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Adoption of New Digital
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An Empirical Inquiry on a
Manufacturing Region**

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Abstract

This paper provides an analysis on the diffusion of the last generation digital technologies (Industry 4.0) in the Veneto region, one of the main manufacturing territory in Italy. Our attention focuses on factors that enable firms to adopt these technologies, with attention to three main aspects: the human capital endowment, the international openness, and the financial structure. Empirical analysis is based on a sample of firms that operate in manufacturing, construction and business services. Our analysis shows a heterogeneous diffusion of Industry 4.0 technologies across different industries, allowing the identification of distinct technologies frontiers among sectors. The logit regression shows a positive relation between the adoption of digital technologies and the openness to international markets, as well as with a highly skilled and highly educated human capital. The digital users show better productivity indexes than other firms, but at the same time financial performances are less clear. Hence, the firms that adopt new digital technologies have a more balanced financial structure, but they do not show higher profitability ratios than non-users. This result depends on a longer run return on investment and in a different distributive policy inside the firm.

Keywords

Digital innovation, Industry 4.0, Enabling factors, Technological upgrading

JEL Codes

O33, L60, J24

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Enabling Factors in Firms' Adoption of New Digital Technologies

An Empirical Investigation of an Italian Manufacturing Region

Giancarlo Corò, Dejan Pejdic, Mario Volpe

Abstract

This paper provides an analysis on the diffusion of the last generation digital technologies (Industry 4.0) in SMEs of Veneto region, one of the main manufacturing territory in Italy. Our attention focuses on factors that enable firms to adopt these technologies, with attention to three main aspects: the human capital endowment, the international openness, and the financial structure. Empirical analysis is based on a sample of firms that operate in manufacturing, construction and business services. Our analysis shows a heterogeneous diffusion of Industry 4.0 technologies through different industries, allowing distinct technologies frontiers among sectors. The Logit regression shows a positive relation between the adoption of digital technologies and the openness to international markets, as well as with a skilled human capital. The digital users show better productivity indexes than other firms, but at the same time financial performances are less clear. Hence, the firms that adopt new digital technologies have a more balanced financial structure, but they do not show higher profitability ratios than non-users. This result depends on a longer run return on investment and in a different distributive policy inside the firm.

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JEL Codes: O33, L60, J24

1. Introduction

Expressions like ‘digital technologies’, ‘digitalization’, ‘digital revolution’ and ‘Industry 4.0’ are spreading across the Internet, the media and the academic world. According to several experts, this could be a very influential industrial revolution. Indeed, the growing diffusion of ICT-based technologies is innovating communication and work (Schwab, 2016), and the debate on the possible impact of such a digital revolution on virtually every industry is more open than ever (McQuivey, 2013; Gordon, 2016).

This digital revolution, or Industry 4.0, is expected to increase flexibility, reduce lead times, allow mass customization, enable new services based on big data and create appealing work structures (Heng, 2014). Productivity gains might be substantial, opening up opportunities in every industry. At the same time, these changes also present a few challenges, the most significant being the increasing job substitution and social inequality (Cowen, 2013; Brynjolfsson and McAfee, 2014, Frey et al., 2016).

The scope of the present contribution is to provide an overview of the key issues concerning the adoption of digital technologies in the region of Veneto (Italy). Although the diffusion of technologies across sectors is strictly linked to the territory under examination, the conclusions drawn on the enabling factors in the present study can be extended to other contexts and tested on additional models.

In this research the following definition of technology will be borrowed from Arthur (2009), “an assemblage of practices and components, collections or tool-boxes of individual technologies and practices”. The ‘digital’ dimension considered here, on the other hand, refers to the ability of all these technologies to transform information (text, sound, image, movement, and preferences) into numerical sequences, ultimately elaborating, managing and using it in that format.

In this study, the expression ‘digital users’ refers to firms which adopt at least one digital technology, in the case of the construction and tertiary sectors. In the case of manufacturing, the label will be employed to denote firms which adopt at least two different technologies. This distinction was necessary for the elaboration of the data collected.

The remainder of the present paper is structured in 7 sections. First of all, Section 2 will discuss the potential of digital innovation and technologies for businesses. Second, Section 3 will present the data collected and outline the methodology employed in the analysis. Next, Section 4 will discuss the main findings of the survey, while section 5 will provide an answer to the following key questions: 1) Can internationalization constitute an enabling factor for the Industry 4.0? 2) Do digital users perform better than digital non-users? 3) Are digital technologies creating or destroying jobs (and what kind of jobs)? Then, section 6 will show a LOGIT model explaining the adoption of digital technologies with regard to its enabling factors. Finally, Section 7 will conclude.

2. The digital innovation and technological upgrading

The world of digital technologies is commonly linked to what is called ‘Industry 4.0’ (I4.0). This, in turn, is usually associated with the cyber-physical systems, i.e. highly automated and hyper connected production processes. Therefore, the expected new industrial paradigm has many facets. Hence, I4.0 requires adequate digital technologies (Baur and Wee, 2015), but is not simply limited to those. Indeed, it embraces both products and processes (Schmidt et al., 2015) and involves a reorganization of the supply chains (Platform I4.0, 2015).

This idea of I4.0 finds similar paradigms in what was called ‘Advanced Manufacturing’, ‘Integrated Industry’, ‘Smart Industry’ or ‘Smart Manufacturing’ (Hermann et al., 2015). These concepts are similar but tend to

emphasize distinct aspects. In this context, there is no consensus on the definition of the I4.0 (Hermann et al., 2015; Liao et al., 2017). The difficulty to define the phenomenon is partly due to the different perceptions that companies hold about the digitization and the I4.0. Sommer (2015) has shown that the importance of change is widely recognized, even though very few companies are ready to or are already investing in that direction.

It is extremely hard to evaluate the value generated by digital technologies (Grover and Kohli, 2012; Yoo et al., 2012) and, consequently, the impact of the ongoing transformation. Nowadays, the 'digital' side is hard to evaluate separately from the 'non-digital' one. Another problem is represented by the lack of shared criteria to identify what makes a business 'digital' or part of the I4.0 paradigm. Thus, the implementation and use of digital technologies surely depend on the IT infrastructures. Although these are essential for further development, it may be misleading to consider this digital upgrading only as a part of an evolved ICT system (OECD, 2014).

The digitalization and IT promote the access to innovative ideas (Pisano and Verganti, 2008), mainly sustaining the knowledge flow (Katz and Rice, 2002) and changing how individuals interact (Hinds and Kiesler, 2002). Therefore, openness and the creation of networks are essential for firms to compete. Hence, firms shall improve the relationship between individuals and business practices with Internet-based technologies (Vaccaro and Madsen, 2009), thus enabling digital technologies to create new types of innovation processes (Henfridsson et al., 2014). Creating relationships with organizations from all over the world has also been labeled 'digital shoring' (Robinson and Light, 2016).

Firms need to implement an adequate IT and business strategy, on the basis of their competitive context, digital organization and IT capabilities to ultimately be able to create value from the digital innovation (Fichman, 2012). Mere investments in the IT infrastructure and related technologies are not enough, even though a well-designed IT-architecture is essential to develop new products and processes (Fink, 2007). Evidence shows that social and organizational capital have both a positive relation with the adoption of innovations (Dost et al., 2016).

The ability to collect and manage multiple types of information is crucial for the innovation and exploitation of digital technologies (OECD, 2015). Managing Big Data (Lycett, 2013) is the key to create value, employing information that is usually already available and whose potential only needs recognition to be released (Fosso Wamba et al., 2015). No evidence of a widespread awareness of the importance of data is available, as academics proposed very few models to evaluate the maturity level of data management (Comuzzi and Patel, 2016). Thus, the main barriers to creating value through data and analytics are mainly managerial and cultural rather than related to technology (La Valle et al., 2011). Overcoming this barrier could lead to an improvement of intellectual and human capital (Secundo et al., 2017), which might benefit both businesses and individuals. Furthermore, the impact of data management is not limited to already existing business models, but it enables the creation of brand new data-driven business models (Hartmann et al., 2016).

Evidence shows that investments involving no human capital are more unlikely to lead to productivity gains, especially in small firms (Díaz-Chao et al., 2015). Additionally, a positive relation between product, service and process innovations with 'innovative human capital' has been observed, as well (McGuirk et al., 2015). Although there is no consensus that improving human and intellectual capital will enhance innovation in the broader sense (Buenechea-Elberdin, 2017), it seems essential to accomplish digital transformation and to have a positive impact on it (Cleary and Quinn, 2016). For instance, Cirillo (2016) shows that hi-tech industries, influenced by international contexts, are usually more productive and accompanied by an expansion of employment, requiring hi-skilled workers. Conversely, low-tech industries

require low-skilled workers, low wages, and highly-flexible labor. At present, learning by doing and intra-firm training are both essential. Evidence from Evangelista et al. (2014) indicates that life-long learning seems to be more important than formal education, with regard to digitalization.

Finally, openness to international markets has a positive impact on the innovation activities, in both large and small enterprises (Boermans and Roelfsema, 2016). Not only does a positive link exist between internationalization and innovation, but also between these two factors and productivity (Altomonte et al, 2013). Moreover, several empirical studies show a positive correlation between the use of digital technologies and the export activities (Morgan-Thomas and Jones, 2009; Higón and Driffield, 2011; Bianchi et al., 2016; Cassetta et al., 2016). However, almost all of them consider the front-end applications of digitalization, using variables such as the use of ICT, social media, e-commerce. Conversely, the digitalization of productive processes has so far been understudied.

3. Data and methodology

This research presents the results of a survey submitted to a sample of firms in the Italian region of Veneto. The firms have been selected on the basis of the number of their employees and production value. Manufacturing firms with at least 6 employees and a minimum of 1€ mln production value were selected. For construction firms, selection criteria were having more than 20 employees, while tertiary firms had to have at least 3 employees and a minimum value of production of 250€ thousands.

Table 3.1 shows the number of respondents, subdivided by sector. The composition of the sample was statistically tested. The chi-squared test (Pearson, 1900; Plackett, 1983) confirms that the composition of the universe and the sample correspond, both in terms of dimension and in terms of activities.

<i>Sector</i>	<i>Respondents</i>	<i>Percent of total</i>
Manufacturing	633	71,04%
Construction	56	6,27%
Tertiary	202	22,69%
Total	891	100%

Table 3.1: Respondents by sector.

The answers were weighted to adjust some minor differences in the composition of the sample. The adjustment did not invalidate nor distort the interpretation of the data. Sectors were identified according to the NACE rev. 2 classification. The subdivision was operated as follows: manufacturing NACE section C, construction NACE section F, tertiary NACE section J and M.

The following digital technologies were considered: robotics and automation, Industrial Internet of Things, smart products, 3D printing, Big data, mixed reality (virtual and augmented reality), virtualization of IT systems. The questionnaire contained a description of each technology, in order to clarify and facilitate the comprehension of the task.

The data about human capital are from 'Veneto Lavoro', a regional labor-market observatory. Meanwhile, the data on the import and export activities are from the Infocamere and the ISTAT databases. Finally, the financial data are from the AIDA database. All of those are firm-level data.

4. Main findings

4.1. The diffusion of the digital technologies

Table 4.1 shows to what extent the digital technologies are known and employed.

<i>Technology</i>	<i>Manufacturing</i>		<i>Construction</i>		<i>Tertiary</i>	
	<i>Knowledge</i>	<i>Use</i>	<i>Knowledge</i>	<i>Use</i>	<i>Knowledge</i>	<i>Use</i>
Robotics	52,66%	26,59%	32,08%	4,04%	29,81%	7,68%
Industrial Internet of Things	37,04%	13,84%	21,49%	9,37%	33,06%	9,25%
Smart products	27,35%	5,23%	23,05%	9,37%	28,86%	7,78%
3D printing	58,57%	8,34%	44,06%	1,56%	52,27%	6,68%
Big data	25,60%	9,49%	28,18%	12,94%	36,49%	20,96%
Mixed reality	32,45%	6,36%	30,66%	4,04%	37,60%	16,96%
Virtualization of IT systems	39,93%	16,87%	40,32%	30,22%	55,56%	45,21%

Table 4.1: Knowledge and use of digital technologies.

The width of the gap between the firms that declare to be familiar with some digital technologies and those which actually use them is shown in Table 4.1. Hence, the variations are shown among sectors and technologies. As expected, considerable differences in the diffusion of the technologies were shown among sectors. In a nutshell, the virtualization of IT systems was the most widely adopted technology, while others were more sector-specific.

No relation between the size of a firm and the number of technologies used could be detected. This evidence is consistent with the idea of different technology frontiers. Among the manufacturers of plastic products, it can be noticed that 89% of them uses robotics or automation, while none of them declares to have introduced sensors for “smart” products, just to make an example.

4.2. The clusters of technologies

Table 4.2 is meant to facilitate a deeper understanding of the technological frontiers, as it shows the combined percentages of two different technologies. For example, the 25,56% of the cases robotic systems would be combined with the Industrial Internet of Things.

	<i>Robotics</i>	<i>IloT</i>	<i>Smart products</i>	<i>3D printing</i>	<i>Big data</i>	<i>Mixed reality</i>	<i>IT systems virtualization</i>
Robotics		25,56%	7,35%	14,38%	17,25%	12,78%	22,68%
IloT	24,84%		11,18%	9,63%	17,70%	12,11%	24,53%
Smart products	12,57%	19,67%		12,02%	15,85%	11,48%	28,42%
3D printing	20,64%	14,22%	10,09%		11,01%	18,35%	25,69%
Big data	16,51%	17,43%	8,87%	7,34%		13,15%	36,70%
Mixed reality	16,33%	15,92%	8,57%	16,33%	17,55%		25,31%
IT systems virtualization	16,14%	17,95%	11,82%	12,73%	27,27%	14,09%	

Table 4.2: Percentage of combination of two different technologies.

Some technologies show a higher degree of complementarity than others. The most striking cases are robotics and IloT (25,56%), big data and IT systems virtualization (36,70%). Some frontiers can be identified just by looking at the numbers in Table 4.2. For instance, robotics, IloT, big data and IT systems virtualization have high percentages, as they are often used together.

The limited sample and, above all, the limited number of the technologies investigated does not allow a more in-depth analysis. However, the results of the survey provide some insights that the technological frontiers can play a significant role in understanding the impacts of digitalization. Hence, it would be helpful to analyse the different impacts and consequences that each of them can have (Evangelista et al., 2014).

5. Enabling factors

The present research takes into consideration the following enabling factors: quality of human capital, openness to international markets and financial structure.

5.1. Human capital

	<i>Manufacturing</i>		<i>Construction</i>		<i>Tertiary</i>		<i>Total</i>	
	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>
No skills	12,31%	10,91%	10,64%	16,65%	0,49%	3,88%	10,90%	10,80%
High skills	24,85%	21,35%	31,91%	14,01%	62,26%	30,56%	29,42%	21,51%
Medium skills	16,65%	16,93%	21,28%	13,53%	34,71%	54,96%	18,93%	19,44%
Low skills	46,18%	50,81%	36,17%	55,81%	2,55%	10,60%	40,75%	48,25%
High school	45,02%	42,61%	45,47%	30,78%	56,92%	49,69%	46,43%	42,33%
Degree	14,70%	8,05%	15,41%	4,17%	38,06%	34,57%	17,47%	9,77%
No education	1,87%	2,79%	2,98%	5,24%	0,45%	1,61%	1,77%	2,87%
Compulsory	38,41%	46,54%	36,14%	59,81%	4,57%	14,13%	34,33%	45,03%

Table 5.1: Composition of the workforce in 2014. The percentages are calculated on stock data.

Digital users and non-digital users show some differences in the composition of their workforce. Table 5.1 shows the composition of the workforce. The most significant finding is that digital users employ more highly-skilled workers, with a degree or high school education. This applies to all sectors, even though the difference is more evident in the construction and tertiary sectors. Furthermore, firms using technologies created more jobs in the period 2012-2014 (table 5.2). Specifically, the highest growth occurred for highly-skilled workers (10,01%). Additionally, the highest growth rate was recorded for workers with a degree (16,78%). Another important fact is that the firms surveyed are no longer hiring non-skilled workers. In this case, technology plays no role. Overall, the trend is an increase in highly- and medium-skilled jobs and a decrease in low-skilled ones.

	<i>Manufacturing</i>		<i>Construction</i>		<i>Tertiary</i>		<i>Total</i>	
	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>
No skills	-1,24%	-5,16%	-9,52%	21,93%	-20,00%	9,68%	-1,88%	-2,52%
High skills	12,48%	5,73%	11,76%	1,74%	2,81%	-2,19%	10,01%	4,68%
Medium skills	6,76%	3,75%	-2,56%	1,80%	2,88%	4,10%	5,27%	3,73%
Low skills	6,67%	1,43%	0,31%	6,15%	13,51%	10,71%	6,35%	1,93%
High school	12,18%	8,14%	1,15%	0,88%	3,76%	5,53%	10,22%	7,51%
Degree	23,28%	12,58%	19,00%	29,17%	1,72%	4,49%	16,78%	10,73%
No education	-5,53%	5,31%	-14,81%	160,00%	40,00%	-7,14%	-5,62%	13,14%
Compulsory	-0,40%	-4,15%	-0,71%	4,95%	-5,33%	-6,56%	-0,50%	-3,44%

Table 5.2: Stock growth from 2012 to 2014.

In the period 2012-2014, digital users exhibited a net occupational growth, creating 870 jobs, i.e. more than 75% of all the jobs created. Meanwhile, in the same years, non-digital users created 279 jobs. This is only partially consistent with the evidence from major European countries, where job creation is led by product innovation and an increase in the value added (Cirillo, 2016). Investments in machinery (that can be

considered comparable to the investments in new technology referred in this study) can be interpreted as a process innovation and thus should have a negative impact on employment.

5.2. Internationalization

The openness to international markets is one of the factors that can enable and accelerate the adoption and diffusion of digital technologies. The relation between import/export activities and the adoption of digital technologies is reported in the table 5.3 below.

	<i>Export</i>		<i>Import</i>	
	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>
Construction	30,35%	8,66%	48,51%	10,59%
Manufacturing	73,69%	58,27%	57,95%	47,39%
Tertiary	8,98%	3,70%	5,83%	8,30%

Table 5.3: Share of respondents that have export or import activities, distinguished in digital users and non-users.

According to the present analysis, digital users are more open to international markets. Such a relation can be seen from two different perspectives. First, digital technologies can represent both a requirement for and a consequence of internationalization. Hence, competing in international markets can be more challenging than on local ones, requiring firms to invest in digital technologies to reach the productivity levels required by the international competition. Thus, digital users have effectively higher productive ratios than digital non-users, as explained in section 5.3. At the same time, firms which operate in global value chains may have to adopt specific technologies to collaborate with their foreign partners.

5.3. Financial structure

Financial ratios have been analyzed to examine the impact of digital technologies on economic performances. Specifically, the present investigation focused on the profitability (ROS, ROE, and ROI), productivity (value added per employee) and capital composition (Leverage, Net financial position, Debt/Equity) of the firms. The comparison between average ratios is illustrated in table 5.4.

	<i>Manufacturing</i>		<i>Construction</i>		<i>Tertiary</i>	
	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>
ROS	6,17%	4,78%	5,67%	1,90%	5,75%	1,79%
ROE	13,65%	14,73%	19,61%	8,12%	23,71%	6,92%
ROI	15,47%	15,70%	6,36%	1,35%	32,04%	3,86%
Value added per employee (va)	65,27	56,45	73,89	49,98	60,62	65,08
leverage (L)	1,28%	1,52%	2,34%	1,29%	1,17%	2,07%
Net financial position (nfp)	4.413	669	11.467	1.919	121	973
debt/equity	1,03	0,82	0,70	1,80	0,47	1,37

Table 5.4: Average financial ratios, separating the firms which adopt digital technologies from those that do not. The value added per employee and the net financial position are reported in thousands of €.

Considering profitability ratios, higher returns can be observed for firms in construction and tertiary sector that employ digital technologies. Conversely, manufacturing shows no clear situation. In particular, digital users show a higher return on sales ratio, while ROE and ROI are higher for the digital non-users. The differences, however, are not very significant.

Additionally, the value added per employee is higher for digital users in manufacturing and in the construction sector. Conversely, in the tertiary sector, digital users show a lower ratio, suggesting that the use of digital technologies does not translate into significant improvements in productivity.

Finally, digital users generally show a better financial composition. No great differences are evident on the leverage ratio, all well below the limit of 3%. Additionally, the NFP is considerably higher for firms adopting digital technologies. Considering the NFP and Debt/Equity ratio jointly, it can be concluded that the digital users achieve a better financial position and use more equity than the digital non-users.

Low profitability ratios for digital users in manufacturing might be justified by a higher distribution of the value to human capital. Such a claim was made after examining the ratio between the labour cost (wL) and the value added (VA). Hence, it can be easily verified that a rise in wL (due to higher salaries, for example) leads to an increase in wL/VA. The assumption, thus, is that a higher ratio leads to a higher value added attributed to the workers, resulting in a lower business' profitability, i.e. a lower ROE and ROI. The same consideration can be drawn considering the EBITDA/VA ratio (or EBIT/VA, thus mitigating the weight of capital-intensive activities). In this case, though, a lower ratio would translate into a higher value added attributed to human capital.

Nevertheless, this explanation does not seem to apply to this study. Hence, table 5.5 shows the three ratios for each sector and the distribution appears clear: a higher value added created by digital users is not distributed to human capital.

	<i>Manufacturing</i>		<i>Construction</i>		<i>Tertiary</i>	
	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>	<i>Digital users</i>	<i>Digital non-users</i>
wL/va	0,63	0,76	0,71	0,86	0,71	0,84
ebitda/va	0,37	0,24	0,28	0,11	0,27	-0,02
ebit/va	0,26	0,12	0,19	0,03	0,17	-0,40

Table 5.5: Distribution of the value added between human and risk capital.

The justification for the low profitability of manufacturing users might lie on reinvestments of the created value. The implementation of digital technologies requires an investment and the higher value created might be reinvested in company's activities, instead of being distributed to shareholders. This would keep the ROI and ROE low. Although no data on the levels of investments are available, indications are pointing in this direction. For instance, the amount of the net fixed assets is four times higher for digital users (16€ million against 4€ million of digital non-users). This hypothesis needs to be tested in further studies, and also taking into consideration the differences across sectors which determine the investments in technological innovation (Aboal and Garda, 2015).

6. LOGIT model

To verify the role of just examined enabling factors on the adoption of digital technologies a LOGIT regression was used. The estimated model is:

$$P(Y_i = 1|f_{ij}, c_{ij}) = \frac{\exp^{\beta f_{ij}, c_{ij}}}{1 + \exp^{\beta f_{ij}, c_{ij}}} \text{ where } \beta f_{ij}, c_{ij} = \beta_0 + \beta f_{ij}, c_{ij}$$

The dependent variable represents the adoption of digital technologies, $Y_i = 1$ when a firm adopts technologies and $Y_i = 0$ when it does not. f_{ij} is a vector of variables related to enabling factors, while c_{ij} are control variables. 6 different regressions were run. Results are shown in Table 6.1.

In all the regressions, the size of the firm (measured by the number of employees) appears significant, although the estimated coefficient is rather low, indicating a limited role of this variable. Similar evidence from Portuguese firms indicates that the size of the firm does not necessarily correlate with the technological adoption (Faria et al., 2002).

A firm's activity in the international market, measured as the presence of import and/or export activities, is significant and correlates positively to the adoption of digital technologies. However, the variance analysis indicates that adding this variable does not improve the quality of the model. Thus, the level of internationalization does not seem to explain the impact of the phenomenon on the technological adoption.

	<i>Reg 1</i>	<i>Reg 2</i>	<i>Reg 3</i>	<i>Reg 4</i>	<i>Reg 5</i>	<i>Reg 6</i>
Intercept	-2,29 **	-2,50 *	-3,74 ***	-4,00 ***	-1,15 ***	-1,35 ***
Number of employees	0,01 **	0,01 **	0,01 *	0,01 *	0,01 ***	0,01 ***
Import/export	0,77 **	0,75 **	0,54 **	0,50 *	0,64 **	0,60 **
Sector manufacturing	-0,51	0,49	-0,48	-0,46	-0,51	-0,49
Sector tertiary	1,37 **	1,33 **	1,32 ***	1,26 **	1,08 **	1,07 **
% of employees with a degree	1,74 **		1,60 ***		1,65 ***	
% high-skilled workers		1,54 ***		1,64 ***		1,49 ***
Log(Net financial position)	0,07	0,07				
Log(EBITDA)			0,21 **	0,22 **		
Debt/equity					-0,01	-0,01

Table 6.1: Estimated coefficients and significance levels for different regressions. The dependent variable is the use of at least 2 technologies for manufacturing and at least 1 technology for construction and tertiary. Significance level codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

The model shows that manufacturing companies are not more likely to use technologies than those in the construction sector. Those in tertiary, however, show a significant positive coefficient in all regressions.

The most interesting result is certainly that of human capital. Thus, the model shows that the quality of human capital is positively related to the technological adoption. Moreover, the estimated coefficients are always the highest, indicating a role of primary importance for this variable. The two proxies for measuring the quality of the human capital used are the percentage of graduates among all employees and the percentage of highly-skilled workers. In both cases, results are similar, as the human capital is essential to use of technologies.

Finally, three different indicators were used to analyze financial health: the net financial position, EBITDA and debt/equity ratio. It can be noticed that the only statistically significant indicator is the EBITDA.

Therefore, the ability of the firm to create significant and steady earnings seems to positively relate to the adoption of digital technologies. Also, it should be kept in mind that each indicator is calculated on average over the last 9 years, then considered in logarithmic value.

	<i>Reg 1</i>	<i>Reg 2</i>	<i>Reg 3</i>	<i>Reg 4</i>	<i>Reg 5</i>	<i>Reg 6</i>
Intercept	-4,76 ***	-5,00 ***	-5,87 ***	-6,21 ***	-2,46 ***	-2,65 ***
Number of employees	0,01 *	0,01 *	0,01	0,01 .	0,01 ***	0,01 ***
Import/export	0,61 *	0,57 .	0,66 **	0,61 *	0,80 ***	0,76 **
Sector manufacturing	0,10	0,16	0,12	0,17	0,01	0,05
Sector tertiary	0,54	0,59	0,47	0,42	0,14	0,12
% of employees with a degree	1,64 *		1,48 **		1,49 **	
% high-skilled workers		1,38 **		1,53 ***		1,37 ***
Log(Net financial position)	0,18 *	0,18 *				
Log(EBITDA)			0,27 ***	0,28 ***		
Debt/equity					-0,01	-0,01

Table 6.2: Estimated coefficients and significance levels for the different regressions. The dependent variable is the use of at least 3 technologies. Significance level codes are as follows: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

Table 6.2 reports the results of imposing a stricter measure for digital users, requiring the use of at least three technologies in the company. The conclusions are in line with what has just been said. Specifically, the human capital maintains the most significant role, remaining the key in the use of digital technologies. Moreover, in the regressions 1 and 2, the Net Financial Position becomes significant, confirming financial health as one of the prerequisites for the adoption of technologies. This empirical evidence suggests that internal resources represent a strong drive toward the adoption the technological innovation, as in Guarascio and Pianta (2016).

Opening to foreign markets remains significantly positive, as in the previous regressions. In this case, the variance analysis indicates a significant contribution of the variable, which then increases the veracity of the model.

The indication of the sector, however, loses its statistical significance. In fact, in this case, there are no advantages associated with operating in one sector rather than another. Moreover, the size of the firm becomes even less important, appearing as non-significant in the regression 3. The use of digital technologies, therefore, seems to cut across sectors irrespective of the size of the company. Specifically, the enabling factors are those linked to the internationalization, human capital and financial health. This conclusion is particularly relevant when a stricter definition of “digital user” is adopted.

7. Conclusion

The diffusion of the digital technologies in the Italian region of Veneto varies across industries. Moreover, the present analysis shows the existence of different technological frontiers among sectors. Therefore, further studies are needed to identify the different cluster of technologies and verify the potentially different effects these could have on the social and economic systems.

The analysis of the skill composition suggests that digital users are characterized by more highly-skilled and high-educated workers than digital non-users. These two characteristics are surely the most significant, as confirmed by the LOGIT models. Evidence from this study shows also that the digital users are mainly hiring skilled and educated workers. In the period 2012-2014, the digital users from the present sample recorded a net occupational growth, creating 870 jobs. Meanwhile, during the same years, the digital non-users created 279 jobs.

A positive correlation can be observed between internationalization and the adoption of digital technologies. This applies to the manufacturing and construction sector, but not to the tertiary. In the present regression model, the openness to international markets plays a significant role but only if digital-users are strictly defined (i.e. at least 3 technologies are used). Thus, the relation can be examined from a dual point of view. First, the internationalization is simultaneously a consequence and a requirement for the use of technologies. Second, an intense competition on the international markets needs flexibility and productivity levels allowed by the digitalization. At the same time, the growing need for global supply chain integration can be satisfied almost exclusively through the ICT related technologies.

Overall, digital users record a better productivity index than digital non-users. Conversely, the financial effect is less clear. Hence, the net financial position is higher for the digital users, while the profitability ratios are similar for the manufacturing. Moreover, the stable ROI and ROE might be linked to the investments required to adopt the technologies and should be observed over time. The LOGIT models confirm that a solid financial structure facilitates the adoption of digital technologies.

Factors enabling an efficient use of digital technologies have to be identified to redirect companies and public investments. The present study and several others underline the value of the intangible assets. Specifically, the specialized workforce, quality relations with suppliers, the know-how of companies, wise management and accurate organization all allow a profitable exploitation of the digital technologies. Hence, the adoption of a single technology is in itself necessary, but far from sufficient. Therefore, the regression models elaborated here suggest the crucial role of the human capital, emerging as a key factor in the adoption of the digital technologies.

To capture all the potential value that digital transformation can add, it is necessary to broaden the horizons and go beyond the technological aspect. Hence, a supporting ecosystem can promote and facilitate the adoption of technologies is essential to enable companies to keep up with their competitors. In doing so, any ideological position on revolutions and new industrial paradigms shall be disregarded. Each company would choose its own model, on the basis of its tradition and needs. Therefore, imposing the same business model to all is certainly not feasible and would surely deplete all the efforts made and the potential benefits deriving from the implementation of the model.

The complicated 'job vs technology' issue shall also be questioned. Clearly, the labor market needs to adapt and adjust. However, the concerns about replacing human workers with robots are often likely to be speculative and not based on reality. Although the data presented in this work are limited and call for further analysis, they suggest that the human capital is one of the most crucial elements for the digital transformation. Specifically, field work conducted for this project clearly shows that the technological

upgrade is generally accompanied by an employment growth, especially in the SMEs. This is very important in fragmented systems where no big players dominate the market, as in the case of Italy and most of Europe. Therefore, understanding the actual situation is crucial to realize the benefits and avoid the negative effects, whether we are observing a revolution or not.

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