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Convergence or divergence of the digital transformation among European institutional regimes: an Eastern European perspective

Intersections. EEJSP
12(1):183–205. (2026)
https://doi.org/10.17356/ieejsp.v12i1.1367
https://intersections.tk.hu

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Abstract

This article analyses the socio-economic consequences of technological transformation in Central and Eastern Europe in a comparative perspective. The analysis has been carried out with datasets prepared in the framework of the European comparative research project BEYOND4.0 on the basis of the results of Eurostat's ICT (Information and Communication Technologies) usage in enterprises (isoc_e) and Eurofound's European Working Conditions Surveys (EWCS). Taking into account the social embeddedness of technology, it maps the level of institutional regimes using advanced statistical techniques from econometrics. The article concludes that, in terms of the digital transformation, all European union (EU) countries made progress during the period under review, although there have been considerable differences among institutional regimes.

Keywords: *digital transformation; Europe; institutional regimes; Central and Eastern Europe; convergence; divergence; inequalities*

1 Introduction

The digital transformation, defined as a process entailing the pervasive adoption of digital technologies in production and consumption activities that rely on a significant dimension of data development and data analysis (Goos et al., 2019), is quickly changing the world of work in the developed societies of Europe and North America. The debate around the impact of digitalisation on work has been relatively polarised between pessimistic and optimistic perspectives among academics, practitioners, and policymakers. Pessimistic ones have dominated the debate during the last decade, stressing on the likely effects of automation through job losses and massive technological unemployment (Frey & Osborne, 2017). By contrast, optimistic perspectives have underlined the potential for job creation that can counterbalance job losses, as well as job change, calling for a more nuanced view (Warhurst et al., 2019) to open avenues for reskilling and job change. However, there has recently been increasing evidence (Dhondt et al., 2022; Kornelakis et al., 2022) that technologies are not deterministic but are rather shaped by institutions and actors at different levels with diverse impacts on both labour and employment.

In a context where there is a deficit of empirical research about the deployment of the digital transformation and analyses often are based only on econometric methods, this article aims at filling the gap for the Central and Eastern European region on the basis of recent quantitative research.

Our approach builds on the theoretical perspective that digital technologies are socially embedded (Granovetter, 1985; Warhurst et al., 2019) and their adoption is mediated by institutional, economic, and cultural contexts. Rather than viewing digitalisation as a linear or purely technological process, we situate it within broader institutional frameworks, such as welfare regimes and varieties of capitalism (Esping-Andersen, 1990; Hall & Soskice, 2001), which shape how digital tools are implemented, governed, and diffused. This allows us to examine not only the levels of digital adoption but also the mechanisms of convergence or divergence across country groupings with shared institutional characteristics. This theoretical orientation informs our empirical strategy, which focuses on comparing institutional regimes and member state groupings to understand differentiated trajectories of digital transformation.

For a long time, the European Union's enlargements included countries with relatively equal levels of economic performance (GDP). However, the enlargement that started in 2004 and was followed in 2007 and 2013 added the former socialist states which had been part of the USSR and its satellites. More than 30 years after the fall of the Berlin Wall and 20 years after the 2004 European Union (EU) enlargement, Central and Eastern European (CEE) countries have not been able to catch up with their Western European counterparts economically, including wages and incomes (Delteil & Kirov, 2017). In this context, there have been various theoretical attempts to address the hypothesis of convergence. A strong argument for catching up could be related to the adoption of transformative digital technologies, which can lead to increased GDP (Berger & Frey, 2016; Bukht & Heeks, 2017). In this context, the article addresses the diversity of European countries and institutional regimes to investigate whether there has been a convergence or a divergence of the impacts of digital transformation.

The article is structured as follows. The second section reviews the literature on employment regimes in Europe with a focus on the Eastern European model. The third section outlines the overall research design, the variables, and the data used. The fourth section presents the results, in terms of digital work, learning capacity, training opportunities, task change, and manual handling, systematically comparing old and new member states and the Eastern European model with other European models. The final section discusses the findings.

2 Theoretical considerations

In the context of digital transformation, there has been a lack of consistent data regarding the role of technologies for convergence among European countries (Warhurst et al., 2019). Digitalisation, although not a new phenomenon, presents new considerations in terms of its pace, scope of technological change, and transformative potential (Meil & Kirov, 2017). While there has been a continuous increase in publications on the impacts of digitalisation and the future of work in recent years, the majority of them have focused on Western Europe and North America. Other regions, including Central and Eastern Europe, have remained understudied despite publications of some papers investigating specific aspects of digital transformation, such as platforms (Piasna et al., 2022), or Industry 4.0 in certain sectors (Drahokoupil, 2020). Moreover,

there is an urgent need to improve the evidence based on the actual effects of digitalisation on labour and employment, with a particular weakness being the lack of relevant data.

After the fall of the Berlin Wall in 1989, the transition to free market-oriented capitalist economies with some form of parliamentary democracy was expected to be a rapid process. However, thirty years later and twenty years after the Central and Eastern Europe Countries (CEECs) acceded to the European Union (EU), they have still retained specificities inherited from their socialist past and have yet to resolve all of the challenges faced later in the transition and EU integration processes (Delteil & Kirov, 2017). These developments have allowed for the emergence of a specific Central and Eastern European model, also known as the post-communist states model in various international typologies. For instance, based on employment regime theory and other research (Gallie, 2007; Goergen et al., 2009), five types of institutional regimes have been identified: Nordic, Continental, North-West, Southern European, and Eastern European regimes. Consequently, the question of convergence[1] has regularly emerged in various arenas and spheres, such as work organisation types in Europe (Valeyre et al., 2009) or quality of work (Holman, 2013). There have been discussions about the development of particular sub-models of the eastern-European regime type — for example, Bohle and Greskovits (2012) categorise the capitalist diversity among CEECs into neoliberal (Bulgaria, Estonia, Lithuania, Latvia, Romania), embedded neoliberal (Czech Republic, Hungary, Poland, Slovakia),[2] and corporatist member states (Slovenia) – while the model itself remains relevant for larger comparisons at European level.

Recent efforts of the European Commission to measure digital performance through the Digital Economy and Society Index (DESI) have partially confirmed the persistent divergence between regions and regimes in terms of overall digital performance and the progress of EU countries in their digital competitiveness (European Commission, 2021). Not surprisingly, companies in CEECs have adopted digital technologies to a lesser degree. With two exceptions, the CEECs have consistently scored below the EU average in terms of digital technology adoption. The countries scoring above the EU average are firstly Estonia, followed by Slovenia. Estonia has become a worldwide success story in terms of digitalisation; yet its digital transformation has been an extended and on-going process over three decades (Kattel & Mergel, 2018). Across most of the region, the adoption of digital technologies lags behind the old member states. A recent comparative analysis between 2015 and 2020 suggests that there are still differences in the level of development of the digital economy and society within the EU, despite all the investments and policies made in recent years (Borowiecki et al., 2021). Moreover, the countries identified as the least digitally developed in earlier studies remained basically the same.

In addition to the deployment of digital technologies in companies, the digital transformation is dependent on the possibility for workers to perform more low-skilled (manual) operations, as further developed in the article.

[1] This convergence has been a preoccupation not only among academics but also a lot of policy makers and stakeholders; see, for example, the Open Society Institute's initiative 'The Catch-Up Index', https://osis.bg/?p=2477&lang=en.

[2] Baltic neoliberalism and Visegrad embedded neoliberalism share their early policy orientation on privatisation, liberalisation, and deregulation aimed at attracting foreign direct investment. However, these countries differ in their approach to making a radical break with the past, regardless of the social costs of preserving some social and welfare policies, in light of neoliberal reforms.

In this context, we pose the following two research questions:

1. Is there a divergence between old and new EU member states and between different institutional regimes in terms of the digital transformation?

2. Is there a convergence of technological transformation regarding certain indicators between old and new EU member states and between different institutional regimes? (*If yes, which ones?*)

3 Data, variables and methods

3.1 Data

The article utilises aggregated data sets from the Beyond 4.0 project's app focusing on both employers and employees (Greenan, 2023b). As described by Greenan (2023b), this empirical tool is 'an original tool based on an application combining data from employer and employee surveys' (p. 5). The indicators are derived from harmonised and pre-processed data, based on average values and regression coefficients, integrating employer data from Eurostat's Community Survey on ICT Usage in Enterprises (isoc_e) (2010; 2014) and employee data from Eurofound's European Working Conditions Survey (EWCS) waves 2010 and 2015 (Eurofound et al., 2012, 2017). The Eurostat ICT survey provides harmonised and comparable data on the adoption and use of digital technologies across enterprises with 10 or more employees. The indicators cover key aspects of digital transformation, such as internet connectivity, cloud computing, e-business integration, enterprise resource planning (ERP), customer relationship management (CRM), and the use of social media. Metadata and indicator documentation are available online via Eurostat[3]. The EWCS, conducted by Eurofound, is a cross-sectional survey targeting workers aged 15 and above (in most countries), and collects detailed, representative data on working conditions across Europe. It includes information on job tasks, learning capacity, digitalisation at the workplace, exposure to repetitive work, training opportunities, and other dimensions relevant to labour market transformation. The data are collected through structured interviews and aim to capture workers' experiences and perceptions of their jobs. Further information on the survey methodology and sampling is available on the Eurofound website[4]. Since our analysis relies on these aggregated indicators rather than raw, micro-level EWCS data, individual distributions of the recoded variables are not included within the scope of this article.

However, it is important to note some limitations of the data sets and time frame.

It should be acknowledged that the available EU-level datasets generally lack detailed regional-level data, so the analysis is based on country-level data. The selected time frame (2010-2015) reflects the availability of comparable data. Subsequent methodological changes in the European Working Conditions Survey (EWCS) after 2020 – including the shift from face-to-face to telephone interviews in the context of Covid-19 – restrict comparability with later waves. Furthermore, since Industry 4.0 is not yet fully established and older waves of technologies are predominantly in use, we selected relatively identical starting and ending years from the available databases to ensure comparability.

[3] Eurostat, ICT usage in enterprises (isoc_e), https://ec.europa.eu/eurostat/cache/metadata/en/isoc_e_esms.htm

[4] Eurofound, European Working Conditions Survey (EWCS), https://www.eurofound.europa.eu/surveys/european-working-conditions-surveys-ewcs

While the binary categorisation of 'old vs new' member states remains analytically useful, it does not fully capture the heterogeneity within the group of new member states. For example, Malta and Cyprus are included based on accession chronology, but differ significantly from post-socialist Central and Eastern European countries. These limitations are addressed in the construction of the independent variables (see Section 3.2), and both countries are excluded from the subgroup analyses. Finally, the research questions do not address whether disparities among post-socialist countries have increased, decreased, or remained stable over the studied period – an important avenue for future research.

3.2 Variables

Table 1 provides a comprehensive list of the variables employed as dependent variables to measure the consequences of digital transformation. In our analyses, we have considered these as the dependent variables because it is assumed they could provide new and systematic insights into the technological transformation (Greenan, 2023a).

As for the **independent variables** (Table 2), we have included two key factors:

1) A country-grouping distinguishing old and new EU member states, with 0 representing old member states as the reference category and 1 representing new member states.

2) A categorical variable representing five types of institutional regime, derived from employment regime theory and other research (Gallie, 2007; Goergen et al., 2009). The reference category is set as 0 for Nordic, 1 for Continental, 2 for North-West, 3 for Southern European, and 4 for Eastern European regimes.

Although the binary categorisation of "old vs new" member states has lost some of its analytical relevance more than two decades after the first major EU enlargement, it remains widely used in contemporary research on convergence and digital transformation. Holobiuc (2021) demonstrates that substantial gaps between new and old member states persisted up to 2019; Boikova et al. (2021) confirm that historical trajectories continue to shape these differences; Brodny and Tutak (2022) identify similar regional disparities in the digitalisation of SMEs; and Mura and Donath (2023) highlight uneven impacts of digitalisation on economic growth across the two groups. We therefore retain the binary division as a macro-analytical benchmark, while acknowledging its limitations, particularly the heterogeneity within the new member states – Malta and Cyprus, for example, do not share the post-socialist legacy of Central and Eastern European countries (CEEC). Future research could apply more nuanced classifications, such as the Bohle and Greskovits (2012) typology, to capture these internal differences more accurately between different groups of CEEC.

3.3 Methods

Our analysis of the consequences of digital transformation has employed descriptive statistics and regression modelling. Regression modelling 'is a technique for modelling of relationships between two (or more) variables' (Miles & Shevlin, 2001, p. 10). Specifically, we utilised four models *for each* dependent variable, employing linear regression (Ordinary Least Square regression), which allowed us to interpret the regression coefficients or slopes (b). These coefficients indicate 'the amount of change in the dependent variable ... that we would expect for a change of one unit of the independent variable' (Miles & Shevlin, 2001, p. 18). Models 1 and 2 incorporate a categorical

Table 1 An overview of variables in use within different databases (dependent variables)

EWCS	*Digital work* Composite indicator reflecting the use of digital technologies in employees' daily work tasks, including the use of computers, software, and digital tools. Constructed variable: weighted (from 0 to 6) sum of digital_w*; higher scores indicate more digital work. *Learning capacity* Composite indicator of learning capacity which, on the one hand, synthesizes a number of work organisation practices and structures of work organisation and, on the other, allows for the three levels of analysis (individual, group, and organisational) and their interactions to be considered. *Training opportunities* Constructed variable (combination of on-the-job training and training paid by the employer). *Tasks 'no' change* During the last 12 months, has your work changed in any of the following ways: your tasks and duties? *Repetitive movements* Does your main paid job involve repetitive hand or arm movements? — all of the time. *Manual handling* Does your main paid job involve carrying or moving heavy loads? *Protective equipment* Does your job ever require that you wear personal protective equipment?
ICT	*Total technology indicator* The indicator is composed of five sub-dimensions and relative variables: Connection technology indicator (Enterprises with internet access & Enterprises internet connection — fixed and mobile broadband access); Web and Social Media technology indicator (Enterprises with a website & Enterprises using social networks); E-commerce technology indicator (Enterprises with e-commerce sales & Enterprises purchasing online); E-business technology indicator (Enterprises using software solutions like Customer Relationship Management [CRM] & ERP [Enterprise Resource planning] to share information between different functional areas); Cloud technology (Enterprises who buy only medium CC services — e-mail, office software, file storage, database hosting — & those buying high CC services — accounting software applications, CRM software, computing power). *High CC services* Standardised indicator: Buying high CC services (accounting software applications, CRM software, computing power). *Medium CC services* Standardised indicator: Buying only medium CC services (e-mail, office software, file storage, database hosting)

Source. Greenan et al., 2023b.

variable representing the institutional regimes, where Model 1 corresponds to the first examined year (EWSC 2010; ICT 2010), and Model 2 corresponds to the last examined year (EWCS 2015; ICT 2014). On the other hand, models 3 and 4 include a dummy variable distinguishing between old and new member states, with Model 3 referring to the first examined year (EWSC 2010; ICT 2010) and Model 4 referring to the last examined year (EWCS 2015; ICT 2014).

The regression models were estimated using STATA version 14 on aggregated, country-level data, with countries serving as the units of analysis (n = 27). Due to the small number of observations, the results of the significance tests should be interpreted with caution. These models are primarily intended to identify broad cross-national associations rather than provide strong causal inference. For this reason, the inclusion of additional control variables was limited, as adding further predictors would substantially reduce the degrees of freedom and increase the risk of overfitting. This should be acknowledged as a limitation of the analysis.

Table 2 An overview of country-groupings (independent variables)

Old and new EU member states (European Commission)	The *old ones* (Belgium, Germany, France, Italy, Luxembourg, the Netherlands, Denmark, Ireland, the United Kingdom, Greece, Spain, Portugal, Austria, Finland, and Sweden); The *new ones* (after 2004: the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia, Slovenia, Romania, Bulgaria, and Croatia).
Based on employment regime theory and other research (Gallie, 2007; Goergen et al., 2009), five types of **institutional regime** can be identified:	*Nordic regimes* (Denmark, Finland, and Sweden);
	Continental regimes (Austria, Belgium, France, Germany, Luxembourg, and the Netherlands); *North-West regimes* (Ireland and the UK); *Southern European regimes* (Cyprus, Greece, Italy, Malta, Portugal, and Spain); *Eastern European regimes* (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia).

Source. European Commission; Gallie, 2007; Goergen et al., 2009.

4 Results[5]

The results section first analyses the data by old vs. new member states and then by institutional regimes (top-down approach), starting from descriptive statistics and then presenting regression models for each variable of interest.

4.1 Digital work

Digital work increased between 2010 and 2015 across all EU countries, with both old and new member states showing improvement (Table 3), though significant differences persist. While progress is notable among new member states, their 2015 levels still lag behind those of old member states in 2010. This pattern is particularly evident in countries with Southern and Eastern European regimes (Table 4).

Regression analysis indicates that new member states exhibited significantly lower levels of digital work in both 2010 and 2015 compared to old member states. However, the gap narrowed slightly from -6.75 in 2010 ($p < 0.001$) to -5.65 in 2015 ($p < 0.01$), indicating modest convergence (Figure 1).

Digital work levels also varied across institutional regimes with statistically significant differences observed for Southern and Eastern European regimes when compared with Nordic regimes. In particular, Southern and Eastern European regimes scored consistently lower than Nordic regimes (Figure 1). In 2010, the gap with the Nordic group was -7.28 for Southern regimes ($p < 0.01$) and -10.38 for Eastern regimes ($p < 0.001$). These differences remained relatively stable in 2015 (-7.79 for Southern regimes, $p < 0.01$, and -10.46 for Eastern regimes, $p < 0.001$, respectively), highlighting

[5] The categorical dummy variables are the frequencies of the respective categories, and the continuous variables are proxies for answers to these questions at country level.

Table 3 Difference between 2010 and 2015 in digital work by old vs. new member states

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	2.650442	2.839097	0.1887
Old and new member states	**Old member states**	2.9638	3.1014	0.1376
	New member states	2.2889	2.5365	0.2476

Table 4 Difference between 2010 and 2015 in digital work by institutional regime

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	2.650442	2.839097	0.1887
Institutional regime	**Nordic regimes**	3.2037	3.4128	0.2092
	Continental regimes	3.0870	3.2229	0.1359
	North-West regimes	3.3409	3.4820	0.1411
	Southern European regimes	2.5183	2.6990	0.1807
	Eastern European regimes	2.2080	2.4328	0.2248

persistent institutional disparities in digital work intensity.

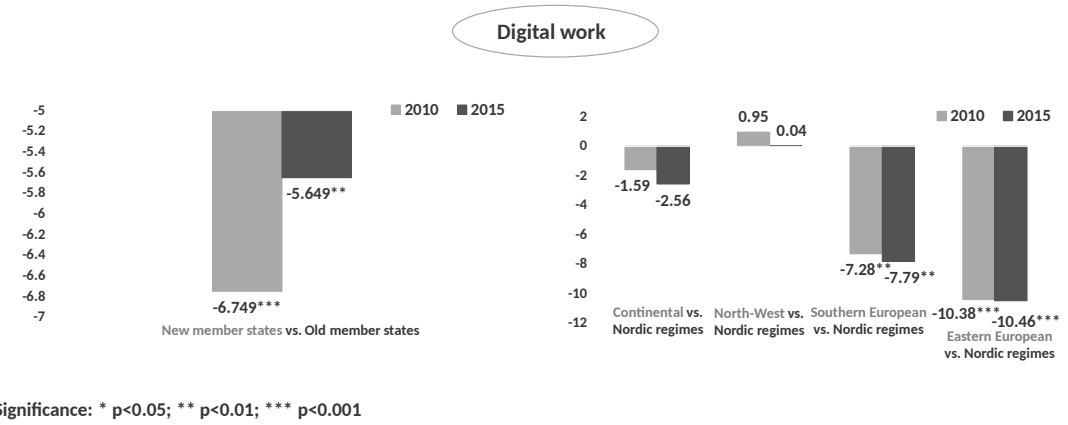

Figure 1 Linear regression coefficients of digital work in 2010 and 2015 by country-groupings

4.2 Learning capacity

Between 2010 and 2015, learning capacity remained largely stagnant in new member states, with a slight negative trend observed in some cases (Table 5). This is especially

true for countries in the Eastern and Southern European regimes (Table 6). While Nordic regime countries did not show progress during this period, they maintained the highest levels of learning capacity. Notably, by 2015, countries in Continental and Southern regimes had not yet reached the Nordic levels observed in 2010.

Table 5 Difference between 2010 and 2015 in learning capacity by old vs. new member states

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	**0.5589**	**0.5573**	**-0.0016**
Old and new member states	**Old member states**	0.5734	0.5748	0.0014
	New member states	0.5421	0.5371	-0.0050

Table 6 Difference between 2010 and 2015 in learning capacity by institutional regime

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.5589	0.5573	-0.0016
Institutional regime	**Nordic regimes**	0.6511	0.6329	-0.0182
	Continental regimes	0.5563	0.5716	0.0153
	North-West regimes	0.6268	0.6335	0.0067
	Southern European regimes	0.5384	0.5237	-0.0147
	Eastern European regimes	0.5340	0.5335	-0.0006

Regression results indicate no statistically significant differences in learning capacity between old and new member states in either 2010 or 2015. However, institutional regime differences were pronounced and stable across both years, particularly for the Southern and Eastern European regimes, which consistently lagged behind the Nordic regime. The gap between Continental and Nordic regimes slightly narrowed over time, decreasing from -0.10 ($p < 0.001$) to -0.07 ($p < 0.05$) (Figure 2). Compared with Nordic regimes, Southern European regimes scored significantly lower in both 2010 (-0.12, $p < 0.001$) and 2015 (-0.12, $p < 0.001$), while Eastern European regimes also showed significantly lower levels in 2010 (-0.12, $p < 0.001$) and 2015 (-0.11, $p < 0.001$). No significant differences were found for North-West regime countries.

4.3 Training opportunities

Descriptive statistics

Between 2010 and 2015, training opportunities slightly increased for both old and new member states, with the latter showing more pronounced improvement (Table 7). When analysed by institutional regime, countries in the North-West group recorded

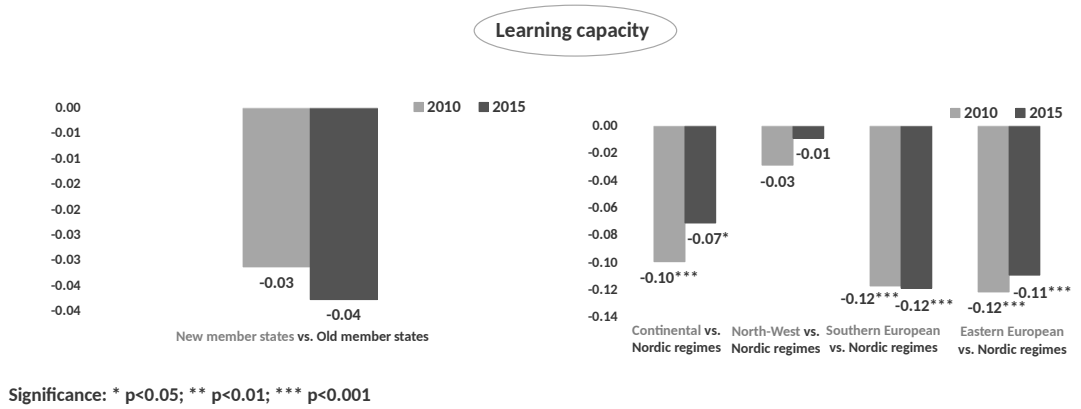

Figure 2 Linear regression coefficients of learning capacity in 2010 and 2015 by country-groupings

the highest increase, while those in the Nordic and Continental regimes experienced a slight decline (Table 8).

Table 7 Difference between 2010 and 2015 in training opportunities by old vs. new member states

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.4101	0.4284	0.0183
Old and new member states	**Old member states**	0.4363	0.4381	0.0018
	New member states	0.3798	0.4172	0.0374

Table 8 Difference between 2010 and 2015 on training opportunities by institutional regime

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.4101	0.4284	0.0183
Institutional regime	**Nordic regimes**	0.5787	0.5755	-0.0032
	Continental regimes	0.4321	0.4188	-0.0133
	North-West regimes	0.5355	0.6353	0.0998
	Southern European regimes	0.3133	0.3352	0.0218
	Eastern European regimes	0.3820	0.4067	0.0247

Regression analyses show no statistically significant differences in training opportunities between old and new member states for either 2010 or 2015. However, insti-

tutional regime differences were observed, particularly when comparing Continental, Southern and Eastern European regimes with the Nordic regime. Compared to the Nordic regime (used as reference), training opportunities remained lower in Continental regimes in both 2010 (-0.13, $p < 0.05$) and 2015 (-0.15, $p < 0.05$), Southern European regimes in both 2010 (-0.25, $p < 0.001$) and 2015 (-0.24, $p < 0.001$), and Eastern European regimes in both 2010 (-0.18, $p < 0.01$) and 2015 (-0.16, $p < 0.01$). No statistically significant differences were found for North-West regime countries in either year. Overall, the coefficients suggest a relatively stable pattern across the two years, rather than a substantial change over time (Figure 3).

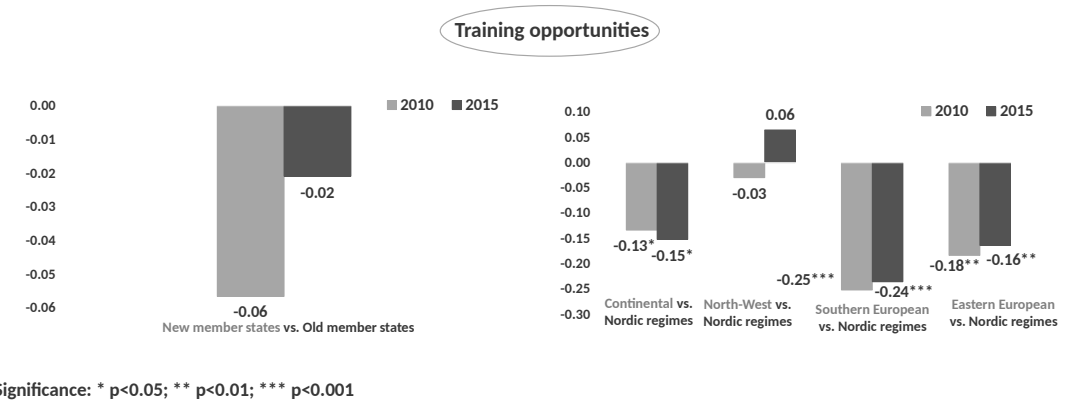

Figure 3 Linear regression coefficients of training opportunities in 2010 and 2015 by country-groupings

4.4 Task 'no' change

In 2015, a higher proportion of individuals from the new member states reported having received no new tasks or duties in the past 12 months compared to individuals from the old member states (Table 9). This pattern was more prominent in countries belonging to Southern European regimes and Eastern European regimes (Table 10).

Table 9 Task 'no' change by old and new member states, 2015

2015		
Mean		
TOTAL	**Average level in EU**	0.6104
Old and new member states	**Old member states**	0.6003
	New member states	0.6219

Regression results support these observations, showing that individuals in Southern European (0.14, $p < 0.05$) and Eastern European (0.13, $p < 0.05$) regimes were more likely to report no change in tasks compared to individuals in Nordic regimes in 2015 (Figure 4).

Table 10 Task 'no' change by institutional regime, 2015

2015		
Mean		
TOTAL	**Average level in EU**	0.6104
Institutional regime	**Nordic regimes**	0.4874
	Continental regimes	0.6029
	North-West regimes	0.5277
	Southern European regimes	0.6553
	Eastern European regimes	0.6385



Figure 4 Linear regression coefficients of task 'no' change, manual handling, repetitive movements, or protective equipment in 2010 and 2015 by country-groupings

4.5 Manual handling

Overall, the prevalence of jobs involving manual handling (carrying or moving heavy loads) declined between 2010 and 2015 across both old and new member states (Table 11). This downward trend was particularly visible in countries with Continental, North-Western, and Eastern European regimes. In contrast, an increase in manual handling was observed in countries classified under Nordic and Southern European regimes during the same period (Table 12).

Table 11 Difference between 2010 and 2015 in manual handling by old vs. new member states

		2010	**2015**	**Difference between 2010 and 2015**
		Mean	*Mean*	
TOTAL	**Average level in EU**	2.8023	2.7701	-0.0322
Old and new member states	**Old member states**	2.7218	2.7132	-0.0086
	New member states	2.8952	2.8356	-0.0595

Regression results broadly align with the descriptive findings. In both 2010 and 2015, individuals in Southern European regimes were more likely to report engaging in manual handling tasks compared to those in Nordic regimes (12.23, $p < 0.01$ in 2010 and 13.53, $p < 0.001$ in 2015). For Eastern European regimes, a statistically significant

Table 12 Difference between 2010 and 2015 in manual handling by institutional regime

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	2.8023	2.7701	-0.0322
Institutional regime	**Nordic regimes**	2.0516	2.1636	0.1120
	Continental regimes	2.8055	2.7084	-0.0971
	North-West regimes	2.3672	2.2997	-0.0675
	Southern European regimes	3.2848	3.4181	0.1333
	Eastern European regimes	2.8212	2.7012	-0.1200

difference compared with the Nordic group was observed only in 2010 (7.60, $p < 0.01$), while by 2015 this difference was no longer significant (Figure 4).

4.6 Repetitive hand or arm movements and protective equipment

The proportion of jobs involving repetitive hand or arm movements throughout the entire working day slightly declined between 2010 and 2015 in both old and new member states (Table 13). This downward trend was observed in countries classified under Continental, Southern, and Eastern European regimes. By contrast, countries in the Nordic and North-Western regime groups experienced a slight increase in such jobs over the same period (Table 14).

Table 13 Difference between 2010 and 2015 in repetitive hand or arm movements by old vs. new member states

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	.2015	.1823	-0.0193
Old and new member states	**Old member states**	.1946	.1826	-0.0120
	New member states	.2096	.1819	-0.0277

In 2010, individuals in Southern European regimes were more likely to report jobs involving repetitive hand or arm movements compared with individuals in Nordic regimes (0.09, $p < 0.05$). No statistically significant regime differences were observed for this indicator in 2015. (Figure 4).

As for the use of personal protective equipment, the regression results indicate no statistically significant differences across country groupings for either 2010 or 2015 or over time (Figure 4).

Table 14 Difference between 2010 and 2015 in repetitive hand or arm movements by institutional regime

		2010	2015	Difference between 2010 and 2015
		Mean	*Mean*	
TOTAL	**Average level in EU**	.2015	.1823	-0.0193
Institutional regime	**Nordic regimes**	.1582	.1591	0.0010
	Continental regimes	.1783	.1740	-0.0043
	North-West regimes	.1847	.1892	0.0045
	Southern European regimes	.2376	.2154	-0.0222
	Eastern European regimes	.2095	.1738	-0.0357

4.7 Total technology indicator

The total technology indicator increased between 2010 and 2014 in both old and new EU member states, reflecting overall technological advancement (Table 15). While all institutional regimes recorded progress, countries classified under Southern and Eastern European regimes notably reached - and in some cases surpassed - the 2010 levels of countries with Nordic regimes by 2014 (Table 16). This trend suggests gradual technological catching-up by lagging regions.

Table 15 Difference between 2010 and 2014 in the total technology indicator by old vs. new member states

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.3919	0.5582	0.1662
Old and new member states	**Old member states**	0.4332	0.6010	0.1678
	New member states	0.3443	0.5087	0.1644

Regression analysis indicates the persistence of statistically significant differences between new and old member states, with the total technology indicator remaining significantly lower in new member states in both years (-0.09, $p < 0.001$ in 2010; -0.09, $p < 0.05$ in 2014).

When grouped by institutional regimes, countries with Southern and Eastern European regimes consistently lagged behind Nordic regimes. Compared with Nordic regimes, Southern European regimes scored significantly lower in both 2010 (-0.11, $p < 0.01$) and 2014 (-0.17, $p < 0.01$), while Eastern European regimes also showed significantly lower levels in 2010 (-0.16, $p < 0.001$) and 2014 (-0.21, $p < 0.001$). Continental regimes differed significantly from Nordic regimes only in 2014 (-0.10, $p < 0.05$), while no statistically significant differences were found for North-West regimes in either year. Moreover, the gap widened over time for Southern and Eastern European regimes, indicating a possible widening of technological disparities relative to

Table 16 Difference between 2010 and 2014 in the total technology indicator by institutional regime

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.3919	0.5582	0.1662
Institutional regime	**Nordic regimes**	0.4831	0.7258	0.2427
	Continental regimes	0.4349	0.5993	0.1644
	North-West regimes	0.4379	0.6097	0.1717
	Southern European regimes	0.3876	0.5304	0.1427
	Eastern European regimes	0.3376	0.4958	0.1582

the Nordic regime (Figure 5).

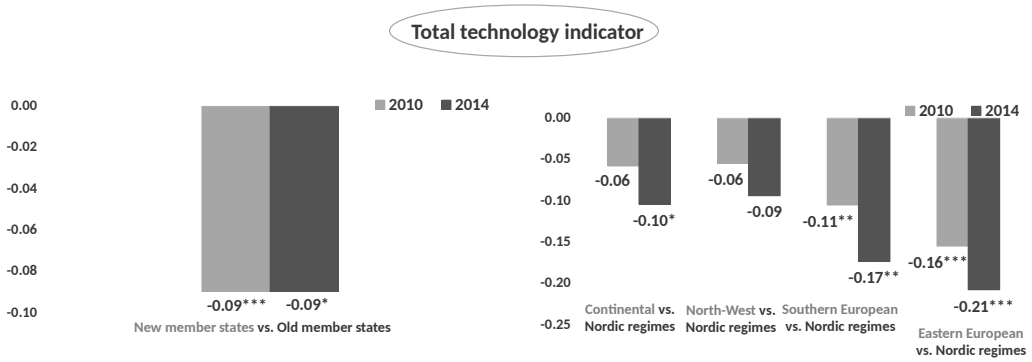

Figure 5 Linear regression coefficients of the total technology indicator in 2010 and 2014 by country-groupings

4.8 High CC services

Between 2010 and 2014, both old and new EU member states increased their purchases of high cloud computing (CC) services, including accounting software, CRM systems, and computing power (Table 17). Despite this growth, companies in old member states were purchasing such services at twice the rate of those in new member states by 2014. By institutional regime, Nordic countries led in the uptake of high CC services, followed by North-West, Continental, Southern, and Eastern European regimes (Table 18). This intensive investment, particularly by more advanced regimes, marked a turning point in the digitalisation trajectory during the mid-2010s.

Regression results for 2014 indicate these differences: new member states reported significantly lower purchases of high CC services compared to old member states (-0.11, $p < 0.01$). Differences by institutional regime were also marked, with all non-Nordic regimes scoring significantly lower than Nordic regimes: Continental regimes (-0.21, $p < 0.001$), North-West regimes (-0.17, $p < 0.05$), Southern European regimes (-0.26, $p < 0.001$), and Eastern European regimes (-0.27, $p < 0.001$) (Figure 6), indicating persistent disparities in access to advanced digital tools.

Table 17 Difference between 2010 and 2014 in high CC services by old vs. new member states

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.0149	0.1759	0.1610
Old and new member states	**Old member states**	0.0149	0.2253	0.2103
	New member states	0.0149	0.1190	0.1040

Table 18 Difference between 2010 and 2014 in high CC services by institutional regime

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.0149	0.1759	0.1610
Institutional regime	**Nordic regimes**	0.0149	0.4179	0.4030
	Continental regimes	0.0149	0.1791	0.1642
	North-West regimes	0.0149	0.2197	0.2048
	Southern European regimes	0.0149	0.1362	0.1212
	Eastern European regimes	0.0149	0.1219	0.1070

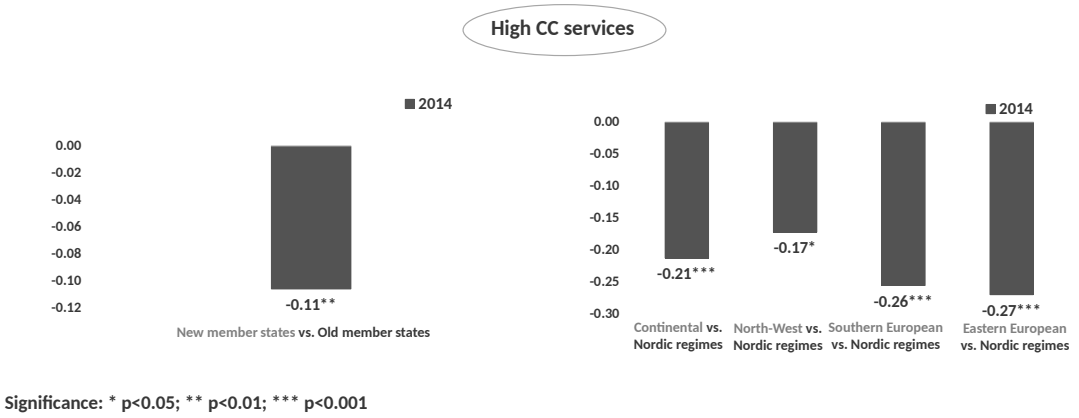

Figure 6 Linear regression coefficients of high CC services in 2014 by country-groupings

4.9 Medium CC services

Between 2010 and 2014, purchases of medium cloud computing (CC) services - including e-mail, office software, file storage, and enterprise database hosting - increased across both old and new member states (Table 19). The pattern closely mirrors that observed for high CC services. At the regime level, countries in the North-West group reported the highest uptake, followed by Nordic, Southern, Continental, and Eastern European regimes (Table 20), revealing persistent differences in access to basic digital infrastructure.

Table 19 Difference between 2010 and 2014 in medium CC services by old vs. new member states

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.0213	0.1866	0.1653
Old and new member states	**Old member states**	0.0213	0.2333	0.2121
	New member states	0.0213	0.1326	0.1113

Table 20 Difference between 2010 and 2014 in medium CC services by institutional regime

		2010	2014	Difference between 2010 and 2014
		Mean	*Mean*	
TOTAL	**Average level in EU**	0.0213	0.1866	0.1653
Institutional regime	**Nordic regimes**	0.0213	0.3089	0.2876
	Continental regimes	0.0213	0.1775	0.1562
	North-West regimes	0.0213	0.3132	0.2920
	Southern European regimes	0.0213	0.2208	0.1995
	Eastern European regimes	0.0213	0.1164	0.0951

Regression analysis for 2014 indicates a statistically significant gap between old and new member states in the adoption of medium CC services, with new member states scoring significantly lower than old member states (-0.10, $p < 0.01$). These differences are further reflected across regimes: countries in Eastern and Continental European regimes show statistically significantly lower adoption levels compared to those in Nordic regimes (Continental regimes: -0.11, $p < 0.05$; Eastern European regimes: -0.17, $p < 0.01$) (Figure 7), although the pattern is less uniform than for high CC services, as no statistically significant differences were found for North-West and Southern European regimes..

Taken together, the results indicate that while digital transformation has progressed across the EU between 2010 and 2015, significant disparities persist. Some convergence is visible in digital work and learning capacity, but gaps remain in training opportunities and technology adoption. Countries with Nordic and North-Western regimes consistently outperform those with Southern and Eastern regimes, suggesting aims to the enduring influence of institutional configurations.

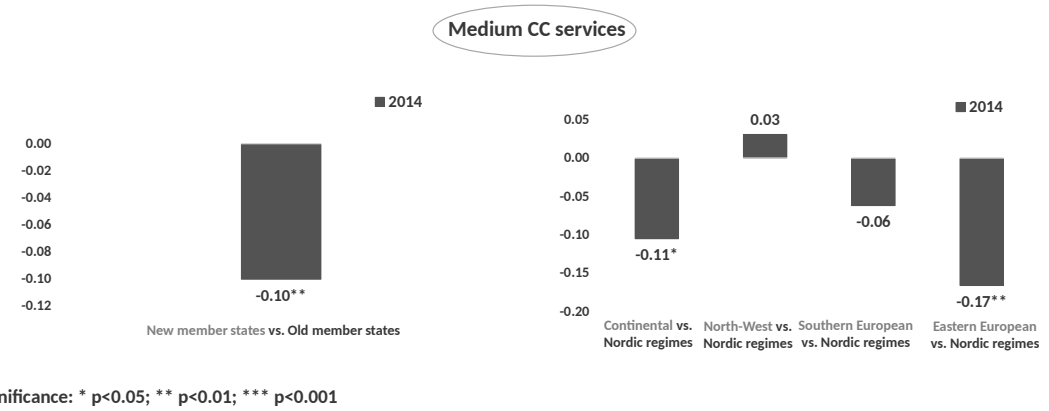

Figure 7 Linear regression coefficients of medium CC services in 2014 by country-groupings

5 Conclusion and discussion

Our analysis indicates that, in terms of the digital transformation, all EU countries made progress during the examined period. However, the more advanced countries, particularly old EU member states and those with Nordic regimes, have been advancing at a faster pace compared to others. The factors that might explain this phenomenon relate to economic structure and to the early involvement of Nordic and North-Western countries in the process of digital transformation and modernisation. These results are consistent with previous findings that the positive effects of digital technology are not observable in the absence of a favourable environment and conditions (such as necessary qualifications among the labour force, adequate organisational systems, the restructuring of public administrative systems, etc.) (Grigorescu et al., 2020). A major barrier for further regional development could be the people who have been excluded from the labour market, the welfare state – as underlined by Illéssy □t al. (2024) – or simply digital literacy (Kornelakis et al., 2022).

However, the analysis has also demonstrated a certain convergence between old and new member states in terms of digital work. Regarding the total technology indicator, we can observe consistent differences over time between old and new member states.

Our analysis shows that there have been significant and stable differences over time regarding training opportunities according to institutional regime, except in North-West countries. The results for training opportunities being most developed in the North-West are consistent with Boyadjieva and Ilieva-Trichkova's findings (2021), which examine indicators of enterprise engagement and training paid for by enterprises.

Furthermore, there has been a convergence between institutional regimes in terms of learning capacity, with the disparity between all institutional regimes (except for Southern European) and the Nordic one narrowing in 2015 compared to 2010. This suggests that a common learning culture is emerging across all European countries. However, our analysis also reveals more pronounced differences among institutional regimes, shedding light on some inequalities that are not apparent when using a narrow binary division of countries (old vs. new).

While the differences between old and new member states persist, we also wanted

to assess the evolution of the different regions. Not surprisingly, Southern European and Eastern European regimes appear quite similar to each other across many indicators, particularly in comparison to other regimes. This could be attributed to the significant presence of multinational companies in these countries, as well as the integration of local companies (e.g., SMEs) in global value chains, but also to particular patterns related to investment in technologies and skills.

Returning to our initial research questions – whether there has been convergence or divergence in the digital transformation across EU member states and institutional regimes, and which factors have shaped these trajectories – the findings suggest a nuanced picture. While overall digitalisation levels have increased across the EU, the pace and depth of change differ considerably between country groupings. Some convergence is observed in digital work and learning capacity, yet persistent and in some cases widening gaps remain in technology adoption and training opportunities. These differences are shaped not only by institutional regime, but also by broader structural and historical factors, such as the presence of multinational firms, integration into global value chains, and national investment patterns. This underscores the continued relevance of differentiated policy approaches.

These findings indicate that there is a major policy problem and, if the EU aims to facilitate convergence, there should be stronger and more targeted policy instruments in place to fill the gaps.

To address these disparities, several policy directions emerge from our findings. First, EU cohesion and digitalisation policies should prioritise targeted investment in lagging regions – particularly in Eastern and Southern Europe – through programmes that strengthen both infrastructure and workforce skills. Second, sector-specific strategies are needed to accelerate digital transformation among SMEs and low-digital-intensity industries. Third, inclusive training and upskilling programmes must ensure equal access to digital competencies for older workers, women, and other groups at risk of exclusion. Finally, fostering stronger coordination between national and regional institutions can improve the effectiveness of digital policy implementation and support long-term convergence across institutional regimes.

Building on these results, future research could explore more granular typologies, particularly within the group of post-socialist countries. For example, the classification by Bohle and Greskovits (2012), which distinguishes between neoliberal, embedded neoliberal, and neo-corporatist types, could reveal institutional and developmental differences not captured by our current grouping. Additionally, further studies could investigate the role of governance, investment strategies, and national policy responses in shaping the pace and character of digital convergence across EU regions. These directions could offer more targeted insights into the diverse pathways of digital transformation. In addition, future research could benefit from access to micro-level datasets that would enable the application of more advanced statistical techniques. The use of non-linear models and interaction terms could help capture the complex dynamics of digital transformation across countries and institutional regimes. Such approaches would make it possible to assess how institutional configurations interact with structural variables, such as sectoral composition, enterprise size, or workforce characteristics, in shaping convergence or divergence patterns.

The analysis also includes some limitations. We acknowledge that the country-groupings are useful for a macro analysis, but there could be differences between countries in the same group. This further justifies the exploration of alternative typologies,

such as that of Bohle and Greskovits (2012), in future research. Additionally, while the binary categorisation of 'old vs new' member states remains analytically useful, it does not fully reflect internal heterogeneity. Malta and Cyprus, for example, do not share the post-socialist legacy of Central and Eastern European countries and were included in the 'new member states' group solely due to the timing of their accession. Therefore, our subgroup analyses exclude these two countries. Finally, the research questions do not examine whether disparities among post-socialist countries have increased, decreased, or remained stable over the study period – an important avenue for future research. Due to the aggregated structure of our data, we are not able to explore sectoral variations in digital adaptation. However, this remains an important avenue for future research, especially considering the varying pace of digitalisation across industry sectors and national contexts.

The results emphasise the social and institutional shaping of technologies, highlighting the role of various stakeholders at different levels driving the digital transformation (Warhurst et al., 2019). Further research could explore the policy implications and provide specific recommendations for European countries and regions, especially those lagging behind in digital transformation efforts.

While our empirical analysis is based on data from 2010–2015, recent Eurostat statistics (2023–2024) confirm the persistence of digital divides across EU countries and institutional regimes (Eurostat, 2025). For example, the uptake of advanced technologies such as AI, cloud computing, and data analytics remains considerably lower in Eastern European countries compared to Nordic and Western countries. Only 6 per cent of SMEs in Bulgaria reached very high digital intensity in 2024, compared to 18 per cent in Finland. These updated figures suggest that the structural and institutional factors identified in our study continue to shape digital transformation outcomes. Our findings can therefore serve as a relevant benchmark for assessing progress toward the EU's 2030 Digital Decade targets.

Acknowledgments

We would like to thank Steven Dhondt, Nathalie Greenan, Silvia Napoletano, Sylvie Hamon-Cholet and Iris Eekhout who provided feedback and suggestions to the analysis carried out initially. The article preparation also benefitted from the comments of Pepka Boyadjieva and Petya Ilieva-Trichkova.

This research was undertaken within the BEYOND4.0 project, which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 822296.

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