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RETRACTED: The impact of regulatory quality on the digital economy: new insights from Italian regions

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Abstract

Purpose – This article seeks to ascertain whether institutional quality has a positive impact on the digital economy.

Design/methodology/approach – By minimizing heterogeneity concerns, we examine the direct impact of regulatory quality upon digital economy using an informative homogenous sample of twenty Italian regions from 2004 to 2019. To address simultaneity and endogeneity concerns, a 2SLS technique was used.

Findings – The empirical findings support the positive impact of regulatory quality on the digital economy. As a result, the most virtuous regions in terms of effective regulation execution encourages the development of the digital economy, with favorable consequences on economic activity and the path of the economic growth.

Practical implications – This paper provides new insights into how institutional quality enhances digital economy, offering valuable implications for policy development aimed at contributing economic growth.

Originality/value – The digital economy has evolved significantly over time, forcing businesses to adjust, especially by promoting smart and agile working practices. This paper adds to the body of existing literature examining whether institutional quality—in particular, regulatory quality—contributes positively to the digital economy.

Keywords Digital economy, Regulatory quality, Italian regions

Paper type Research paper

1. Introduction

As is widely known, the phenomenon of digital economy has grown dramatically over the years, requiring businesses to adapt to the circumstances, particularly by supporting agile and smart working. Digital technologies have permeated almost every aspect of economic activity since their inception in the mid-twentieth century, transforming production patterns (for example, through automation, industry 4.0, the Internet of things, digital twins) and consumption patterns (infrastructure, software, platforms). According to The European Commission (2016), digitization has the potential to improve global economic growth by up to USD 3.7 trillion while also serving as a powerful anti-corruption tool (Andersen *et al.*, 2011).

According to Goldfarb and Tucker (2019), the basis of digital technology is the binary-digits (or "bits") structure for storing information, which has facilitated data processing, storage and exchange and resulted in significant cost savings.

Along with changes in integration, demographics and climate, the rise of digital technologies, also known as digitalization, is one of the most significant transformations influencing microeconomic allocation (relative prices and preferences, as well as market functioning). Digitalization, like other ongoing structural developments, has the potential to have far-reaching effects for modern economies and society. Milkau and Bott (2015) argue that "digitalisation has not changed the fundamental laws of economics but has triggered changes in how agents interact in the market or intermediaries facilitating this interaction".

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Prior research has looked into numerous areas of digitalization's effects, at least qualitatively. This includes the macroeconomic consequences of digitalization, specifically on productivity and labor markets. While new technologies affect industries differently, they generally contribute to productivity increases at the firm level, with more productive enterprises being more digital on average (see, for instance, Gal *et al.*, 2019; OECD, 2019).

The general-purpose nature of digital technologies (Trajtenberg, 2018) and/or such technologies being inventions in the way of invention (Cockburn *et al.*, 2018) add to the productivity-boosting effect. The literature stresses the so-called productivity puzzle, in which GDP growth is significantly lower than expected in an era of fast technological advancement, which appears to contradict firm-level evidence. This demonstrates that, as mentioned by Gordon (2016), there may be negative effects of technology on productivity, even if they are more difficult to quantify, such as the use of digital and non-digital systems concurrently, or the repercussions of distraction and/or addiction.

Some authors (Acemoglu and Restrepo, 2019; Acemoglu, 2012; Acemoglu *et al.*, 2005) argue that digital technologies have the potential to either augment and amplify human skills (which would complement labor) or, conversely, re-place human capabilities (which would replace labor), as proposed by Trajtenberg (2018). According to Acemoglu and Restrepo (2019), digital technologies have the potential to replace labor in routine and repetitive tasks, resulting in the elimination of those jobs that rely significantly on them. In this sense, polarization of the labor market may result from digital technology, as it did from prior technologies.

Nonetheless, the way that digital transformation affects public services depends heavily on the institutional environment. The effective integration of digital technologies in public sectors is determined by institutions, which include legislation, norms and policies (Edvardsson *et al.*, 2014; Koskela-Huotari *et al.*, 2016). Sazanova and Kuznetsov (2020), for example, point out that in order to maximize the advantages of digital technology and minimize any potential inequality, it is imperative that appropriate institutional frameworks are in place. Pestoff and Brandsen's (2010) research provides additional evidence for the idea that institutional rules and governance play a crucial role in shaping innovation and service delivery in the public sector.

Although the literature has previously explored the relationship between institutions and economic growth (Acemoglu and Robinson, 2010), digital economy and economic growth (Habibi and Zabardast, 2020; Myovella *et al.*, 2020; Zhang *et al.*, 2021; Li and Wu, 2023) and digital economy and institutions on economic growth (Olofin, 2024), to our knowledge, little attention has also been paid to examine the direct impact of institutions on the digital economy (De Pascale *et al.*, 2024) [1]. By examining the role of institutional quality on digital economy in Italy, this paper seeks to fill the gap in the literature. Moved by this promise, this paper adds to the previous literature debate by providing evidence about the role of institutional quality—in particular, regulatory quality—on digital economy. In this regard, we will attempt to respond to the following research question:

RQ1. Is regulatory quality beneficial to the digital economy?

Some literature-based works provide support to our hypothesis. Labhard and Lehtimäki (2022), for instance, posit that the growth effects of digitalization may be stronger in the presence of high-quality institutions and governance, with the degree to which this is dependent upon measurement methods. This result is based on an examination for several country groups (EU, OECD and the study's overall sample, which consists of 101 nations worldwide), covering the years 1996–2019 (up to a maximum of 24 years). Strong evidence also supports the idea that higher-quality institutions and governance have a larger positive impact on digitalization.

To study the nexus between regulatory quality and digital economy, we employ a representative sample of twenty Italian regions (from 2004 to 2019) that are homogeneous, eliminating concerns about heterogeneity that may have an adverse impact on the empirical findings. Using this sample, we can discern between territorial and institutional variability. Basically, ISTAT gathers data on the digital economy (pc adoption in businesses), while Nifo and Vecchione (2014, p. 1,633) gather data on regulatory quality, which includes the level of economic openness, the business environment and the capacity of local authorities to support and promote business activity. The ability of local administrators to support and safeguard economic activity would be implied by higher regulatory quality (refer to Section 3 for more information regarding the definition of regulatory quality). To contribute to the growth and productivity of the region, this would require the regions to make larger expenditures (i.e. investments) to be involved in the process of digital economy. Therefore, higher-quality regulations would raise the level of the digital economy, allowing companies to establish commercial networks (both in a domestic and worldwide setting) that may foster innovation and economic growth. This suggests that the success of digitalization in promoting economic growth depends in large part on the quality of the institutions involved. As expected, the empirical findings, which also account for the endogeneity problem using two instruments suggested by Tabellini (2010) (i.e. regional literacy rates at the end of the nineteenth century and executive limitations on local political institutions from 1600 to 1850), show that regulatory quality has a positive impact on the digital economy. As a result, the most virtuous regions in terms of efficient regulation execution can encourage the development of the digital economy, which has a favorable impact on economic activity and leads to higher levels of economic growth.

The remainder of the paper is organized as follows: Section 2 presents a literature review on the relationship of institutions and the digital economy. Section 3 provides data and source used in this analysis. The approach used to analyze the effect of regulatory quality on the digital economy is described in Section 4. Section 5 contains statistics and correlations about institutions, digital economy and factors for the Italian regional context. Section 6 provides empirical evidence for the proposed econometric estimates, while Section 7 discusses a battery of robustness tests. Section 8 concludes by discussing and shedding light relevant policy implications.

2. Institutions and digital economy

Since North’s groundbreaking research in 1991, which demonstrated that institutions shape contemporary economies and are significant (positive or negative) drivers of economic growth, many economic activities have been stimulated by institutions, which should be taken into consideration when modeling growth, even though they may be seen as “background forces” that support the basic neoclassical model rather than core elements.

Indeed, North (1991) made an early reference to the relationship of institutions and technology, saying that “an institutional framework [. . .] allows [. . .] to capture the potential economic benefits of modern technology”.

Murphy *et al.* (1993) also noted that poor quality institutions may slow down economic activities, causing economic agents to remain engaged in redistributive politics with lower economic returns rather than growth-promoting economic activities, whereas good quality institutions may promote incentive structures that spur economic growth by reducing uncertainty and promoting efficiency (North, 1991). In addition, Hall and Jones (1999) contended that a nation’s institutions determine the total productivity of its factors of production. Bernard and Jones (1996) also point out that the adoption of new technology by a nation can be facilitated by high-quality institutions, thereby leading to development.

Acemoglu *et al.* (2005), who explore the significance of institutions from many viewpoints and investigate historical data on the reasons for changes in institutions between countries, also show the importance of institutions for economic growth (or, as he calls it, development). More recently, Acemoglu and Robinson (2010) found that institutions have an important and fundamental role in determining economic growth and development stages across countries.

Nelson (2005) first noted the importance of taking institutions into account alongside industrial structure when analyzing economic growth driven by technological change, as well as the fact that institutions exhibit a wide range of characteristics that must be considered when attempting to understand economic growth. Several researchers began to investigate the growth consequences of governance, although with a narrower definition than that utilized in this study.

Gradstein (2004), for example, gives evidence of a positive growth effect of property rights, while Mendez-Picazo and Ribeiro-Soriano (2012) indicate to a considerable indirect influence of governance on growth through effects on entrepreneurship.

This study takes the approach of looking at the direct impact of institutional quality on digital economy, after accounting for different contextual factors, such as economic activity, evolution of financial system, degree of globalization, regional inequality, human capital development, population's level of youth, population's wealth level. This association should be studied further because the interaction may have more growth benefits. Indeed, economic agents benefit from digitalisation and institutions, for example, by creating a framework for market transactions, ensuring accountability for stakeholders (for example, by improving the traceability of agents and acts) and enabling enforcement.

An example may help to clarify some of the working mechanisms. Consider an economy with high-quality institutions but limited digital technology, such as no digital communication tools or platforms, or any complementary human capital required to use such tools or platforms. This would most certainly result in less investment and growth since information on investment opportunities would be costly or out of date, making investing risky.

However, there are two instances in which the contact is especially important. The first area is to digitalize institutions and governance. Institutions are becoming more likely to fulfill their mandates and achieve their objectives because of the adoption of digital technology, contributing to a more favorable climate for growth. The second area is digitalisation, institutions and governance – how the process of digitalisation is carried out, both the organizations and the checks and balances that are in place to accompany that process, as opposed to pure self-governance, which is common in the context of new technologies. A proper digitization policy will raise the likelihood that the process will be inclusive and favorable to greater growth rates.

3. Data and variables

Various data sources were combined using the NUTS2 code retrieved from ISTAT to analyze the relationship between digital economy and regulatory quality in Italian regions. In this way, we were able to achieve a perfect coincidence in combining data from the 20 Italian regions during a 15-year period (2004–2019). The information on regional digital economy comes from the Italian Statistical Office (ISTAT), while data on regulatory quality were obtained from Nifo and Vecchione (2014). Basically, the regulatory quality index, which ranges in the [0,1] interval, with higher scores indicating higher levels of regulatory quality, "comprises information concerning the degree of openness of the economy, business environment and, hence, the ability of local administrators to promote and protect business activity" (Nifo and Vecchione, 2014, p. 1,633). We also employ a number of regional contextual factors (e.g. NUTS2) to control for economic and financial activities, socioeconomic conditions and degree of globalization as follows (for a more detailed explanation of these controls, see Equation (1) in Section 4.1).

4. Methodology

4.1 OLS regression

First, the effect of regulatory quality on digital economy is investigated using a simple OLS regression. The model is formalized as follows:

$$ln\,(DE)_{i,t} = \beta_0 + \beta_1 (REG)_{i,t} + \vartheta \sum \ln\,(Z)_{i,t} + \eta_i + \tau_t + \varepsilon_{i,t} \quad (1)$$

where *ln* stands for natural logarithm, *DE* denotes total digital economy using as proxy the pc adoption in businesses [2], *REG* is the regulatory quality indicator proposed by Nifo and Vecchione (2014) [3], whereas *Z*, on the other hand, is a vector of control variables designed to capture the impact of various environmental conditions on digital economy (for further details, refer to Table 1), such as: *GDP* is the gross domestic product to inhabitant accounting for economic activity; *FD*: private bank credit as a percentage of the Gross Domestic Product controlling for evolution of financial system; *EXP* denotes export measured as the value of exports as a percentage of the Gross Domestic Product adjusting for degree of globalization; *GINI* represents the proxy of income inequality, incorporating rents) [4] adjusting for regional inequality; *GRAD* is the percentage of graduates in the 25–64-year-old population (Human capital stock) accounting for disparities in human capital between areas; this indicator has been highlighted as one of the primary factors of regional productivity in the modern economy controlling for human capital development; *POP* is the average age of the population, in years, adjusting for population's level of youth; *INC* is the disposable income to population (in current prices) adjusting for population's wealth level. Finally, η is an unobserved macro area-specific effect controlling for heterogeneity effect (such as the different level of technology or growth), τ represents a set of time dummies adjusting for time-specific effects or exogenous shocks (such as the recent advent of financial crisis), while ε is the disturbance terms.

Table 1. Definition of the variables

Variables	Definitions	Source
DE1 (benchmark)	PC adoption in businesses	Istat
DE2	Broadband deployment in businesses	Istat
DE3	Website proliferation in businesses	Istat
DE4	Degree of Internet use in businesses	Istat
REG	Regulatory Quality	Nifo and Vecchione (2014)
CORR	Control of Corruption	Nifo and Vecchione (2014)
GOV	Government Effectiveness	Nifo and Vecchione (2014)
RULE	Rule of Law	Nifo and Vecchione (2014)
VA	Voice and Accountability	Nifo and Vecchione (2014)
IQI_MEAN	Institutional Quality (Mean)	Nifo and Vecchione (2014)
IQI_PCA	Institutional Quality (PCA)	Nifo and Vecchione (2014)
GDP	Gross domestic product to inhabitant	Istat
FD	Private bank credit as a percentage of the Gross Domestic Product	Istat
EXP	Exports as a percentage of the Gross Domestic Product	Istat
GINI	Income inequality, incorporating rents	Istat
GRAD	Percentage of graduates in the 25–64-year-old population	Istat
POP	Average age of the population, in years	Istat
INC	Disposable income to population (in current prices)	Istat

Source(s): Authors' elaboration on ISTAT and Nifo and Vecchione (2014) data

Subscripts i (1, . . ., 20) and t (2004, . . ., 2019) refer to regions and time periods (years) [5], respectively.

To assess the accuracy of our model, we employ the VIF (Variance Inflation Factors) test to handle the possibility of multicollinearity. This test frequently yields values less than 10, which show that multicollinearity is absent and that the estimated model is correctly identified [6]. Stata 18 is used to run each regression model estimated for this study, while the standard errors are clustered at regional level.

4.2 2SLS regression

The potential endogeneity of our regulatory quality measure due to reverse causality problems poses a significant risk to the OLS estimator's application and could lead to conflicting results. To be more precise, while it is true that a stronger regulatory framework fosters a more robust digital economy, a stronger digital economy may also necessitate higher institutional quality. In order to tackle these issues, we examine the influence of regulatory quality on the digital economy in Italian regions using an Instrumental Variable approach based on the Two-Stage Least Squares (2SLS) model [7]. The model is estimated formally as follows:

$$ln\,(DE)_{i,t} = \delta_0 + \delta_1 (REG)_{i,t} + \varphi \sum \ln\,(Z)_{i,t} + \eta_i + \tau_t + \varepsilon_{i,t} \quad (2)$$

$$REG_{i,t} = \gamma_0 + \gamma_1 (INSTR)_i + \omega \sum \ln\,(Z)_{i,t} + \eta_i + \tau_t + \varepsilon_{i,t} \quad (3)$$

where Equation (2) represents the second stage regression and Equation (3) denotes the first stage regression. *INSTR* refers to the instruments proposed by Tabellini (2010) to address the endogeneity problem, such as: (1) regional literacy rates at the end of the nineteenth century (LIT) and (2) executive limitations on local political institutions from 1600 to 1850 (INST). Specifically, the instruments affect regulatory quality in the first stage (Equation (3)), but the indirect effect of the instruments modifies the impact of regulatory quality on the digital economy in the second step (Equation (2)), allowing to control for endogeneity issue. In other words, the impact of regulatory quality on digital economy (second stage) is mitigated by the influence of instruments (first stage). To justify the use of the instruments to address the endogeneity problem, the reduced form, which evaluates the direct impact of the instruments on the digital economy, was evaluated [8]. To determine whether the instruments utilized (i.e. INST and LIT) address the endogeneity issue, we additionally perform a number of diagnostic statistics as per customary. The exogeneity test really shows that endogeneity exists. In our situation, the test with the over-identifying restriction (Hansen J) validates the validity of the instruments used, while the *F*-test on the first-stage instruments removes the weaker instruments (since the test should be more than 10% as a rule to validate the exclusion of weak instruments).

5. Results and discussion

5.1 Summary statistics

Table 1 describes the variables employed, whereas Table 2 presents an overview of the variables dispersed for the three Italian macro-areas (North, Center and South) in order to capture the main environmental differences.

Although the variations are insignificant, the digital economy, as measured by PC adoption in businesses (DE1), is lower in the Southern areas (0.9627) than in the Northern (0.9792) and Central (0.9636) regions. The same pattern emerges when various digital economy proxies are employed (refer to DE2, DE3 and DE4). There are major differences in regulatory quality (REG) amongst macro regions. Southern regions have lower levels of regulatory quality (0.3410) than Northern (0.6733) and Central (0.6477), highlighting the sharp division between the South and the Central–North. The same pattern exists for the other institutional quality

Table 2. Summary of statistics

Variables	North M	SD	Center M	SD	South M	SD	Italy M	SD
DE1	97.9296	1.8922	96.3697	2.7001	96.2701	2.8593	96.9538	2.5997
DE2	85.1405	13.7471	82.4561	14.5665	79.6390	17.9367	82.4030	15.8524
DE3	66.1946	10.3131	60.6877	8.5155	50.7814	9.2478	58.9279	11.7962
DE4	35.1835	8.4236	35.3493	11.3832	24.9432	7.3889	31.1205	10.0548
REG	0.6733	0.1192	0.6477	0.0945	0.3410	0.1301	0.5352	0.1987
CORR	0.8875	0.0688	0.9129	0.0559	0.6260	0.1899	0.7880	0.1857
GOV	0.4615	0.1359	0.4438	0.0993	0.2257	0.1096	0.3636	0.1639
RULE	0.7565	0.1500	0.6163	0.1264	0.3688	0.1707	0.5734	0.2331
VA	0.7348	0.1075	0.6454	0.0751	0.3911	0.1710	0.5794	0.2053
IQI_MEAN	0.7699	0.0978	0.6765	0.1004	0.3233	0.1425	0.5726	0.2379
GDPC	32866.7969	4002.2399	28471.8750	3564.3058	19295.3125	2365.0626	26559.2188	6998.7763
FD	52.6384	13.9030	55.9800	8.3591	33.3425	6.9346	45.4076	14.5204
EXP	24.8563	8.9303	19.9553	8.4128	13.9729	14.0864	19.5228	12.1875
GINI	26.5305	1.6117	27.2531	2.2091	29.5891	2.2977	27.8984	2.4660
GRAD	8.6903	1.5687	9.9667	1.8288	7.6521	1.3449	8.5303	1.7590
POP	44.9469	1.8098	45.0594	1.1666	43.0273	1.9239	44.2016	1.9925
INC	68058.1072	61218.1495	52937.6954	35028.8452	32768.5133	23890.8515	50918.1872	47036.7187
Obs	128		64		128		320	

Note(s): M: Mean; SD: Standard Deviation; North: northeast and northwest; Center: center; South: south and islands
Source(s): Authors' elaboration on ISTAT and Nifo and Vecchione (2014) data (for further information on definitions, refer to Table 1)

indicators (CORR, GOV, RULE, VA), including the composite indicator (IQI), emphasizing the disparity between the Northern and Central regions and those of the South.

The statistics of the control variables are provided to comprehend the reference framework and the differences between the Italian macro regions. According to the criteria used to capture regional differences, the statistics confirm that the Central regions have a higher human capital stock than the Northern and Southern areas. The Northern regions, as expected, hold higher disposable income, GDP per capita, financial development and trade openness than the Central and Southern regions. Finally, the Southern regions have higher levels of income inequality than the Northern and Central regions.

5.2 Pairwise correlation

Table 3 shows the pairwise correlations between the primary variables used in this paper's econometric study [9] and digital economy. As expected, there is a positive and strongly correlation between regulatory quality and digital economy. This could imply a positive relationship between the two measurements, while it does not rule out simultaneity or reverse causality. According to the association between digital economy and control variables, we find that GDP per capita, disposable income and trade openness are positive and highly strongly correlated with the digital economy. However, no meaningful relationship is discovered between the remaining controls and the digital economy.

5.3 Stylized facts

For simplicity, the regulatory quality index suggested by Nifo and Vecchione (2014) is plotted against digital economy at the regional level. This approach allows us to comprehend the link that exists between the two economic magnitudes under investigation. Figure 1 depicts a direct link between the digital economy and regulatory quality. This suggests the existence of a positive relationship between the two measurements. Figure 1 illustrates the strong relationship between the digital economy and regulatory quality in the Northern regions (Trentino, Valle D'Aosta, Piemonte, Veneto, Friuli-Venezia Giulia, Emilia Romagna and Lombardia) compared to the Southern (Puglia, Calabria, Campania and Sicilia) and Central (Lazio and Umbria) regions. Stated differently, this trend is primarily explained by the Northern regions [10].

Figure 2 depicts an overall downward trend in regulatory quality across the sample period, with maximum values in 2006 and 2014. This could imply that the standard of rule implementation has deteriorated over time. This could have impacted the stages of digital economy, as well as economic activity.

Instead, Figure 3 displays an overall upward trend in digital economy during the sample period, with minimum values in 2004, 2010 and 2018. This suggest that the expansion of the digital economy throughout time has made it possible for administrative processes to be completed more quickly. Additionally, this process enhanced agile and smart working.

Lastly, Figure 4 shows how the digital economy and regulatory quality are distributed, which helps to explain the differences among Italian regions. As expected, the Northern regions (dark blue) have higher levels of regulatory quality and digital economy than Central and Southern regions (light blue).

6. Empirical evidence

6.1 Baseline estimates. OLS versus 2SLS

The key findings of the effect of regulatory quality on the digital economy (proxied by pc adoption in businesses) are presented in Table 4, which includes both OLS and 2SLS regressions. As expected, we find that regulatory quality has a positive and statistically significant effect on digital economy when OLS regression is employed. In other words, the implementation of effective regulations that promote and safeguard business activity tends to

Table 3. Pairwise correlation

	DE1	DE2	DE3	DE4	REG	GDPC	FD	EXP	GINI	GRAD	POP	INC
DE1	1.00											
DE2	0.53***	1.00										
DE3	0.46***	0.62***	1.00									
DE4	0.37***	0.71***	0.75***	1.00								
REG	0.20**	0.10	0.54***	0.38***	1.00							
GDPC	0.31***	0.28***	0.68***	0.63***	0.86***	1.00						
FD	0.14	0.24***	0.53***	0.36***	0.64***	0.61***	1.00					
EXP	0.20**	0.26***	0.36***	0.22**	0.19**	0.17*	0.29***	1.00				
GINI	−0.04	0.04	−0.34***	−0.04	−0.67***	−0.53***	−0.45***	−0.11	1.00			
GRAD	0.12	0.58***	0.63***	0.85***	0.32***	0.48***	0.41***	0.19**	−0.03	1.00		
POP	0.14	0.44***	0.46***	0.56***	0.39***	0.41***	0.41***	0.28***	−0.38***	0.65***	1.00	
INC	0.18*	0.18*	0.37***	0.43***	0.11	0.30***	0.31***	0.15	0.19**	0.28***	−0.05	1.00

Note(s): $*p < 0.10$, $**p < 0.05$, $***p < 0.01$; DE1: pc adoption in businesses; DE2: broadband deployment in businesses; DE3: website proliferation in businesses; DE4: degree of Internet use in businesses
Source(s): Authors' elaboration on ISTAT and Nifo and Vecchione (2014) data (for further information on definitions, refer to Table 1)

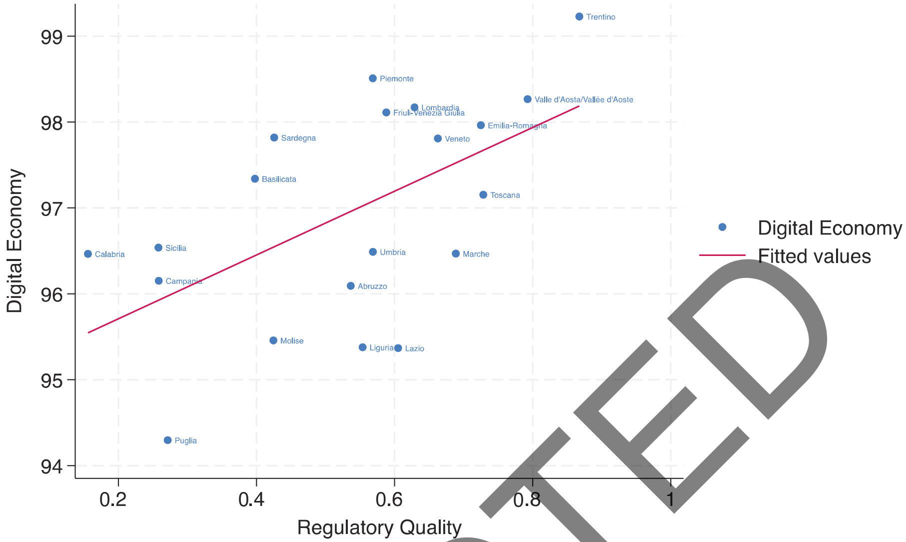

Figure 1. Digital economy and regulatory quality (by region). Note: Digital economy (DE1): pc adoption in businesses. Source: Authors' elaboration on ISTAT data

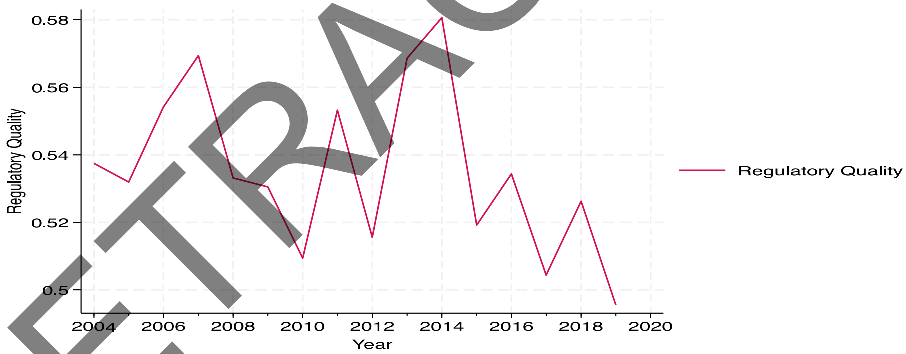

Figure 2. Regulatory quality (time series). Source: Authors' elaboration on Nifo and Vecchione (2014) data

improve the digital economy, with a significant impact on the innovation and economic activity. The results are likewise validated when we adopt 2SLS regression, which uses the two instruments suggested by Tabellini (2010) to handle the endogeneity issue [11]. The 2SLS regressions report both the effects of the two instruments on regulatory quality (first stage) and the effect of regulatory quality (cleansed through the impact of the two instruments) on digital economy as a result of the two instruments (second stage) [12].

In this regard, we provide three specifications: the first two make use of the instruments singly, while the third makes use of them both simultaneously. The two instruments are always statistically significant, indicating that the mechanism and then the identification of the model is correctly specified, pointing out the two instruments solve the issue of endogeneity.

The *p*-values of the Hansen test and the *F*-statistic are reported in Table 4 to evaluate the validity of the instruments' set and to assess whether the instruments are weak, respectively. Moreover, we also report the Durbin-Wu-Hausman-test (DWH) for endogeneity test defined

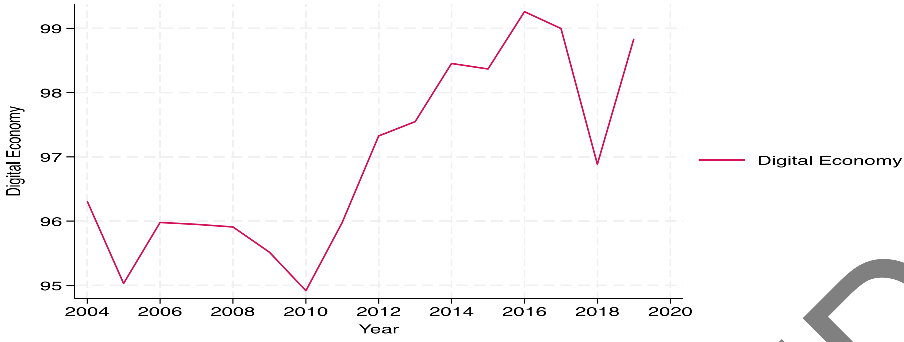

Figure 3. Digital economy (time series). Note: Digital economy (DE1): pc adoption in businesses. Source: Authors' elaboration on ISTAT data

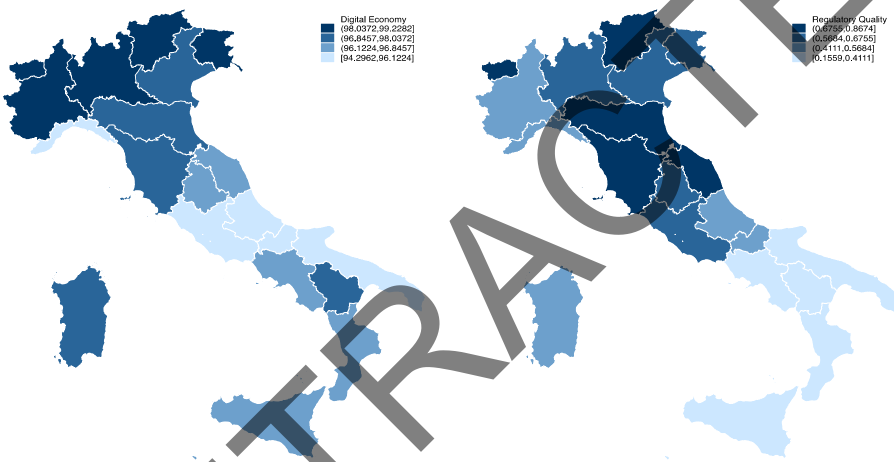

Figure 4. Map of digital economy and regulatory quality in Italian regions. Note: Digital Economy (DE1): pc adoption in businesses and regulatory quality. Source: Authors' elaboration on ISTAT and Nifo and Vecchione (2014) data

as the difference of two Sargan–Hansen statistic (one for the equation with the smaller set of instruments, where the suspect regressor(s) are treated as endogenous, and one for the equation with the larger set of instruments, where the suspect regressors are treated as exogenous). Basically, the test statistic is distributed as chi-squared with degrees of freedom equal to the number of regressors tested. For the Hansen test (over-identification restriction), a p-value larger than 10% gives favorable evidence for the validity of the instruments used. In the case of the F-statistic, a threshold value greater than 10 indicates that the instruments utilized are not weak. The validity of such tests demonstrates that the model is correctly specified, removing any uncertainty regarding its identification. Moreover, the endogeneity test indicates that a p-value lower than 10% provides favorable evidence that the regulatory quality (endogenous regressor) must be treated as endogenous, giving credit to our empirical design based on IV approach. Furthermore, as a goodness-of-fit measure, we additionally report the adjusted R^2. This indicator shows that our model explains 50% of the phenomenon under investigation.

In terms of control variables, we find that financial development and economic growth have no effect on the digital economy; on the other hand, public spending and the number of

Table 4. Digital economy and regulatory quality

	OLS	FS (1)	2SLS (1)	FS (2)	2SLS (2)	FS (3)	2SLS (3)
LIT		0.0115 [0.0015]***				0.0124 [0.0015]***	
INST				−0.0232 [0.0056]***		−0.0307 [0.0047]***	
REG	0.048 [0.013]***		0.108 [0.038]***		0.204 [0.072]***		0.133 [0.033]***
ln(GDPC)	−0.003 [0.002]*		−0.002 [0.002]		−0.001 [0.002]		−0.001 [0.002]
ln(FD)	0.006 [0.008]		−0.004 [0.010]		−0.021 [0.017]		−0.007 [0.011]
ln(EXP)	−0.004 [0.003]		−0.008 [0.003]**		−0.014 [0.005]***		−0.010 [0.003]***
ln(GINI)	0.037 [0.022]*		0.051 [0.025]**		0.072 [0.032]**		0.058 [0.025]**
GRAD	−0.007 [0.002]***		−0.009 [0.002]***		−0.011 [0.003]***		−0.009 [0.002]***
POP	0.002 [0.001]*		0.004 [0.001]**		0.006 [0.002]***		0.005 [0.001]***
ln(INC)	−0.000 [0.002]		0.004 [0.003]		0.010 [0.005]**		0.006 [0.002]**
Adj-R^2	0.462		0.459		0.456		0.480
F-test (FS)	–		56.34		17.14		45.12
H-test (*p*)	–		–		–		0.188
DWH-test (*p*)	–		0.077		0.010		0.007
Macro FE	Yes		Yes		Yes		Yes
Time FE	Yes		Yes		Yes		Yes
Period	2004–2019		2004–2019		2004–2019		2004–2019
Obs	312		312		312		312

Note(s): $*p < 0.1$; $**p < 0.05$; $***p < 0.01$; standard errors clustered at regional level in brackets; Digital Economy (DE1): PC adoption in businesses; FS: 1st Stage; *F*-test: *F*-test on excluded instruments; *H*-test: Hansen J test on over-identifying restrictions; Durbin–Wu–Hausman-test (DWH): endogeneity test defined as the difference of two Sargan–Hansen statistic
Source(s): Authors' elaboration

graduates considerably diminish the digital economy, while population, disposable income and income inequality greatly enhance it.

In all regressions, we incorporated both macro area fixed effects (using South and Islands as a control group) to account for territorial heterogeneity (e.g. different policy implementation speeds result in varying degrees of technology and investment) and time fixed effects to account for the presence of exogenous factors (e.g. financial and debt crises) which could produce bias in the estimates.

7. Sensitivity analysis

To validate our empirical analysis, we move to employ different proxies of digital economy, such as: (1) broadband deployment in businesses (DE2), (2) website proliferation in businesses (DE3) and finally (3) degree of Internet use in businesses (DE4) (for further information about definitions, refer Table 1). The empirical findings, provided in Tables 5–7, for the three separate indices of digital economy, confirm the favorable influence of regulatory quality on the digital economy, both in the OLS and 2SLS regressions [13]. This evidence highlights the

Table 5. Digital economy and regulatory quality

	OLS	FS (1)	2SLS (1)	FS (2)	2SLS (2)	FS (3)	2SLS (3)
LIT		0.0115 [0.0015]***				0.0124 [0.0015]***	
INST				−0.0232 [0.0056]***		−0.0307 [0.0047]***	
REG	0.091 [0.042]**		0.112 [0.107]		0.515 [0.212]**		0.186 [0.102]*
ln(GDPC)	0.013 [0.007]*		0.013 [0.006]**		0.020 [0.007]***		0.016 [0.006]***
ln(FD)	−0.026 [0.028]		−0.030 [0.028]		−0.098 [0.054]*		−0.029 [0.029]
ln(EXP)	−0.003 [0.008]		−0.005 [0.010]		−0.031 [0.015]**		−0.014 [0.009]
ln(GINI)	0.035 [0.080]		0.039 [0.087]		0.130 [0.083]		0.091 [0.081]
GRAD	−0.018 [0.005]***		−0.019 [0.005]***		−0.030 [0.008]***		−0.018 [0.005]***
POP	0.007 [0.004]*		0.008 [0.005]		0.019 [0.005]***		0.012 [0.005]***
ln(INC)	0.024 [0.009]***		0.026 [0.007]***		0.053 [0.016]***		0.029 [0.008]***
Adj-R^2	0.907		0.865		0.789		0.876
F-test (FS)	–		56.34		17.14		45.12
H-test (p)	–		–		–		0.612
DWH-test (p)			0.085		0.036		0.033
Macro FE	Yes		Yes		Yes		Yes
Time FE	Yes		Yes		Yes		Yes
Period	2004–2019		2004–2019		2004–2019		2004–2019
Obs	312		312		312		312

Note(s): *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$; standard errors clustered at regional level in brackets; Digital Economy (DE2): broadband deployment in businesses; FS: 1st Stage; F-test: F-test on excluded instruments; H-test: Hansen J test on over-identifying restrictions; Durbin–Wu–Hausman-test (DWH): endogeneity test defined as the difference of two Sargan–Hansen statistic
Source(s): Authors' elaboration

relevance of institutions in ensuring digital economy and territorial development and reducing disparities between macro regions.

Thereafter, higher institutional quality would ensure greater investment for businesses to improve their network of digitalisation (for example, the presence of more efficient broadband and/or Internet network efficiency). This mechanism has the potential to increase commercial relations, both locally and internationally, with favorable consequences for the territory's progress.

In these sensitivity analyses, the Hansen test provides favorable evidence for the validity of the instruments employed, whereas F-statistic indicates that the instruments used are not weak. Finally, endogeneity test indicates that regulatory quality must be treated as endogenous, giving credit to our empirical design based on IV approach.

Some discrepancies are shown in Tables 5–7 with respect to the control variables, but they do not significantly affect the relationship between the regulatory quality and the digital economy.

Table 6. Digital economy and regulatory quality

	OLS	FS (1)	2SLS (1)	FS (2)	2SLS (2)	FS (3)	2SLS (3)
LIT		0.0115 [0.0015]***				0.0124 [0.0015]***	
INST				−0.0232 [0.0056]***		−0.0317 [0.0047]***	
REG	0.124 [0.056]**		0.162 [0.116]		0.563 [0.206]***		0.262 [0.102]**
ln(GDPC)	−0.003 [0.005]		−0.002 [0.005]		0.004 [0.007]		0.000 [0.005]
ln(FD)	0.111 [0.035]***		0.105 [0.036]***		0.037 [0.050]		0.092 [0.036]**
ln(EXP)	0.003 [0.011]		0.000 [0.012]		−0.025 [0.018]		−0.005 [0.012]
ln(GINI)	−0.325 [0.113]***		−0.317 [0.113]***		−0.227 [0.115]**		−0.252 [0.107]**
GRAD	−0.006 [0.007]		−0.007 [0.007]		−0.017 [0.009]*		−0.008 [0.007]
POP	−0.013 [0.004]***		−0.012 [0.005]**		−0.001 [0.007]		−0.009 [0.005]*
ln(INC)	0.023 [0.008]***		0.025 [0.010]***		0.053 [0.016]***		0.032 [0.009]***
Adj-R^2	0.852		0.756		0.799		0.811
F-test (FS)	–		56.34		17.14		45.12
H-test (*p*)	–		–		–		0.102
DWH-test (*p*)			0.072		0.030		0.011
Macro FE	Yes		Yes		Yes		Yes
Time FE	Yes		Yes		Yes		Yes
Period	2004–2019		2004–2019		2004–2019		2004–2019
Obs	312		312		312		312

Note(s): $*p < 0.1$; $**p < 0.05$; $***p < 0.01$; standard errors clustered at regional level in brackets; Digital Economy (DE3): website proliferation in businesses, FS: 1st Stage; *F*-test: *F*-test on excluded instruments; *H*-test: Hansen J test on over-identifying restrictions; Durbin–Wu–Hausman-test (DWH): endogeneity test defined as the difference of two Sargan–Hansen statistic
Source(s): Authors' elaboration

Basically, in Table 5, we observe a negative and significant effect of number of graduates and a positive effect of economic productivity and disposable income on digital economy, highlighting the fact that both territorial expansion and wealth accumulation lead to an increase in this level of digitalization.

Table 6 illustrates the positive impact of both financial development and disposable income on digital economy, highlighting the pivotal role that financial system and local wealth play in guaranteeing elevated levels of economic digitalization. Businesses in the area could invest in improving the efficiency of digital economy (e.g. broadband and/or faster Internet) with the loans provided by local banks, thereby enhancing commercial contacts and fostering the growth of the community. Income inequality and population, on the other hand, lessen digital economy.

Table 7 shows that digital economy is positively impacted by economic activity, income inequality, human capital, population and disposable income, but negatively by financial development and degree of globalization.

Table 7. Digital economy and regulatory quality

	OLS	FS (1)	2SLS (1)	FS (2)	2SLS (2)	FS (3)	2SLS (3)
LIT		0.0115 [0.0015]***				0.0124 [0.0015]***	
INST				−0.0232 [0.0056]***		−0.0307 [0.0047]***	
REG	0.438 [0.072]***		1.280 [0.215]***		0.510 [0.258]**		1.080 [0.182]***
ln(GDPC)	0.038 [0.009]***		0.051 [0.012]***		0.039 [0.009]***		0.047 [0.011]***
ln(FD)	−0.175 [0.041]***		−0.317 [0.062]***		−0.187 [0.057]***		−0.288 [0.056]***
ln(EXP)	−0.026 [0.015]*		−0.080 [0.023]***		−0.030 [0.023]		−0.069 [0.021]***
ln(GINI)	0.336 [0.155]**		0.525 [0.190]***		0.353 [0.159]**		0.424 [0.176]**
GRAD	0.047 [0.008]***		0.024 [0.009]***		0.045 [0.010]***		0.025 [0.009]***
POP	0.009 [0.006]		0.032 [0.007]***		0.011 [0.007]		0.025 [0.006]***
ln(INC)	0.078 [0.012]***		0.135 [0.016]***		0.083 [0.019]***		0.122 [0.014]***
Adj-R^2	0.908		0.867		0.799		0.879
F-test (FS)	–		56.34		17.14		45.12
H-test (*p*)	–		–		–		0.313
DWH-test (*p*)			0.000		0.077		0.000
Macro FE	Yes		Yes		Yes		Yes
Time FE	Yes		Yes		Yes		Yes
Period	2004–2019		2004–2019		2004–2019		2004–2019
Obs	312		312		312		312

Note(s): $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$; standard errors clustered at regional level in brackets; Digital Economy (DE4): degree of Internet use in businesses; FS: 1st Stage; *F*-test: *F*-test on excluded instruments; *H*-test: Hansen J test on over-identifying restrictions; Durbin–Wu–Hausman-test (DWH): endogeneity test defined as the difference of two Sargan–Hansen statistic
Source(s): Authors' elaboration

Finally, we consider other fundamental dimensions of institutional quality (refer to Nifo and Vecchione, 2014), namely control of corruption (CORR), government effectiveness (GOV), rule of law (RULE), voice and accountability (VA), they further exploit these five dimensions of governance to construct an overall index of institutional quality (IQI_MEAN) [14] (Table 2 provides more statistics on these indicators). Beyond the application of the full set of indicators developed by Nifo and Vecchione (2014), we propose an additional aggregate index of institutional quality, obtained through the application of the Principal Component Analysis (PCA) to the afore-mentioned five elementary dimensions (IQI_PCA). This procedure seems to be suitable for our purposes, as the institutional quality indicators employed in the paper exhibit strong linear correlations.

In Table 8, we only report the findings utilizing the 2SLS technique and both of Tabellini's suggested instruments [15]. The findings reinforce the importance of institutional quality in promoting the digital economy. In these regressions, the Hansen test shows solid evidence for the validity of the instruments used, and the *F*-statistic suggests that the instruments used are not weak.

Table 8. Digital economy and other measurements of institutional quality (2SLS)

	FS (1)	INST = CORR IV (1)	FS (2)	INST = GOV IV (2)	FS (3)	INST = RULE IV (3)	FS (4)	INST = VA IV (4)	FS (5)	INST = IQI_ MEAN IV (5)	FS (6)	INST = IQI_ PCA IV (6)
LIT	−0.0008 [0.0018]		−0.0004 [0.0014]		0.0108 [0.0011] ***		0.01067 [0.0011] ***		0.0089 [0.0010] ***		0.0519 [0.0055] ***	
INST	−0.0315 [0.0056] ***		0.0276 [0.0045] ***		−0.0152 [0.0045] ***		−0.0147 [0.0047] ***		−0.0064 [0.0042]		−0.0718 [0.0232] ***	
IQ		0.123 [0.043]***		0.169 [0.060]***		0.158 [0.043]***		0.152 [0.044]***		0.155 [0.053]***		0.031 [0.009]***
ln (GDPC)		0.002 [0.002]		−0.002 [0.002]		0.006 [0.002]**		0.005 [0.002]**		0.005 [0.002]**		0.005 [0.002]**
ln(FD)		−0.011 [0.013]		0.024 [0.012]**		0.005 [0.009]		−0.008 [0.010]		−0.006 [0.010]		−0.008 [0.010]
ln(EXP)		−0.002 [0.002]		−0.003 [0.003]		−0.013 [0.004]***		−0.010 [0.003]***		−0.010 [0.004]**		−0.010 [0.003]***
ln(GINI)		0.050 [0.029]*		−0.033 [0.035]		0.142 [0.042]***		0.083 [0.030]***		0.121 [0.044]***		0.083 [0.030]***
GRAD		−0.005 [0.002]***		−0.008 [0.002]***		−0.005 [0.002]***		−0.010 [0.002]***		−0.006 [0.002]***		−0.010 [0.002]***
POP		−0.001 [0.002]		0.003 [0.001]**		0.005 [0.001]***		0.003 [0.001]***		0.002 [0.001]**		0.003 [0.001]***
ln(INC)		0.000 [0.002]		0.008 [0.004]*		0.013 [0.004]***		0.009 [0.004]**		0.004 [0.003]*		0.009 [0.004]**
Adj-R^2		0.466		0.398		0.489		0.511		0.456		0.423
F-test (FS)		20.73		20.00		48.46		44.77		39.83		44.77
H-test (*p*)		0.103		0.108		0.113		0.114		0.102		0.114

(*continued*)

Table 8. Continued

	FS (1)	INST = CORR IV (1)	FS (2)	INST = GOV IV (2)	FS (3)	INST = RULE IV (3)	FS (4)	INST = VA IV (4)	FS (5)	INST = IQI_ MEAN IV (5)	FS (6)	INST = IQI_ PCA IV (6)
DWH-test (p)		0.007		0.001		0.000		0.006		0.024		0.006
Macro FE		Yes		Yes		Yes		Yes		Yes		Yes
Time FE		Yes		Yes		Yes		Yes		Yes		Yes
Period		2004–2019		2004–2019		2004–2019		2004–2019		2004–2019		2004–2019
Obs		312		312		312		312		312		312

Note(s): *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$; standard errors clustered at regional level in brackets; Digital Economy (DE1): PC adoption in businesses; FS: 1st Stage; F-test: F-test on excluded instruments; H-test: Hansen J test on over-identifying restrictions; Durbin–Wu–Hausman-test (DWH): endogeneity test defined as the difference of two Sargan–Hansen statistic
Source(s): Authors' elaboration

In summary, we may infer that, without exception, all institutional quality indicators play a critical role in supporting and ensuring the digital economy, with a direct impact on innovation processes and hence economic growth. Furthermore, when we select a different digital economy indicator, we find that adj-R^2 increases with values ranging from 0.7 to 0.9 (see Tables 5–8). This indicates that between 70 and 90% of the phenomenon under study may be explained by our model. In other words, our model has a very high prediction rate.

8. Conclusion and implications

Since their inception in the mid-20th century, digital technologies have permeated almost every aspect of economic activity, transforming production patterns (e.g. automation, industry 4.0, the Internet of things, digital twins) and consumption patterns (infrastructure, software, platforms). According to Goldfarb and Tucker (2019), the binary-digit (or "bits") structure for storing information serves as the foundation of digital technology, facilitating data processing, storage and exchange while saving significant costs.

Along with changes in integration, demography and environment, the rise of digital technologies, often known as digitalisation, is one of the most fundamental shifts influencing microeconomic allocation (relative pricing and preferences, as well as market functioning). Digitalization, like other current structural transformations, has the potential to have far-reaching consequences for contemporary economies and society. Milkau and Bott (2015) argue that "digitalisation has not changed the fundamental laws of economics but has triggered changes in how agents interact in the market or see intermediaries facilitating this interaction".

Prior research has investigated, at least qualitatively, various aspects of the effects of digitalization. This encompasses the macroeconomic implications of digitalization, particularly for productivity and labor markets. While new technologies affect different industries differently, they generally contribute to firm-level productivity improvements, with more productive firms being more digital on average (Gal *et al.*, 2019; OECD, 2019).

The general-purpose nature of digital technologies (Trajtenberg, 2018) and/or such technologies being inventions in the way of invention (Cockburn *et al.*, 2018) add to the productivity-boosting effect. The literature stresses the so-called productivity puzzle, in which GDP growth is significantly lower than expected in an era of fast technological advancement, which appears to contradict firm-level evidence. This demonstrates that, as mentioned by Gordon (2016), there may be negative effects of technology on productivity, even if they are more difficult to quantify, such as the use of digital and non-digital systems concurrently, or the repercussions of distraction and/or addiction.

This study addresses the critical need to understand how institutional quality, namely regulatory quality, affects the digital economy in the face of rising regional growth concerns. To that end, we examine a fairly informative sample of 20 homogeneous Italian areas (from 2004 to 2019), minimizing worries about heterogeneity that might have an impact on the empirical findings.

Using this sample, we can discern between territorial and institutional variability. As is generally known, the phenomenon of digital economy has grown dramatically over the years, requiring businesses to adapt to the circumstances, particularly by supporting agile and smart working.

The findings support the positive impact of institutions on the digital economy, notably the regulatory quality that is implemented. As a result, the most virtuous regions in terms of good regulation execution can promote the development of the digital economy, which has a positive impact on economic activity. In other words, better regulations would raise the bar for the digital economy and enable businesses to create global and local commercial networks that might promote economic expansion and innovation. The findings are similarly supported when we include additional pillars of institutional quality, as well as composite index.

Based on the empirical analysis conducts in the research, which exposes the crucial role of institutional quality in contributing the digital economy, the following practical policy implications, to be taken to apply the theoretical conclusions, emerge for Italian regions seeking to improve their digital economy and hence their growth outcomes:

(1) Strengthen institutional quality: To increase digital regulation enforcement and create sustainable growth practices, regions should prioritize strengthening institutional frameworks, with an emphasis on anti-corruption measures, government efficacy and regulatory quality.

(2) Tailor policy frameworks: To maximize growth effectiveness, each region should establish and implement digital policies that are tailored to its specific levels of institutional quality.

(3) Proactive measures: Regulators and legislators should prioritize efficient rules that accelerate the digital economy. The emergence of the digital economy should consequently lead to more innovation and economic growth, as well as a reduction in sectoral imbalances.

Despite its findings, this study has several drawbacks. The use of aggregate data may obscure regional differences and neglect the complexities of local government. Furthermore, the study's cross-sectional design limits its capacity to capture long-term trends and the influence of dynamic policy changes. Future research could benefit from local longitudinal studies (in a provincial setting) that track the evolution of institutional quality, as well as more granular analyses that investigate local disparities and sector-specific influences on the digital economy and economic growth. Furthermore, investigating the consequences of various policy initiatives in diverse institutional contexts (e.g. European economies) may provide greater insight into effective growth tactics. Finally, it is important to identify transmission mechanisms that can explain the dynamics of the digital economy, as well as the need to identify possible moderating effects associated with different environmental conditions as specified in the empirical analysis.

Notes

1. A few studies, for instance, have examined how digitalization affects economic activity (Verma *et al.*, 2024; Emiru and Wajebo, 2025), especially during the COVID-19 pandemic (Mansour, 2022).
2. Other substitute proxies, such as broadband deployment in businesses, website proliferation in businesses and degree of Internet use in businesses were employed. The results are quite similar.
3. According to Nifo and Vecchione (2014, p. 1633), regulatory quality "comprises information concerning the degree of openness of the economy, business environment and, hence, the ability of local administrators to promote and protect business activity".
4. Similarly, we also employ the Gini index-net of rents. The estimated are very similar to the ones reported in this paper. For the sake of parsimony, these results have not been reported in the paper but are available upon request.
5. The dataset's timeframe is determined by the availability of regulatory quality indicator.
6. For the sake of parsimony, VIF test is not reported, but it is available upon request.
7. For a similar approach, refer to Barra *et al.* (2023).
8. In order to establish a good process that permits the validity of the model, the instruments must have a statistically significant impact (positive or negative) on the digital economy.
9. After integrating regional data and taking the average across the sample period (2004–2019), we obtain the correlations shown in Table 3.
10. This could imply that more virtuous regions in terms of institutional quality (e.g. enforcing more efficient norms) will contribute more to digital economy than less virtuous ones. However, OLS and 2SLS regression will be used to bolster the research and minimize the degree of uncertainty regarding the causal relationship between regulatory quality and the digital economy.

11. The two instruments are: (1) the regional literacy rates at the end of the 19th century (LIT); and (2) the constraints on the executive of local political institutions in the period from 1600 to 1850 (INST).
12. The reduced form, which assesses the direct impact of the instruments on the digital economy, was assessed to validate the usage of the instruments to deal the endogeneity problem. To be valid, the instruments have to a statically significant impact (both positive or negative) on the digital economy. In our situation, such a mechanism is validated, highlighting the suitability of the instruments employed. For the sake of brevity, the results are not reported but available on request.
13. We also run FE (fixed effect) and RE (random effect) regressions in order to make our results more robust. The Hausman test confirms the validity of FE with respect to RE. FE results are very similar to OLS ones. For this reason, we remain OLS regression in the paper. However, FE and RE estimations are available on request.
14. (1) Specifically Corruption (CORR): "summarizes data on a crimes committed against the Public Administration (PA), the number of local administrations overruled by the federal authorities and the Golden-Picci Index, measuring the corruption level on the basis of "the difference between the amounts of physically existing public infrastructure (. . .) and the amounts of money cumulatively allocated by government to create these public works" (Golden and Picci, 2005, p. 37)" (Nifo and Vecchione, 2014, p. 1633); (2) Government effectiveness (GOV): "measures the endowment of social and economic structures in Italian provinces and the administrative capacity of provincial and regional governments in relation to policies concerning health, waste management and the environment" (Nifo and Vecchione, 2014, p. 1633); (3) Rule of law (RULE): "summarizes data on crime against persons or property, on magistrate productivity, trial times, the degree of tax evasion and the shadow economy" (Nifo and Vecchione, 2014, p. 1633); (4) Regulatory quality (REG): "comprises information concerning the degree of openness of the economy, business environment and, hence, the ability of local administrators to promote and protect business activity" (Nifo and Vecchione, 2014, p. 1633); finally, (5) Voice and accountability (VA): "captures the participation in public elections, the phenomenon of associations, the number of social cooperatives and cultural liveliness measured in terms of books published and purchased in bookshops" (Nifo and Vecchione, 2014, p. 1633). Nifo and Vecchione (2014) then combine these five elementary dimensions of governance to obtain an overall measure of institutional quality, namely the Institutional Quality Index (IQI). The IQI is the outcome of three different stages, respectively represented by normalisation, weight assignment and aggregation. Specifically, the normalisation process, based on the distance from the ideal point, serves to transform each elementary dimension in an indicator bounded in the [0,1] interval, while the weighting scheme is based on the analytic hierarchy process (AHP) developed by Saaty (1980, 1992). The last stage instead consists in the aggregation of the elementary dimensions of institutional quality to obtain the IQI index. Nevertheless, beyond the five indices of institutional quality provided by Nifo and Vecchione (2014), we propose an alternative aggregation of the five elementary dimensions, based on the application of the Principal Component Analysis (PCA). As stated before, the PCA allows to shrink the dimensions of governance and to better deal with the existing variability in the data.
15. For the sake of brevity, the other estimates are not reported, but available on request.

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