Follow the cloud! The impact of ICT on Italian provinces’ trade

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Abstract
This study investigates the role of digital capacities in the internationalisation processes of Italian provinces using a panel dataset built upon the territorial statistical database of ISTAT (Italian National Institute of Statistics) for the period 2014–2017. The purpose is to explore the link between three internationalisation indicators (export value, export intensity and export in most dynamics sectors) and two ICT drivers (use of e-business digital technologies, such as cloud computing, and use of social media) expected to enable firms to share information along the supply chain and to ease firms’ communication and fixed cost investment. To purge the analysis from unobserved determinants of export performance and ICT adoption reverse causation problems, the identification relies on an instrumental variables approach that addresses the endogeneity of our two variables of interest related to ICT. The results show a significant relationship between the ICT capacities related to cloud adoption and our export indicators confirming the role of e-business digital technologies in explaining the export performance of Italian provinces. The use of social media also appears weakly able to impact on the export performances indicators. These results are robust to our endogeneity checks.

Keywords Information and Communication Technology · Internationalization · Social Media · Cloud Computing Technologies · Export

JEL Classification F14 · O33 · R10 · L60

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1 Introduction

In this hyper globalized economy information and communication technologies (ICT) play a fundamental role to improve companies’ business performance. Digitalisation is a new, complex and evolving phenomenon encompassing an array of different tools and processes ranging from new IT products to redesigning of existing processes and organisational changes (European Commission, 2019; ISTAT, 2020; OECD, 2014; Tippins & Sohi, 2003). These digital tools and processes are at the heart of the new global economy, a growing digital ecosystem (Vergura, 2010).

This fundamental shift in the digital technologies available to firms has also induced a new channel of transmission of ICT to export performances. The new technologies affect internationalisation processes of firms in terms of accessibility of foreign markets as well as of potential for resources, skills, and competencies acquisition from abroad (Hervé et al., 2020). According to a large stream of literature, broadband Internet has fostered countries and firms’ participation in international trade of goods and services, by reducing information-search and communication costs between buyers and sellers (Clarke & Wallsten, 2006; Freund & Weinhold, 2004; Lendle et al., 2016). At the same time, widespread use of internet to support business processes allows both small and large companies to gain more equal access opportunities to world markets. Internet is, in fact, able to positively influence firms’ internationalization activities by improving network information and providing new and cheaper ways to access foreign markets, crucial for small- and medium-sized companies (SMEs) which have limited capital resources (Díaz-Chao et al., 2015; Etemad et al., 2010; Giuffrida et al., 2018; Moen et al., 2008; Sinkovics et al., 2013; Visser, 2019).

A new even more disruptive change has occurred with the cloud computing revolution allowing firms to exploit the opportunity to acquire their storage, processing and software needs as a service subscription on a pay-to-go basis. Hence, while the acquisition of traditional information and communication technology (ICT) required high sunk investments in hardware infrastructure and software and to maintain large IT departments, now IT shifted to a variable cost (Destefano et al., 2019a; Iansiti & Richards, 2011; OECD, 2015).

The aim of this study is to achieve insights into the relationship between ICT and the export performances of firms in the Italian provinces. We use indicators related to two ICT tools increasingly adopted belonging respectively to the e-business and e-marketing domain: the use of cloud computing technologies, designed to create integrated production structures, and the adoption of social media, which include the widest range of modern internet-based communication tools, such as microblogs, social networking sites like Facebook and Twitter, and websites with social content. We supplement these two focal variables in our analysis with information on other local context controls.

To purge the analysis from unobserved determinants of export performance and reverse causation problems in the adoption of these tools, the identification relies on an instrumental variables approach that addresses the endogeneity of
our two variables of interest related to ICT. Our instrumental variables strategy entails the use of three different exogenous variables adopted to instrument our key ICT variables. First, we use the share of graduates in science and technology fields, as ICT adoption requires specialized skills to be developed, handled, and managed (Bengtsson et al., 2007). Then, we use the percentage of households with broadband access in relation to households with internet access, as a proxy of the hard infrastructural endowments of Italian provinces broadband adoption. Finally, we use the percentage of firms that internally organized training courses for ICT/IT skills for their employees. These three different excluded instruments are related to both drivers and pull factors in the adoption of ICT technologies.

In addition, investigating the relationship between the internationalisation and digitalization level of Italian provinces is crucial for several reasons: Italy is characterised by a strongly uneven regional contribution to international trade. Although digital transformation is occurring in many provinces, indeed, there are some areas which continue to lag in the adoption and implementation of IT tools. Firms located in southern regions suffer from locational disadvantages, which are partly a result of context variables that go beyond specific firm characteristics (Basile, 2001; Bugamelli et al., 2000; de Matteis et al., 2019). With respect to this, digitalisation appears a crucial indicator of development of territories and at the same time is a key tool to drive territories out of the current economic crisis and to enhance their integration into global markets.

However, this transformation does not only entail investing in digital technologies (hereafter, DTs), but also embedding them in the productive system organisation and investment. The introduction of DTs, indeed, may often involve implementing product or process innovations, human capital investment especially in ICT skills and STEM education (i.e., Science, Technology, Engineering and Mathematics), in addition to being influenced by local development performance and localisation economies. 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 (Brynjolfsson & Hitt, 2000).

Hence, in our empirical exercise, we include control variables which play a fundamental role in the process of DTs adoption. As ICT should increase the need for concurrent internal technological investment, we account for the introduction of innovation, proxied by patents. We also control for other types of ICT tools market-oriented, such as percentage of firms with websites. Furthermore we include shares of SMEs with respect to the total number of firms located in the same province, whether a given province is to be considered a regional capital or not, and the province’s GDP.

Our results show that overall, the DTs have an important impact on the export volume and on the ability to export in more dynamic sectors. E-business DTs, measured by an increase in the percentage of enterprises using could computing, strongly increases the export performance indicators, and the use of social media is also affecting the export performances. The use of system and processes enabling firms to share information along the supply chain can contribute to increasing firms’ exporting activities due to the support supplied to deal with customers.
and suppliers within global and regional networks. These results are robust to different specifications and to our endogeneity checks.

The remainder of the paper is organised as follows: the next section reviews the existing literature on ICT’s impact on internationalization processes. In Sect. 3 some key features of internationalization and digitalization level of Italian regions are pictured. In Sect. 4 the empirical strategy and the available data are presented. In Sect. 5 the econometric estimates and the results and some preliminary policy implications are discussed. Finally, Sect. 6 outlines the conclusions and examines the possible future development.

2 Literature background

In recent years, several studies have been conducted on how digital technologies are able to yield sensitive benefits to firms’ internationalisation. They are mostly grounded in business or marketing literature (Sinkovics et al., 2013). Various potential advantages deriving from the adoption and the use of DTs have been described: DTs can constitute additional sales channels, thus facilitating information availability and external knowledge on product varieties and characteristics (Bianchi & Mathews, 2013). ICT tools can help export-oriented firms through improved access to the international markets and reduced transaction cost. Internet-based tools can be used, for example, as a vehicle through which exporting activities may be launched as well as a tool for promotion, information, and export increase (Aspelund & Moen, 2004).

Advances in digital technologies can be exploited to enable better connectivity with business partners, suppliers, distribution networks, and customers, also supporting integration in the emerging global value chains and technology adoption (Strange & Zucchella, 2017).

It has been shown that an Internet-related reduction in fixed costs is likely to enhance export growth (Alarcón-del-Amo et al., 2018; Freund & Weinhold, 2004) and business performances increasing the quality and efficiency of production factors (Bertschek et al., 2013; Grimes et al., 2012; Haller & Lyons, 2015; Hagsten, 2016; Majumdar et al., 2010). Likewise, other studies attest a significant effect of indicators of “hard” infrastructures (physical capital and the diffusion of information and communication technology) on the level of exports (de Matteis et al., 2019; Portugal-Perez & Wilson, 2012).

A recent study by Hervé et al. (2020) states that with the integration of new technologies into the value chains and by managing a huge amount of data, it is possible that firms will be able to seize new opportunities, to reach potential customers and to operate immediately with a global reach. According to Jin et al. (2014), 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.

Freund and Weinhold (2004) introduced in a traditional gravity model a variable approximating the diffusion of Internet (number of web hosts with export origin country’s domain name in export destination country and vice versa). Their results,
based on a sample of 56 countries, show that Internet bilateral expansion encouraged trade especially in developing countries.

Internet tools also contribute to reduce the transaction cost related to distance and entry costs, overcoming the commercial barriers to access international markets. Lohrke et al. (2006), based on a survey of 42 US SMEs, emphasise the transaction cost reduction for SMEs which by the use of internet may establish direct customer contact, thereby reducing reliance on channel intermediaries for customer support. Firms deploying Internet marketing capabilities will benefit due to the reduction of information uncertainty and increased capacity to develop international network capabilities. Sector specific analyses have been carried out by Kneller and Timmis (2016) for UK business services firms following an instrumental variable (IV) approach based on telephone network historical data also finding a positive association between use of broadband Internet and export propensity. Closer to our study, Fernandes et al. (2019) found that increased Internet penetration at the province level positively affected Chinese firms’ inclination and intensity to export.

However, against this positive backdrop, some analysis started to show how there are conditions to realise this transmission of positive effects. As shown by Mathews et al. (2016), on a sample of 224 Australian firms, internet marketing capabilities lead to international market growth when the firm has a high level of international strategic orientation and international network capabilities.\(^1\) In line with this evidence, is the paper by Visser (2019) which conducts a gravity analysis based on panel bilateral trade data from 162 origin countries to 175 destination countries, for the period 1998–2014 showing how internet penetration is increasing exports to high-income countries along both the extensive and intensive margins, while increasing exports to lower-income countries along the intensive margin only. Carolle et al. (2020) provide evidence that subsequent to an increase in bilateral Submarine cable connections, the number of exporting firms increases in developed countries and declines in developing countries, especially in Middle East and North Africa (MENA), South Asia (SA) and Sub-Saharan Africa (SSA). They interpret this finding as evidence that firms from developed and developing areas differ in their ability to undertake information technology upgrading. In fact, most firms in developed countries can benefit from broadband Internet and related information technologies, thanks to a greater absorptive capacity (in terms of digital skills, R&D investment, and organisational structure) and greater proximity to urban centres and hard infrastructures. Conversely, in developing countries, the number of exporting firms can decline following an improved bilateral digital connection as only the largest and the high-productivity firms tap into the Internet. The remaining firms might consist of non-exporters, and small and low-productivity exporters, which are unable to fully exploit Internet potential. Hence, their findings tend to mitigate previous evidence on the positive effect of Internet diffusion on trade, showing heterogeneous

\(^1\) SMEs are facing high asset specificity in product information transmitted to and received from customers and benefit from the use of internet to a greater degree than those firms facing lower information specificity.
effects of bilateral connectivity on trade participation, based on income-group and geographical location.

The role played by internal firm characteristics and the environment in which they operate has been unanimously emphasised by the supply chain management literature (Jin et al., 2014; Tippins & Sohi, 2003). Export behaviour and international sales critically depend on complementary organisational changes and human capital endowment of adequate skills to manage DTs (Bianchi & Mathews, 2016).

In this paper we build on a quite restricted literature on the effects of cloud computing and social media on firms. Social media are different from other kinds of technologies in that they employ mobile and web-based technologies to create highly interactive platforms by which individuals and communities interact with customers and businesses in their social networks (Kietzmann et al., 2011). These technologies have the potential to provide greater access to customer information through firm-customer interactions or indirectly through customer-customer interactions. Furthermore, social media allow for this exchange of information in a fast, low cost, and efficient manner (Schniederjans & Hales, 2016). Therefore, social media can have a more direct and faster impact on performance than other information technologies.

Some authors focusing on social media usage and its connection to firm internationalization emphasise their potential influence on international business and export marketing strategies. Social media are highly relevant for carrying out international activities, as these technologies may improve communication with foreign customers, reducing or even eliminating distances. Bell and Loane (2010) highlighted this international potential and showed that small born global companies are using Web 2.0 technologies to intensify their relationships with international partners. Okazaki and Taylor (2013) suggested that the social networking platforms such Facebook, Google+, Twitter or LinkedIn make them effective leverages for international strategies. Alarcón-del-Amo et al. (2018) confirm how belonging to the specific cluster of exporting firms showing the highest level of managerial involvement with social media actually predicts a higher level of firm performance.

As for the use of Internet of Things (IoT), devices such as cloud computing, which can connect and share data with each other in real-time, imply changes in the management of the geographically dispersed supply chain that will allow firms a reduction of the costs of their international production.

We investigate a possible channel of transmission of cloud service use to export performance at the province level. This is a new field of investigation which can build upon the recent evidence on cloud adoption and firm growth (Destefano et al., 2019b). These authors describe a "scale-without-mass" effect, an additional benefit with respect to the general advantages of the use of internet such as lowering information asymmetries and increase network information. Firms (in particular young ones) can scale operations quickly without the need for acquiring a mass of ICT assets, labor or establishments. This change is expected to have particularly strong effects for new entrants given their hard financial constraints. Hence, the change in the nature of IT costs to a largely variable cost enables new business models. In our view the "scale-without-mass" effect is a very useful vehicle of improvement of firm and province level exports. The reason for this expected impact is that the new characteristics of digital markets facilitate specifically the internationalisation
of smaller and younger companies, despite their limited budget and resources for internationalisation.

At firm level previous analyses have already shown these effects on firm internationalisation. (Hagsten & Kotnik, 2017; Hervé et al., 2020). DeStefano et al., 2019b) using new firm-level data also examine the impact of cloud on firm growth, using zip-code-level instruments of the timing of high-speed fibre availability and speeds. In this case cloud also leads to the growth of employment and revenue for young firms, while for incumbents the authors find smaller scale effects but closing of establishments and moving employment farther from the headquarters.

In this line Bloom and Pierri (2018) find that the adoption of cloud is occurring at a faster rate amongst young and small business entities than for previous IT technologies. While traditional digital technologies trigger dynamics that benefit a minority of leading frontier firms and widen disparities across firms, conversely, cloud computing appears to be more accessible to younger and small entities, potentially reducing disparities between firms. Our analysis building upon this previous literature investigates the issue at province level for Italy.

A few studies are specifically focused on ICTs in the internationalisation processes of Italian firms or regions. Cassetta et al. (2020) have focused on the influence of e-business and e-commerce in addition to ICT training on export at firm level controlling for size and internal innovation. Aronica et al. (2021) measure the impact of social media on the internationalisation of Italian regions, aggregating firm-level data. To our knowledge, our paper differs from these studies in being specifically devoted to providing an analysis at territorial level focusing on the internationalisation of Italian provinces and on the intensity of diffusion of social media and cloud computing. Investigating these relationships at the level of Italian provinces is an underexplored field of analysis especially relevant for Italy, which is characterised by uneven trade participation of territories. This study moves exactly in this direction with the aim of getting additional information on the relationship between ICT and internationalisation of Italian provinces driven by two innovative ICT tools: cloud computing and social media.

### 3 Data description

Our analysis aims to acquire a more in-depth knowledge of ICT usage and internationalization of firms located in different Italian provinces for the period 2014–2017. To do this, we use data on ICT adoption, focusing on two different ICT technologies, namely the adoption of social media and cloud computing technologies by Italian firms located in a given province, and information on provincial export, the intensity of firms’ export, and the export in the most dynamic sectors. Italy represents an interesting case study given the historical economic gap between the southern and the northern areas of the country.

Our data are mainly obtained from different data sources made available by the Italian National Institute of Statistics (ISTAT) and, in particular, from the Territorial Statistical Database—containing 327 indicators available at regional level, for
macro-areas and for objective areas of development policies within the Sistan (Systema Statistico Nazionale) network—and from I.Stat and Coeweb databases.\footnote{See Appendix A (Table 3) for a more detailed explanation of the variables used.}

In the analysis of trade we include for 110 Italian provinces the Export Performance (EX) measured as the value of total exports, the Export Intensity (EXI), computed as the average value of exports per firm, and, finally, the Export Ability (EXA), calculated as the value of exports in dynamic global demand sectors, all referred to the firms located in a given province.

ICT variables (i.e., social media and clouding), instead, reflect different dimensions and they are partly inspired by Morgan-Thomas (2009), who has identified a capacity set linked to ICT tools able to contribute towards export performances of small and medium enterprises. These include relational (1) and transactional (2) resources; ICT complementary resources (3) and additional export capabilities (4).

The existing literature distinguishes between ICT for general purpose (e-mail, Internet, etc.), market-oriented ICT defined as belonging to the field of the e-commerce (websites, e-commerce, etc.) and ICT that integrate production, named e-business (Cloud Computing, SCM, etc.). Mazzarol (2015) examining the adoption, diffusion, and deployment of DTs, classify them according to the purpose of use as follows: (a) to undertake marketing and promotion activities (e-marketing); (b) to carry out transactions such as business to business and business to consumer (e-commerce); (c) to enhance production processes, customer engagement processes, and internal management processes (e-business). In the analysis we check for two of these dimensions: online presence (i.e., using a social media and having a website) which enables a company to share information and to communicate with customers, and percentage of enterprises using Cloud Computing technologies which could be defined as the availability of computer system resources (like data storage and computing power) that could be available on-demand, namely, as the possibility to access data and applications over the internet from remote.

Briefly looking at the internationalization level of the Italian provinces, Fig. 1 shows Italian provinces’ performance in terms of exports for the three different proxies considered: the level of exports at province level, the intensity of firms’ export, and the export in the most dynamic sectors.\footnote{We define dynamic sectors according to the Ateco 2007 classification including: CE—Substances and chemicals; CF—Pharmaceutical, chemical-medicinal and botanical articles; CI—Computers, electronic and optical equipment; CJ—Electrical appliances; CL—Means of transport; M—Professional, scientific and technical activities; R—Arts, entertainment and fun activities; S—Other service activities.} As we can see, looking at the value of exports at province level (Panel (a) of Fig. 1), the map confirms that on average the northern provinces of Italy show higher export levels, with Milan (41 billions EUR) being the province exporting the most, followed by Turin (22.27 EUR bn), Vicenza (17.7 EUR bn), Brescia (15.79 EUR bn), and Bergamo (15.46 EUR bn). On the other side, southern provinces lag quite behind. Many of the provinces with a negative performance are, in fact, located in this part of the country like, for example, in Sicilia (Enna with 10.75 millions of EUR), in Calabria (Crotone, 23.30 EUR mil; Vibo-Valentia, 35.75 EUR mil), in Sardegna (Olivia-Tempio, 52.30 EUR mil; Oristano 53.4 EUR mil), or in Campania (Benevento, 182 EUR mil).
Fig. 1 Italian provinces export 2017 (mln euro, 2017). Notes: Authors’ elaborations on ISTAT data. 
a Shows the Export Performance of Italian provinces measured as the value of exports of firms located in a given province in 2017. 
b Shows the Export Intensity of Italian provinces measured as the average value of exports per firm for firms located in a given province in 2017. 
c Shows the Export Ability of Italian provinces measured as the value of exports in dynamic global demand sectors of firms located in a given province in 2017.
As said, as further indicator of internationalization, we used the export intensity, measured by the average level of exports at firm level. By looking at the maps (Panel (b) of Fig. 1), we still see that export intensity is much stronger in the North (i.e., provinces Gorizia export on average 292 thousands of EUR, Belluno 276 thousands of EUR, Vicenza 252 thousands of EUR, Reggio nell’Emilia 249 thousands of EUR).

A different scenario is observed when we examine the Export Ability (i.e., the share of the value of exports in sectors with dynamic world demand on total exports) (Panel (c) of Fig. 1). In this case, the central and southern provinces record good performances. In 2017 Potenza, where the 90% of exports are in sectors in which global demand is more dynamic, is the province with the highest percentage, followed by Frosinone (88.8%) and Latina (88.32%). On the other side, provinces having the lowest performance in sectors with more dynamic the demand on global markets are Nuoro (1.92%), Agrigento (1.07%), Carbonia-Iglesias (0.9%), Oristano (0.3%).

Equally significant for the purpose of the analysis are descriptive data referring to new technologies’ adoption by Italian firms in the provinces and regions.

Among the most used technological tools by companies, the Cloud Computing (CC) services are undoubtedly the frontier of digital innovation. However, looking at Panel (a) of Fig. 2, we can notice that in 2017 there is a strong diversification between the various regions with some of the traditionally most productive regions in the north of Italy (Lombardia, Emilia-Romagna, and Trentino Alto-Adige) being those with highest shares of firms which buy cloud computing technologies, and with southern regions lagging behind (with the exception of Basilicata) as the
purchase percentage does not exceed 20% confirming the traditional North–South divide in technology adoption (Fabiani et al., 2005). Firms located in the main islands, instead, seem to be on average more prone to adopt cloud computing technologies than their southern peninsular counterparts.

The maps in Fig. 2 clearly illustrate how the percentage of social media use is greater in some regions than others. The success, related to the southern regions, is probably due to the cheapness of their adoption, in the sense that the adoption of social media requires less investment compared to other technologies. However, the simple adoption of ICTs does not necessarily entail an improvement of firm or regional performances, but they also require sizeable investments in software and digital competences by workers especially if the economic scenario is mainly characterized by a higher share of SMEs (Aronica et al., 2021).

4 Empirical strategy

In order to empirically explore the role of ICT in explaining the export performance of Italian provinces we focus on the adoption and implementation of ICT and its impact respectively on the level of export at province level ($EX_{p,t}$), the export ability of Italian provinces in the sector with dynamic world demand ($EXA_{p,t}$) and the export intensity, measure as the average export at firm level ($EXI_{p,t}$). Hence, we estimate the three following equations:

$$Export_{p,t}^m = \beta_0 + \gamma X_{r,p,t-1} + \beta_1 Social_{r,t-1} + \beta_2 Clouding_{r,t-1} + \mu_p + \delta_t + \epsilon_t$$

(1)

where $m=\{EX, EXI, EXA\}$ represents the (log of) export performance of Italian provinces, $\gamma$ is a set of coefficients associated with a set of controls indexed by time ($t$) and province ($p$) or region ($r$) that we include in our regression likely to influence the export performance. In this set, we include the share of firms having a website as control for technological adoption of firms located in region $r$ at the year $t-1$, the GDP of province $p$ at time $t-1$ in logs, the share of SMEs located in province $p$ at time $t-1$, and, finally, we include the patent intensity—computed as the number of patents per million inhabitants at province level—to have a measure of the output side of the intensity in R&D investments. To avoid simultaneity issues, and to capture the effect of the adoption of ICT technologies over time, we design our Eq. 1 with a lagged structure of the RHS of the equation. Moreover, we include a set of dummies to control for both province specific characteristics ($\mu_p$)—particularly if a province is the capital of a region $r$—, and finally we estimate our model by using macro-area—and year fixed effects to control for area specific characteristics and time variation ($\delta_t$) that could influence our analysis.\textsuperscript{4}

\textsuperscript{4} We identify four main macro-areas (North-East, North-West, Center, South) to control for the heterogeneity that characterizes these areas.
By including these variables in our empirical analysis to properly investigate the correlation between the adoption of ICT and the internationalization of Italian provinces, we expect them to be in most of the cases positively correlated with the internationalization dimensions we consider.

To anticipate our findings from the OLS estimations, as we will see in the next section, we find the export performance of Italian provinces being positively associated with the adoption of ICT technologies. However, the positive correlation could be influenced by unobserved determinants of export performance and ICT adoption and could suffer from reverse causation problems. In particular, OLS results could underestimate the effect of ICT technologies on export performance since greater export performance could translate into incentives for firms located in a given province to adopt ICT technologies to more efficiently compete in international markets.

For these reasons, we use an IV approach setting based on three instruments to control for incentives for firms to adopt and implement ICT technologies using region-, province- and geography-related controls.

In our setting, we expect the use of social media technologies and clouding technologies to be endogenous and, so, we use three excluded instruments related to both push and pull factors in the adoption of ICT technologies.5

First, we include as excluded instrument the percentage of households with broadband access in relation to households with internet access in region \( r \) at time \( t \), as a proxy of the infrastructural endowments of Italian provinces (\( \text{Broadband}_{r,t} \)).6 Looking at the geographical patterns of the variables we used as instruments in our analysis (Fig. 3) first, we note that in all regions on the national territory access to Internet is quite homogeneous and most households that are served by an internet connection also have broadband coverage. In many regions, indeed, almost all households are served by a broadband connection (e.g., in Lombardia, Sardegna, Veneto, Emilia-Romagna, and Abruzzo), as confirmed in Panel (a) of Fig. 3. However, as mentioned, our data panel overlaps with the period in which policy BUL strategy was implemented. In fact, many regions improved the coverage of broadband on their territory during this period. To give a few examples, Campania, in 2012, had a percentage of households served by broadband of 80%, while in 2017 it reached 97%. Molise had also a considerable improvement in the supply of broadband to its citizens, going from 80 in 2012 to 95 in 2017, as well as Trentino Alto-Adige (moving from 84 to 98%), or Valle d’Aosta (from 85 to 97%). Overall, all regions showed an increase in the population served by broadband, with a national average increase over the 5-year period of 12.67%.

5 See Appendix B for the correlation matrix between the instruments and the dependent variables.
6 To include this variable, we benefit from a recently released data set by the Eurostat “Percentage of households with broadband access in relation to households with internet access, by NUTS 2 regions” (2022). It must be noticed that in 2015 Italy has started the so-called BUL Strategy (namely, Strategia per la Banda Ultralarga) which was “a strategic plan that had the objective of developing an ultra-broadband network throughout the country to create a public telecommunications infrastructure consistent with the objectives of the European Digital Agenda”. This testifies the relevance of the investments in ICT infrastructure. Future developments would require to investigate the impact of ultra-broadband adoption (or coverage) on export performance.
Second, to control for the supply of scientific and technological skills that firms could benefit from being located in a given province, so enhancing the usage of ICT technologies, we use the share of graduates in science and engineering disciplines in region $r$. More specifically, we use the (log of) number of the graduates over the resident population in the age group 20–29 years old, every thousand inhabitants, and to mitigate simultaneity concerns, we took the data for 2012, before the beginning of our sample ($\text{Sci}_{deg,r,2012}$). In this case, Fig. 3 (Panel (b)) highlights a similar pattern as before with central and northern regions performing better (Friuli-Venezia Giulia, 18.72%; Emilia-Romagna, 18.7%; Lazio, 17.94%; Piemonte 17.57%) with respect to southern regions (Puglia, 6.68%; Basilicata, 4.68%; Molise, 3.5%).

Finally, as an additional element of external variation in the adoption of ICT technologies, we use the share of firms that internally organized training courses for ICT/IT skills for their employees in the previous year ($\text{ICT}_{training,r,t}$). However, this kind of information is not available at regional level, but only at a macro-area level (North-East, North-West, Center, South). For this reason, we we scaled the values by the share of firms that are located in a given region $r$ by using data from the ASIA database from ISTAT (namely, $\text{Registro Statistico delle imprese attive}$). Also in this case, Fig. 3 (Panel (c)) shows a substantial imbalance to the disadvantage of the southern regions (which show an average percentage of 7.67% of companies that have organized training courses in ICT) compared to the northern regions (Lombardia with 2.77% of firms organising training course in ICT; Veneto with 1.32% contrast with weak performances of regions like Molise (0.04%), and Basilicata (0.03%).

5 Results and discussion

Table 1 shows the results of the estimation of Eq. (1) with all the variables at year $t-1$. First of all, we observe that most of the results are consistent across estimations.

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7 The definition of "Graduates in science and technology" includes university graduates, PhDs, graduates from specialization, postgraduate and master’s level I and II courses (levels 5 and 6 of the international ISCED97 classification) in the subject areas of Natural Sciences, Physics, Mathematics, Statistics, Computer Science, Information Engineering, Industrial Engineering, Architecture and Civil Engineering. The denominator considers the population aged 20–29 years. The data on the graduates are available until 2012. As a robustness check, we tested also the average in the 5 years preceding our sample (i.e., 2007–2012) as well as we tested the results by using the number of graduates (i.e., the numerator of the indicator), finding consistent results. Results are available upon request.

8 We included employees in 11 sectors according to the Ateco 2007 classification (3 digit): 5 sectors for ICT manufacturing and 6 sectors for ICT services. For ICT Manufacturing we included: (26.1) Manufacture of electronic components and boards; (26.2) Manufacture of computers and peripheral equipment; (26.3) Manufacture of communication equipment; (26.4) Manufacture of consumer electronics; (26.8) Manufacture of magnetic and optical media. When considering the ICT Services sectors, we included: (46.5) Wholesale of information and communication equipment; (58.2) Software publishing; (61) Telecommunications; (62) Computer programming, consultancy, related activities; (63.1) Data processing, hosting, and related activities; web portals; (95.1) Repair of computers and communication equipment.

9 Given the data availability, we also tested the validity of our instrument by assuming that all the regions in a same area have the same share of firms organizing courses in ICT/IT with consistent findings. Results are available upon request.
Fig. 3 External instruments—Broadband connections, Graduates in science and technology, ICT/IT courses. Notes: Authors’ elaborations on ISTAT and Eurostat data. All the figures are by NUTS 2 region. 

a Shows the percentage of households with broadband access in relation to households with internet access. 
b Shows the average percentage of graduates over the total number of graduates in science and technological disciplines in 2012. 
c Shows the share of firms that internally organized training courses for ICT/IT skills in 2017.
Starting with the level of GDP, this positively correlates, although weakly significantly, with the internationalization of provinces \((EX_{p,t})\), and also with the ability of provinces of being competitive in most dynamic sectors \((EXA_{p,t})\). It shows, instead, negative (but not significant) coefficient with respect to the average export at firm level \((EXI_{p,t})\).

As to the number of SMEs, an increase is positively associated with all the three of export indicators we used. Being the Italian economic scenario traditionally constituted by SMEs, a greater presence of this kind of firms with respect to the total number of firms may lead to a positive and significant propensity towards internationalization (Cassetta et al., 2020). As expected, the patent intensity is also positively correlated with the internationalization, affecting the export, the average export per firm, and also the export in most dynamic sectors, in line with Añón Higón and Driffield (2011). These results confirm that investing in R&D makes a company more productive and competitive, allowing to enter new markets more easily while facing high initial sunk costs of entry.

Finally, by controlling for the share of firms that have a website, we find that implementing this kind of basic ICT endowment positively correlates with all the three dimensions of internationalization we consider (although the results do not show strong statistical significance), in line with Hagsten (2015), Hagsten and Kotnik (2017), and Pickernell et al. (2016). In fact, firms using websites for more advanced purposes and services, such as marketing and e-commerce, have been shown a greater propensity to export also spurring the export performance at province level.

In addition, this is consistent also with the results of Bianchi and Mathews (2013) and Freund and Weinhold (2004), according to which, by using a website, firms may increase their sales to international markets with small capital investments, also being able to rapidly identify new customers, suppliers and partners worldwide.

Moving to our variables of main interest, the results related to the social media appear, at this stage, a bit surprising, because in general sharing electronic information with suppliers (electronic sharing) should have a positive effect on internationalization, but in our case the internationalization decreases with it.

A positive relationship, instead, is found when we consider the Cloud-based information and communication technology. The adoption of Cloud-based ICT services, indeed, may be highly suitable particularly for SMEs, as they could reduce some of the traditional disadvantages that SMEs potentially, including capacity and financial constraints, enhancing their SMEs to exploit business opportunities across national borders (Ross & Blumenstein, 2015).

In order to ensure that our results are not somehow driven by a self-selection mechanism of the provinces that perform better in international markets (i.e. that export more, trade more in dynamic sectors, or have companies that on average have higher export values), we tested the results using the growth rate of the dependent variables, instead of levels and the results resemble those in Table 1. We also performed the same type of analysis on the simple variation of the dependent variable between \(t−1\) and \(t\), with coherent results (see the results in the Appendix Table 6).

As said in Sect. 4, we deal with issues related to endogeneity and reverse causality that could arise in our context by using a traditional 2SLS approach. In particular,
we simultaneously instrument the adoption of (both social media and cloud-based) ICT technologies with three different excluded instruments: the share of graduates in science and engineering disciplines in region \(r\) in 2012 (\(Sci\_deg_{r,2012}\)), the share of firms that internally organized training courses for ICT/IT skills for their employees in the previous year (\(ICT\_training_{r,t-1}\)), and, finally, the percentage of households with broadband access in relation to households with internet access in region \(r\) at time \(t\), as a proxy of the infrastructural endowments of Italian provinces and actual broadband penetration across the country (\(U\_Broadband_{r,t}\)).

Table 2 shows the results of the 2SLS estimation where the results related to cloud computing technologies and to our control variables are in line with the ones from the OLS and show a positive (and significant) effect of the use of cloud computing on Export Performance and Export Ability.. Also the effect of social media, after controlling for endogeneity, appears positive and weakly significant for the extensive margin of export and on the Export Ability, preserving a negative coefficient but not statistically significant with respect to the Export Intensity of Italian provinces.

As said, in general social media technologies would be expected to reduce spatial distances helping firms to access cross-border markets and this is mostly the case of ICT technologies characterized by low costs of adoption like social media (Aronica et al., 2021). Nevertheless, to fully exploit the potential of these new technologies, important investments are necessary (Bloom et al., 2014; Pellegrino & Zingales, 2017). The economic benefits deriving from the adoption of social media, indeed, could be partially nullified if their implementation is not accompanied by an adequate awareness in their strategic use (Aronica et al., 2021; Cardona et al., 2013; Cesaroni & Consoli, 2015). This could be the case of some Italian regions, especially those located in southern regions. As previously showed (Fig. 2), indeed, despite showing high percentage of firms using social media technologies, southern
regions could be likely to adopt social media technologies, but it could also be the case that they are not ready to fully exploit all the possible advantages, as they may remain “basic-user” (e.g., adopting only Facebook) not able to use them in a very profitable way. All the digital variables in our estimation are affecting differently the three dimensions of exports considered in particular the impact on the intensive margin is absent whereas the DTs have an important impact on the volume and the ability to export in more dynamic sectors. Hence, this might suggest the relevance of these technologies in helping firms to expand their market potential for instance entering new markets and sectors more than expanding their average activities in their market and sectors.

**6 Conclusions**

Digitalisation and internationalisation are confirmed in this study as strongly related factors. This study differs from previous analyses on Italy as it provides a perspective of analysis under investigated before: we use a panel of data at province level and adopt an instrumental variable approach which allows us to go beyond simple correlations detecting true causal effects while incorporating the economic contexts conditions. The adoption of some forms of basic and e-business ICT technologies, as well as investment to improve digital skills are strongly uneven geographically hence the province level perspective provides a fundamental enhancement of the analysis.

Our approach focuses on the phenomenon of digitalisation considering simultaneously e-commerce and e-business indicators, which are instrumented by using different variables: related to employment in ICT, graduated in STEM disciplines, investment in digital skills, broadband connection.
Our analysis confirms previous evidence, particularly concerning the relationship between propensity to export and use of digital tools such as e-business and websites adoption, while a less significant relationship is found with the use of social media adoption.

Regarding the additional results, they confirm that international activities need specific business strategies and an appropriate business and external environment as suggested by the significant and positive role that patent intensity, trade openness and the share of SMEs play.

Besides, the results of the first stage (see Appendix C), where the share of firms adopting social media and cloud computing technologies are regressed on the instruments we selected, support the argument that as the range of technological choices grows, they need appropriate human capital investments and hard infrastructures.

Our empirical results also emphasise the importance of the external context in promoting the internationalisation through the adoption of DTs. Competitive advantage can result from the way territories leverage DTs to build unique competencies and capabilities rather than from simply adopting them.

The agenda for future research includes a more detailed analysis to explore the different role that digitalisation play at sectoral level to explore potential heterogeneity in digitalisation among different industries. In fact, digitalisation, in addition to local context variables related to innovation, GDP and openness, may have different effects on internationalisation in different sectors and a more detailed assessment of the connectedness between technological alternatives and specific industries is crucial. A further fundamental insight might be gained by studying the relation between cloud adoption and exports in relation to possible sectoral specificities. Hence, a further future development of the analysis should be in direction of studying whether the "scale-without-mass" may impact differently on the export activity of firms’ in manufacturing sectors vis-à-vis service ones. In particular, manufacturing firms with respect to service firms are less likely to be cloud adopters.\(^\text{10}\)

Besides, firm level data would allow to get crucial information on how firms may combine investment in DT with non-digital ones, how their existing product and process innovation and organisation of production processes, and how the upgrading of the level and type of skills may affect SMEs’ export propensity and their participation in global and regional value chains.

Digging deeper into the relationship between investment and the adoption of ICTs, would allow to guide policy makers to adopt more targeted investment policies to stimulate digital development, including investments in digital infrastructures, digital businesses and adoption of the digital by traditionally non-digital actors (Stephenson et al., 2021). It is crucial addressing these issues regarding policy implications, such as the necessary changes in terms of sources of innovation—internal and sectoral—needed to better exploit digital technologies that may influence SMEs’ propensity to export and their participation in global value chains.

\(^{10}\) At this stage, we could not implement this analysis due to lack of data disaggregation on manufacturing and services exports at province level. We are grateful to an anonymous reviewer for this suggestion for further research.
Appendix

A Dataset description

In this section we provide the description of the data we used in the regressions. In Table 3 brief description of the variable and summary statistics are shown.

B Correlation of instrumental variables to dependent variables

In this section, we provide correlation matrix of the instrumental variables with the dependent variables \((EX_{p,t}, EXA_{p,t}, EXI_{p,t})\) in logs (Table 4).

C 2SLS regression: first-stage results

In this section, we provide results from the first stage of our 2SLS estimations. In Table 5, the results of the first stage where the share of firms adopting social media and cloud computing technologies are regressed on the instruments we selected, on the control variables and the set of fixed effects we used in Eq. (1) are shown. We simultaneously instrument the adoption of (both social media and cloud-based) ICT technologies with three different excluded instruments. In principle, we would expect all three instruments to have more or less positive effects on endogenous variables. The share of graduates in science and engineering disciplines in region \(r\) in 2012 \((Sci\_deg_{r,2012})\) shows positive relation with the adoption of social media, while negative (albeit not significant) relationship with cloud computing. From our results, the share of firms that internally organized training courses for ICT/IT skills for their employees \((ICT\_training_{r,t-1})\), in \(t-1\) positively correlates with the adoption of cloud computing but not significant relationship with the social media adoption by firms. Finally, percentage of households with broadband access in relation to households with internet access in region \(r\) at time \(t\), as a proxy of the infrastructural endowments of Italian provinces \((U\_Broadband_{r,t})\) shows a positive effect with the adoption of social media, and it has a not statistically significant effect on the adoption of cloud-based technologies. Moving to the other controls, better innovation performances have a positive correlation with the adoption of social media and, while a greater SMEs presence in the province has a positive effect on the adoption of social media, on the contrary, it reduces the likelihood of firms adopting cloud-based technologies. this is also because the adoption of more complex technological systems may require a larger scale.

D Growth in export and self-selection of provinces

In order to ensure that our results are not in any way determined by a self-selection of the provinces that perform best in international markets (i.e., that export more, perform better in dynamic sectors or have firms that on average have higher export values), we also performed the same type of analysis with the variation of the dependent variables \((t-1\rightarrow t)\) finding qualitatively congruent results (Table 6)\(^{11}\)

\(^{11}\) We also estimated the model with the annual growth rate of our dependent variables on the LHS of the equation, finding qualitatively similar results for the variable of main interest (albeit with less significance of the cloud-based technologies on the EXA). The results are available upon request to the authors.
Table 3: Variable description and descriptive statistics

| Variable        | Description and source                                                                 | Obs  | Avg       | Min  | Max       |
|-----------------|----------------------------------------------------------------------------------------|------|-----------|------|-----------|
| \(EX_{p,t}\)    | Value of province export (EUR mil)                                                     | 440  | 3763.075  | 0.197| 41,203.53 |
| \(EXA_{p,t}\)   | Ability to export to sectors with dynamic world demand                                  | 440  | 28.82     | 0.3  | 93.89     |
| \(EXI_{p,t}\)   | Average export per firm                                                                 | 440  | 90,483.76 | 129  | 329,349   |
| **Controls**                                             |                                                                                         |      |           |      |           |
| Social media_{p,t} | Percentage of companies using social media                                             | 440  | 38.309    | 23.8 | 59.8      |
| Cloud computing_{p,t} | Percentage of companies purchasing Cloud Computing services                          | 440  | 27.612    | 12.8 | 48.5      |
| Patent Intensity_{p,t} | Patents registered with the European Patent Office (EPO) (number per million inhabitants) | 440  | 0.7       | 0    | 1.8       |
| Website_{p,t}    | Percentage of companies having a website at time \(t\)                                | 440  | 13.036    | 1.258| 85        |
| GDP_{p,t}        | GDP of province \(p\) at time \(t\) (EUR mil)                                         | 440  | 15,081.59 | 3.467| 175,125.5 |
| SME_{p,t}^{a}    | Percentage of active companies at time \(t\) by class of employees in the province \(p\) (10–249 employees) | 428  | 4.309     | 1.68 | 7.78      |
| Capital_{p}      | Dummy variable (1 = province \(p\) is a regional capital; 0 = otherwise)               | 440  | 0.182     | 0    | 1         |
| **Excluded instruments**                                 |                                                                                         |      |           |      |           |
| Sci_deg_{2012}^{b} | Graduates at levels 5 and 6 of the international ISCED97 classification in scientific disciplines in 2012. The denominator considers the population aged 20–29 years at the same reference year | 440  | 13.119    | 0.809| 18.72     |
| ICT_training_{p,t}^{a,c} | Percentage of firms that internally organized training courses for ICT/IT skills for their employees | 428  | 0.708     | 0.03 | 2.78      |
| Broadband_{p,t}  | Percentage of households with broadband access in relation to households with internet access, by NUTS 2 regions^{d} | 440  | 98.2      | 95   | 100       |

Source: All the data come from Italian National Statistics Institute (ISTAT)

^{a}Variable standardized in the regressions

^{b}Available until 2012

^{c}Not available at regional level. We rescaled the values at regional level by using the share of firms located in a given region \(r\) by using data from the ASIA database from ISTAT (namely, Registro Statistico delle imprese attive)

^{d}Source: Eurostat, Percentage of households with broadband access in relation to households with internet access, by NUTS 2 regions (2022). [Data set]. European Commission, Eurostat
Table 4  Correlation matrix of instrumental variables to dependent variables

| log(EXₚ,ₜ) | log(EXAₚ,ₜ) | log(EXIₚ,ₜ) | Ultrabroadbandₜ₋¹ | logSci_deg,2012 | ICT_trainingₜ₋¹ |
|-----------|-------------|-------------|-------------------|----------------|-----------------|
| log(EXₚ,ₜ) | 1           |             |                   |                |                 |
| log(EXAₚ,ₜ) | 0.930       | 1           |                   |                |                 |
| log(EXIₚ,ₜ) | 0.909       | 0.837       | 1                 |                |                 |
| Ultrabroadbandₜ₋¹ | 0.034      | 0.264       | 0.075             | 1              |                 |
| logSci_deg,2012 | 0.464      | 0.424       | 0.462             | 0.067          | 1               |
| ICT_trainingₜ₋¹ | 0.549      | 0.505       | 0.621             | 0.105          | 0.495           | 1               |

Table 5  Correlations between excluded instruments and instrumented variables

|                      | Social_mediaₜ₋¹ | Cloudingₜ₋¹ |
|----------------------|-----------------|-------------|
| logSci_deg,2012      | 1.41*** (0.499) | −0.036 (0.38) |
| ICT_trainingₜ₋¹      | −0.802 (0.733)  | 3.41*** (0.52)  |
| Broadbandₜ₋¹         | 1.36*** (0.337) | −0.48 (0.33)   |
| Patent Intensityₚ,ₜ  | 4.523*** (0.720) | −0.436 (0.561) |
| log Websiteₜ₋¹       | 0.552 (0.441)   | 0.498 (0.403)  |
| log GDPₚ,ₜ           | −0.176 (0.195)  | 0.018 (0.105)  |
| SMEₚ,ₜ               | 1.011*** (0.394) | −1.109*** (0.445)  |
| Capitalₚ              | −0.482 (0.834)  | −0.245 (0.675)  |
| Observations          | 307             | 307           |
| Area FE               | ✓               | ✓            |
| Year FE               | ✓               | ✓            |

Source: Authors’ elaboration on ISTAT data. Clustered robust standard errors at the province level are reported in parentheses. *p < 0.1; **p < 0.05; ***p < 0.01

Table 6  OLS results for variation of the dependent variables (t − 1 → t)

|                      | ΔEXₚ,ₜ | ΔEXAₚ,ₜ | ΔEXIₚ,ₜ |
|----------------------|--------|---------|---------|
| Social mediaₜ₋¹      | 0.01   | 0.05*   | 0.02    |
| Cloud computingₜ₋¹   | 0.12** | 0.11**  | 0.06    |
| Patent Intensityₚ,ₜ  | 0.51*  | 1.35*** | 0.37    |
| log Websiteₜ₋¹       | 0.44** | 0.45**  | −0.01   |
| log GDPₚ,ₜ           | 0.27***| 0.25**  | −0.16   |
| SMEₚ,ₜ               | 0.32** | 0.12   | 0.18    |
| Capitalₚ              | 0.22   | 0.47    | 0.18    |
| Observations          | 221    | 221     | 219     |
| Area FE               | ✓      | ✓       | ✓       |
| Year FE               | ✓      | ✓       | ✓       |
| Adj R²               | 0.41   | 0.33    | 0.29    |

Source: Authors’ elaboration on ISTAT data. The dependent variable in each regression is respectively the logarithm of exports (EXₚ,ₜ); the export ability (EXAₚ,ₜ) and the export intensity (EXIₚ,ₜ). Clustered standard errors at the province level are reported in parentheses. *p < 0.1; **p < 0.05; ***p < 0.01
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Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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