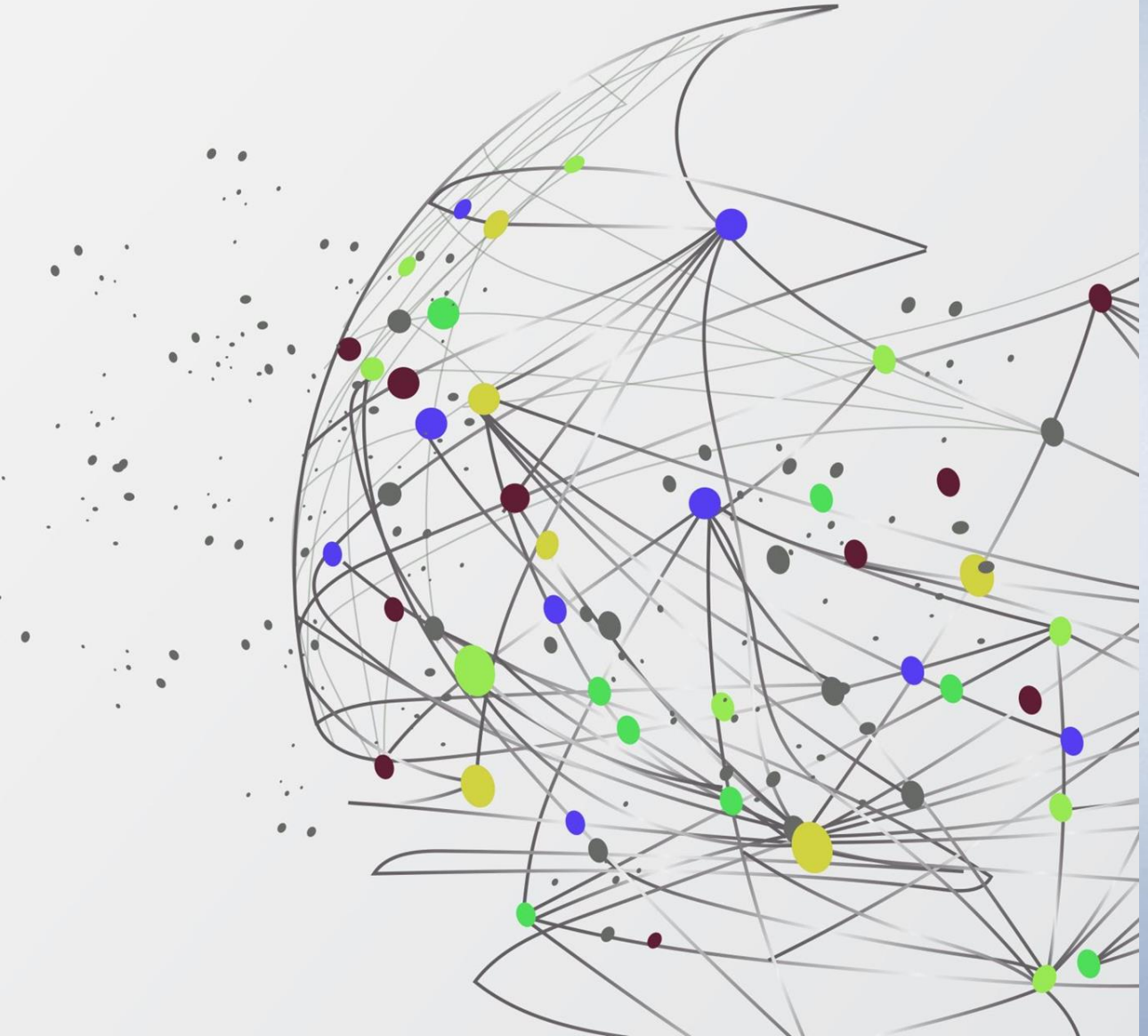

Digital Transformation, Quality of Government and Productivity Growth in European Regions

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Very preliminary

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Outline

- Background and motivation
- Research goal
- Spatial units of analysis and outcome variable
- Methodology
- Main findings (so far)
- **In progress**

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Background and motivation

- Digital technologies are transforming the economy and society by rapidly spreading across countries, sectors, and organizations.
- Recent years have witnessed an increasing interest on this issue in both academic and policy debate.
- Digital transformation is indeed at the center of the current policy agenda in many European and non-European countries.

Background and motivation

- Digital technologies have the particular property that they do not only offer cost and efficiency gains but additionally have many applications and may be combined with many other (more specific) technologies (Labhard and Lehtimäki, 2022).
- Digital technologies are potential catalysts for technological progress, economic and productivity growth.

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Background and motivation

- A bulk of literature has studied the link between digital technologies (ICT and that followed) and economic growth, using both a macro (country-level) and a micro (firm-level) perspective.
- The majority of these contribution find a positive impact of the former on the latter (Stanley et al. 2018 and Vu et al., 2020 for comprehensive reviews of the literature).
- Most of these studies focus on the United States or offer cross-country analyses that, however, fail to capture differences in economic growth and digital technology diffusion that emerge within the same country.
- Nevertheless, with few exception (Iammarino and Jona-Lasinio, 2015) literature at the subnational level is scarce mainly due the availability of data.

Research goal

- This paper aims to investigate the impact of digital technologies on productivity growth emphasizing the role that the quality of institutions plays in this relationship.
- Our contribution lies in an analysis of a large sample of European regions.
- Previous literature focused mainly on cross-country analyses that are unable to capture heterogeneities emerging within the same country.
- In this perspective, regions of Europe are an interesting case to study since they are characterized by differences in the spatial distribution of digitalization (internet access), productivity as well as quality of local governments.

Research goal

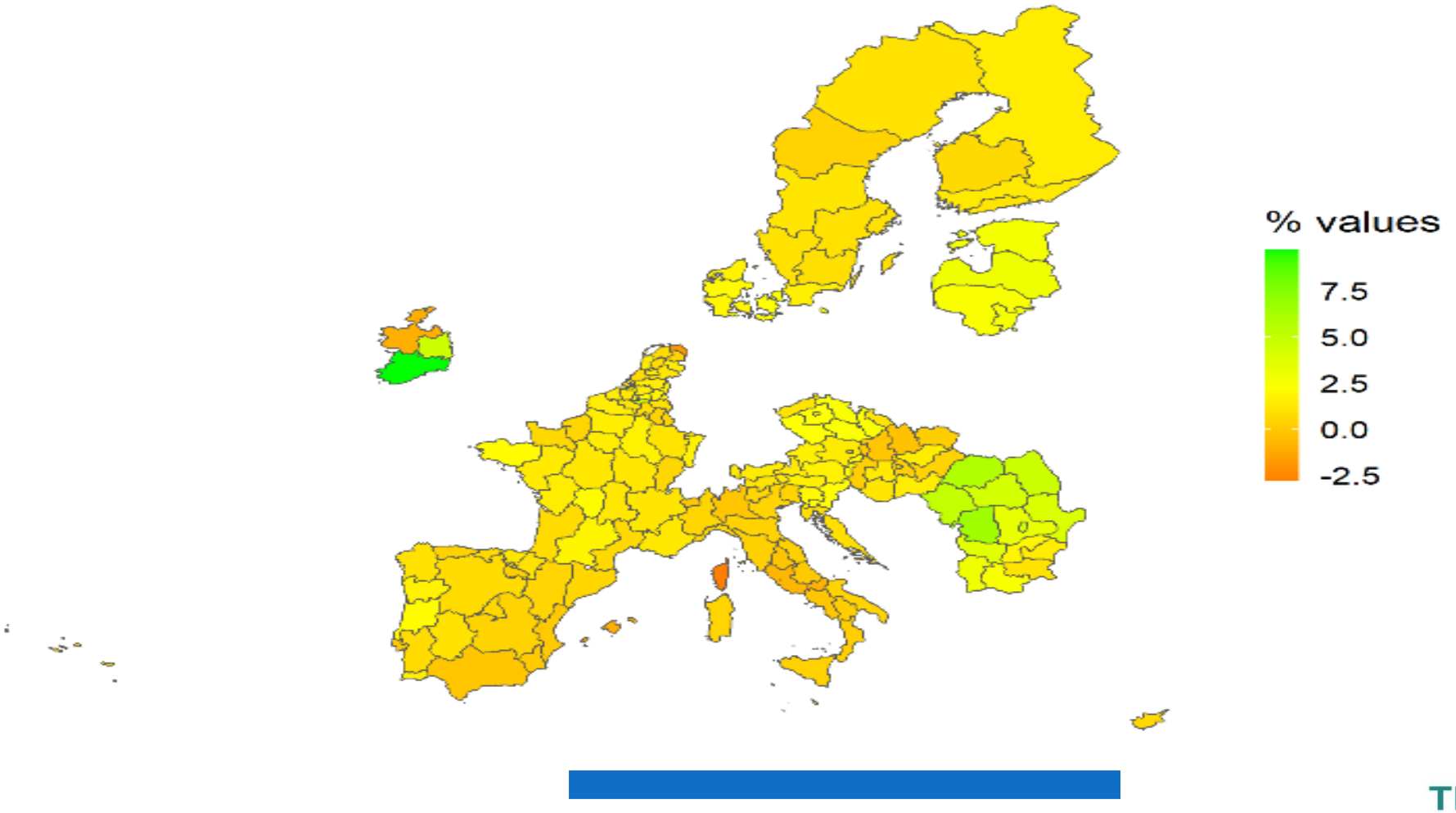
- Focusing on the link between digital technologies and productivity growth this paper also underlies the hypothesis that the quality of local institutions impacts on productivity growth directly and indirectly through the amount of public funding in sectoral policies (like public service provision and education).
- The ability to implement the necessary measures (through e.g., regulation, promotion of innovation, facilitation of knowledge among actors, legality, absence of corruption and trust) makes policy choices effective.
- However, the role of local institutions in influencing local productivity both directly and indirectly has, so far, attracted very limited attention.

Spatial unit of analysis

- We use a panel dynamic framework on a sample of 156 European regions across 23 EU countries, spanning the period 2011-2020.
- Our outcome variable is the labor productivity growth:

$$\Delta LP_{it} = \log\left(\frac{LP_{it}}{LP_{it-1}}\right)$$

Spatial distribution of yearly productivity growth (2011-2020 average)



Digitalization measures

- To capture the level of digitalization in European regions three main variables are considered:
- *Households with home internet access:* the share of households with access to the internet at home - tracks the degree of penetration of internet in the different EU regions
- *Internet use with PA:* the percentage of individuals who used the internet for interaction with public authorities
- *Internet banking use:* the percentage of individuals who used the internet for interaction with banks
- Internet access and internet use are important digital technologies as they enable the use of digital goods and services and other types of digital technologies, in a sense augmenting human capital.
- *Data are from Eurostat*

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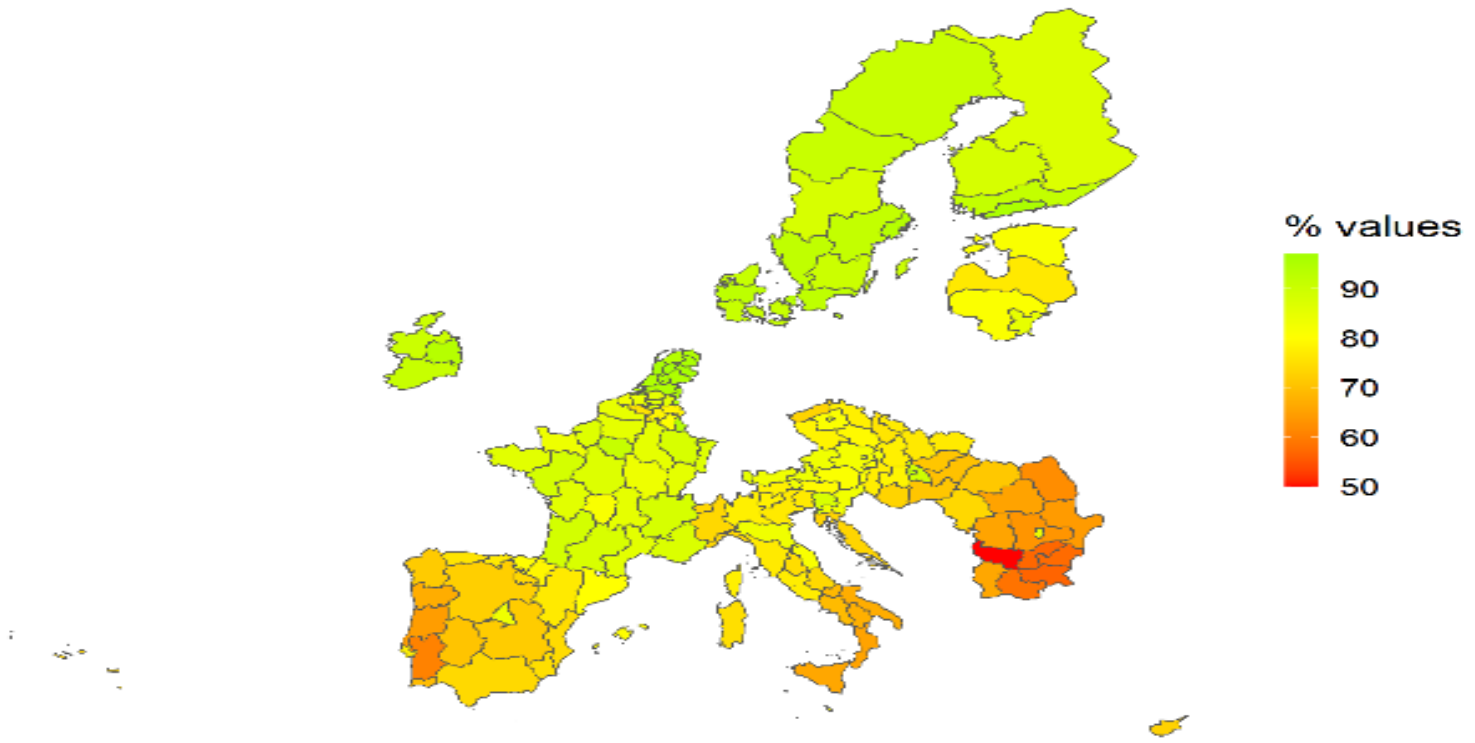
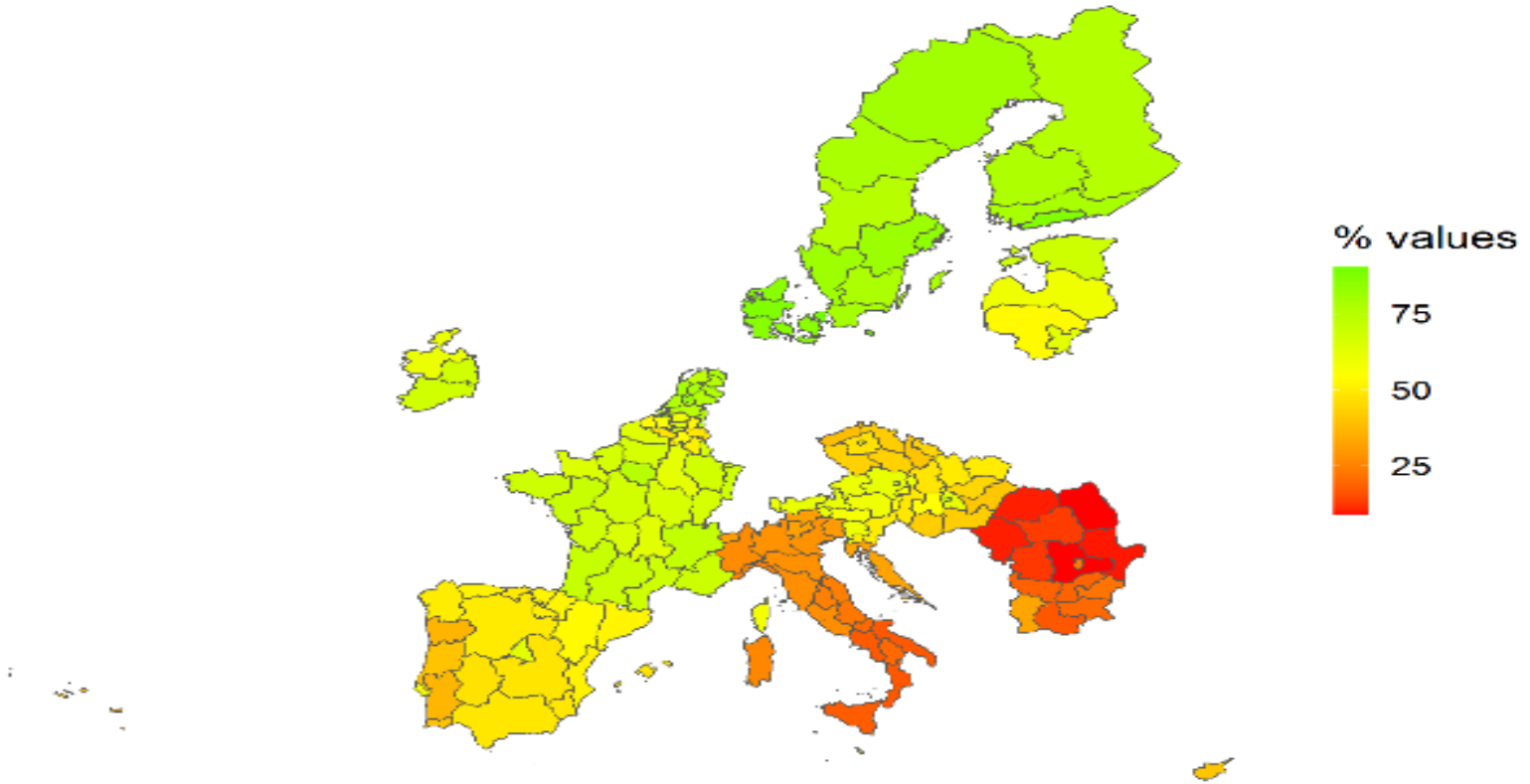
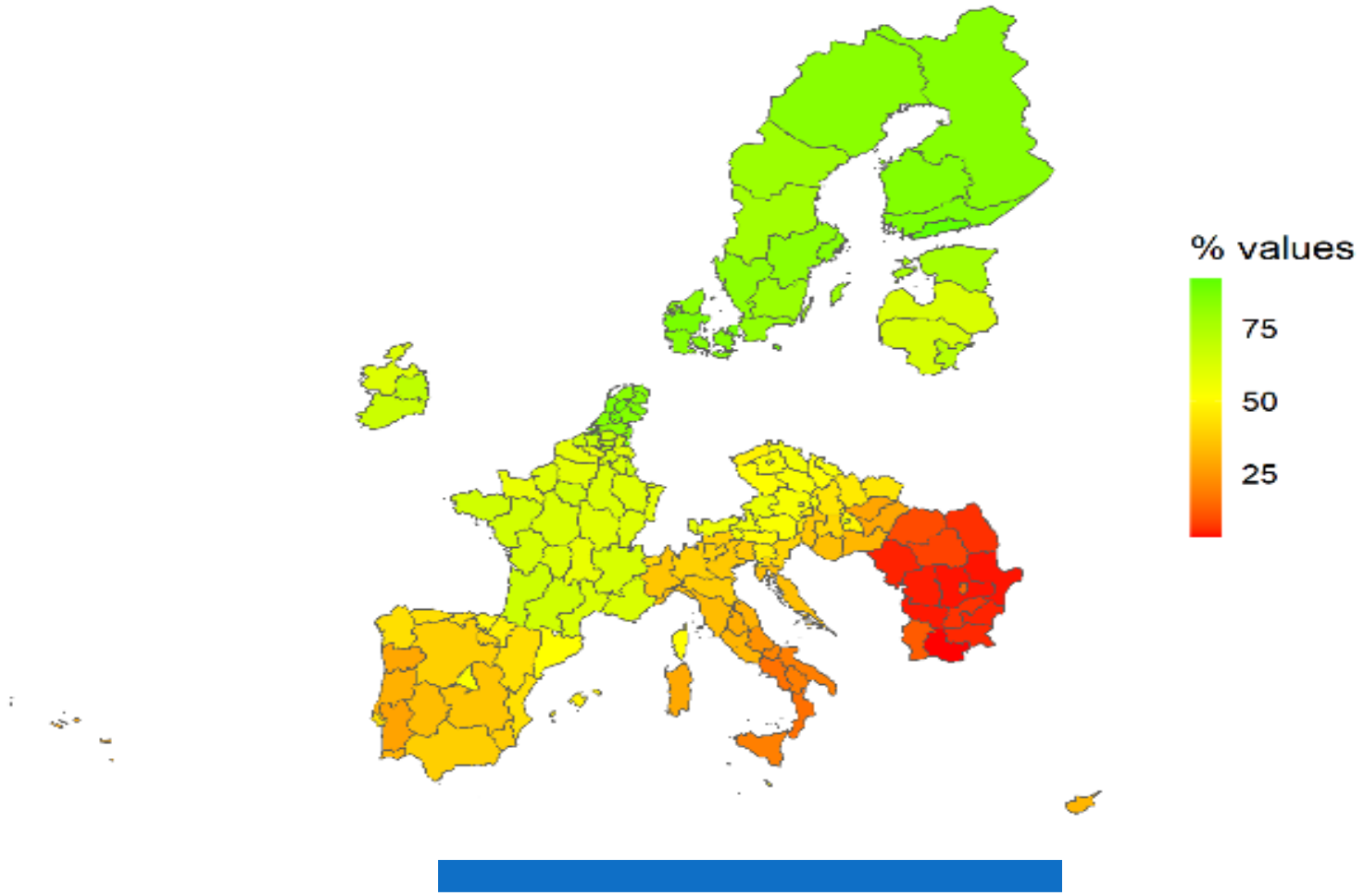
Spatial distribution of yearly *Households with home internet access* (2011-2020 average)



Spatial distribution of yearly *Internet use with PA* (2011-2020 average)



Spatial distribution of yearly *Internet banking use* (2011-2020 average)



Quality of Institutions

- Data on regional quality of institutions are defined using the European Quality of Government Index (EQI), developed by the University of Gothenburg.
- We adopt the methodology proposed by Charron et al. (2014) to transform these series into annual frequency data, aligning them with other data included in the analysis.
- Trends in European regions are characterized by marked heterogeneity in the quality of institutions: regions in Finland, Scandinavia and the Netherlands have the highest quality of institutions, while regions in Italy, Greece and Romania show the lowest level of the index.

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Methodology

- To estimate the impact of digital technologies on productivity growth we combine elements of the classical, neoclassical and endogenous growth literature with elements from existing empirical work assessing the link between institutions and productivity growth.
- Our empirical strategy consists in estimating a Dynamic Panel Data with Generalized Method of Moments (DPD-GMM).
- This framework allows to consistently evaluate the regression parameters in the presence of incidental parameters (because of cross-sectional unobserved heterogeneity) and endogeneity issues (because of omitted variables).

Methodology

- The DPD-GMM model developed in this study has the form:

$$y_{it} = \mu_i + \beta y_{i,t-1} + Z_{it}\gamma + X_{it}\delta + I_{it}\theta + D_{im}\rho + u_{it}$$

- where $i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$, y_{it} is a (NTx1) vector of outcomes for individual i at time t, μ_i refers to the intercept term denoting individual–specific parameters, $y_{i,t-1}$ is a (NTx1) vector of lagged dependent variable, Z_it is a (NTx1) vector of endogenous variables for each i, X_{it} is a (NTx1) vector of control variables for each i and $u_{it} \sim N(0, \sigma_u^2)$ is an unpredictable shock (or idiosyncratic error term).

Methodology

- The model also estimates a set of interaction terms (I_{it}) to highlight cross-unit interdependency and dynamic feedback.
- Finally, our model includes two dummy variables to deal with regional characteristics that are time-invariant.
- The dummy variables are so constructed: $d_{i1} = 1$ whether the region belongs to a developed country, and 0 otherwise; $d_{i2} = 1$ whether the region is virtuous (share of employed in ICT bigger than the average value at time t), and 0 otherwise.

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Table 1: DPD-GMM estimates

	Model 1	Model 2	Model 3	Model 4.A	Model 4.B	Model 4.C
L.Productivity	-0.028*** (0.006)	-0.401*** (0.037)	-0.576*** (0.079)	-0.153*** (0.002)	-0.072*** (0.005)	-0.080*** (0.020)
ICT emp	-0.013* (0.008)	0.024*** (0.003)	0.063*** (0.008)	0.006*** (0.001)	0.018*** (0.002)	0.158*** (0.016)
Human capital	-0.046*** (0.005)	-0.084*** (0.027)	0.176*** (0.046)	0.045*** (0.006)	0.098*** (0.009)	0.092*** (0.007)
EQI		0.245** (0.102)	0.192* (0.111)	0.027*** (0.005)	0.036*** (0.012)	0.046*** (0.002)
Physical capital			0.165*** (0.001)	0.008*** (0.005)	0.030*** (0.008)	0.044*** (0.005)
Internet access				0.005*** (0.002)		
Internet PA					0.026*** (0.005)	
Internet bank						0.008*** (0.003)
Adjusted R-squared	0.117	0.138	0.310	0.393	0.330	0.335
J-test Over-identification Restrictions	124.78 **	124.78 **	104.790	35.280	50.710	70.09
AB-test Serial Correlation	2.86	2.53	2.06	*1.51*	*1.19*	*0.98*
H-test Panel Unit Root	-3.033 ***	-3.033 ***	-4.013 ***	-2.254 **	-2.475 **	-2.288 **
Im-test Panel Unit Root	-3.281 ***	-3.281 ***	-4.268 ***	-2.305 **	-2.507 **	-2.370 **

Note. The Standard Errors are adjusted for heteroskedasticity and displayed in parentheses. The main diagnostic test statistics used in dynamic panel regression are the Sargan-Hansen's test for over-identification (J-test); the Arellano-Bond's serial correlation test (AB-test); and the panel unit root tests according to the Hadri (2000)'s (H-test) and the Im et al. (2003)'s (Im-test) test statistics. The significance codes correspond to: *** significant at 1%, ** significant at 5%, and * significant at 10%.

Table 2-DPD-GMM estimates with interactions

	(1)	(2)	(3)
L1.prod	-0.551***	-0.482***	-0.467***
	(0.010)	(0.009)	(0.008)
ict	0.005*	0.005*	0.005*
	(0.003)	(0.003)	(0.003)
hcapital	0.280***	0.280***	0.280***
	(0.029)	(0.029)	(0.029)
eqi	0.231***	0.231***	0.231***
	(0.008)	(0.008)	(0.008)
pcapital	0.072***	0.484***	0.580***
	(0.005)	(0.017)	(0.021)
internet	0.043***		
	(0.005)		
int_pa		0.027***	
		(0.007)	
int_bank			0.073***
			(0.003)
hcapital-int	-0.569***		
	(0.004)		
pcapital-int	0.210***		
	(0.010)		
int-eqi	0.231***		
	(0.075)		
hcapital-int_pa		-0.327***	
		(0.038)	
pcapital-int_pa		0.203***	
		(0.003)	
eqi-int_pa		0.192***	
		(0.085)	
hcapital-int_bank			-0.386***
			(0.004)
pcapital-int_bank			0.173***
			(0.002)
eqi-int_bank			0.184***
			(0.052)
hcapital-pcapital-int	0.219***		
	(0.009)		
hcapital-pcapital-int_pa		0.234***	
		(0.003)	
hcapital-pcapital-int_bank			0.231***
			(0.003)
d_i1	-0.022***	-0.019***	-0.011***
	(0.006)	(0.002)	(0.005)
d_i2	0.050***	0.050***	0.050***
	(0.010)	(0.010)	(0.010)
Adjusted R-squared	0.431	0.425	0.433
J-test Over-identification Restrictions	88.16	87.71	86.84
AB-test Serial Correlation	1.21	1.42	1.37
H-test Panel Unit Root	-2.389 **	-2.721 **	-2.709 **
Im-test Panel Unit Root	-2.450 **	-2.836 **	-2.786 **

Note. The Standard Errors are adjusted for heteroskedasticity and displayed in parentheses. The main diagnostic test statistics used in dynamic panel regression are the Sargan-Hansen's test for over-identification (J-test); the Arellano-Bond's serial correlation test (AB-test); and the panel unit root tests according to the Hadri (2000)'s (H-test) and the Im et al. (2003)'s (Im-test) test statistics. The significance codes correspond to: *** significant at 1%, ** significant at 5%, and * significant at 10%.

Main findings (so far)

- The empirical results suggest that digitalization has positive effects on productivity.
- The results also show that local government institutions influence productivity growth to a considerable extent.
- Nevertheless, the effect is not only direct. Good local institutions improve the impact of digital technologies on labor productivity growth.

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In progress

- IV estimates
- Sub-indices of quality of government (rule of law, corruption)

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Thank you!

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