

# Digitalization in the Public Sector: Unravelling (Un)Conditional Effects of E-Government on the Absorption of European Cohesion Policy

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Received 6.3.2024 (revision received 20.5.2024), Accepted (reviewed) 10.8.2024, Published 13.12.2024

## Abstract

This paper contributes to the recent empirical literature on the absorption determinants of the European Cohesion Policy (ECP). In particular, it attempts to verify the effect of the digitalization of the public sector in the form of e-government services on the ECP absorption rates during the period 2007–2016. Using the fixed effects panel models, we confirm that increased usage of e-government services is associated with higher absorption rates of the beneficiaries. Moreover, we reveal its conditional effects in connection with government quality, human capital, and recessionary periods. While its positive effect is neutralized in the recession, the benefits of the e-government use towards ECP absorption are more pronounced at a higher level of government quality and a share of skilled labor. The results therefore suggest that the promotion of digitalization and training can not only promote economic growth and innovation as commonly known but, as the analysis shows, can also be valuable in terms of ECP absorption rates.

## Keywords

*Digitalization, European Cohesion Policy, e-government, absorption*

## DOI

<https://doi.org/10.54694/stat.2024.11>

## JEL code

*E22, H50, I25, O38*

## INTRODUCTION

In the current era characterized by technological breakthroughs, digitalization has become one of the key elements in driving social progress and economic growth (Ding et al., 2021; Rong, 2022; Zhang et al., 2021). Previous research points to its ability to improve entrepreneurial performance by lowering

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operational costs and higher efficiency of supply chains which turns into increased revenues, market expansion, and finally accelerates the GDP growth rates (see, e.g., Endres et al., 2022; Gomes et al., 2022; Kreiterling, 2023).

Digital technologies can not only support innovation in private companies, but similar effects can be observed in the public sector as well (Dos Santos et al., 2022; Fischer et al., 2021). In this regard, *e-government* has been acknowledged to boost labor productivity in the public sector, its efficiency, and economic growth (Corsi et al., 2006). It can also increase transparency and make government services more accessible to citizens (Castro and Lopes, 2022).

Such benefits prevail in many European countries that stand out globally for their resilient digital government strategies and efficient online services (see, United Nations, 2022). Moreover, the European Union (EU) is proactively shaping the digital landscape of Europe by advancing *e-government*, ensuring transparency, and prioritizing citizen-centric services. In this respect, the European Commission acts, among other things, in building European interoperable platforms, such as a common framework for the management of citizens' electronic identity (European Commission, 2022).

The EU acknowledges the significant transformative potential of *e-government* not only in streamlining public services but also in promoting cohesion. In this respect, the *e-government* should represent an important catalyst with regard to the EU's main investment policy, the European Cohesion Policy (ECP). The projects financed by the ECP may contribute to the fulfillment of the EU's digital strategy, "*A Europe fit for the digital age*", but also the *e-government* should play a pivotal role in the active engagement of the citizens, transparent management, and efficient absorption of the ECP funds, i.e., the ability to efficiently use the ECP payments (European Commission, 2024a; Tiganasu and Lupu, 2023).

Although the theoretical assumptions point to the relevance of *e-government* in the ECP absorption, it must be said that there has been published only one paper that attempts to quantitatively evaluate the effect of *e-government* on ECP absorption (Tiganasu and Lupu, 2023) those findings are restricted to the Central and Eastern European (CEE) region.

Given that above, we formulate the research question as follows: *is the increased use of e-government services in all EU beneficiary countries contributing to the ECP absorption directly or are there any conditionalities?* Since most of the previous empirical research on the determinants of the ECP absorption capacity has been done in the form of qualitative studies lacking answers to this question (see, e.g., Milio, 2007; Moreno, 2020; Tosun, 2014; Surubaru, 2017), this paper aims to contribute to this strand of research by providing a quantitative analysis of absorption capacity determinants for all EU recipient countries in the period 2007–2016, with a focus on the *e-government* and its effects.

Our results suggest that *e-government* seemed to boost the ECP absorption rates in the selected period directly, but it had also a conditional dimension. While its positive effect diminished during the recessionary periods, the beneficial effect of increased *e-government* usage on the ECP absorption rates became more noticeable with a higher share of skilled labor and government quality.

The remainder of this article is structured as follows. The next section reviews empirical studies focusing on the driving forces of the ECP absorption and their expected outcomes. In the second section, we explain our choice of model specification, including the selected variables under investigation. The third section is devoted to the empirical results and discussion. The last part summarizes our findings and offers recommendations regarding *e-government* intending to support the ECP absorption rates in the EU beneficiary countries.

## 1 LITERATURE REVIEW

So far, empirical research on the ECP absorption rate has been predominantly carried out in the form of case studies or comparative analyses (see, e.g., Milio, 2007; Moreno, 2020; Terracciano and Graziano,

2016; Tosun, 2014; Surubaru, 2017). In this context, the authors evaluate the absorption levels across countries, regions, and individual programming periods, but also attempt to clarify which determinants drive the ECP absorption.

Overall, the absorption levels tend to be relatively low initially for many recipient countries, followed by accelerated spending at the end of program periods. This pattern in expenditure is debatable as it can distort the expected effects of the ECP due to a possible “*absorption-for-all*” approach (Stiblarova, 2022; Surubaru, 2017).

Significant differences regarding absorption may, however, emerge between countries or regions. Some studies point out that, compared to the old EU member states, newer members tend to absorb a higher proportion of the ECP funding because of their greater need for investments in key areas, such as infrastructure or institutional capacity-building (see, e.g., Ciffolilli et al., 2023; Tosun, 2014). Moreover, Moreno (2020) investigates the regional absorption capacity in the programming period 2007–2013, which is not so much of interest compared to absorption at the national level. The author finds significantly heterogeneous evidence not only between countries but also within the regions of one country, which in a certain way alleviates the effect of cultural factors on the absorption capacity.

The majority of empirical studies on the ECP absorption, although, acknowledge that sound institutional, political, and legal conditions are the primary drivers of absorption (see, e.g., Bachtler et al., 2014; Ciffolilli et al., 2023; Incaltarau et al., 2020; Surubaru, 2017). Since good government quality is a prerequisite for development (Incaltarau et al., 2020), it can mediate not only the effect of the Cohesion Policy but also its implementation (Rodriguez-Pose and Garcilazo, 2015).

In this regard, good government quality should ensure higher transparency and accountability in the ECP allocation and implementation, which should be in turn reflected in the higher absorption rate of the funds (Ciffolilli et al., 2023; Surubaru, 2017). Mendez and Bachtler (2024) confirm this assumption for 173 European regions in the period 2007–2013. The authors acknowledge the government quality to be the fundamental determinant of timely spending and outcomes of the ECP. Based on the results, Mendez and Bachtler (2024) also call for capacity-building in regions that suffer from low government quality to boost ECP implementation.

Tosun (2014) provides the analysis of the European Regional Development Fund (ERDF) absorption capacity of 25 recipients in the 2000–2006 programming period. In line with expectations, the author observes a positive relationship between government effectiveness and ERDF absorption. Similar evidence is provided by Incaltarau et al. (2020) who investigated the absorption capacity in the period 2007–2015. The authors confirm that government effectiveness and control of corruption strongly support the ECP absorption, and this holds especially for the newer member states, i.e., countries that joined the EU in 2004 and 2007. Such results could explain why some of these countries still face difficulties regarding efficient ECP funding compared to the old member states.

The absorption of the ECP funds can be accelerated or slowed down by the way the country is able to manage the disbursement of funds from the ECP. Thus, political support can help build institutional structures needed for ECP administration (Ciffolilli et al., 2023). In this context, Surubaru (2017) focuses on the ECP absorption in two recipient countries—Bulgaria and Romania during the period 2007–2013. Based on the questionnaire, the author stresses that greater Bulgarian absorption could be attributed to the simplification of processes regarding the drawing of funds by the political agency. Although both countries had less experience with managing funds, it seems that they significantly improved in terms of establishing the institutional structure and procedures needed to manage the ECP funds.

In addition to the government quality, administrative capacity has been approved to be one of the strongest predictors of ECP absorption (see, e.g., Ciffolilli et al., 2014; OECD, 2020; Terracciano and Graziano, 2016; Tosun, 2014). Here, the focus is placed on the human resource-related infrastructure (both quantity and quality) in public administration responsible for the processing of the ECP funding.

A high administrative capacity enables better implementation of EU policies and thus promotes the absorption of the ECP funds (see, e.g., Bachtler et al., 2014; Incaltarau et al., 2020). For this reason, Incaltarau et al. (2020) suggest aiming at administrative capacity-building and control of corruption in regions with low administrative capacity. Dimitrova and Toshkov (2009) and Incaltarau et al. (2020) claim that the weakness regarding administrative capacity has been mainly observed in newer EU member, both before and after their accession. The elimination of unfair practices in the form of corruption or rent-seeking could therefore assist countries to reach their growth potential through more efficient ECP.

The socio-economic conditions of recipient countries/regions have been also considered relevant in absorption research in previous empirical studies (see, e.g., Ciffolilli et al., 2014; Kersan-Skabic and Tijanic, 2017; Mendez and Bachtler, 2024). Ciffolilli et al. (2014) observe that low-income countries tend to spend the ECP rapidly to boost their economic growth. The absorption of the ECP also positively correlates with the ECP allocation itself; here, the authors find that higher allocation is associated with a higher absorption rate (Incaltarau et al., 2020; Mendez and Bachtler, 2024). This is related to the fact that with a higher allocated amount of the ECP, the implementing agencies can expand their capacities, but also do scalable projects (Ciffolilli et al., 2014).

Except for that, successful project implementation requires skilled labor. Taking this into consideration, a sufficient level of human capital may allow to implement the ECP projects more effectively and in turn, contribute to the higher absorption. A similar relationship may be expected for the infrastructure as well (see, e.g., Kersan-Skabic and Tijanic, 2017).

On the contrary, the effect of some absorption drivers has not been clearly confirmed yet. Such a case is, for example, fiscal decentralization. Kersan-Skabic and Tijanic (2017) find a positive effect of fiscal decentralization on the absorption of the ECP in the period 2000–2011. While according to Tosun (2014), it seems that fiscal decentralization decelerates the absorption performance, which may be the result of the need for greater coordination across multiple entities and subsequent delays in drawing funds. However, the results do not seem to be robust. A similar, insignificant evidence on the effect of political decentralization has been brought by Incaltarau et al. (2020) while investigating absorption capacity in the period 2007–2015.

The absorption level can be additionally related to exogenous factors, such as economic crises. In this regard, the recession can lead to lower absorption, as during the crisis it can be more difficult to co-finance projects from the ECP due to fiscal consolidation (European Commission, 2013; Surubaru, 2017).

Difficulties in terms of the ECP may also arise due to the lack of digitalization, although, it has not been extensively explored in quantitative studies with connection to the ECP absorption. A rare econometric analysis is provided by Tiganasu and Lupu (2023) who examine the trilateral relationship between regional governance, digitalization, and the ECP payments for 56 regions from the CEE countries. The authors confirm a positive effect of digitalization on the ECP payments in the observed period 2007–2018. Tiganasu and Lupu (2023) also state that in the CEE regions with weak governance, the possibility of carrying out massive digitalization decreases, and so does the subsequent access to the ECP funding.

Since the evidence on this matter is limited, the aim of this paper is to investigate how the digitalization of government services, i.e., the e-government activities of individuals are related to the absorption of the Cohesion Policy. In contrast to Tiganasu and Lupu (2023), we provide evidence for all recipients of the ECP in the programming period 2007–2013, including the  $n + 3$  allocation rule at the national level, by which we contribute to this strand of literature. Not only direct effect of e-government is the subject of investigation. We assume that there might be some conditionalities regarding e-government. While in general, the recessionary period may be associated with lower absorption rates, the effect of e-government

during the crisis period has not been investigated. Additionally, the effectiveness may also depend on the governance quality and the human capital, i.e., the ability of citizens to use such services. Although in the majority of professions digital skills are considered crucial, according to the European Commission (2024b), more than a third of working Europeans still lack basic digital skills which could diminish the e-government benefits. The obtained results will be used for the formulation of recommendations with the aim of ensuring effective and faster absorption of the ECP funds.

## 2 METHODOLOGY AND DATA

Since the aim of this paper is to examine the main drivers of the ECP absorption, with an emphasis placed on the effect of e-government, we estimate the fixed effects panel model (Baltagi, 2021) in the following way:

$$Absorption_{it} = \beta Egov_{it-1} + \sum_{c=1}^C \gamma_c \log CV_{cit-1} + \alpha_i + \varepsilon_{it}. \quad (1)$$

Our dependent variable  $Absorption_{it}$  presents the ECP absorption rate (%) in the particular recipient country  $i$  in period  $t$ . The set of explanatory variables consists of  $Egov_{it-1}$ , the proxy for digitalization in the public sector, and several control variables ( $CV_{cit-1}$ ). Among them, frequently mentioned are absorption determinants, such as human capital, ECP expenditure, and government quality. These continuous explanatory variables are considered lagged by one year ( $t - 1$ ) to control for possible endogeneity problem. We also control for the crisis period (2008–2009) and the effect of the membership in the euro area. Finally, the term  $\alpha_i$  denotes fixed effects, and  $\varepsilon_{it}$  is the random term.

As for defining the dependent variable, the ECP absorption rate is calculated in a standard way as a percentage share of total spent ECP funds on the total allocated sum of ECP funds (see, e.g., Ciffolilli et al., 2023; Surubaru, 2017; or Tosun, 2014):<sup>2</sup>

$$Absorption_{it} = \frac{ECP\ payments_{it}}{ECP\ allocation_{it}}. \quad (2)$$

It follows from this that the absorption rate of the ECP is restricted in its range, i.e., it varies from 0 to 100 percent (see Table 1).

**Table 1** Descriptive statistics

	Obs.	Mean	Std. dev.	Min	Max
Absorption	280	44.667	33.612	0.000	100.000
E-gov	223	42.893	18.178	4.930	88.080
ECP	251	0.997	1.230	0.009	4.990
Human cap	245	30.879	8.735	14.700	49.200
Govern	252	6.763	1.084	4.592	8.878

**Source:** Author's calculations based on data from the European Commission, Eurostat, and the World Bank

Regarding the proxy variable for digitalization, our main independent variable of interest  $Egov_{it-1}$  represents the proportion of residents who have communicated with public bodies through websites

<sup>2</sup> As for the definition of the variable, to prevent non-stationarity and consequent spurious regression, we express most variables as ratio indicators (i.e., % of population, GDP).

in the past year.<sup>3</sup> Here, we anticipate that the use of e-government initiatives will reduce administrative burdens and expedite procedures related to project implementation, and, among other things, will thus be linked to a higher rate of ECP fund absorption.

Furthermore, it is probable that the effect of e-government will depend on some other variables. Because of this, we also look at the possibility of how the e-government interacts with crisis prevalence ( $E-gov_{t-1} \times Crisis_t$ ), human capital ( $E-gov_{t-1} \times Human\ cap_{t-1}$ ), and government quality ( $E-gov_{t-1} \times Govern_{t-1}$ ).

Firstly, the effect of e-government in times of crisis has not been closely investigated yet. The e-government could potentially play a positive mediating role through the improvement of the ECP management and selection processes, which could be later translated into faster ECP absorption. However, we expect that the progress of e-government has likely been moderated in the crisis of 2008–2009 as a result of fiscal consolidation.

For the government quality and human capital, we posit that they may play a mediator role in delivering a positive effect of the e-government activities on the ECP absorption. While the positive effect regarding government quality has been confirmed by Tiganasu and Lupu (2023), the empirical literature lacks evidence on the interaction of human capital and e-government. In this regard, we expect that the synergy between e-government and human capital can boost the absorption of the European Cohesion Policy funds by promoting efficiency, transparency, and stakeholder engagement.

The mentioned explanatory variables are listed in the model also as the linear terms, i.e., the control variables. The choice of our control variables has been made based on previous empirical studies concerning the ECP absorption rate. Concerning this, we include the total ECP expenditure (as a share of GDP) to the recipient countries ( $ECP_{it-1}$ ) as it has been shown that larger amounts are associated with faster absorption (see, e.g., Mendez and Bachtler, 2024).

We also consider human capital ( $Human\ cap_{it-1}$ ), proxied by a share of employed people with tertiary education. We expect that highly skilled labor can contribute to more effective implementation and faster absorption of the ECP funds as in Ciffolilli et al. (2023).

Similarly, a higher-level government quality ( $Govern_{it-1}$ ) has been acknowledged to promote the ECP absorption rates (Bachtler et al., 2014; Surubaru, 2017; Terracciano and Graziano, 2016). To construct this variable, we follow the study of Incaltarau et al. (2020); we define government quality as the equally weighted composite measure of control of corruption and political stability indicators. The used indicators have been retrieved from the World Governance Indicators database provided by the World Bank.

Finally, we consider two dummy explanatory variables. One for controlling the crisis period 2008–2009 ( $Crisis_{it}$ ) and the other for controlling the membership in the euro area ( $Euro_{it}$ ). While in the case of the crisis, past studies point to a lower absorption (Surubaru, 2017), in the second case, we expect that member countries may experience higher ECP absorption due to policy alignment and enhanced coordination.

The model is estimated based on 28 recipient countries in 2007–2016.<sup>4</sup> We chose this period since it fully covers the programming period 2007–2013, including the  $n + 3$  allocation rule. The descriptive statistics for considered variables are provided in Table 1. We also provide the correlation matrix in Table A1 in the Appendix.

<sup>3</sup> To the best of our knowledge, there is not a more suitable indicator that directly captures communication between legal entities and public institutions. While we acknowledge that the ECP recipients include both individuals and legal entities, the rationale for using this indicator stems from the fact that the level of interaction of individuals with public institutions should be highly correlated with the interaction of legal entities with public institutions. Notably, countries like Denmark, Finland, and Sweden exhibit the highest values in our e-government proxy. These countries also lead in more complex e-government rankings, such as the United Nations' E-Government Development Index (EGDI), validating our assumption.

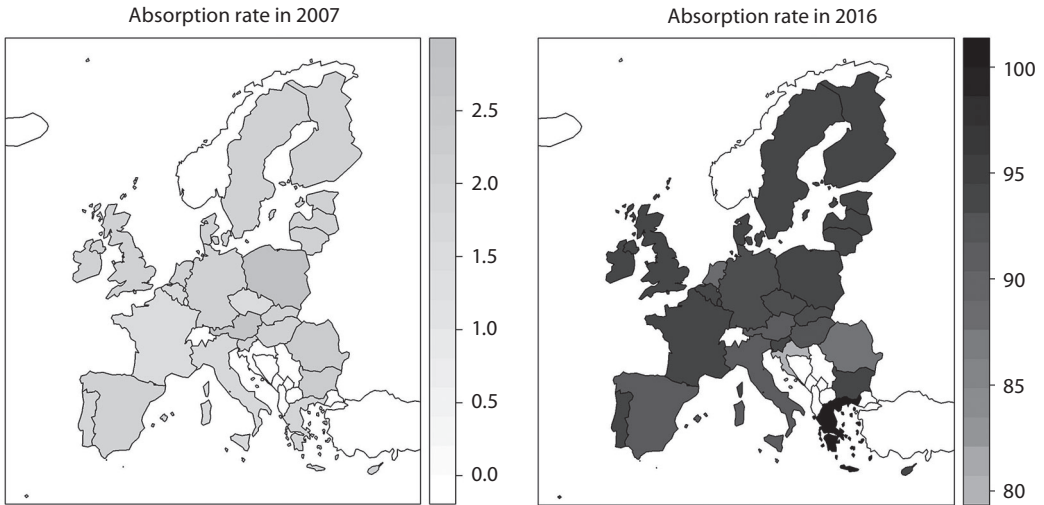
<sup>4</sup> The newer observations have not been included since we would not be able to capture the absorption rate for the entire programming period 2014–2020. That is, we would not be able to capture a significant use of funds which occurs mostly after the end of the programming period.



### 3 EMPIRICAL RESULTS AND DISCUSSION

Firstly, we provide empirical evidence on the ECP absorption rate across the recipient countries. The comparison of the start (year 2007) and the end of drawing on ECP (year 2016) within a given programming period is depicted in Figure 1.

**Figure 1** Absorption rate of the ECP in the EU countries (year 2007 and 2016)



Source: Author's elaboration based on data from the European Commission © EuroGeographics for the administrative boundaries

As can be seen, the difference over time is significant. The absorption rate in the first year of the programming period 2007–2013 reached a deficient level in all beneficiary countries, while in 2016 it ranged between 80–100 percent. The obtained evidence thus confirms the slow start of ECP funding, with the minimum absorption rate achieved by Luxembourg, at 1%.

On the other hand, Poland has been a leader with the absorption of 2.8%. It must also be said that Poland has been the largest recipient of the ECP in this programming period, with a budget of over 67 billion EUR which may indicate that a higher budget is associated with faster absorption as in Mendez and Bachtler (2024).

Similar to the Polish economy, many CEE countries have benefited from higher ECP funding and shown above-average absorption rates, such as Estonia, Lithuania, or Slovenia. The results, therefore, do not necessarily imply that more developed countries with better digitization are also more adept at securing funding and meeting monitoring criteria, leading to a higher absorption rate. However, some differences in the dynamics of the absorption of financial resources can be observed in the CEE countries over time compared to the average absorption rate in the EU as well (see Figure A1 in the Appendix). For instance, Romania and Croatia have absorbed significantly lower ECP funding throughout the whole programming period (see also Figure 1 on the right). Such evidence can be explained by the fact that these countries lacked sufficient administrative capacity and institutional quality, needed for efficient management and implementation of the ECP projects.

It should also be noted that Croatia became the EU member state only in 2013 and before that, it only received pre-accession funding to build administrative capacity and improve the quality of institutions devoted to the EU funds' management. Despite this effort, many authors point out that an “*absorption shock*” occurred in the next program period as well (see, e.g., Puljiz et al., 2019).

**Table 2** Direct effect of the absorption drivers (fixed-effects panel model)

	Absorption rate of the ECP (in %)					
	(I)	(II)	(III)	(IV)	(V)	(VI)
E-gov <sub>t-1</sub>	2.786*** (0.230)	2.630*** (0.230)	1.023*** (0.256)	0.955*** (0.246)	0.976*** (0.217)	0.975*** (0.215)
ECP <sub>t-1</sub>		9.919*** (2.552)	3.877* (2.017)	3.741* (2.004)	3.962** (1.872)	4.024** (1.882)
Human cap <sub>t-1</sub>			6.910*** (1.103)	6.886*** (1.088)	6.942*** (1.199)	6.945*** (1.193)
Euro <sub>t</sub>				12.269 (7.688)	12.647 (7.636)	12.472* (7.236)
Crisis <sub>t</sub>					1.738 (4.511)	1.559 (4.607)
Govern <sub>t-1</sub>						2.711 (7.010)
No. of observations	223	223	217	217	217	217
No. of countries	28	28	28	28	28	28
R-squared	0.498	0.546	0.804	0.809	0.809	0.809
Log likelihood	-987.640	-976.533	-858.103	-855.391	-855.264	-855.160
AIC	1 977.280	1 957.067	1 722.205	1 718.781	1 720.529	1 722.320

**Note:** Standard errors are in parentheses. \*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

**Source:** Author’s calculations based on data from the European Commission, Eurostat, and the World Bank

However, such a scenario did not occur in all recipient countries. To provide a bigger picture of the effects of the absorption driving forces, we present the estimation results from fixed-effects panel models in Table 2. To address potential issues of heteroskedasticity and autocorrelation, robust standard errors of estimated regression coefficients are reported in parentheses. Several model variants are considered (columns (I)–(VI)) altering a set of regressors to check the robustness of the results, while we focus solely on the direct effects of considered determinants.

Firstly, we focus on our main variable of interest, e-government (*E-gov*). In line with our assumptions, we confirm that the more citizens use e-government services, the higher the absorption rate is observed in the recipient countries (columns (I)–(VI)). We therefore validate the scarce evidence on the CEE countries provided by Tiganasu and Lupu (2023) according to which digitalization seems to remove certain administrative obstacles and facilitate communication and partnership with governing bodies in the ECP implementation, leading to higher ECP absorption rates. As for the e-government services, their higher rates of usage are not typical simply for the countries of Western or Northern Europe—for instance, Estonia made great progress in digitalization after gaining independence in the 1990s, thanks to which today it excels in digital public services. Along with Denmark, Finland, and Sweden, it has been also ranked by the United Nations as one of the most digitally advanced economies in the world (see, United Nations, 2022). At the same time, their ECP absorption rate was also above average.

Similarly, we find a positive and statistically significant effect of the total ECP expenditure (*ECP*) on the ECP absorption rate in 2007–2016 (columns (II)–(VI)). The results therefore point to the fact that countries with a higher budget achieve a higher absorption on average, of which the aforementioned



Poland was a perfect example. Additionally, a larger proportion of skilled labor (*Human cap*) is associated with increased ECP absorption rates, aligning with the research by Kersan-Skabic and Tijanac (2017).

Regarding our binary explanatory variables, *Euro* and *Crisis*, we observe that countries that use the common currency, the Euro, have adopted on average more ECP funding (columns (IV)–(VI)). The same applies to the crisis period 2008–2009 (columns (V)–(VI)) which does not confirm the claims about the worsened possibility of drawing the ECP funds in the recessionary periods. We must add, however, that the significance of the estimated coefficients related to the *Euro* and *Crisis* has not been proved in all considered model specifications, so we cannot draw clear conclusions based on these models. Similar insignificant evidence is provided for government quality (*Govern*, column, VI).<sup>5</sup>

**Table 3** Conditional effects of the e-government (fixed-effects panel model)

	Absorption rate of the ECP (in %)		
	(I)	(II)	(III)
E-gov <sub>t-1</sub>	0.919*** (0.160)	-0.143 (0.450)	-0.789 (0.767)
ECP <sub>t-1</sub>	3.989*** (1.509)	5.276*** (1.648)	4.876*** (1.598)
Human cap <sub>t-1</sub>	6.677*** (0.425)	4.907*** (0.783)	6.955*** (0.446)
Euro <sub>t</sub>	8.959* (4.874)	6.355 (5.181)	12.215** (5.699)
Crisis <sub>t</sub>	7.507 (6.294)	-4.619 (3.505)	3.435 (3.825)
E-gov <sub>t-1</sub> x Crisis <sub>t</sub>	-0.271** (0.137)		
E-gov <sub>t-1</sub> x Human cap <sub>t-1</sub>		0.034*** (0.013)	
Govern <sub>t-1</sub>			-6.963 (7.593)
E-gov <sub>t-1</sub> x Govern <sub>t-1</sub>			0.273** (0.116)
No. of observations	217	217	217
No. of countries	28	28	28
R-squared	0.833	0.810	0.815
Log likelihood	-962.788	-981.958	-851.9001
AIC	1 939.575	1 977.916	1 719.802

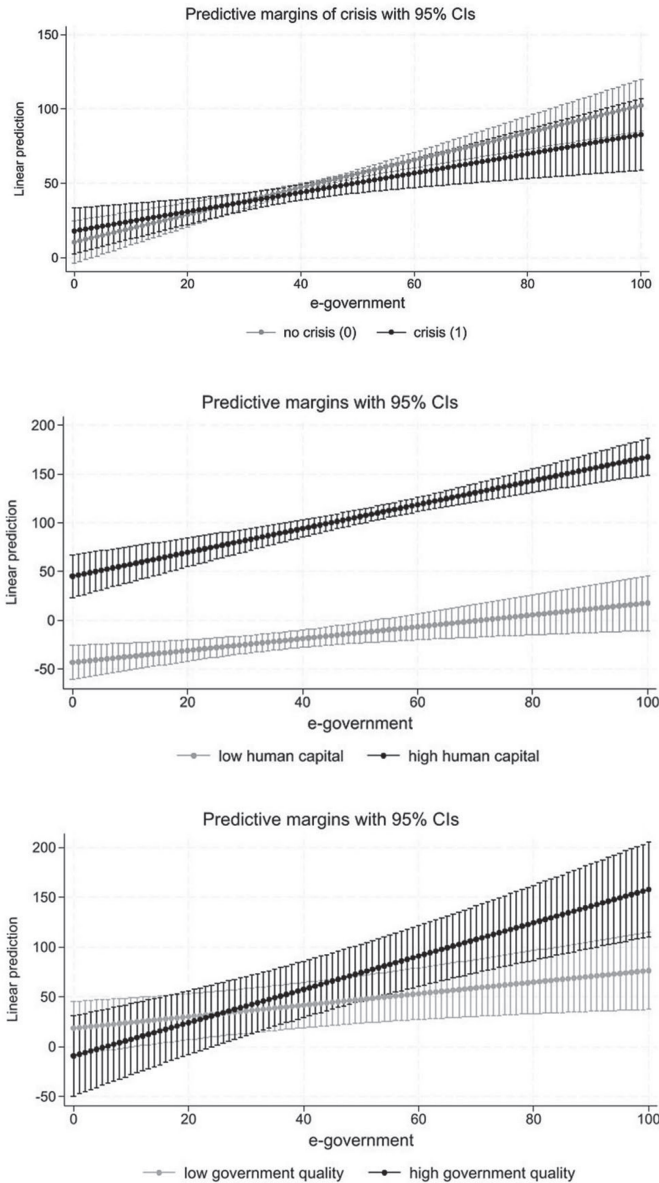
**Note:** Standard errors are in parentheses. \*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01.

**Source:** Author's calculations based on data from the European Commission, Eurostat, and the World Bank

<sup>5</sup> Since the main goal of this study is to focus on the effect of e-government on the ECP absorption rate, we opted for the model specifications in which this main explanatory variable is always represented. This brings the disadvantage of a higher correlation of the E-gov variable with government quality (see correlation matrix in Table A1 in the Appendix). To address multicollinearity, we explore various model specifications by sequentially incorporating individual explanatory variables, ensuring the E-gov variable is included last. Moreover, the effect of government quality is not key from the point of view of this analysis, and its insignificance is, through the lens of higher correlation, rather taken with caution.

When examining the driving forces behind the ECP absorption rate, it is also plausible that certain conditional effects may arise. Since we focus on the role of e-government, we provide the estimation results where we consider several interaction terms. In particular, interaction terms of the e-government with the *Crisis* variable, human capital (*Human cap*), and government quality (*Govern*). The results on the conditional effects of the e-government are available in Table 3.

**Figure 2** Interaction plots



**Note:** We depict the interaction plots for statistically significant interaction terms.  
**Source:** Author's calculations based on data from the European Commission, Eurostat, and the World Bank

Firstly, we focus on the interaction between e-government and the crisis. Although the difference in slopes is relatively modest (as indicated by the upper interaction plot in Figure 2), our results show that the positive effect of greater e-government use is neutralized during the examined recessionary period. Given that the 2008–2009 recession was characterized by fiscal austerity, our findings suggest that modernization and innovation were deprioritized due to fiscal consolidation and austerity measures during this crisis. During challenging fiscal periods, the advancement of e-government can be particularly arduous, especially in countries lacking a robust internet infrastructure. This was notably the case in many (especially Central and Eastern) European countries at the time, which validates such findings.

On the other hand, we find a positive and statistically significant coefficient related to the interaction term of the e-government and human capital. This suggests that the benefits of the increased use of e-government towards ECP absorption rate are more pronounced in the case that there is a higher proportion of highly skilled labor in the recipient countries (as indicated by the middle interaction plot in Figure 2). The results can be explained in the sense that higher-skilled labor will more likely have the necessary digital skills, which present a prerequisite for the efficient use of e-government. For digital literacy, it needs to say that it has been increasing in the EU countries, however, in some countries, the share of people with these skills is still relatively low—for example in Bulgaria or Romania (see, European Commission, 2024b; Tarjani et al., 2023). The promotion of these skills can therefore not only foster economic growth and innovation but also, as the analysis shows, be valuable from the point of the ECP absorption rate.

We also find a positive and statistically significant interaction term of the e-government and government quality, suggesting that sound institutions go hand in hand with e-government activities facilitating the ECP absorption. The findings imply that superior government quality, coupled with increased utilization of e-government services, leads to a greater ECP absorption rate. Our evidence of the conditional effect of e-government on government quality also validates the regional evidence of Tiganasu and Lupu (2023) and thus calls for an increase in the quality of the institution with the aim of delivering a higher absorption of the ECP funding.

## CONCLUSIONS

Unlike the existing case studies and comparative analyses concerning the determinants of the ECP absorption, this paper aimed to quantitatively measure the effect of the e-government on the ECP absorption rates, which is still not the subject of extensive research. Based on the fixed-effects panel estimation, our results confirm that e-government matters for the absorption of the ECP payments. In particular, the more these services are used, the higher absorption rates are observed in the period 2007–2016, which validates the scarce evidence on the CEE region by Tiganasu and Lupu (2023).

The main contribution of this paper, however, lies in revealing its conditional effects. We find that the positive effect of e-government diminishes in times of crisis, and thus does not deliver the expected outcome on the EU absorption rates. To overcome such problems, it would be advisable to strengthen the e-government systems to assure their resilience during the recessionary periods. Not only robust digital infrastructure but also ensuring training and capacity building for responsible ECP authorities and coordinators could increase their ability to cope with difficult crisis periods and mitigate the consequences of crisis on the ECP absorption rates in the next programming periods.

For the human capital and government quality, we discover the opposite—higher skilled labor and government quality seem to enhance the benefits of e-government on the ECP absorption. While the improvement of government quality has already been proven to contribute to the effectiveness of e-government concerning ECP absorption, the positive interaction of human capital with e-government presents a novel finding. This suggests that the use of the expertise of highly qualified workers is important

for optimizing the benefits of e-government. To enhance the ECP absorption, the effort could be thus directed to facilitate the establishment of digital innovation hubs, and strengthen cooperation between universities and research institutions, which can boost innovations and transfer of knowledge, but also provide highly skilled graduates. The policies should be also targeted at training and promoting digital literacy. In this respect, the EU's initiative "A Europe fit for the digital age" with a budget of 250 billion from NewGenerationEU could bring desired effects, as it aims to ensure that 80 percent of the EU citizens have basic digital skills by 2030.

Although, it must be added that some challenges in applying digital technologies in the public sector include, for instance, high deployment costs, privacy and ethical concerns, legal frameworks, and data security (for more, see, e.g., Dos Santos et al., 2022). By addressing them, building robust infrastructure, and focusing on training and cooperation of the responsible authorities, the beneficiary countries could, therefore, promote their ECP absorption rates.

## ACKNOWLEDGMENT

This work was supported by the Scientific Grant Agency VEGA under Grant No. 1/0154/24.

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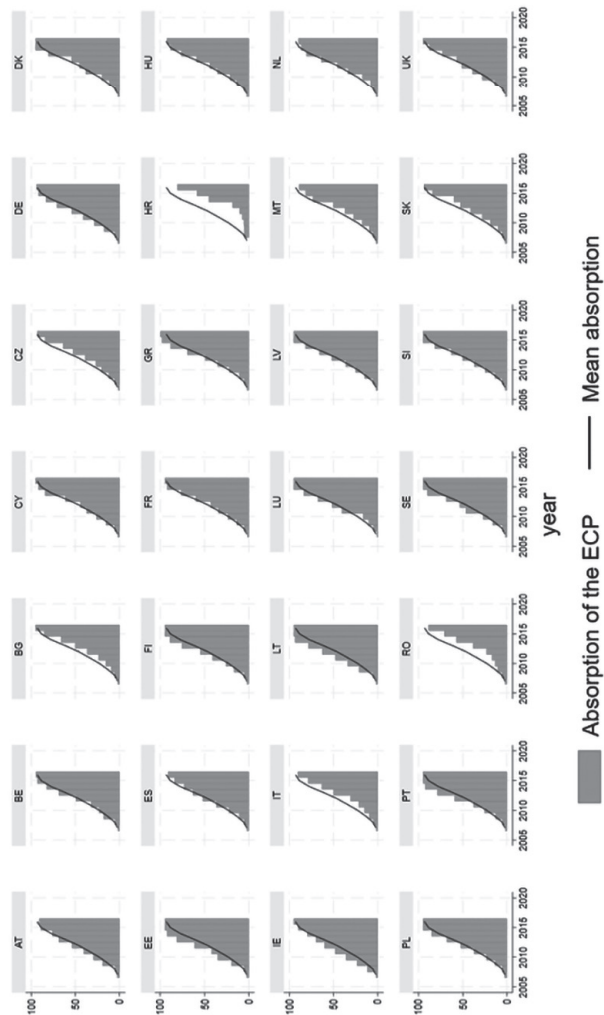
# APPENDIX

**Table A1** Correlation matrix of considered variables

	Absorption	E-gov	ECP	Human cap	Govern
Absorption					
E-gov	0.385				
ECP	0.190	-0.323			
Human cap	0.422	0.506	-0.175		
Govern	0.099	0.781	-0.496	0.424	

Source: Author's calculations based on data from the European Commission, Eurostat, and the World Bank

**Figure A1** Absorption of the ECP by EU countries and years



Source: Author's elaboration based on data from the European Commission