The relationship between digital technologies andinternationalisation. Evidence from Italian SMEs

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Introduction

Several studies have emphasised the role of digital technologies (DTs) asa complementary or even alternative mean of accessing international markets(Sinkovics, Sinkovics, and Bryan Jean 2013; Olejnik and Swoboda 2012). DTs can contribute to reducing the distance and entry costs and overcoming the commercial barriers related to the involvement in international markets by providing an additional channel for commercial relationships, marketing and sales and increasing knowledge on foreign markets and potential competitors (Bianchi and Mathews 2016; Freund and Weinhold 2004). Furthermore, advances in DTs can be exploited to enable better connectivity with business partners, suppliers, distribution networks, and customers, also supporting integration in the emerging global value chains (Marchi, Maria, and Gereffi 2018; Jin et al. 2014; Jean, Sinkovics, and Tamer Cavusgil 2010). The potential benefits from the adoption of DTs may be even greater for small and medium enterprises(SMEs) since it can contribute to mitigating the traditional burdens to internationalisa- tion related to firm size and to the inability to commit financial and human resources (Tseng and Johnsen 2011; Houghton and Winklhofer 2004; Tarutė and Gatautis 2014; Mathews and Healy 2008).

However, empirical studies have reported mixed findings regarding the effects of DTs on different performance metrics with many firms continuing to fall into what has been called the Information Technology (IT) productivity paradox (Tippins and Sohi 2003; Lucas 1999; Brynjolfsson 1993; Biagi 2013). The extent to which investing in digital transformation translates into better economic performances thus remains challenging (Calvino et al. 2018).

It has increasingly been recognised that digitalisation is a rather complex and multi-faceted phenomenon encompassing an array of different business strategies ranging from the purchase of new software or IT products to redesigning existing processes and organisational changes (Barney 1991; Tippins and Sohi 2003; OECD 2014; Yoo et al.

2012). The concept of DTs itself is not consistently defined, that is an accepted definition of DTs is still lacking (Denner, Püschel, and Maximilian 2018). Literature focusing on business organisations mainly seeks to assess the process of digital transformation by examining the adoption, diffusion, and deployment of DTs (Mazzarol 2015): (a) to undertake marketing and promotion activities (e-marketing); (b) to carry out transac- tions such as business to business and business to consumer (e-commerce), and; (c) to enhance production processes, customer engagement processes, and internal manage- ment processes (e-business).

Moreover, it is likely that other factors mediate the effects of DTs on performance, as digital transformation does not only entail investing in DTs, but also embedding them in the organisational structure of the firm. The introduction of DTs may often involve implementing product or process innovations, re-engineering business processes, adopting new marketing methods and significant organisational changes both within the organisation of a firm and between firms (Spiezia 2012). Drawing on the Resource- Based View (RBV), a number of studies have increasingly stressed the role of complementarities among resources as a source of sustained competitive advantage to explain differences in firm performance. Resources complementarity may help to overcome the productivity paradox of single DTs, which can hardly be by themselves sources of competitive advantage (Popa, Soto-Acosta, and Perez-Gonzalez 2018; Barney 1991; Jin et al. 2014). As a result, the investments in non-DTs resources, the reconfiguration of existing production processes, and the level and type of skills may affect the potential positive impact of DTs (Moen, Madsen, and Aspelund 2008; Jones et al. 2014; Brynjolfsson and Hitt 2000; Díaz-Chao, Sainz-González, and Torrent-Sellens 2015), and foster firms' ability to assimilate and use knowledge from the external environment (Cohen and Levinthal 1990). In addition, changes in the organisation of world manufacturing production are stimulating firms to reconsider how they can take advantage of the application of DTs. From this perspective, particulrly the DTs used to enhance internal production pro- cesses and to deal with clients and suppliers, such as cloud computing, mobile services, Supply Chain Management (SCM), and Enterprise Resource Planning (ERP) applica- tions, have increasingly been regarded as processes to be developed rather than tools to

be implemented (Bianchi and Mathews 2016; Cardona, Kretschmer, and Strobel 2013; Bryan Jean 2007; Sanders 2005; Marinagi, Trivellas, and Sakas 2014).

This paper contributes to the debate on whether DTs applications have a direct effect on firm performance by empirically exploring the role of different DTs in explaining the export propensity of Italian SMEs. To define DTs that fit our purpose, the distinction between e-commerce and e-business DTs should be clear. By e-business DTs, we mean the use of cloud computing and/or software applications enabling firms to share information with their suppliers, customers, and business partners along the supply chain. On the other hand, e-commerce DTs refer to DTs such as websites, e-commerce, and social media, which are used to carry out transactions as well as marketing and promotion activities.

We argue that the effects of DTs on firms' decisions to export depends on paths of digitalisation in terms of e-commerce and e-business DTs and that process and organisational innovations as well as the upgrading of internal digital skills are even more relevant for leveraging e-business DTs.

The paper focuses on SMEs. Although expectations relating to digital transformation are continually increasing for small firms, they continue to lag behind in the adoption and implementation of IT tools, and in particular as regards e-business DTs (European Commission 2019). As a result, increasing research is being devoted to investigating the impact of DTs on SMEs performance (Hagsten and Kotnik 2017). Many explanations have been provided for SMEs' constraints. These ranges from the inability to access financial and human resources, to rely on relevant and specific external technical skills and to understand the benefits arising from the use of DTs (Consoli 2012). Changes in the approach to entrepreneurship and business management are likely to be more significant when considering the rise of networked production through global and regional value chains. Within this context, small companies must often dedicate signifi- cant tangible and intangible investments in a particular form of inter-organisational IT chosen by larger firms, in order to participate in a specific network. In this situation, it has been questioned whether the advantages of the application of ITs are evenly dis- tributed between firms (Sanders 2005; Z. Liu, Prajogo, and Oke 2016; Strange and Zucchella 2017; Jean, Sinkovics, and Tamer Cavusgil 2010). From a policy perspective, improving our understanding of SMEs' digital behaviour provides insights into possibly new dimensions of policy intervention.

From a methodological perspective, the present paper is one of the few studies focusing on microdata at the firm level. We use data from an original survey on SMEs (based on data drawn from the 2015 annual survey of the Italian Union of Chambers of Commerce) which provide information on export performance, adoption of DTs and investments in human capital. In our analysis, we run five binary probit regression models to test the impact of several regressors on the export propensity of a firm.

Our results show that e-business DTs have a positive impact on the internationalisa- tion of businesses only when they are embedded in production with the process and organisational innovations and with appropriate human capital investments. These findings thus support the argument that as the range of technological choices grows,there is an increasing need for concurrent internal changes, together with a detailed assessment of the ectedness between technological alternatives and specific businesstypes, industries, or trading environments. The use of software applications enabling

firms to share information along the supply chain can contribute to increasing firms' exporting activities by also improving the ability to deal with customers and suppliers within global and regional networks. However, due to some data limitations, caution must be taken when interpreting these results and deriving possible policy implications. Further research should be carried out so as to gain a deeper understanding of industrial policy implications and in order to design specific policy measures.

The remainder of the article is organised as follows. In Section 2 the literature background is presented and research hypotheses are proposed. Building on this conceptual background, Section 3 presents the empirical strategy and available data. Section 4 discusses the results and draws some preliminary policy implications. Finally, Section 5 outlines the conclusions and examines the limitations of the research and its possible future development.

1. Theoretical background

1.1. The relationship between DTs and firms' exporting activities

The economic impacts of DTs have been widely debated in the literature since the question of the IT productivity paradox was first raised (OECD 2016b; Spiezia 2012; Brynjolfsson 1993). Great attention has been paid to aggregate consequences both at national, regional or sectoral levels of ICT adoption in terms of productivity, industrial performance, innovation, and export growth (Andrews, Criscuolo, and Gal 2015; Cardona, Kretschmer, and Strobel 2013; Freund and Weinhold 2004; Jorgenson and Khuong 2007; OECD 2013; Portugal-Perez and Wilson 2012).

The complexity and pervasiveness of digital transformation make measuring the scope and pace of such a multifaceted phenomenon inherently difficult (Calvino and Criscuolo 2019). At the firm level, studies have mostly explored the drivers and effects of ICT adoption. They emphasise the role of firm size, age, skill intensity, productivity, as well as the prevailing level of technology use, human skills and resources as key factors in explaining differences and heterogeneities between firms (Bayo-Moriones and Fernando 2007; Brynjolfsson and Hitt 2000; Hollenstein 2004; Kretschmer 2012; Taylor 2015).

Although recent empirical studies have brought new evidence regarding the positive role of the adoption and use of DTs for increasing productivity, studies focusing on exactly which IT channels may affect economic performances to improve industrial processes and facilitate the development of innovative products and services are stillrare (Liao et al. 2016). Benefits of specific performance measures resulting from the adoption and implementation of digital tools have also been extensively investigated. Focusing on the internationalisation of firms, a large body of research mostly grounded in business or marketing literature has strongly emphasised the role of DTs in affecting firms' export decisions and their international market growth (Sinkovics, Sinkovics, and Bryan Jean 2013; Olejnik and Swoboda 2012). Various and potential advantages derivingfrom the adoption and the use of DTs have been widely described. DTs can constitute additional sales channels, thus facilitating information availability and external knowl- edge on product varieties and characteristics (Bianchi and Mathews 2013). More speci- fically, ITs may improve knowledge of foreign markets, which in turn facilitates better

product customisation, providing a greater ability to identify and assess the characteristics of local demand (Borges, Hoppen, and Luce 2009; Loane and Bell 2006; Mathews and Healy 2008). They may also support trade activity through international marketing and advertising strategies (Lohrke 2006). Finally, DTs can increase information concerning potential competitors (Borges, Hoppen, and Luce 2009; Loane, McNaughton, and Bell 2004; Petersen, Welch, and Liesch 2002) and not only support internal functions, butcan also reinforce the commercial relationships by means of closer and more direct linkswith customers, suppliers and distributors (Morgan-Thomas 2009; Piercy, Kaleka, and Katsikeas 1998; Samiee 1998; Teo and Choo 2001). According to Jin et al. (2014) and Wu et al. (2006), global and regional value chains are increasingly relying on DTs to improve flexibility in manufacturers' supply chains, reduce cycle time, and deliver products to customers in a timely manner (Z. Liu, Prajogo, and Oke 2016; D. Kim, Cavusgil, and Calantone 2006).

Several authors have observed that the potential benefits from the adoption of DTs may be even greater for SMEs since they mitigate the traditional burdens to internationalisation specifically related to firm size (Cassetta, Meleo, and Pini 2016; Consoli 2012; Tseng and Johnsen 2011; Tarutė and Gatautis 2014; Fillis and Wagner 2005; Pini, Dileo, and Cassetta 2018). By providing new channels of information, marketing and sales, and by reducing distance and entry-related costs, DTs can contribute to overcoming the barriers facing SMEs as regards expanding into foreign markets. DTs may compensate for a weaker physical presence of SMEs compared to large firms on foreign markets as in the case of the so-called 'born-global firms' (Rebecca and Fischer 2011).

As already mentioned, empirical evidence collected so far reports mixed findings about the direct effects of DTs on firms' exporting activities (Ghalandari 2013). Many studies have specifically targeted e-commerce DTs, including websites, online sales plat-forms and social media (Gabrielsson and Manek Kirpalani 2004; Lichtenthal and Eliaz 2003; Mathews et al. 2016; Morgan-Thomas and Bridgewater 2004). Often focusing on multinationals and large firms, these studies generally provide evidence that online activities and use of DTs positively affect export sales (Bennett 1997; Bianchi and Mathews 2013). Mathews et al. (2016) pointed out that the positive impact of internet-based technologies and processes on export performance is widely acknowledged to such an extent that some scholars have been encouraged to introduce the neologism of *internetization*. This was first proposed within the context of international marketing practice and education (Bell et al. 2001), to describe their importance as the back bone of internationalisation (Etemad, Wilkinson, and Dana 2010). However, internet-based technologies should not be regarded as a strict substitute for the physical presence on foreign markets and/or the direct relationships with customers and suppliers (Yamin and Sinkovics 2006), but should to be evaluated in the light of a more comprehensive internationalisation strategy (Bennett 1997).

In line with these arguments, many studies drawing from the RBV and supply chain management literature agree that benefit from DTs is expected to be influenced by factors within the firm and its environment (Tippins and Sohi 2003; Soto-Acosta and Meroño-Cerdan 2009; Jin et al. 2014). More specifically, export behaviour and interna- tional sales growth critically depend on concomitant organisational changes and human capital capabilities with adequate skills to manage DTs (Bianchi and Mathews 2016; Bryan Jean 2007). Additional complementary investments in non-IT resources, the

integration of DTs and the reconfiguration of existing processes, the organisational structure of firms, and the level and type of skills are all factors capable of positively boosting the potential of DTs (Ashurst, Cragg, and Herring 2012; Brynjolfsson and Hitt 2000; Díaz-Chao, Sainz-González, and Torrent-Sellens 2015; Jones et al. 2014; Moen, Madsen, and Aspelund 2008), also influencing firms' ability to assimilate and use knowledge from the external environment (Cohen and Levinthal 1990). Thus, positive outcomes of using DTs may depend on the adoption of co-innovation strategies by firms (Brynjolfsson and Hitt 2003; Cardona, Kretschmer, and Strobel 2013; OECD 2016b; Spiezia 2012). Those strategies transform openly available DTs, which per se do not differentiate the firm from competitors, into unique capabilities that can generate superior performance over time (Fawcett et al. 2011).

This implies that costs of DTs adoption and integration go beyond the financial investment needed to purchase them (Lohrke 2006; Martens 2013; Morgan-Thomas and Jones 2009; Wright, Westhead, and Ucbasaran 2007). Indeed, apart from resource constraints, these factors are of particular importance when considering SMEs which are deemed to be unable to use the full potential of the new digital tools or even to understand the opportunities brought about by DTs (Taylor 2015; Hagsten and Kotnik 2017). Nevertheless, the specific internal context in which DTs are adopted by SMEs has often been ignored, failing to consider digital technology decisions as an integral part of business practices (Morgan-Thomas 2016; Chatzoglou and Chatzoudes 2016). SMEs often lack a proactive approach to DTs adoption that would trigger those organisational changes, which are crucial to effectively combining DTs tools with internal competencies and capabilities. Finally, tangible and intangible DTs investments in small companies may not be the result of an intentional strategic choice. It is more likely that they are the consequence of the particular form of inter-organisational technologies adopted by current and potential business partners to which it is necessary to comply in order to participate in global and regional value chains and so expand exporting activities (Sanders 2005; Jean, Sinkovics, and Tamer Cavusgil 2010).

1.2. Conceptual framework and research hypotheses

According to the previous background literature, we believe there is room to go further in empirically analysing the impact of DTs on the export propensity of SMEs, by exploring the effects of the exploitation of e-business DTs and their relationship with process and organisational innovations, as well as the upgrading of internal digitalskills.

The rise of networked production through global and regional value chains hasbrought out the role of e-business DTs, such as those enabling firms to share informationwith their suppliers, manufacturers, warehouses, distributors and retailers along thesupply chain, in improving the performance of both the individual firm and the supply chain as a whole. Diversity in the patterns of technology adoption and implementation across multiple DTs could thus influence SMEs' export behaviour on the grounds that different types of DTs may well have heterogeneous effects on internal and external integration of their business processes (Marinagi, Trivellas, and Sakas 2014; Bloom et al.2014; Ghalandari 2013).

So far, the empirical literature focused on SMEs has paid great attention to DTs related to e-commerce and e-marketing applications, such as websites (Bianchi and Mathews 2013; Daniel, Wilson, and Myers 2002; Morgan-Thomas 2016; SAban andRau 2005), online selling (T.-K. Liu et al. 2013; Peltier, Zhao, and Schibrowsky 2012; Pickernell et al. 2013), and social media (Kim, Lee, and Lee 2013). The overall aim of these studies is to investigate how and to what extent DTs directly contribute to increasing sales, including exports. Firms using websites for more advanced purposes and services, such as marketing and e-commerce, have been shown to have a greater propensity to export (Pickernell et al. 2016). Ghalandari (2013) shows that the positive relationship between DTs and firms' export performance varies depending on how DTs are used, with a higher impact on international markets and new market knowledge when DTs tools are employed for communication development instead of information search and sales activities. Focusing on online presence, online transactions, the proportion of broadband internet-enabled employees and IT-schooled human capital, Hagsten and Kotnik (2017) have recently found that websites are key elements in the decision of SMEs to export, whereas online sales are more important in terms of their export intensity.

To date, little evidence has been collected for e-business DTs, such as ERP, CRM, cloud computing, and other information-sharing services, despite these being increasingly regarded as highly suitable for small firms' internationalisation strategies (Oviatt and McDougall 2005; Rebecca and Fischer 2011; Ross and Blumenstein 2015; Tseng and Johnsen 2011). Especially small firms are seen to be unfamiliar with most DTs, with the exception of emails, websites, social media and software packages relating to order processing and accounting. There is still room for improvement in the adoption of e-business technologies such as SCM, supplier management, e-procurement and CRM (European Commission 2019).

Firm size continues to be one of the most significant drivers in explaining e-business adoption decisions (Chatzoglou and Chatzoudes 2016). However, most previous studies indicate that the mere adoption of e-business DTs does not necessarily guarantee better economic performances. The role of e-business DTs are rather different from e-commerce and e-marketing software as they potentially contribute to changing production and internal management processes as well as to supporting customer integration and supplier integration in the supply chain (Devaraj, Krajewski, and Wei 2007). However, within a context of increasing supply chain complexity, e-businessDTs make it possibile to rapidly deploy information and to reduce support infrastruc- ture needs, thus improving the capability of organisations to provide supply chainpartners with real-time information (Schniederjans and Hales 2016; Sanders 2007).From this perspective, the opportunity to serve international markets often requires the adoption of DTs which, in turn, are usually chosen by supply chain network leaders,thus requiring coordination and collaboration with their suppliers (Sanders 2005; Malhotra and Temponi 2010).

In line with the previous empirical findings, we test the following hypothesis:

H1: SMEs' export propensity is positively influenced by the adoption and implementation of e-business DTs, enabling firms to share information with business partners along the supply chain.

An explanation for divergent results in previous studies is the failure to take into account the underlying mediating factors whereby the adoption and the implementation of DTs relate to firm performance (Lucia-Palacios et al. 2014). Although e-business implementation may impact on export performance indirectly, very little work has been undertaken to identify variables that mediate this relationship (Popa, Soto-Acosta, and Perez-Gonzalez 2018).

Managerial and organisational studies on the impact of DTs on firms' economic performance have increasingly used the theoretical framework of the RBV to investigate the relations between technological resources and business performance. Most of the previous literature strongly agrees that the advantages of DTs can be leveraged as long as they are embedded in organisational practices and process, or implemented along with other complex unique resources within the firm (Bianchi and Mathews 2013; Wu et al. 2006). Organisational aspects may hinder or promote the adoption and the implementation of DTs (Tippins and Sohi 2003; Bryan Jean 2007). From a resource-based perspective, resources cannot be a source of competitive advantage by themselves (Barney 1991; Fawcett et al. 2011). As DTs become increasingly uniform and readily available for purchase, how single technologies interact with other capabilities and business process represents a key factor for explaining the potential to generate a sustained competitive advantage. Better firm performance may result from emerging complementarities among firm' resources and from the way firms integrate DTs into their organisational processes thus leveraging their resources and building unique competencies and capabilities (Soto-Acosta and Angel Luis 2008; Bhatt and Grover 2005).

Unique capabilities may also reside in the integration among resources across the whole supply chain, between the firm and its suppliers and customers. Investments in DTs are important resources which can enhance supply chain capabilities and achieve competitive advantage in international supply chain activities (Jin et al. 2014; Bryan Jean 2007). E-business use may thus contribute positively to organisational innovation by enabling efficient information sharing and business data analysis (Soto-Acosta, Popa, and Daniel 2015). In this respect, recent studies in knowledge management (Pérez-López and Alegre 2012) suggest that knowledge processes could also mediate the relationship between the DTs and the internationalisation of firms. The company's ability to effectively transform DTs into capabilities critically depends on human capital with adequate skills to develop, preserve and make use of them, including managerial skills and problem-solving skills, in addition to core technical skills (Soto-Acosta and Angel Luis 2008).

It can be argued that the need for concurrent internal changes is even more crucial for e-business DTs than software applications enabling firms to communicate both internally among various areas of the firm and externally with supply chain members. This is because the adoption and implementation of such changes in smaller firms require a detailed assessment of the connectedness between technological alternatives and specific business types, industries, or trading environment. In order to enable the integration of external business functions and improve their visibility (Yamin and Sinkovics 2007), firms must adopt DTs that are compatible with those implemented by supply chain partners. This clearly requires, especially in the international value chains, tangible and intangible investments to coordinate and integrate interdependent struc- tures able to enhance supply chain capabilities including information exchange, coordination and responsiveness (Wu et al. 2006; Jean, Sinkovics, and Tamer Cavusgil 2010). In

addition, when asymmetric interorganisational relationships are considered, the circumstance that SMEs could be forced to adopt certain software applications to engage in international relationships with large business partners makes it extremely important to fully exploit the DTs adopted, the complementary investments in non-IT resources, and the level and type of internal digital skills (Sanders 2005; Z. Liu, Prajogo, and Oke 2016; Bryan Jean 2007).

Based on the above, the following two hypotheses are thus addressed:

H2: E-business DTs have a positive impact on firms' export propensity when they are embedded within process and organisational innovations.

H3: Improving internal digital skills has a positive impact on the internationalisation of businesses when they are embedded within process and organisational innovations.

2. Empirical strategy

2.1. Data

The data used for our empirical research were obtained from the Si.Camera- Unioncamere (Italian Union of Chambers of Commerce) at the end of 2015. These data are drawn from the first accounting, industrial and export flow survey that includes coverage of diverse sectors. This dataset is a cross-sectional sample and covers 2,516 active Italian SMEs which are statistically representative of a total of 3,700,000 enterprises from all macro-economic sectors (agriculture, manufacturing and services) with at least one person employed.

The survey collects information on exports, digitalisation and innovation processes. The first part presents the structural features of the firms, such as business size, turnover, Italian geographical location at a macro-regional level (north-west, north-east, centre and south and islands), industrial sector and export propensity. The second part includes information on company performance, such as investment propensity and financial resources. The third section includes detailed information on innovation processes with a special focus on individual types: product, process and organisational, and marketing. The final section reports data on the different forms of digitalisation, includ- ing e-commerce DTs (websites, online selling and social networks), e-business DTs (sharing information via the internet with suppliers and uses of cloud computing) and digital skills (such as training to improve digital and ICT skills).

2.2. Description of variables

The dependent variable refers to the firm's presence in foreign markets. In line with Hagsten and Kotnik (2017) and Pickernell et al. (2016), we consider a dummy variable which takes a value of 1 = if the firm exports and 0 = if the firms do not export.

Regarding the independent variables, we included several covariates. Like many scholars (Bianchi and Mathews 2013, 2016; Hagsten and Kotnik 2017; Bianchi andMathews 2016), we also include website usage and online selling activities. In line with Hagsten and Kotnik (2017), we compute dummy variables with 1 = if the firm has

a website and 0 = it does not and, for online selling, which uses value 1 = if the firm uses e-commerce and 0 = it does not.

In order to test the effect of DTs on supply chain management (Liu, Prajogo, and Oke 2016; Kim, Cavusgil, and Calantone 2006), we include a dummy variable with 1 = if the firm shares information through the Internet with its own suppliers and 0 = if it does not. Finally, since the literature considers other typologies of DTs such as social media (Kim, Lee, and Lee 2013) and cloud-based ICT services (Ross and Blumenstein 2015), we have taken into account a dummy variable which refers to whether the firm uses social media and another dummy variable relating to whether or not the firm uses cloud computing.

Furthermore, to grasp the impact of skills needed for the adoption of new technologies (Bengtsson, Boter, and Vanyushyn 2007; Bianchi and Mathews 2016), we include a variable using value 1 = if the firm has employed people with ICT competencies and 0 = no ICT competencies[1] Also, we added another dummy variable (digital training) which approximates for the effect of ICT employees' skills retraining on the firm's export propensity. To evaluate the relationship between internationalisation and innovation (Basile 2001; Love and Roper 2015; Nassimbeni 2001; Añón Higón and Driffield 2011) we introduced three variables: if the firm has carried out product innovation; if the firm has introduced organisation and business process changes; and if the firm has implemented marketing innovation. In line with Añón Higón and Driffield (2011), these are dichotomous variables.

Finally, we verify firm's characteristics such as location (north-west, north-east, centre, south and islands) and, in line with D'Angelo (2012), size (1–9, 10–49 and 50–249 employees), and economic sector (Lopez Rodriguez and Garcia Rodriguez 2005; Cavusgil and Zou 1994; Harris and Li 2009).

2.3. Descriptive statistics

Following the aims of the paper, we use variables that are typically found to affect export behaviour plus other specific variables. These variables include digital and innovation variables and some controls including a set of firms' characteristics. The list of covariates also considers a set of industry dummies, which enabled us to account for the omission of sector-specific characteristics that might bias our parameter estimates.

Among the available output measures, we followed the innovation-internationalisation literature (Lachenmaier and Ludger 2006) in selecting product and organisational changes implemented by firms, and distinguished between the two types because they are presumed to have a different impact on export propensity. We also added another form of innovation: marketing innovation.

The variables and their descriptions are summarised in Table 1. All variables are qualitative in nature. The dependent variable, e-business DTs, e-commerce DTs, digital skills and all forms of innovation are binary variables. While the business size and turnover variables are ordinal qualitative variables the rest of the firms' characteristics are nominal qualitative variables.

[1]Accordingly, Hagsten and Kotnik (2017) estimated the proportion of post-upper secondary ICT-educated employees in addition to the Non-ICT educated ones..

Table 1. Description of variables and their domains.

Variables	Description
	Dependent variable
Export	Propensity to export is defined as whether or not a firm exports onto foreign markets in 2015 (yes = 1, *no* = *0*)
Independent variables	
	e-commerce DTs
Website	whether the firm uses a website that provides information about the company/products and to raising awareness of own company to potential customers (yes = 1, *no* = 0)
Online selling	whether the firm uses e-commerce procedures to sell products and services (yes = 1, *no* = 0)
Social network	whether the firm uses a social network or social media (yes = 1, *no* = 0)
	e-business DTs
Electronic sharing	whether a firm shares through internet with own suppliers information on supply chain management (yes = 1, *no* = 0)
Cloud computing	whether the firm uses cloud computing (yes = 1, no = 0)
	Digital skills
Digital training	whether the firm organises training courses to upgrade and develop digital skills of employed (yes = 1, *no* = 0)
ICT skills	ICT competencies in scientific and technical subjects (engineers, designers, marketing technicians, ICT specialists) (yes = 1, *no* = 0)
	Innovation
Product innovation	whether the firm introduced some product innovation in the last three years (2012–2014)(yes = 1, *no* = 0)
Process and organisational innovation	whether the firm introduced some process and organisational innovation in the last three years (2012–2014) (yes = 1, *no* = 0)
Marketing innovation	whether the business introduced any marketing innovation in the last three years (2012–2014) (yes = 1, *no* = 0)
	Firm characteristics
Business size	Firm size broken down into size-bands (*micro* = 1–9, small = 10–49, medium = 50–249 employees)
Geographical location	Geographical location of firm (North-West = 1, North-East = 2, Centre = 3, *South and islands* = 4)
Turnover	Firm's turnover between 2014 and 2015 (*decreased* = 1, constant = 2, increased = 3)
Industrial sector	Sector of activity (Primary sector = 1, manufacturing = 2, construction = 3, trade = 4, *hotels & restaurant* = 5, other services = 6)

Source: own elaboration.

Table 2 presents the proportions with their standard errors and 95% confidenceintervals for all firms, and separately for exporting and non-exporting firms.

Our statistics show that a website dominates among exporting firms (87.1%) and its proportion is twice that for all firms (45.7%) and non-exporting (40.1%) firms. Only 9.9% of exporting firms use e-commerce (online selling) in their business, which isa very small percentage, but more than three times above that of all firms and non- exporting firms.

Table 3 highlights the statistical relationship between the dependent variable (export), digital variables, innovation variables and ICT skills. Overall, the proposed relationships were found to be statistically significant at a .01 level with only two exceptions. Correlations ranged from .02 to .39. A moderate positive correlation was found between social networks and websites ($r = 0.39$, p-value<0.01) and between product innovation and process and organisational innovation ($r = 0.35$, p-value<0.01). Similarly, a positive correlation emerged between sharing information through the Internet with the firm's own suppliers and the website ($r = 0.34$, p-value<0.01).

Table 2. Descriptive statistics for all firms, exporting firms and non-exporting firms.

	All firms			Exporting firms			Non-exporting firms		
Digital variables	Proportion	95% CI		Proportion	95% CI		Proportion	95% CI	
Web site									
No	54.3 (0.99)	52.3	56.2	12.9 (1.93)	9.5	17.2	59.9 (1.04)	57.9	61.9
Yes	45.7 (0.99)	43.8	47.7	87.1 (1.93)	82.8	90.5	40.1 (1.04)	38.1	42.1
Online selling									
No	96.8 (0.35)	96.0	97.4	90.1 (1.72)	86.2	93.0	97.7 (0.32)	97.0	98.2
Yes	3.2 (0.35	2.6	4.0	9.9 (1.72)	7.0	13.8	2.3 (0.32)	1.8	3.0
Social Network									
No	79.8 (0.80)	78.2	81.3	67.7 (2.69)	62.2	72.7	81.5 (0.83)	79.8	83.0
Yes	20.2 (0.80)	18.7	21.8	32.3 (2.69)	27.3	37.8	18.5 (0.83)	17.0	20.2
Electronic sharing									
No	48.6 (1.00)	46.7	50.6	32.3 (2.69)	27.3	37.8	50.8 (1.06)	48.8	52.9
Yes	51.4 (1.00)	49.4	53.3	67.7 (2.69)	62.2	72.7	49.2 (1.06)	47.1	51.2
Cloud computing									
No	98.0 (0.28)	97.3	98.5	93.4 (1.43)	90.0	95.7	98.6 (0.25)	98.0	99.0
Yes	2.0 (0.28)	1.5	2.7	6.6 (1.43)	4.3	10.0	1.4 (0.25)	1.0	2.0
Digital Training									
No	98.0 (0.28)	97.3	98.5	93.1 (1.46)	89.6	95.4	98.6 (0.25)	98.1	99.1
Yes	2.0 (0.28)	1.5	2.7	6.9 (1.46)	4.6	10.4	13.6 (0.25)	0.9	1.9
ICT skills									
No	88.0 (0.65)	86.7	89.2	73.3 (2.55)	68.0	78.0	90.1 (0.64)	88.7	91.2
Yes	12.0 (0.65)	10.8	13.3	26.7 (2.55)	22.0	32.0	9.9 (0.64)	8.8	11.3
Innovation									
Product Innovation									
No	86.4 (0.68)	85.0	87.7	60.7 (2.81)	55.1	66.1	89.9 (0.64)	88.6	91.1
Yes	13.6 (0.68)	12.3	15.0	39.3 (2.81)	33.9	44.9	10.1 (0.64)	8.9	11.4
Process and organizational innovation									
No	79.3 (0.81)	77.7	80.9	52.5 (2.88)	46.8	58.1	83.0 (0.80)	81.4	84.5
Yes	20.7 (0.81)	19.1	22.2	47.5 (2.87)	41.9	53.2	17.0 (0.80)	15.4	18.6
Marketing Innovation									
No	93.7 (0.49)	92.7	94.6	84.5 (2.08)	79.9	88.2	94.9 (0.47)	93.9	95.8
Yes	6.2 (0.49)	5.4	7.3	15.5 (2.08)	11.8	20.1	5.1 (0.47)	4.2	6.1
Business size									
Micro	68.1 (0.93)	66.3	69.9	24.8 (2.48)	20.2	30.0	74.1 (0.93)	72.2	75.8
Small	18.9 (0.78)	17.4	20.5	38.0 (2.79)	32.6	43.6	16.3 (0.79)	14.8	17.9
Medium	13.0 (0.67)	11.7	14.3	37.2 (2.78)	38.0	42.3	9.6 (0.63)	8.5	10.9
Geographical location									
North-West	21.8 (0.82)	20.2	23.5	36.3 (2.77)	31.1	41.9	19.8 (0.85)	18.2	21.6
North-East	21.2 (0.81)	19.6	22.8	27.1 (2.56)	22.3	32.4	20.4 (0.86)	18.8	22.1
Centre	25.1 (0.86)	23.4	26.8	20.1 (2.31)	16.0	25.1	25.8 (0.93)	24.0	27.6
South and Island	31.9 (0.93)	30.1	33.8	16.5 (2.14)	12.7	21.1	34.0 (1.00)	32.1	36.0
Turnover									
Decreased	33.0 (0.94)	31.2	34.9	19.1 (2.26)	15.1	24.0	34.9 (1.01)	33.0	36.9
Constant	48.9 (1.00)	46.9	50.8	38.6 (2.80)	33.3	44.3	50.3 (1.06)	48.2	52.4
Increased	18.1 (0.77)	16.6	19.6	42.2 (2.84)	36.8	47.9	14.8 (0.75)	13.4	16.3
Industrial sector									
Primary Sector	8.3 (0.55)	7.3	9.5	8.3 (1.58)	5.6	11.9	8.3 (0.59)	7.2	9.5
Manufacturing	22.8 (0.84)	21.2	24.5	59.7 (2.82)	54.1	65.1	17.7 (0.81)	16.2	19.4
Construction	14.9 (0.71)	13.5	16.3	5.9 (1.36)	3.8	9.3	16.1 (0.78)	14.6	17.7
Trade	19.1 (0.78)	17.6	20.7	19.8 (2.29)	15.7	24.7	19.0 (0.83)	17.4	20.7
Hotel & Restaurant	14.9 (0.71)	13.6	16.4	0.3 (0.03)	0.0	23.3	16.9 (0.80)	15.4	18.5
Other services	20.1 (0.80)	18.6	21.7	5.9 (1.36)	3.8	9.3	22.0 (0.88)	20.3	23.8

Source: own calculation. Note: standard error of proportion is between parentheses. 95% CI denotes 95% confidence interval for a proportion.

Table 3. Correlation matrix. Export, digital technologies and innovation variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Export	1.000										
2. Website	.31	1.000									
3. Online selling	.14	.17	1.000								
4. Social network	.11	.39	.15	1.000							
5. Digital training	.13	.12	.05	.08	1.000						
6. Electronic sharing	.12	.34	.02	.12	.06	1.000					
7. Cloud computing	.12	.14	.18	.14	.22	.08	1.000				
8. ICT skills	.17	.22	.11	.12	.21	.16	.17	1.000			
9. Product innovation	.28	.21	.06	.15	.07	.11	.07	.15	1.000		
10. Process and organisational innovation	.25	.24	.08	.12	.14	.15	.12	.22	.35	1.000	
11. Marketing innovation	.14	.17	.08	.10	.03	.05	.05	.14	.16	.16	1.000

Source: own calculation.

2.4. Estimation methodology

The aim of this paper is to assess the impact that the activities and characteristics of SMEs in Italy have on a firm's propensity to export. Since the dependent variable, export, has only values 1 and 0 (whether or not a firm exports), limited dependent variable models, and more specifically, probit models were used, as explained in the introduction. Probit models are non-linear models focusing on the response probability:

$$P(EXPORT = 1 | x) = \Phi(\beta_0 + x\beta^0) \quad (1)$$

where x is a vector containing observations for the following 14 variables: website, online selling, social networks among e-commerce DTs, electronic sharing and cloud computing among e-business DTs, digital training and ICT skills among digital skills; innovation (product innovation, process and organisational innovation, marketing innovation) and firms' characteristics (business size, geographical location, turnover, industrial sector). Φ is a standard normal cumulative function which takes values strictly between zero and one for all parameter values and independent variables, and $\beta_0 + x\beta^0$ is a linear function of independent variables; vector $\beta^0 = \beta_1; \beta_2; \ldots ; \beta_{15}{}^0$ contains 14 coefficients in thelinear function.

The probit model summary statistics are used to assess the quality of the estimated probit model. Log likelihood is used in the likelihood ratio Chi-square test (LR $chi^2(.)$) to determine whether all independent variable regression coeffi- cients in the probit model are simultaneously zero. The number in parentheses indicates the degree of freedom of the Chi-square distribution used to test the LR Chi-square statistic and is defined by the number of independent variables in the model. Prob>chi^2 is the p-value, i.e. the probability of getting a LR test statistic as extreme as, or more so, than the observed statistic under the null hypothesis (all the regression coefficients are simultaneously equal to zero). In an attempt to measurethe strength of association in a probit regression model, various R^2 − like measureswere proposed. Stata reports Pseudo R^2 which is McFadden's pseudo R^2. It shouldbe used and interpreted with great caution because this statistic does not have the same meaning as R^2 in the OLS regression.

Stata version 13 was used for all estimations in this paper. Since the probit model is non-linear model, it cannot be estimated using OLS/WLS (i.e. ordinary or weighted

least squares). Instead, the maximum likelihood estimation method was used. While in linear regression model coefficients are marginal effects, this is not the case in probit models. In probit models, $y = \beta_0 + x\beta + \varepsilon$, finding marginal effects is not as straightfor-ward as in linear regression models, because we need to calculate the slope of x within the function $\Phi(\cdot)$. We did not directly use estimated coefficients of a probit model because in empirical economic research the marginal effects are more intuitive and easier to interpret and understand. Marginal effects in probit models give a single number that expresses the effect of a variable on the probability that the firm will export its products and services. Marginal effects often provide a good approximation of the amount of change in the export propensity that will be generated by a 1-unit change in the independent variables.

Therefore, after estimating the probit model, we used it to find the marginal effects. This is a two-step process where we first estimate the probit model, and then use it to calculate the marginal effects of independent variables on the propensity to export, i.e. the probability that the firm will export to foreign markets, $P(Export = 1) = \Phi(\cdot)$.

There are various marginal effects we can calculate to estimate the probit model. We used the *marginal effects at the means*. This means that when calculating the marginal effects, the independent variables in the probit models are kept at their mean values. Clearly, any conclusion regarding causality is limited by the cross-sectional nature of the data. The study design, though appropriate for detecting structural associations, does not focus on the direction of causality.

3. Results

One way to assess the robustness of the results is to specify alternative probit models and calculate the marginal effects based on these alternative specifications. These alternative probit models and their marginal effects are presented in Table 4. According to the LR chi-square test statistic, all models in Table 4 have jointly significant coefficients. As an approximate measure of the strength of association, Pseudo R^2 indicates that Model 5 fits the data better than the other four models.

On the basis of the empirical findings, the regressors are expected to be positive. The use of a website showed positive and significant marginal effects (p-value<0.01), in line with Hagsten (2015), Hagsten and Kotnik (2017), and Pickernell et al. (2016). Thus, if the firm uses a website, the marginal effect slightly decreases from 5.4% to 4.7% when we include all the e-business DTs and innovation variables together (Model 1 to Model 5).

Online selling showed marginal positive effects and was statistically significant at 1% in all the specifications considered. This is in line with Hagsten (2015), although the author also focused on large firms, whereas Hagsten and Kotnik (2017) did not find any significance. Finally, Pickernell et al. (2016), testing the impact of the website for selling/buying (thus relating to e-commerce) found a significance of between 5% and 10%.

ICT skills show positive and significant marginal effects at 1% also in Models 2 and 3 of Table 4. This is in line with the results obtained by Hagsten and Kotnik (2017), where the variable of accounting for the proportion of post-upper secondary ICT-educated employees was used. ICT skills are not statistically significant only in model 5, i.e. when innovation variables are included.

Table 4. Results from binary probit models and marginal effects at means.

Variables	Model 1	dy/dx (1)	Model 2	dy/dx (2)	Model 3	dy/dx (3)	Model 4	dy/dx (4)	Model 5	dy/dx (5)
e-commerce DTs										
Web site	0.828*** (0.105)	0.054*** (0.009)					0.816*** (0.109)	0.052*** (0.009)	0.742*** (0.110)	0.047*** (0.009)
Online selling	0.508*** (0.171)	0.033*** (0.011)					0.513*** (0.172)	0.033*** (0.011)	0.508*** (0.176)	0.032*** (0.012)
Social Network	0.084 (0.100)	0.005 (0.006)					0.080 (0.101)	0.005 (0.006)	0.056 (0.104)	0.004 (0.007)
e-business DTs Electronic sharing										
Cloud computing					0.177** (0.085)	0.014** (0.007)	0.034 (0.092)	0.002 (0.005)	0.005 (0.094)	0.000 (0.006)
					0.310 (0.216)	0.025 (0.018)	0.039 (0.221)	0.002 (0.014)	0.044 (0.226)	0.003 (0.014)
Digital Skills										
Digital training			0.410* (0.230)	0.034* (0.019)			0.351 (0.233)	0.022 (0.015)	0.325 (0.233)	0.021 (0.015)
ICTskills	0.275** (0.108)	0.018** (0.007)	0.378*** (0.108)	0.032*** (0.009)	0.371*** (0.106)	0.030*** (0.009)	0.231** (0.112)	0.015** (0.007)	0.142 (0.116)	0.009 (0.007)
INNOVATION										
Product Innovation									0.488*** (0.106)	0.031*** (0.008)
Process and organizational innovation									0.194** (0.100)	0.012** (0.007)
Marketing Innovation									0.173 (0.147)	0.011 (0.009)
Business size										
Micro										
Small	0.621*** (0.102)	0.048*** (0.011)	0.781*** (0.097)	0.080*** (0.015)	0.757*** (0.097)	0.076*** (0.014)	0.614*** (0.102)	0.047*** (0.011)	0.553*** (0.105)	0.040*** (0.011)
Medium	0.934*** (0.113)	0.097*** (0.020)	1.176*** (0.107)	0.168*** (0.025)	1.165*** (0.108)	0.164*** (0.025)	0.911*** (0.114)	0.093*** (0.019)	0.870*** (0.117)	0.087*** (0.019)
Geographical location										
South and Islands										
North-West	0.509*** (0.118)	0.035*** (0.010)	0.562*** (0.113)	0.051*** (0.012)	0.576*** (0.113)	0.052*** (0.012)	0.507*** (0.118)	0.035*** (0.010)	0.502*** (0.120)	0.035*** (0.010)
North-East	0.329*** (0.123)	0.019*** (0.008)	0.366*** (0.117)	0.027*** (0.009)	0.373*** (0.118)	0.027*** (0.009)	0.327*** (0.124)	0.018** (0.007)	0.311** (0.126)	0.018** (0.008)
Centre	0.211* (0.125)	0.010 (0.006)	0.215* (0.119)	0.014* (0.008)	0.212* (0.120)	0.013* (0.007)	0.210* (0.126)	0.010 (0.006)	0.153 (0.129)	0.007 (0.006)
Turnover										
Decreased										
Constant	0.008 (0.107)	0.000 (0.006)	0.043 (0.102)	0.003 (0.007)	0.062 (0.103)	0.004 (0.007)	0.011 (0.108)	0.000 (0.006)	-0.014 (0.110)	-0.001 (0.006)
Increased	0.419*** (0.117)	0.035*** (0.011)	0.542*** (0.113)	0.060*** (0.015)	0.530*** (0.113)	0.057*** (0.014)	0.432*** (0.118)	0.036*** (0.011)	0.305** (0.123)	0.024** (0.011)

(*Continued*)

Table 4. (Continued).

Variables	Model 1	dy/dx (1)	Model 2	dy/dx (2)	Model 3	dy/dx (3)	Model 4	dy/dx (4)	Model 5	dy/dx (5)
Industrial Sectors										
Hotel & Restaurants										
Primary sector	2.429*** (0.406)	0.125*** (0.026)	2.138*** (0.400)	0.116*** (0.024)	2.142*** (0.402)	0.115*** (0.024)	2.449*** (0.411)	0.125*** (0.027)	2.383*** (0.424)	0.109*** (0.025)
Manufacturing	2.672*** (0.386)	0.182*** (0.018)	2.538*** (0.382)	0.214*** (0.019)	2.535*** (0.385)	0.210*** (0.018)	2.688*** (0.391)	0.181*** (0.018)	2.669*** (0.404)	0.173*** (0.019)
Construction	1.410*** (0.401)	0.014*** (0.005)	1.326*** (0.398)	0.022*** (0.007)	1.319*** (0.401)	0.021*** (0.006)	1.424*** (0.406)	0.014*** (0.005)	1.470*** (0.420)	0.016*** (0.006)
Trade	2.044*** (0.390)	0.062*** (0.011)	1.922*** (0.386)	0.079*** (0.012)	1.917*** (0.389)	0.077*** (0.012)	2.067*** (0.394)	0.062*** (0.011)	2.092*** (0.407)	0.064*** (0.012)
Other services	1.330*** (0.399)	0.012*** (0.004)	1.235*** (0.395)	0.017*** (0.005)	1.251*** (0.398)	0.018*** (0.005)	1.343*** (0.404)	0.011*** (0.004)	1.352*** (0.417)	0.012*** (0.004)
Constant	-4.576*** (0.411)		-4.055*** (0.230)		-4.159*** (0.408)		-4.609***(0.420)		-4.603***(0.431)	
Observations	2516	2,516	2,516	2,516	2,516	2,516	2,516	2,516	2,516	2,516
LR chi^2	724.09		634.31		637.85		726.71		761.07	
Log Likelihood	-563.28		-608.17		-606.4		-561.97		-544.8	
Prob> chi^2	0		0		0		0		0	
Pseudo R^2	0.391		0.342		0.344		0.392		0.411	

Source: Own calculation. Standard error in brackets. *** p < 0.01, **p < 0.05, *p < 0.10.

Focusing on e-business DTs (Models 3, 4 and 5), sharing electronic information with suppliers (electronic sharing) is significant at 5% only in the model that did not include other digitalisation variables (Model 3), with a low marginal effect (1.4%) in comparison to those of other types of DTs present in the various models.

In addition, the use of cloud computing was found not to be statistically significant in all models. This is in contrast with Ross and Blumenstein (2015), who underlined the positive relationship between cloud technologies and international entrepreneurial orientation. Both innovations (product innovation, and process and organisational innovation) were found to be statistically significant at the 1% and 5% levels, respectively. In line with Añón Higón and Driffield (2011), product innovation showed the greatest positive effect among determinants affecting propensity to export. This outcome sup- ports the idea according to which human capital is important for the internationalisation of SMEs (Moen, Madsen, and Aspelund 2008).

Thus, these results do not confirm to the first hypothesis regarding the positive influences of the adoption of e-business *DTs on firm export propensity.*

When we introduce interaction effects (Table 5) some interesting results arise. Interaction terms are used extensively in nonlinear models, such as probit models, in order to infer how the effect of the independent variable on the dependent variable depends on the magnitude of another regressor. More specifically, we ran interactions between process and organisational innovation with electronic, social network ad ICT skills to approximate the embeddedness effect of DTs on export propensity.

Results show that when the interaction between electronic sharing and process and organisational innovations is included, the probability of a firm exporting increases by 1.7% at $p < 0.01$ (Model 1). This corroborates findings of other studies (Bianchi and Mathews 2016, 2013; OECD 2016b; Wu et al. 2006), which pointed out the positive effect of the integration between DTs and organisational innovations on firms' competitiveness.

Furthermore, when we run interaction between ICT skills and process and organisational innovations (Model 3), the coefficients are positive and statistically significant. These results are in line with those obtained by Bengtsson, Boter, and Vanyushyn (2007) and Bianchi and Mathews (2016) related to the need to integrate appropriate digital skills to organisational strategies to support a firm's competitiveness.

These results confirm the second and third hypotheses. E-business DTs and digital skills have a positive impact on firm export propensity when they are embedded in processes and organisational innovations.

As regards control variables, if the firm belongs to a medium-sized business, the probability of being involved in foreign markets increased from 8.7% to 16.8%, depending on the probit model (Table 4). All these marginal effects were statistically significant at the 1% significant level. Access to a specific location is essential to increase a firm's ability to export (Freeman and Styles 2014), especially when the company is located in the north-west of Italy.

The positive sign of the turnover variable indicates that if a firm has grown sufficiently over time, the likelihood of exporting will also increase. All these marginal effects were statistically significant at the 1% level in the first four models and at the 5% level in the last model (Table 4).

Regarding the sector of activity, manufacturing showed the highest propensity for export compared with other sectors. However, marginal effects for manufacturing were

Table 5. Binary probit models with marginal effects at means and interaction effects.

Variables	Model 1	dy/dx (1)	Model 2	dy/dx (2)	Model 3	dy/dx (3)
e-commerce DTs						
Web site	0.799*** (0.107)	0.052*** (0.009)	0.803*** (0.106)	0.052*** (0.009)	0.814*** (0.109)	0.053*** (0.010)
Online selling	0.533*** (0.173)	0.034*** (0.012)	0.517*** (0.172)	0.033*** (0.012)	0.529*** (0.173)	0.034*** (0.012)
Social Network	0.091 (0.102)	0.006 (0.006)			0.089 (0.102)	0.006 (0.007)
e-business DTs						
Electronic sharing			0.045 (0.093)	0.003 (0.006)	0.043 (0.092)	0.003 (0.006)
Cloud computing	-0.007 (0.224)	-0.000 (0.014)	-0.004 (0.223)	-0.000 (0.014)	0.005 (0.225)	0.000 (0.015)
Digital Skills						
Digital training	0.336 (0.235)	0.022 (0.015)	0.336 (0.235)	0.022 (0.015)	0.304 (0.239)	0.020 (0.016)
ICTskills	0.194* (0.114)	0.013* (0.008)	0.218** (0.113)	0.014* (0.008)		
INNOVATION						
Process and organizational innovation X Electronic	0.270*** (0.106)	0.017*** (0.007)				
Process and organizational innovation X Social Network			0.344** (0.147)	0.022** (0.010)		
Process and organizational innovation X ICT skills						
					0.387*** (0.149)	0.025*** (0.010)
Business size						
Micro						
Small	0.602*** (0.103)	0.046*** (0.011)	0.609*** (0.103)	0.047*** (0.012)	0.616*** (0.103)	0.048*** (0.012)
Medium	0.885*** (0.116)	0.089*** (0.019)	0.904*** (0.115)	0.092*** (0.020)	0.898*** (0.115)	0.091*** (0.020)
Geographical location						
South and Islands						
North-West	0.512*** (0.119)	0.035*** (0.010)	0.517*** (0.119)	0.036*** (0.010)	0.500*** (0.119)	0.035*** (0.010)
North-East	0.340*** (0.124)	0.020** (0.008)	0.327*** (0.124)	0.019** (0.008)	0.321*** (0.124)	0.019** (0.008)
Centre	0.201 (0.127)	0.010 (0.007)	0.214* (0.126)	0.011 (0.007)	0.202 (0.126)	0.010 (0.007)
Turnover						
Decreased						

(*Continued*)

Table 5. (Continued).

Variables	Model 1	dy/dx (1)	Model 2	dy/dx (2)	Model 3	dy/dx (3)
Constant	0.007 (0.108)	0.000 (0.006)	0.011 (0.109)	0.001 (0.006)	0.008 (0.109)	0.000 (0.006)
Increased	0.395*** (0.120)	0.033*** (0.011)	0.408*** (0.119)	0.034*** (0.011)	0.420*** (0.119)	0.035*** (0.012)
Industrial Sectors						
Hotel & Restaurants						
Primary sector	2.432*** (0.409)	0.121*** (0.027)	2.475*** (0.415)	0.126*** (0.027)	2.460*** (0.414)	0.124*** (0.027)
Manufacturing	2.687*** (0.389)	0.180*** (0.019)	2.715*** (0.395)	0.182*** (0.019)	2.701*** (0.394)	0.180*** (0.019)
Construction	1.437*** (0.404)	0.015*** (0.005)	1.453*** (0.411)	0.015*** (0.005)	1.455*** (0.410)	0.015*** (0.006)
Trade	2.076*** (0.392)	0.063*** (0.012)	2.091*** (0.399)	0.063*** (0.012)	2.096*** (0.398)	0.064*** (0.012)
Other services	1.343*** (0.402)	0.012*** (0.004)	1.368*** (0.408)	0.012*** (0.004)	1.368*** (0.407)	0.012*** (0.004)
Constant	-4.606*** (0.414)		-4.630*** (0.424)		-4.613*** (0.423)	
Observations	2,516	2,516	2,516	2,516	2,516	2,516
LR chi^2	732.96		731.53		729.23	
Log Likelihood	-558.85		-559.57		-560.72	
Prob> chi^2	0		0		0	
Pseudo R^2	0.396		0.395		0.394	

Source: Own calculation. Standard error in brackets. *** p < 0.01, **p < 0.05, *p < 0.10.

increasingly lower when the digital variables were included in the model. The statistical significance of the manufacturing industry in explaining a firm's presence in foreign markets was also reported in Pickernell et al. (2016).

We conducted some simple robustness tests using probit models which also included the export propensity regressions. These included other variables such as proxies of public investments, the credit crunch, legal form of the firm, and the ratio of people witha higher educational qualification out of the total number of employees, etc. Nevertheless,these variables were not significant, suggesting that there is no clear evidence of strong positive and negative effects on export propensity.

4. Discussion and policy implications

Our findings focused on the impact of DTs on a firm's export propensity, distin- guishing between e-commerce DTs and e-business DTs (Morgan-Thomas 2009; Sinkovics, Sinkovics, and Bryan Jean 2013; Loane 2005). In line with Hagsten and Kotnik (2017), Pickernell et al. (2016) and Hagsten (2015) we observed the positive role of e-commerce DTs, particularly the website. Additionally, online selling is another important determinant of export propensity. According to Bianchi and Mathews (2013) and Freund and Weinhold (2004), by using a website and onlineselling, firms may increase their sales to international markets with small capital investments, also being able to rapidly identify new customers, suppliers and partners worldwide. Finally, with a web-based operational strategy and e-commerce, SMEs can facilitate a reduction in operational costs, including transaction costs aswell as any other overhead costs as the use of these two forms of DTs do not requirea particular physical location for the firm. This is of fundamental importance especially for SMEs, which operate and grow with financial constraints.

Further, social networking is likely to be crucial in terms of rapidity and flexibility for the implementation of an internationalisation strategy. However, although it may seem intuitive that internationally active entrepreneurs rely on interpersonal linkages andsocial interactions to obtain the particular advantages arising from knowledge acquisitionand transfer regarding potential market opportunities, the role of social networks in stimulating the propensity to export for SMEs still remains inconclusive (from Table 4 to Table 5).

Besides confirming the positive role of internet-based technologies already investi- gated in the current literature, our results show that also e-business DTs may play a role in explaining small firms' exporting activities. Global and regional value chains are increasingly relying on DTs to improve flexibilities in manufacturers' supply chains, reduce cycle time, and deliver products to customers manner promptly (Jin et al. 2014). As a result, especially SMEs are increasingly being forced to reconsider how they can take advantage of the adoption and implementation of DTs. As markets become increasingly international and competitive, SMEs should find new ways and organisational strategies to advance their capability to compete and find new strategies for their expansion, so how to use in the best way possible their specific characteristics, including competencies and skills. Thus, especially for the use of different forms of e-business DTs, new strategies claim for the incorporation of techniques and digital practices within the organisational context of a firm.

Leveraging the full potential of DTs requires the alignment of specific IT applications with the firm's organisational competitive priorities and strategic objectives as well as with those of their supply chain partners in order to improve production planning, inventory management, order scheduling, and customer relationship management (Bryan Jean 2007; Sanders 2005; Marinagi, Trivellas, and Sakas 2014).

Among e-business DTs, we have shown that DTs enabling the sharing of information within the supply chain has a more significant effect on a firm's decision to export when they are incorporated within in a context of internal innovative organisational changes (Table 5). Indeed, as observed by Tippins and Sohi (2003), Spiezia (2012) and Yoo et al. (2012), e-business DTs may contribute to improving firms' performance when they are embedded in an organisation innovation through complementary and co-specialisation processes. This means that once advanced DTs have been considered to be internally related processes of transformation and absorption by firms, these technologies can spread their effects and foster openness to internationalisation. DTs must be cross- functional and need formal compliance across functions and new technology. Thisprocess also includes suitable and specific capabilities to obtain higher productivity and rapidity for better positioning in terms of international competitiveness (OECD 2014; Yoo et al. 2012), also because they are capable of leveraging other complementary resources (Tippins and Sohi 2003). Achieving higher levels of IT competencies enables better management of the 'invisible assets' for reaching market leadership.

From a policy perspective, our findings highlight that efforts should not be limited to simply promoting technological opportunities, but also to stimulate the use of DTs and enhance digital skills and capabilities. The effectiveness of current approaches for SMEs has been recently criticised on the grounds that they fail tolook at digital technology decisions as an integral part of business practices and to take into account heterogeneity among firms, organisations and sectors (Morgan- Thomas 2016; OECD 2015; 2016a). As emerged in a recent survey on SMEs (European Commission 2016), the main reason for not adopting basic DTs is related to the perceived inappropriateness with firms' business models. This could partly explain the low rate of adoption of new services, such as globally accessible cloud computing and online marketing platforms, even though they can significantly reduce capital expenditure, transaction costs and most of the barriers faced by SMEs (OECD 2014; World Economic Forum 2016).

Governments could thus improve their policies in at least three directions: strengthening the 'digital awareness' among SMEs by highlighting the benefits of DTs for upgrading competitiveness; promoting complementary investments in non-ICT resources and organisational changes, also targeting industrial specialisation and their relative export potential (Bianchi and Mathews 2016; Bryan Jean 2007) and by encoura-ging training courses to improve workers' digital skills (OECD 2016a).

5. Concluding remarks

different DTs interact with organisational processes and other firm' Digitalisation and internationalisation are widely recognised as two key success factors of firms. This study builds on the recent stream of empirical research, which draws on RBV to explore how resources and capabilities and thus impact on business performance. Nevertheless, our

approach differs from the literature methodologically, as it focuses on the phenomenon of digitalisation considering simultaneously e-commerce and e-business DTs, as well as investments in digital skills.

Focusing on digitalisation and internationalisation at the level of Italian SMEs, our analysis confirms previous evidence, particularly concerning the relationship between propensity to export and the use of some digital tools such as websites, internet and e-commerce. Most importantly, the empirical results emphasise the potential role of firms' characteristics, but also the importance of the internal context of a firm in promoting the internationalisation of SMEs through the adop- tion of DTs. These findings add to the ongoing debate about the unclear effects ofDTs on business performance. Apart from the role-played by the level of intensity of product innovations, embeddedness forms of innovation organisation may be the strength point upgrading micro-processes in a supply-chain perspective, as they, in turn, may improve information exchange coordination and responsiveness, thus leading to superior firm performance in international markets. Furthermore, embed- ding innovation methods within the organisation may effectively stimulate firms to internalise and leverage employees' knowledge and skills for further technological upgrading processes.

This is consistent with the theoretical arguments that sustained competitive advantage can result from the way firms leverage DTs to build unique competencies and capabilities rather than from simply adopting them. As the array of technological choices increases, the need for concurrent reconfiguration of existing process and internal organisational changes thus become more and more important. A detailed assessment of the connect-edness between technological alternatives and specific business types, industries, or international supply chain relationship is crucial to identify those organisational changes that are required to effectively combining DTs tools with internal competencies and capabilities.

The present study can help explain SMEs' digital behaviour, which often reflects the perception that DTs are not unsuitable to their business models. Lack of investments in non-DTs resources, in the reconfiguration of existing production processes, and in the upgrading of the level and type of skills may affect SMEs' export propensity and their participation in global and regional value chains.

However, while this study presents interesting findings, a number of data limitations suggest that caution should be used regarding the generalisability of these results and that many questions regarding policy implications are still open. First, our data are cross-sectional (as most studies based on surveys). The cross-sectional nature of the study and the choice of proxies may only provide information on correlations ratherthan unequivocal cause-effect mechanisms. A more detailed analysis of these issues using panel data would, therefore, be useful for further research. Future research should also explore potential heterogeneity in digitalisation paths among different industries, as well as in other countries. In fact, it is reasonable that digitalisation, together with other variables, may have different effects on internationalisation in different sectors and economic contexts. The adoption of some forms of basic and e-business DTs, as well as investments to improve digital skills is geographically uneven, thus affecting available policy options.

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