Lindsay, V. 2016, 'E-commerce adoption within an entrepreneurial context', International Conference on Organization and Management (ICOM) 2015, pp. 1-39.

E-Commerce adoption within an Entrepreneurial Context

P. Ganotakis[1], V. Lindsay[2],
[12]Faculty of Business, University of Wollongong in Dubai, Dubai, UAE
(panagiotisganotakis@uowdubai.ac.ae)

Abstract

This paper investigates the effect of entrepreneurial characteristics on the adoption of E-Commerce, at different levels of sophistication, by New Technology Based Firms in the UK. This is achieved by using a survey on the actual E-Commerce adoption of 412 firms operating in both high-tech manufacturing and service sectors. The study combines the Resource Based Theory with the 'Technology, Environment and Organization' framework and with the Entrepreneurship and Human Capital theories in order to provide a theoretical base for the inclusion and measurement of the characteristics of all the entrepreneurs that form an Entrepreneurial Founding Team. Results showed that older entrepreneurs and firms were less likely to adopt E-Commerce, whereas exporting firms and entrepreneurial teams characterized with high levels of commercial/marketing experience were more likely to adopt it at the advanced level. Different types of formal collaborative agreements with other companies as well as the level of competition were found to affect E-Commerce adoption at different levels of sophistication. Policy implications are provided.

Keywords: eCommerce; New technology based firms; Entrepreneurial human capital; Resource based theory; Technology environment organization framework; Human capital theory

Jel codes: L26, O3, O14

1. Introduction

SMEs although considered to operate with limited resources they are believed to be at the centre of a nation's economic activity (Bruque and Mayano, 2007) as they have been found to exert a significant impact on a country's economic performance and growth (Jutla et al., 2002). A group of SMEs characterized by a significantly higher contribution to a country's employment and productivity levels (Storey and Tether, 1998) are firms that operate in highly innovative sectors and are formed by highly educated entrepreneurs (BERR, 2008).

Those firms, known as New Technology Based Firms (NTBFs), achieve high rates of growth mainly due to their ability to successfully introduce often radically innovative products/services to the market (Lynskey, 2004) which enhances not only their productivity (Marvel and Lumpkin, 2007) but also the competitiveness of a country's economy even in a period of economic stagnation (Lynskey, 2004). On those lines Porter and Ketels (2003) and later Cox (2005) argued that if a higher proportion of UK firms are able to introduce innovative products/services but also innovate *through out the organization* (i.e. new ways to produce/deliver products services, to do business, and to carry out marketing) it will allow UK's economy not only to reduce the productivity gap that exists in relation to its current competitors (e.g. US, Germany) but also to respond to future pressure from the developing economies. E-Commerce (EC) is considered to be a technological innovation that once adopted can lead to a significant increase in a firm's productivity and profitability levels (Quan, 2008).

Mainly, this will be a result of EC enabling SMEs to gain instant access to international markets at a cost effective way while at the same time allowing them to

increase their market share at the domestic but also local markets (Fillis and Wagner, 2005). This means that SMEs can eclipse the cost advantage that larger companies enjoy (Santarelli and Altri, 2003) and compete with them directly in both domestic and foreign markets by bypassing some of the intermediary linkages and reducing therefore the need to invest for the development of expensive marketing/distribution channels or to use the services of a specialized dealer (Molla and Licker, 2005). Using a cost-effective method to reach customers from a single location is especially important for NTBFs, as they usually operate in specialist niche markets which means that their potential customers are likely to be spread all over the globe (Santarelli and Altri, 2003).

As EC can increase the productivity and competitiveness of the high-tech sector and that of UK's economy it is important to identify the factors that contribute to EC usage, as they are still argued to not be clearly understood (Simmons et al., 2008). This is important especially because EC adoption research in this sector (Wareham et al., 2005) is scarce (to the best of the author's knowledge non-existent) and as the spread of an innovation among its potential users might take several decades before it is fully diffused (Forester, 1985).

Apart from the factors that affect the general adoption of EC what still remains generally unexplored are the factors that differentiate between the different levels of EC adoption, as EC can be adopted by a firm at different levels of sophistication and for a number of reasons. This study is differentiated from others as it concentrates on the factors that distinguish none-adopters from basic adopters and basic from more advanced adopters. Knowledge of those factors can assist efforts to stimulate EC adoption (Simmons et al., 2008) depending on a firm's existing level of EC usage. For the

purposes of this study, firms that used the Internet to purchase products/services will be considered to be basic users whereas those that used it either to sell and purchase or just sell products/services will be considered to be advanced users. Non-adopters will be considered to be those firms that had not adopted EC for any purpose[1]. EC will be defined as any business (purchasing or selling products/services) carried out over the Internet (both B2B and B2C) and it does not include sending and receiving text-based e-mail messages (Jean et al., 2006).

2. Paper's theoretical and empirical contribution

SMEs/NTBFs tend to have more centralised managerial structures in relation to larger firms (Bruque and Mayano, 2007) and the top management of those firms consists of the founding entrepreneur(s) who are responsible for strategic decision making (Thong, 1999; Fillis and Wagner, 2005). NTBFs can be formed either by lone entrepreneurs or Entrepreneurial Founding Teams (EFTs) defined in this paper as those individuals that own part of a firm's equity and are responsible for making strategic decisions at the time of the founding (Ucbasaran et al, 2003; Wright et al., 2007).

Because of the greater decision authority that they enjoy, the investigation of their characteristics is considered to be an integral part of SME studies (Molla and Licker, 2005; Jean et al., 2006; Quaddus and Hofmeyer, 2007) as they have been suggested and found to be a major determinant of a number of firm attributes such as innovation adoption including IT (Raymond, 2001; Fillis and Wagner, 2005; Marvel and Lumpkin, 2007) and opportunity identification (Ucbasaran et al., 2008).

More specifically it is thought that it is the skills or the human capital (education and experience) that entrepreneurs posses that helps them to recognize and take advantage of

unexplored opportunities and formulate appropriate strategies (West and Noel, 2009). Although a number of theories and frameworks that have been applied so far in the area of IT adoption (alone or in combination) acknowledge the importance of the characteristics of top managers or that of their perception on EC adoption (or the intention to adopt EC) very few studies have actually examined the effect that the capabilities (e.g. education, experience) of decision makers have on IT/EC adoption (usually managerial support is examined) and even fewer have based their investigation on an underlying theory.

Moreover when characteristics of decision makers are examined, 'soft' or subjective measures are used to construct the relevant variables (e.g. CEO's *innovativeness* measured by Likert scales or dummy variables such as 'I have original ideas', *IT knowledge* as whether computer is used at work or home) only the CEO rather than the whole top management team is examined (e.g. Thong, 1999; Jean et al., 2006), those characteristics are considered in isolation of the components of other theories (e.g. Chuang et al., 2009) or finally the IT adoption variables used do not consider the level of IT sophistication (also argued in Molla and Licker, 2005).

On those lines Jeyaraj et al (2006) after carrying out a meta-analysis of IT adoption studies suggested that researchers should continue to use the best predictors (e.g. external pressure, external information sources, organizational size, top management support) of IT adoption while at the same time use promising factors that have not been explored enough such as *top management characteristics*. This is proposed to be achieved through *the synthesis and identification of linkages between individual and organization adoption research*. It was further suggested that in order for recall and pro-adopter bias to be

avoided, research should focus on the study of actual system adoption rather than intention to adopt (Burton-Jones and Hubona, 2006) and it was concluded that research on actual adoption *needs to be moved forward both methodologically but also theoretically*. Moreover Williams et al (2009) in a similar analysis argued that although a number of diverse theories and constructs can be applied to investigate IT adoption, studies up to this date have overwhelmingly made use of the TAM theory the continuous usage of which can weaken the area of IT adoption research as it appears to be moving towards complete homogeneity. It is therefore suggested that future research in order to be innovative should use alternative appropriate theories. Finally Yu and Tao (2009) argued that literature on business level technology adoption is scarce in relation to individual-level technology adoption.

Based on the arguments presented so far, this study will attempt to fill the existing gap in IT adoption literature by (1) investigating actual EC adoption, removing therefore self-reporting bias, at the organizational level (2) linking individual with organizational adoption by considering the characteristics of all individuals with decision making responsibilities and investigating their effect on EC adoption (3) using appropriate theories (other than the TAM, the application of which is not appropriate in this study[2]) to provide the theoretical basis for the inclusion of those characteristics and therefore extending the existing theoretical models whilst considering theories already used in IT adoption studies (4) considering the effect of variables already identified as good predictors of IT adoption and considering promising ones and (5) taking into account different levels of sophistication of EC usage.

More specifically this study is going to combine the theory of entrepreneurship (Casson, 2005) with the Human Capital theory (Becker, 1964) adjusted for the case of entrepreneurs (Bruderl et al., 1992) and parts of the Resource Based Theory (RBT) and the Technology Environment and Organizational (TEO) framework in order to investigate the adoption of EC by NTBFs in the UK. Top management support will not be considered, at least not in its traditional manner, as the *perceptions and attitudes* of the EFT will be assumed to be influenced by their skills and characteristics and also external to the firm factors (Quaddus and Hofmeyer, 2003; Casson, 2005) already included in the model.

The remainder of the paper is organized as follows: The theoretical framework is presented in section 3, followed by the formulation of hypotheses in section 4. A description of the dataset appears in section 5 and in section 6 the results from the analysis carried out are presented, followed by a discussion of those results in section 7. Concluding remarks together with practical as well as policy implications appear in the final section.

3. Theoretical Background

All theories considered in the framework that follows emphasize the role of the entrepreneur(s) in the formulation of strategy and opportunity identification. The theory of entrepreneurship (Casson, 2005) emphasizes that it is the entrepreneur of a firm who specializes in and has decision making responsibility related to investment associated with strategy formulation. By applying it, researchers can directly link the entrepreneur with EC adoption. Based on this theory the entrepreneur is perceived to be responsible for the effective supply of inputs and for the identification of appropriate markets for the

firm's product/service as well as for the extension of the existing market to new customers and locations. The adoption of EC can assist a firm to achieve exactly this, as it is a cost effective way for both purchasing inputs and selling products/services to local but also foreign based customers (Fillis and Wagner, 2005).

In the RBT, human capital resources are considered to be a source of competitive advantage as they are believed to be valuable, heterogeneous and immobile (Zhuang and Lederer, 2006). It is specifically mentioned that a firm's managerial team is an important part of the theory as it is considered to be a resource with the potential of generating competitive advantage through opportunity identification and exploitation (Barney, 1991; Caldeira and Ward, 2003). A connection therefore exists (Casson, 2005) between RBT and the theory of entrepreneurship. The RBT emphasizes the importance of human resources and highlights the role of managers (Teece and Pisano, 1994) and the theory of entrepreneurship argues that entrepreneurial capabilities are a firm's main human resource and that the capabilities of scientists and middle managers employed by a firm derive from those of the entrepreneur(s) as it is the entrepreneur(s) that has selected employees with certain skills and capabilities (Caldeira and Ward, 2003; Porter and Ketels, 2003).

Finally in the organizational part of the TOE framework (Tornatzky and Fleischer, 1990) which refers to a firm's characteristics such as its size, scope, and *the quality of its human resources*, it is stated that a firm's human resources (especially the knowledge of its executives in managing an innovation), are more valuable for innovation adoption than physical assets as specific knowledge is harder to be imitated by competitors.

Although the above theories emphasize the importance of the capabilities of an EFT and its role on innovation adoption they do not provide the theoretical basis of how these capabilities can be measured. This can be achieved by using the Human Capital theory (Becker, 1964) where entrepreneurial characteristics are divided into general and specific human capital. Bruderl et al (1992) first fitted this theory in the entrepreneurial context and it was argued that entrepreneurs with higher human capital are expected to be more effective in opportunity identification and exploitation and therefore able to create higher performing firms (Colombo and Grilli, 2005). Entrepreneurial general human capital refers to skills acquired through formal education, training and work experience. These skills have a certain wage value in the economy depending on the expected level of productivity (Preisendorfer and Voss, 1990). On the other hand entrepreneurial specific human capital refers to those skills that the entrepreneur is able to apply directly to his role as a self-employed individual. Those skills according to both the RBT and the TEO framework as they are rare they are expected to have a higher contribution to effective strategy formulation.

Apart from the role of top manager(s)/entrepreneur(s) a number of firm specific and environmental characteristics have also been identified to affect innovation adoption by the theories considered. All aforementioned theories emphasize the role of external networks (i.e. business partners, customers/suppliers) and the level of competition that a firm faces is identified from the theory of entrepreneurship as well as the TOE framework. Moreover both the RBT and the TEO framework stress the importance of the existence of physical capital resources that can support the adoption of a specific innovation and access to external resources is considered by the RBT to be able to serve

as an external source of competitive advantage. Finally the size and scope of a firm as well as the centralization of a firm's management structure have been identified by the TOE framework and have been considered by a number of studies (e.g. Zhu et al., 2003; Quaddus and Hofmeyer, 2007). A firm's age as well as whether it operates in the high tech manufacturing or service sector will serve as control variables.

Figure 1 portrays the theoretical framework formulated after taking into account the above arguments. Four rectangular shapes are used in order to include the concepts identified by each of the theories considered. Concepts identified by two or more theories are located at those parts of the model shared by the theories' corresponding rectangular shapes. Each concept in the figure is accompanied by its corresponding hypothesis (e.g. H1, H2, etc).

4. Hypotheses development

4.1 Entrepreneurial Human Capital (General/Specific)

Apart from general education and experience (Chuang et al., 2007; 2009) four types of specific human capital have been identified as important for IT/EC and innovation adoption; commercial/marketing skills, IT knowledge/experience, ability to innovate and sector experience (Jean et al., 2006; West and Noel, 2009) and will also be explored in this study. It is generally believed that the higher the human capital (both general and specific) the higher the performance of entrepreneurs in a variety of tasks will be (Becker, 1964) including that of opportunity identification and innovation adoption (e.g. Shane, 2000; Ucbasaran et al., 2008).

4.2 General Human Capital (general education and experience)

Entrepreneurs with high levels of general education have been considered to be more likely to make use of innovative technology, recognise an opportunity and be able to deal effectively with complex scenarios (Burton-Jones and Hubona, 2006; Marvel and Lumpkin, 2007; Ucbasaran et al., 2008). High levels of general education are usually associated with a higher stock of information and skills, greater open-mindedness, receptivity to innovation and higher learning ability (Avermaete et al., 2004). Those characteristics can enable an entrepreneur to understand the underlying technologies required for EC adoption, recognise the value that EC can bring to the organization and try new solutions to problems. Previous studies have found significant positive effects between high education, opportunity exploitation (Avermaete et al., 2004) and innovativeness (Marvel and Lumpkin, 2007).

General experience has been argued to assist individuals in the accumulation and integration of knowledge (Davidsson and Honig, 2003) with more experienced entrepreneurs believed to be more likely to recognize the benefits that IT usage can bring to the integration of business processes (Chuang et al., 2007). On the other hand high levels of experience have been found to limit strategic flexibility (Hitt and Barr, 1989) and be highly associated with entrepreneurial age (Chuang et al., 2007). Older entrepreneurs are believed to be more risk averse and less likely to adopt an innovation that will cause a significant change to the way that a firm functions (Casson, 2005; Burton-Jones and Hubona, 2006) as they have a psychological commitment to the organizational ‘status quo’ (Hamrick and Mason, 1984). Younger entrepreneurs on the other hand usually have a more favorable attitude towards risk taking, as well as up to

date technical knowledge that can assist them in appreciating the value of EC (Chuang et al., 2009). Previous studies showed that entrepreneurial age has a negative effect on innovative activity (Avermaete et al., 2004) and also to be negatively related to entrepreneurial success (Harada, 2003). Therefore,

Hypothesis 1: General education is expected to have a positive effect on the extent of EC adoption whereas general experience is expected to have the opposite one.

4.3 Specific Human Capital

Whether an EFT includes individuals that have the capability and willingness to innovate (or show entrepreneurial behavior), which means showing preference to solutions that could change the way a particular firm process has been carried out, has been considered and found to be an important factor for IS adoption including EC (Thong, 1999; Jean et al., 2006; Lee et al., 2006; Scupola, 2009). In order to capture the ability of an EFT to innovate (which also manifests entrepreneurship) it will be assumed that the level/intensity of technical education (e.g engineering, biotechnology knowledge) and experience (e.g. experience in working in an engineering, R&D or manufacturing role) that is present in an EFT (Lynskey, 2004) shows exactly that. Technical education and experience have been found to be highly related to performance, innovativeness and innovation adoption within an organization (Wang et al., 2004; Marvel and Lumkin, 2007). Therefore,

Hypothesis 2: High levels of technical education and experience present in an EFT will have a positive effect on the extent of EC adoption.

A number of studies have argued that the extent to which firms are effective in their adoption of complex innovations such as EC depends on the firm's level of market orientation and capabilities (Attuahene-Gima and Ko, 2001). Market orientation is believed to enhance business learning that can be crucial during the implementation of an innovation such as EC (Rogers et al., 2008) especially as firms can use the market knowledge gathered to guide strategy recognition, and the understanding, implementation and modification of identified opportunities (Shane, 2000; Ardichivili et al., 2003). Commercial skills can allow entrepreneurs not only to identify market opportunities and associate them with the product/service being developed by their firm, but also to identify value creating processes that can connect the two (Jones et al., 2003). Finally entrepreneurs with commercial skills are more likely to have Rogers' (1995) 'how to' knowledge (knowledge of how to use the adopted innovation) which can enhance EC adoption. Previous studies found a positive association between a firm's market orientation and web-site adoption (Raymond, 2001; Teo and Ranganathan, 2004). Therefore,

Hypothesis 3: High levels of formal business education and commercial experience in an EFT will have a positive effect on the extent of EC adoption.

The level of IT skills (education and experience) present in an EFT is considered to be an important determinant for IT and EC adoption (Thong, 1999; Caldeira and Ward, 2003; Chen and McQueen, 2008). It is believed that top managers are more likely to discover opportunities and adopt innovations that are related to their knowledge (Venkataraman, 1997; Thong, 1999) and that IT educated entrepreneurs are more likely

to act as technology champions (Lee et al., 2006) for IT related innovations. The existence of individuals with IT skills in an EFT is especially important for the case of resource constrained SMEs as it is harder for them to hire qualified IS experts or to develop those skills internally (Caldeira and Ward, 2003). Entrepreneurs' IT skills can be related to Rogers' (1995) 'principles' knowledge (that refers to the theoretical underpinnings of the innovation) which is argued to be a necessity in order for an innovation to be adopted. Therefore,

Hypothesis 4: The existence of high levels of IT education and experience in an EFT will have a positive effect on the extent of EC adoption.

Whether entrepreneurs in an EFT had previous working experience in a similar to the one that their current firm operates sector is considered to be a rare skill not easily imitated that can contribute to a firm's competitive advantage (West and Noel, 2009). Shane (2000) and Marvel and Lumpkin (2007) indicate that specific industry experience can enhance opportunity identification as it provides entrepreneurs with experience in strategic solutions applied in similar industries which leads to a reduction in the uncertainty about the success of a strategy and increases the likelihood of its adoption (Von Hippel, 1988). Therefore:

Hypothesis 5: Same sector experience in an EFT will be expected to have a positive effect on the extent of EC adoption.

4.4 Environmental Impact (Competition/Formal Collaborations)

Competitive pressure is believed (Coltman et al., 2007; Bayo-Moriones and Lera-Lopez, 2007; Yu and Tao, 2009) and has been found (Iacovou et al., 1995; Quaddus and Hofmeyer, 2007) to increase the likelihood of innovation/IT adoption (Lim et al., 2002). The influence that a firm's competitors will exert on EC adoption, as it is on most process innovations, has been argued to depend on the intensity of EC usage within the industry (critical mass) that a firm operates in (Quaddus and Hofmeyer, 2007; Simmons et al., 2008). An increased usage of a specific innovation by rival companies can reduce a firm's competitive advantage and will therefore force a firm to adopt that innovation or influence its adoption through increased awareness (Di Maggio and Powell, 1983). Therefore:

Hypothesis 6: The higher the proportion of firms in a specific industry that use EC for purchasing or for both purchasing and selling, the higher the likelihood will be that a certain firm will adopt it for these reasons respectively.

Formal collaborative agreements with other companies has been argued to affect not only innovation and EC adoption but also the performance of SMEs (Zhu et al., 2003; Jeyaraj et al., 2006; Zhuang and Lederer, 2006). By collaborating with other companies, SMEs can access information (i.e. customer needs, technological knowhow), which can enhance the adoption of an innovation by increasing the level of 'how to' and 'principles' knowledge present in an EFT (Avermaete et al., 2004; West and Noel, 2009) and by increasing awareness about the benefits of innovation adoption (Quaddus and Hofmeyer,

2007). Finally trading partners can also exert direct pressure for its adoption (Chong and Pervan, 2007; Quaddus and Hofmeyer, 2007; Simmons et al., 2008; Yu and Tao, 2009).

Hypothesis 7: The existence of formal collaborative agreements with other companies prior to EC adoption will have a positive effect on its adoption.

4.5 Firm Size and Scope

The scope of a firm will be considered by investigating a firm's commercial strategy and geographic spread. Therefore the dependence of a firm's sales to its main customers (Levy et al., 2001); a firm's export behavior (Fillis and Wagner, 2005) and group membership (Zhu et al., 2003) will be taken into account. If a large proportion of sales is derived from a few main customers then a firm is more likely to adopt Information Systems in order to improve internal efficiency or just to exchange info with those customers rather than adopt EC in order to sale products (Levy et al., 2001). Moreover as EC can improve exporting efficiency (as mentioned in section 1) it is reasonable to expect that exporting firms will be more likely to adopt it (Fillis and Wagner, 2005; Bayo-Moriones and Lera-Lopez, 2007). Finally group membership can increase the awareness about the benefits of EC as well as the pressure for its adoption while reducing its adoption risks (Bayo-Moriones and Lera-Lopez, 2007). Therefore:

Hypothesis 8: Firms with greater scope will be more likely to adopt EC.

In terms of firm size, larger firms are believed to have resource advantages (Xu et al., 2004) over smaller ones which can be used to leverage IT investment over a large revenue base (Gibbs et al., 2003) and possess a higher level of financial resources,

infrastructure and in house IT expertise that can be used in order for a technological innovation to be implemented (Thong, 1999; Zhu et al., 2003; Quaddus and Hofmeyer, 2007). Results of the effect that size has on EC/Internet adoption have been mixed with some studies finding a positive effect (Zhu et al., 2003), others an insignificant one (Teo and Ranganathan, 2004; Jean et al., 2006) and others a negative (Bayo-Moriones and Lera-Lopez, 2007). Nevertheless as stronger arguments/evidence for a positive than a negative relationship exists:

Hypothesis 9: Firm size is expected to have a positive effect on the extent of EC adoption.

4.6 Access to External Resources

Access to external resources can allow an SME to gather the funds required for the development of an EC infrastructure and for the hiring of suitably qualified IT professionals. If a NTBF has received governmental support for the R&D of an innovative product/service then it will be more likely that it will have the extra resources that are needed in order to invest for the development and management of an EC system. Moreover if a firm is located in a science park will have significantly lower operating costs (e.g. lower rent, shared resources/services) while taking advantage of technological and business/commercial knowledge and advice that can be derived from links with universities and other companies located in the science park (Westhead, 1997; Westhead and Batstone, 1999; Siegel et al., 2003). Therefore,

Hypothesis 10: Firms located in a science park or those that have received governmental support are more likely to have adopted EC.

4.7 IT Infrastructure

As EC consists of various IT components the firm's IT infrastructure and context (the existence of a computer network in this study) has been considered to be an important determinant of EC adoption as it can provide the platform on which EC can be built (Fillis and Wagner, 2005; Quaddus and Hofmeyer, 2007) and serve as an indication of the level of IT skills of a firm's employees. Therefore:

Hypothesis 11: The existence of a computer network will be expected to have a positive effect on EC adoption.

4.8 Managerial Structure

The size of an EFT is expected to be associated with a greater degree of specialization in decision making (Eisenhardt and Schoonhoven, 1990) as larger EFTs are usually associated with a higher level of heterogeneous and often complementary resources both financial and skill related (Ucbasaran et al., 2003; Marvel and Lumpkin, 2007). Teams with a variety of (heterogeneous) skills are more likely to react to environmental changes and to reach creative solutions after gathering information from a greater range of resources (Aspelund et al., 2005). Therefore,

Hypothesis 12: Firms that have been founded by larger EFTs will be more likely to adopt EC.

Finally the study will control for the age of a firm and whether it belongs to the high tech manufacturing or service sector. Older firms are believed to be less likely to adopt innovations (Chuang et al., 2007) especially as they have survived and therefore performed reasonably well for a long period of time without adopting EC. Furthermore it

is reasonable to assume that firms belonging to the manufacturing sector will be more likely to adopt EC for purchasing in order to reduce related expenses and that firms belonging to the services (i.e. telecommunications and software) will be more likely to adopt EC for selling due to the nature of the product/service they provide. Firms in service orientated industries tend to have more information content in their products/services (Bayo-Moriones and Lera-Lopez, 2007) and will be expected to adopt and use Internet technologies (e.g. for selling goods/services) earlier than manufacturing firms (Teo and Ranganathan, 2004) that tend to encounter more inhibitors in comparison to other sectors.

5. Dataset

The empirical analysis is based on data from a representative survey of NTBFs. These are defined as firms that are independently owned (i.e. the founder(s) owns at least 50% of the company), are less than 25 years old and belong to a high technology sector (Tether and Storey, 1998). The survey gathered information about the EC usage of the firms, the background of the founders, as well as firm specific and environmental characteristics.

The accurate identification of the population of NTBFs is not easy. The greatest difficulty with the identification of their population is that they are not covered by official UK statistics, or the statistics of other countries which makes the identification of an unambiguous population very difficult something acknowledged by *all existing* NTBF studies (e.g. Dellapierre et al 1998; Lofsten and Lindelof, 2002; Colombo and Grilii, 2005). The main problem that hinders the identification of the population of NTBFs by official data sources is that they typically offer no discrimination between independent

firms and subsidiaries. A combination of official (ONS) data and data from a commercial database was therefore used in order to arrive at a suitable population from which a sample could be drawn, improving from all existing NTBF studies as in those, either official data sources are not used or the independence criterion is not included.

In order to identify the UK high technology sectors an approach similar to that used by Butchard (1987)[3] was followed, based on the twin criteria of firms with high R&D intensity (measured as R&D expenditure over the amount of sales or value added) and firms with a high proportion of scientists and engineers who spend the majority of their time in R&D activities. By using the OECD STAN indicators and the 'Research & Development in the UK' (2002) published by the Office of National Statistics, the expenditure over sales as well as the R&D expenditure over value added criterion (also compared with the DTI innovation report (2003)) was used, for each sector according to the UK SIC classification. The ratio of scientists and engineers who spend the majority of their time in R&D activities over total employment was also calculated by using the ONS MA_14 reports and the STAN indicators.

The categorization of companies according to the independence criterion was done by using FAME (Financial Analysis Made Easy), a database that contains contact details of all the limited UK companies and their directors, which can also be used to isolate the companies where individual owners own more than 50% equity. The population count in this study therefore consisted only of all the independent firms in the UK that were less than 25 years old and belonged to high-tech sectors, and therefore it offers a clear improvement in relation to studies that did not include the independence criterion at all or

included only firms that were independent at their founding stage (e.g. Storey and Tether 1998; Saemundsson and Dahlstrand, 2005).

The second step in the sampling frame involved the stratification of companies according to age and size for each high-tech sector[4]. This led to an initial calibrated semi-proportional random sample of 4000 companies selected from the high-tech sector population[5] (see Table 1a column 1). Data were collected by postal questionnaire between April and July 2005, following interviews with five entrepreneurs (five companies) in order to receive feedback on the clarity of the questions included in the questionnaire, and a pilot study of 100 NTBFs. Of the original sample of 4000 companies 412 companies took part in the survey. All questionnaires were answered by one of the firms' founders.

The distribution of the response rate across the industries identified as high-tech is illustrated in Table 1a. On initial examination a chi-square test appears to show that the distribution of the original population and the sample significantly differ ($\chi^2(9)= 31.546$ and $p=0.000238$). However, this is due to the high incidence of consultants in the lowest employment band-size of just two sectors. The ONS data do not distinguish between consultants and (genuine) R&D-intensive businesses within the software and telecommunication sectors. Consultants in these sectors could not be excluded ex-ante from the population count provided by the ONS, but were excluded from the survey (a similar problem is expressed by Colombo and Grilli, 2005). As the study concentrates exclusively on R&D intensive businesses, any comparisons between the ONS figures and the study's sample proportions for these sectors would be misleading. When they are omitted from the count, the relative distribution provided by the ONS and that of the

respondents to the survey does not significantly differ ($\chi^2(7)= 4.049$ and $p=0.77$) confirming the representativeness of the study's survey in terms of sectoral composition. As indicated in Table 1b, the sample was also representative of the population in terms of employee size bands (χ^2 (2) = 3.8).

In this study EC intensity was measured as a categorical variable (0, 1, 2) in order to capture which firms were basic (1), advanced (2) or non-users (0). The definition of the independent variables used as well as a set of summary statistics of those variables is included in table 2. From the 412 sampled firms, 403 provided details regarding their EC activity. From those, 78.5 % had adopted EC and more specifically 73.26 % used it in order to make purchases whereas 40.94 % to sell products/services. In more detail, 35.64 % used it for both buying and selling, 37.62 % only for purchasing and 5.19 % only for selling.

6. Empirical Analysis

In order to explore what differentiates between **a)** those firms that have not adopted EC and those that were basic users (use EC just for purchasing) and **b)** between those that are basic and enhanced (use it for both sales and purchasing or just for sales) users, a multinomial logit model was used. Such a model was preferred as it was judged to be more suitable in terms of being able to take into account the mutually exclusive choices that a firm can make (non-adopter, basic-adopter, advanced-adopter), where adoption is not necessarily sequential or ordered.

Furthermore by using a multinomial logit model, the odds ratios of the independent variable can be estimated which provide more useful interpretations of the model's coefficients (the odds ratio of a variable for example can be used to estimate the change

in the odds of a firm adopting EC at the advanced rather than the basic level when a one unit change in a specific independent variable occurs). Given the higher usefulness of the odds ratios, they are going to be included in brackets next to the coefficient of each variable. Results are presented in tables 3 and 4. Four different models are used in order to avoid multicollinearity between the human capital variables.

The first column of each model differentiates between being *a non user* rather than a basic user and the second column differentiates between being an *enhanced* rather than a basic user. The pseudo R^2 statistics show that the models explain a considerable proportion of the variance of the dependent variable.

6.1 Basic Users vs Non Users

Results showed that firms that had EFTs with relative more years of average working experience were more likely not to have adopted EC at all rather than adopting it for purchasing products/services. The same was found for older and also (in two of the four models) for larger firms. On the other hand firms that had formed formal collaborative agreements of a technical nature with other companies were more likely to have adopted EC for purchasing rather than not adopting it at all and the same was found for firms that operate in the high tech manufacturing sectors and for those that were using a computer network prior EC adoption. Finally it was found that the higher the proportion of firms in a specific industry that a firm operates that were basic users, the more likely it is that that a firm belonging to that industry will adopt EC at the basic level as well.

6.2 Enhanced Users vs Basic Users

Firms that had entrepreneur(s) with previous sales/marketing experience present in their EFT were more likely to be enhanced rather than basic users and the same was

found for exporting firms and for those that had formed formal collaborative agreements of a commercial nature with other companies. Moreover the higher the percentage of firms in a specific industry sector that a firm belongs to that are enhanced users, the more likely it will be that a firm belonging to such sector will also adopt EC at the advanced level. On the other hand those firms that have a high percentage of their sales derived from their two main customers are less likely to adopt EC in order to sell or in order to sell and purchase products.

7. Discussion of findings

Results provided *partial support for hypothesis 1* as although education was not found to have a positive effect on EC adoption at any level; as expected, firms formed by entrepreneur(s) with more years of experience were more likely not to adopt EC even at the basic level. Such entrepreneurs might perceive that their extensive experience provides them with all the information needed to make decisions, which might stop them from gathering information from other sources which in turn can reduce the likelihood of opportunity identification and innovation adoption (Ucbasaran et al., 2008). They are also more likely to adopt strategies and routines that have worked in the past, ignoring practices that have not been used before. This result is in line with arguments that older entrepreneurs are risk averse, less comfortable with ambiguity and uncertainty and less likely to be attracted to fresh ideas as they usually resist adoption of processes that can lead to radical changes to existing practices (Hambrick and Mason, 1984; Lynskey, 2004; Casson, 2005).

Rogers' (1995) 'how to' was found to be more important than 'principles' knowledge as commercial experience, believed (Jones et al., 2003; Simons et al., 2008) to capture

the former, was found to be a differentiating factor between advanced and basic adopters (*providing partial support for hypothesis 3*). Findings are similar to those of Teo and Ranganathan (2004) and show that EC can be viewed by teams with commercial skills as an essential for the firm commercial/marketing tool (Simmons et al., 2008). It appears therefore that it is the commercial/market knowledge rather than the IT, technical (general innovation) or similar sector skills that enhances a firm's learning related to EC adoption (Rogers et al., 2008) that ultimately allows entrepreneurs in the high tech sector to adopt a complex innovation such as EC (Jones et al., 2003; Elliot and Boshoff, 2005).

Both variables capturing the adopting behavior of firms operating in the same sector (critical mass) at either the basic or advanced level were found to have a significant effect on both levels of EC adoption, *providing support for hypothesis 6*. This agrees with studies arguing that competitive pressure is an important driver of innovation adoption (Iacovou et al., 1995; Thong, 1999; Zhu et al., 2003) and that the influence of competitors does depend on the intensity of the usage of a specific innovation within the industry a firm operates (Di Maggio and Powel, 1983; Quaddus and Hofmeyer, 2007).

The fact that firms that formed formal collaborative agreements of a technical (R&D, manufacturing) nature were more likely to adopt EC for purchasing shows that such firms perhaps received information about the reduction in the transaction/operational costs involved with the purchasing process that EC can bring and also about how EC can improve the effectiveness of the manufacturing process by allowing a firm to search, identify and order from a greater number of cheaper/higher quality suppliers located all over the globe. On the other hand that fact that formal collaborative agreements of a commercial nature led to the adoption of EC for selling or for both selling and purchasing

can be a result of an increased awareness about the benefits of EC, or due to firms receiving direct support from the commercial partners to adopt EC or finally can be a result of pressure received from those partners to adopt EC as a way of doing business (Quaddus and Hofmeyer, 2007; Simmons et al., 2008). Results therefore *provided support for hypothesis 7.*

Hypothesis 8 was also supported verifying that the greater the scope of a firm is the more likely it will be that EC will be adopted at the advanced level. Exporting firms were found to be more likely to adopt EC at the advanced level, perhaps as it has been identified as a cost effective way to approach and trade with foreign based customers (Fillis and Wagner, 2005) and large sales dependence to a firm's main customers will cause EC adoption for selling products/services to be unnecessary as the need to approach new customers will decrease.

Size on the other hand was found to have the opposite effect on EC adoption as smaller firms were found to be more likely to adopt EC at the basic level rather than not adopt it all which agree with the findings of Teo and Ranganatham (2004) (EC study) and Bayo-Moriones and Lera-Lopez (2007) (ICTs study). This can be explained as larger firms have been argued to suffer from 'Structural Inertia' (Xu et al., 2004) that is, they tend to be less agile and flexible than smaller firms. Smaller firms are perceived to be more likely to adopt an innovation as they are generally believed to be more innovative, more flexible and adaptable to a changing environment and therefore being able to respond quicker to innovation implementation (Goode and Stevens, 2000), as they require less communication and coordination to make decisions. Size had no effect when differentiating between basic and enhanced adopters.

Finally *hypothesis 11 was supported* as the existence of a computer network prior the adoption of EC was found to be a differentiating factor between non-adopters and basic adopters but not between basic and advanced adopters. It appears therefore that firms that have invested in the development of a computer network are more likely to adopt EC for purchasing as it does not require any further major investment however it does not increase the likelihood of adoption at the advanced level as still a substantial investment in both software and skills is required. Finally both control variables appeared to behave as expected as older firms were found to be less likely whereas firms operating in the manufacturing sectors more likely to adopt EC at the basic level.

8. Conclusion

This study explored the factors affecting the adoption of EC by NTBFs in the UK by using data derived from 412 firms and it is (to the best of the author's knowledge) the first study that explores this issue in the important for a country's economy high tech sector. The paper contributed to the existing literature of EC adoption by SMEs, first by moving the theoretical framework forward (Williams et al., 2009) by not only combining the RBT and the TOE framework, both already used in EC adoption studies, but also by considering the Entrepreneurship and Human Capital Theory. The study therefore was able to link theoretically individual with organization adoption research (Jeyaraj et al., 2006), by considering all individuals responsible for the main decision making within a firm (Chuang et al., 2009).

Empirically the study contributed as a large dataset was used to investigate EC adoption which allows for results to be generalized to the wider population of NTBFs in the UK (studies investigating EC/e-business adoption are rarely carried out by using large

datasets (Zhu et al., 2003; Bayo-Moriones and Lera-Lopez, 2007)). Moreover the study investigated actual rather than perceived EC adoption, removing therefore self-reported bias whereas at the same time avoiding the usage of 'soft' measures in order to capture the characteristics of individuals that compile an EFT. Finally the paper also differentiated between different levels of sophistication of EC adoption. This allows for an effective identification of the action that needs to be taken in order for a firm to switch from not using EC to adopt it for purchasing and if it is already using it for purchasing to indentify the action that needs to be taken in order to adopt it for selling products/services.

From a theoretical perspective it appeared that most components of the TOE framework (internal technological infrastructure, firm's scope, competition, collaborative agreements) have a significant effect on EC adoption at either or both the basic and enhanced levels and the components of the RBT that were conceptually common with the TOE framework (internal infrastructure (internal resources), collaboration with other companies (external resources)) were also found to affect EC adoption at both levels. Finally by using the theory of entrepreneurship combined with the human capital theory the study showed that more experienced/older entrepreneurs were less likely to adopt EC and also that Rogers' (1995) 'how to' knowledge (commercial experience) was a determinant factor for EC adoption at the advanced level.

From an empirical perspective results can be of interest to both practicing and future entrepreneurs but also to policy makers. Entrepreneurs that are interested in using EC as a tool to approach new local but especially foreign based customers can receive valuable knowledge and resources related to the development of EC from business partners. The

latter can also provide a firm with complementary resources (Tanriverdi and Venkatraman, 2005) as it can assist a NTBF in acquiring financial capital, manufacturing and marketing capabilities, access new distribution channels and achieve economies of scale (Wilkund et al., 2009). It is suggested that dependence of sales on a few customers should be avoided as it has been argued to adversely affect not only innovation adoption but also the general performance of a firm (Venkatraman et al., 1990) and that individuals that start NTBFs need to make sure that appropriate commercial skills are present in the EFT, as it appears that commercial experience is beneficial in order for a firm to be able to reach a higher level of sophistication of EC usage and as it has been found to be an important factor that can enhance a firm's performance.

Finally policy makers can use results of this study in order to target their efforts for SMEs to adopt EC more effectively, depending on a firm's current level of EC usage. High tech firms less likely to adopt EC at any level where perhaps governmental assistance can be targeted, are those that are relatively older or are formed by older entrepreneurs. The provision of funds for hiring professionals with appropriate commercial skills or access to consultants with those skills has been identified to be one of the areas that support can be directed towards.

References

Aspelund, A., Berg-Utby, T. and Skjevdal, R. (2005) 'Initial resources' influence on new venture survival: a longitudinal study of new technology-based firms', *Technovation* 25: 1337-1347.

Atuahene-Gima, M. and Ko, A. (2001) 'An empirical investigation of the effect of market orientation and entrepreneurial orientation alignment on product innovation', *Organization Science* 12 (1): 54-58.

Avermaete, T., Viaene, J. and Morgan, E.J. (2004) 'Determinants of product and process innovation in small food manufacturing firms', *Trends in Food Science & Technology* 15: 474–483.

Barney, J. (1991). 'Firm resources and sustainable competitive advantage', *Journal of Management* 17 (1), 99-120.

Bayo-Moriones, A. and Lera-Lopez, F. (2007) 'A firm level analysis of determinants of ICT adoption in Spain', *Technovation* 27: 352-366.

Becker, G.S., 1964. Human Capital. Chicago: University of Chicago Press.

BERR (Department of Business Enterprise and Regulatory Reform), 2008. 'High growth firms in the UK: Lessons from an analysis of comparative UK performance'. BERR Economics Paper No.3.

Bruderl, J., Preisendorfer, P. and Zielger, R. (1992) 'Survival chances of newly founded business organizations', *American Sociological Review* 57: 227-242.

Bruque, S. and Moyano, J. (2007) 'Organisational determinants of information technology adoption and implementation in SMEs: The case of family and cooperative firms', *Technovation* 27: 241-253.

Butchard, R. (1987) 'A new definition of high technology industries', *Economic Review* 400: 82-88.

Burton-Jones, A. and Hubona, G.S. (2006) 'The mediation of external variables in the technology acceptance model', *Information & Management* 43: 706-717.

Caldeira, M.M. and Ward J.M. (2003) 'Using resource-based theory to interpret the successful adoption and the use of information systems and technology in manufacturing small and medium-sized enterprises', *European Journal of Information Systems* 12: 127-141.

Casson, M. (2005) 'Entrepreneurship and the theory of the firm', *Journal of Economic Behavior and Organization* 58: 327–348.

Chen J. and McQueen R.J. (2008) 'Factors Affecting E-Commerce Stages of growth in Small Chinese Firms in New Zealand: An Analysis of Adoption Motivators and Inhibitors', *Journal of Global Information Management* 16 (1): 26-60.

Chuang, T., Rutherford, M.W. and Lin, B. (2007) 'Owner/Manager characteristics, organizational characteristics and IT adoption in Small and Medium Enterprises', *International Journal of Management and Enterprise Development* 4 (6): 619-634.

Chuang, T., Nakatani, K. and Zhou, D. (2009) 'An exploratory study of the extent of information technology adoption in SMEs: an application of upper echelon theory', *Journal of Enterprise Information Management* 22 (½): 183-196.

Chong, S. and Pervan, G. (2007) 'Factors influencing the extent of deployment of electronic commerce for small and medium-sized enterprises', *Journal of Electronic Commerce in Organizations* 5 (1): 1-29.

Coltman, T.R., Devinney, T.M. and Midgley, D.F. (2007) 'e-Business strategy and firm performance: a latent class assessment of the drivers and implications to success', *Journal of Information Technology* 22: 87-101.

Colombo, M.G. and Grilli, L. (2005) 'Founders' human capital and the growth of new technology based firms: a competence-based view', *Research Policy* 34: 795-816.

Cox, G. (2005). Cox review of creativity in business: Building on the UK's strengths, HM Treasury.

Davidsson, P. and Honig, B. (2003) 'The role of social and human capital among nascent entrepreneurs' *Journal of Business Venturing* 18 (3): 301-331.

Department of Trade and Industry, (2003) Innovation Report, London.

Delapierre, M., Madeuf, B. and Savoy, A. (1998) 'NTBFs – the French case', *Research Policy* 26: 989-1003.

Di Maggio, P. and Powell, W. (1983) 'The iron cage revisited: industrial isomorphism and collective rationality in organizational fields' *American Sociology Review* 63 (4): 149-160.

Eisenhardt, K.M. and Schoonhoven, C.B. (1990) 'Organizational growth: linking founding team, strategy, environment and growth among U.S. semiconductor ventures, 1978–1988', *Administrative Science Quarterly* 35: 504–529.

Fillis I. and Wagner, B. (2005) 'E-Business Development. An explanatory Investigation of the small firm', *International Small Business Journal* 23 (6): 604-634.

Forester, T. (1985) 'The Information Technology Revolution', Blackwell, Oxford.

Gibbs, J., Kraemer, K.L. and Dedrick, J. (2003) 'Environment and policy factors shaping global e-commerce diffusion: a cross-country comparison', *The Information Society* 19: 5–18.

Hambrick, D.C. and Mason, P.A. (1984) 'Upper echelons: The organization as a reflection of its top managers', *Academy of Management Review* 9: 193-206.

Harada, N. (2003) 'Who succeeds as an entrepreneur? An analysis of the post-entry performance of new firms in Japan', *Japan and the World Economy* 15: 211-222.

Iacovou, C.L., Benbasat, I. and Dexter, A.S. (1995) 'Electronic data Interchange and small organizations: adoption and impact of technology', *MIS Quarterly* 19 (4), 465-485.

Jean, B.N., Han, K.S. and Lee, M.J. (2006) 'Determining factors for the adoption of e-business: the case of SMEs in Korea', *Applied Economics* (38): 1905-1916.

Jeyaraj, A., Rottman, J.W. and Lacity, M.C. (2006) 'A review of the predictors, linkages, and biases in IT innovation adoption research', *Journal of Information Technology* 21: 1-23.

Jones, C., Hecker, R., Holland, P. (2003) 'Small firm Internet adoption: opportunities forgone, a journey not begun', *Journal of Small Business and Enterprise Development* 10 (3): 287-297.

Jutla, D., Bodorik, P. and Dhaliwal, J. (2002) 'Supporting the e-business readiness of small and medium-sized enterprises: approaches and metrics', *Internet Research: Electronic Networking Applications and Policy* 12 (3): 139-64.

Lee, S.M., Kim, I., Rhee, S. and Trimi, S. (2006) 'The role of exogenous factors in technology acceptance: The case of object-orientated technology', *Information & Management* 43: 469-480.

Levy, M., Powell, P. and Yetton, P. (2001) 'SMEs: Aligning IS and the Strategic Context', *Journal of Information Technology* 16: 133–44.

Lim, J. Gan, B. and Chang, T. (2002) A Survey on NSS Adoption Intention. Proceedings of the 35th HICS.

Lofsten, H., Lindelof, P. (2002) 'Science parks and the growth of new technology-based firms academic-industry links, innovation and markets', *Research Policy* 31: 859-876.

Lynskey, M.J. (2004) 'Determinants of innovative activity in Japanese technology-based start-up firms', *International Small Business Journal* 22 (2): 159-196.

Marvel, M.R. and Lumpkin, G.T. (2007) 'Technology entrepreneurs' human capital and its effectiveness on innovation radicalness', *Entrepreneurship Theory and Practice* 31: 807-828.

Molla, A. and Licker, P.S. (2005) 'eCommerce adoption in developing countries: a model and instrument', *Information & Management* 42: 877-899.

Office of National Statistics (2003) Press Release, Unique Reference Number 03/92, London.

Office of National Statistics (2002) Research and Development in the UK, London.

Porter, M.E. and Ketels, C. (2003) 'UK Competitiveness: Moving to the next stage', DTI Economics Paper N.3.

Preisendörfer, P. and Voss, T. (1990) 'Organizational mortality of small firms: the effects of entrepreneurial age and human capital', *Organizational Studies* 11: 107–129.

Quaddus, M. and Hofmeyer. G. (2007) 'An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses' *European Journal of Information Systems* 16, 202-215.

Quan, J. (2008) 'Evaluating E-Business Leadership and its Links to firm Performance', *Journal of Global Information Management* 16 (2): 81-90.

Raymond, R. (2001) 'Determinants of Web Site Implementation in Small Businesses', *Internet Research* 11 (5), 411-423.

Rogers, E.M. (1995) Diffusion of Innovations' 5th ed. Free Press, NY.

Saemundsson, R. and Dahlstrand, A.L. (2005) 'How business opportunities constrain young technology-based firms from growing into medium-sixed firms', *Small Business Economics* 24: 113-129.

Santarelli, E. and D'Altri, S. (2003) 'The diffusion of E-commerce among SMEs: Theoretical implications and empirical evidence', *Small Business Economics* 21 (3): 273-283.

Scupola, A. (2009) 'SMEs' e-commerce adoption: perspectives from Denmark and Australia', *Journal of Enterprise Information Management* 22 (½): 152-166.

Shane, S. (2000) 'Prior Knowledge and the Discovery of Entrepreneurial Opportunities', *Organization Science* 11: 448–469.

Siegel, D.S., Westhead, P. and Wright, M. (2003) 'Science parks and the performance of New Technology-Based Firms: A review of recent U.K. evidence and an agenda for future research', *Small Business Economics* 20: 177-184.

Simmons, G., Armstrong, G.A. and Durkin, M.G. (2008) 'A conceptualization of the determinants of small business website adoption. Setting the research agenda', *International Small Business Journal* 26 (3): 351-389.

Storey, D.J. and Tether, B.S. (1998) 'Public policy measures to support new technology-based firms in the European Union', *Research Policy* 26: 1037-1057.

Tanriverdi, H. and Venkatraman, N. (2005) 'Knowledge relatedness and the performance of multibusiness firms', *Strategic Management Journal* 26: 97-119.

Teece, D.J. and Pisano, G. (1994) 'The dynamic capabilities of firms: an introduction', *Industrial and Corporate Change* 3: 537–556.

Teo, T.S.H. and Ranganathan, C. (2004) 'Adopters and non-adopters of business-to-business electronic commerce in Singapore' *Information & Management* 42: 89-102.

Tether, B. and Storey, D. (1998) 'Smaller firms and Europe's high technology sectors: a framework for analysis and some statistical evidence', *Research Policy* 26, 947-971.

Thong, J.Y. (1999) 'An integrated model of Information Systems adoption in small businesses' *Journal of Management Information Systems* 15 (4): 187-214.

Tornatzky, L.G. and Fleischer, M. (1990) 'The Processes of Technological Innovation', Lexington Books, MA.

Ucbasaran, D., Lockett, A., Wright, M. and Westhead M. (2003)' Entrepreneurial Founder Teams: Factors Associated with Member Entry and Exit', *Entrepreneurship Theory and Practice* 28: 107-128.

Ucbasaran, D., Westhead, P. and Wright, M. (2008) 'Opportunity Identification and Pursuit: Does an Entrepreneur's Human Capital Matter?' *Small Business Economics* 30: 153-173.

Venkataraman, S., Van de Ven, A.H., Buckeye, J. and Hudson, R. (1990) 'Starting up in a turbulent environment – A process model of failure among firms with high customer dependence' *Journal of Business Venturing* 5: 277-295.

Venkataraman, S. (1997) The distinctive domain of entrepreneurship research: An editor's perspective, in Katz, J., Brockhaus, R., (Eds), *Advances in Entrepreneurship, firm, emergence and growth*, Greenwich, CT.

Von Hippel, E., 1988. The sources of Innovation. Oxford University Press, NY.

Wang, Y., Lo, H. and Yang, Y. (2004) 'The constituents of core competencies and firm performance: evidence from high-technology firms in china' *Journal of Engineering Technology and Management* 21: 249-280.

Wareham, J., Zheng, J.G. and Straub, D. (2005) 'Critical themes in electronic commerce research: a meta-analysis' *Journal of Information Technology* 20: 1-19.

West, G.P. and Noel, T.W. (2009) 'The Impact of Knowledge Resources on New Venture Performance', *Journal of Small Business Management* 47: 1-22.

Westhead, P. (1997) 'R&D inputs and outputs of technology based firms located on and off science parks', *R&D Management* 27 (1): 45-62.

Westhead, P. and Batstone, S. (1999) 'Perceived benefits of a managed science park location', *Entrepreneurship and Regional Development* 11: 129-154.

Williams, M.D., Dwivedi, Y.K., Lal, B. and Schwarz, A (2009) 'Contemporary trends and issues in IT adoption and diffusion research', *Journal of Information Technology* 24: 1-10.

Wright, M., Hmieleski, K.M., Siegel, D.S. and Ensley, M.D. (2007) 'The Role of Human Capital in Technological Entrepreneurship', *Entrepreneurship Theory and Practice* 31 (6): 791-806.

Xu, S., Zhu, K. and Gibbs, J. (2004) 'Global technology, local adoption: across-country investigation of Internet adoption by companies in the United States and China', *Electronic Markets* 14 (1): 13–24.

Yu, C.S. and Tao, Y.H. (2009) Understanding business-level innovation technology adoption, *Technovation* 29: 92-109.

Zhu, K., Kraemer, K.L. and Xu, S. (2003) 'Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors', *European Journal of Information Systems* 12: 251-268.

Zhuang, Y. and Lederer, A.L. (2006) 'A resource based view of electronic commerce', *Information & Management* 42: 251-261.

Figure.1 Theoretical Framework

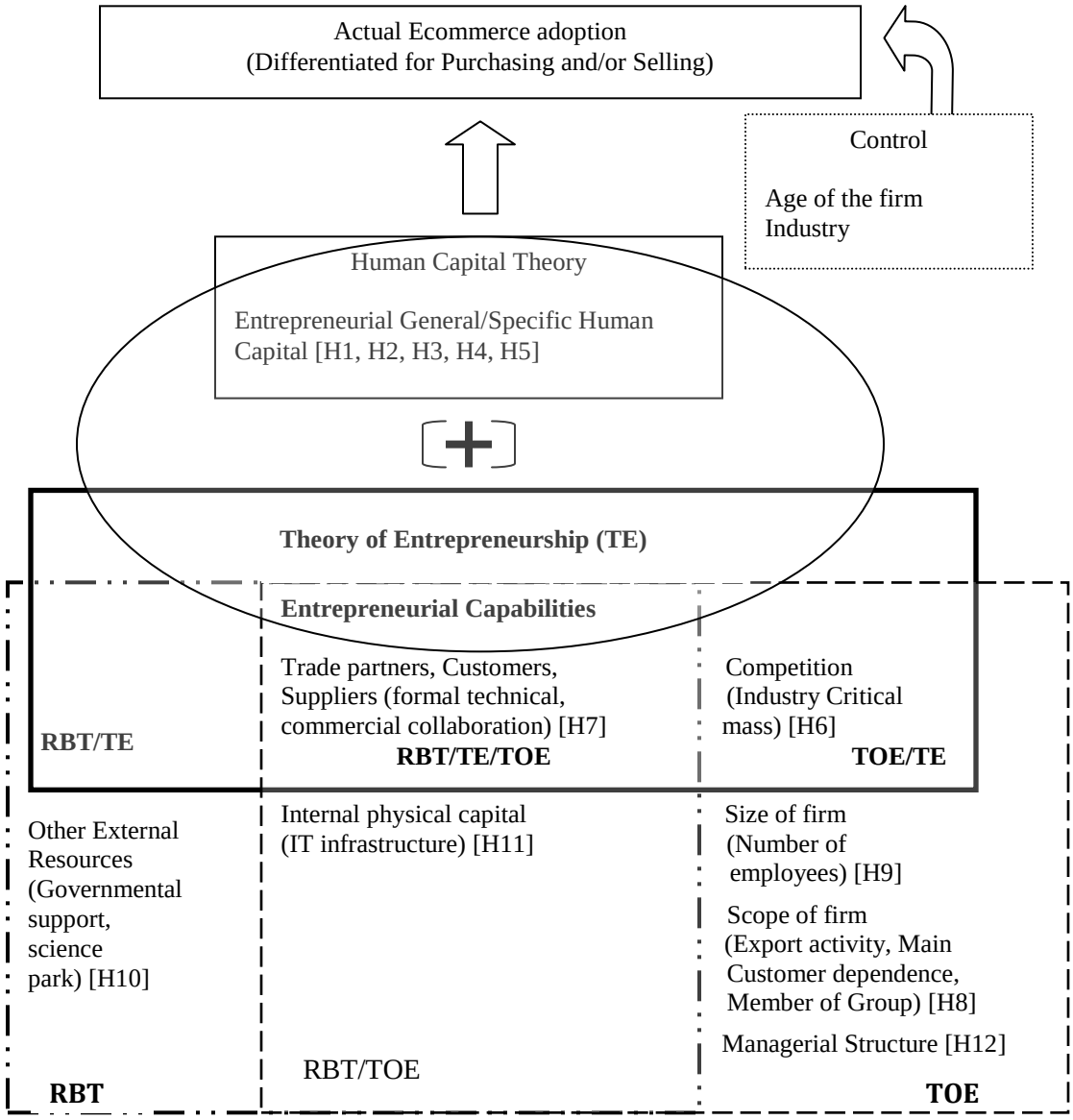

Table 1a. Distribution of population and sample firms by industry

High Technology Sectors	**Sampling frame**	**Sample respondents**
Pharmaceutical	1.19	3.16
Computers	2.82	4.87
Electrical	9.96	15.57
TV and Radio	7.88	11.44
Medical, instrumentation, optical	12.14	22.39
Aerospace	1.22	1.7
Telecommunications	13.71*	5.84
Software	39.85*	21.9
R&D in natural sciences and engineering	6.12	6.33
Technical testing	5.1	6.81
Total	100 % (4000 firms)	100 % (412 firms)

Table 1b. Distribution of population and sample firms by size band

Size Categories (Number of employees)	**Size**	
	Sampled Firms	**Population**
Small	94 %	95.7 %
Medium	5.5 %	3.7 %
Large	0.5 %	0.6 %
Chi-square	3.8	

Table 2. Descriptive statistics of independent variables

Variable Description	Mean	S.D.
Human Capital variables		
General education – Average years of general education in an EFT	13.94	2.270
General experience – Average years of general experience in an EFT until a firm's incorporation date	19.74	8.774
IT education – scale variable (0-5)[1]	2.16	1.778
Business education – scale variable (0-5)	0.27	0.920
Technical (e.g. engineering, manufacturing, biotechnology) education – scale variable (0-5)	0.64	1.500
IT experience – The proportion of the entrepreneurs in an EFT with IT experience[2]	0.13	0.307
Technical experience – The proportion of the entrepreneurs in an EFT with technical experience	0.48	0.437
Commercial experience – The proportion of the entrepreneurs in an EFT with commercial experience	27.61	38.753
Different sector experience – The proportion of the entrepreneurs in an EFT with different sector experience	0.324	0.42
Firm specific Characteristics		
Firm age – age of the firm in years	10.57	6.76
Size of the firm – The natural logarithm of the number of employees	16.07	26.37
Number of founders – Number of individuals that founded a firm	1.966	1.02
Part of a group (other company owns less than 50 % equity or firm is head of group) (0/1)	0.0803	0.272
Industry sector - Whether a firm belongs to the high tech manufacturing or service sector (0/1)	0.59	0.492
Computer network – Whether a computer network was in place prior to EC adoption (0/1)	0.241	0.428
Science Park – Whether a firm was located in a science park during EC adoption	0.08	0.277
Environment characteristics		
Industry basic adopters – Percentage of firms in the same industry that a firm operates that have adopted EC at the basic level (%)	0.376	0.111
Industry enhanced adopters – Percentage of firms in the same industry that a firm operates that have adopted EC at the enhanced level (%)	0.409	0.093
Technical agreements – Whether a firm had formed formal collaborative agreements of a technical nature with other companies prior EC adoption (0/1)	0.21	0.406
Commercial agreements – Whether a firm had formed formal collaborative agreements of a commercial nature with other companies prior EC adoption (0/1)	0.26	0.437
Governmental support – Whether a firm had received governmental support for R&D activities prior EC adoption (0/1)	0.12	0.329
Marketing strategy		
Exports – Whether a firm had a consistent presence in foreign markets (0/1)	0.53	0.5
Customer dependence – Percentage of sales accounted by 2 main customers (scale variable 1 – 4 1: less than 25 %, 2: 25-49 %, 3: 50-74 %, 4: more than 75 %)	2.13	1.115

[1] 0 was given if any of those qualifications did not exist in a team, 1 if the higher was Higher National Certificate, 2 if it was Higher National Diploma, 3 for a degree, 4 for a Masters/MBA and 5 for a PhD. Apart from this specification the models were first re-estimated by using the average years in an entrepreneurial team of technical, business and IT education and second by using dummy variables of whether at least one member of the entrepreneurial team had any level of the above types of education. Results were robust regardless of the definition of those variables used.

[2] Apart from this specification, dummy variables of whether at least one member of the entrepreneurial team had a specific type of experience were also used and results remained unchanged.

Table 3. Multinomial logit models

Variable	Gen. Education Gen. Experience		Gen. Education Spec. Experience	
	Non Users	Enhanced Users	Non Users	Enhanced Users
Constant	1.658	-1.143	4.593	0.0617
Human Capital				
General education	0.0652 (1.067)	0.00497 (1.005)	0.0537 (1.055)	-0.0108 (0.989)
General experience	**0.0451** ** **(1.046)**	0.0242 (1.025)		
Technical education				
Business education				
IT education				
Technical experience			0.848 (2.335)	0.197 (1.218)
Commercial experience			-0.0505 (0.951)	**0.847** ** **(1.156)**
IT experience			0.555 (1.742)	0.145 (2.334)
Different sector experience			-0.00482 0.995)	-0.0008 (0.999)
Physical Resources				
Computer network	**-2.944** *** **(0.053)**	-0.121 (0.886)	**-2.951** *** **(0.052)**	-0.116 (0.89)
Managerial Structure				
Number of founders	0.21 (1.234)	-0.0598 (0.942)	0.125 (1.133)	-0.0889 (0.915)
Environment				
Technical agreements	**-1.341** ** **(0.261)**	-0.281 (0.755)	**-1.354** ** **(0.258)**	-0.00629 (0.994)
Commercial agreements	0.172 (1.188)	**0.772** ** **(2.165)**	0.276 (1.318)	0.482 (1.620)
Industry basic adopters	**-0.0798** ** **(0.923)**	-0.02 (0.981)	**-0.105** *** **(0.901)**	-0.024 (0.976)
Industry enhanced adopters	0.032 (1.033)	**0.062** *** **(1.064)**	0.032 (1.033)	**0.053** *** **(1.054)**
External Resources				
Science Park	0.531 (1.702)	0.312 (1.366)	0.882 (2.415)	0.384 (1.469)
Governmental support	-0.0724 (0.93)	-0.138 (0.871)	-0.0592 (0.943)	-0.0509 (0.95)
Firm's Scope				
Exports	0.521 (1.683)	**0.778** *** **(2.179)**	0.469 (1.6)	**0.677** ** **(1.969)**
Customer dependence	-0.0958 (0.909)	**-0.327** ** **(0.721)**	-0.0694 (0.933)	**-0.294** ** **(0.745)**
Part of a group	-1.251 (0.286)	-0.0271 (0.973)	-0.917 (0.4)	0.153 (1.166)
Firm Size				
Size of the firm	0.197 (1.218)	-0.0736 (0.929)	**0.274** * **(1.315)**	-0.11 (0.896)
Control variables				
Firm age	**0.0928** *** **(1.097)**	0.0342 (1.035)	**0.0755** ** **(1.078)**	0.0391 (1.04)
Industry sector	-0.789 (0.454)	-0.332 (0.717)	**-1.274** ** **(0.28)**	-0.37 (0.69)
N (observations)	332		328	
Log-Likelihood	-294.01		-288.92	
Pseudo R^2				
Nagelkerte/McFadden	0.331/0.163		0.336/0.166	
Likelihood ratio test				
Chi-square/p-value	375.722/0.000		114.7/0.000	

NOTE: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Odds ratios in brackets

Table 4. Multinomial logit models

Variable	Gen. Experience Spec. Education		Spec. Education Spec. Experience	
	Non Users	Enhanced Users	Non Users	Enhanced Users
Constant	1.645	-1.084	4.548	-0.211
Human Capital				
General education				
General experience	**0.0417** * **(1.043)**	0.023 (1.023)		
Technical education	0.1537 (1.166)	-0.00294 (0.997)	0.139 (1.15)	-0.0117 (0.988)
Business education	-0.122 (0.885)	-0.00447 (0.996)	-0.0484 (0.953)	-0.0242 (0.976)
IT education	-0.115 (0.891)	-0.0288 (0.972)	-0.127 (0.881)	-0.0977 (0.907)
Technical experience			0.769 (2.159)	0.173 (1.19)
Commercial experience			0.571 (1.77)	**0.825** ** **(2.283)**
IT experience			0.0979 (1.103)	0.185 (1.204)
Different sector experience			-0.00431 (0.996)	-0.000545 (0.999)
Physical Resources				
Computer network	**-3.011** *** **(0.049)**	-0.114 (0.892)	**-2.98** *** **(0.051)**	-0.101 (0.904)
Managerial Structure				
Number of founders	0.171 (1.187)	-0.0486 (0.952)	0.0857 (1.09)	-0.0642 (0.938)
Environment				
Technical agreements	**-1.358** ** **(0.257)**	-0.281(0.755)	**-1.391** ** **(0.249)**	-0.0282 (0.972)
Commercial agreements	0.126 (1.135)	**0.772** ** **(2.165)**	0.246 (1.28)	0.495(1.641)
Industry basic adopters	**-0.071** ** **(0.932)**	-0.019 (0.981)	**-0.098** ** **(0.907)**	-0.022 (0.978)
Industry enhanced adopters	0.033 (1.033)	**0.062** *** **(1.064)**	0.032 (1.033)	**0.053** *** **(1.054)**
External Resources				
Science Park	0.652 (1.921)	0.326 (1.386)	0.877 (2.406)	0.4 (1.492)
Governmental support	-0.117 (0.899)	-0.13 (0.878)	-0.0716 (0.931)	-0.04 (0.961)
Firm's Scope				
Exports	0.498 (1.647)	**0.777** *** **(2.176)**	0.487 (1.628)	**0.68** ** **(1.974)**
Customer dependence	-0.0864 (0.917)	**-0.324** ** **(0.723)**	-0.0621 (0.94)	**-0.285** ** **(0.752)**
Part of a group	-1.282 (0.277)	-0.0256 (0.975)	-0.946 (0.388)	0.17 (1.185)
Firm Size				
Size of the firm	0.247 (1.281)	-0.0768 (0.926)	**0.299** * **(1.349)**	-0.105 (0.9)
Control variables				
Firm age	**0.0893** *** **(1.093)**	0.0335 (1.034)	**0.0732** ** **(1.076)**	-0.35 (1.038)
Industry sector	-0.7 (0.496)	-0.329 (0.719)	**-1.164** * **(0.312)**	0.037 (0.704)
N (observations)	332		328	
Log-Likelihood	-292.52		-287.84	
Pseudo R^2				
Nagelkerte/McFadden	0.338/0.167		0.341/0.169	
Likelihood ratio test				
Chi-square/p-value	117.214/0.000		116.852/0.000	

NOTE: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Odds ratios in brackets.