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E-government as a Democratic Catalyst: Evidence from OECD Countries (2006–2024)

Demokratik Bir Katalizör Olarak E-Devlet: OECD Ülkelerinden Kanıtlar (2006–2024)

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E-government as a democratic catalyst: evidence from OECD countries (2006–2024)

Abstract

This study investigates the causal relationship between e-government development and democracy across 38 OECD countries over the period 2006–2024. While the administrative benefits of e-government such as efficiency gains, cost reduction, and improved service delivery are well established, its broader implications for democratic governance remain less explored. This paper addresses that gap by asking whether advancements in e-government contribute to strengthening democratic performance. Specifically, it examines whether progress in the United Nations E-Government Development Index (EGDI) is associated with measurable improvements in the Economist Intelligence Unit's Democracy Index (EIU). The analysis is grounded in multiple theoretical perspectives. Institutional Theory highlights how digital reforms are often motivated by legitimacy-seeking behavior and embedded within broader governance structures. Meanwhile user-centered frameworks such as the Technology Acceptance Model (TAM) and Diffusion of Innovations (DOI) explain how citizens adopt and engage with e-government services. Taken together, these frameworks suggest that the democratic impact of e-government depends not only on institutional design but also on citizen trust, digital literacy, and social inclusion. Methodologically, the study applies a panel data approach and employs advanced panel econometric techniques, including tests for cross-sectional dependence, unit roots, slope heterogeneity, cointegration, and Dumitrescu-Hurlin Granger causality. The results demonstrate a clear unidirectional relationship: improvements in e-government statistically precede and predict gains in democratic quality, particularly in transparency, accountability, and citizen participation. No evidence is found for the reverse relationship. These findings carry important implications for both scholarship and policy. They empirically suggest that digital transformation can serve as a predictive driver for democratic strengthening, but primarily in contexts with participatory and rule-based systems, as found in OECD countries. At the same time, the study cautions that such outcomes may not materialize in non-OECD contexts, where weaker institutions, lower digital literacy, or symbolic adoption of digital reforms may limit democratic benefits. Policymakers are therefore encouraged to move beyond technical deployment and prioritize inclusive, citizen-centered digital strategies that reduce participation gaps and safeguard democratic values. By integrating theoretical perspectives with robust empirical evidence, this research contributes to closing a key gap in the literature and offers actionable insights into how digital governance can reinforce democratic resilience.

Keywords: E-government development index (EGDI), democracy index, OECD digital transformation, Dumitrescu and Hurlin test, panel data, Granger causality test

Demokratik bir katalizör olarak E-devlet: OECD ülkelerinden kanıtlar (2006–2024)

Öz

Bu çalışma, 2006–2024 dönemi boyunca 38 OECD ülkesinde e-devlet gelişimi ile demokrasi arasındaki nedensel ilişkiyi incelemektedir. E-devletin etkinlik artışı, maliyetlerin düşürülmesi ve hizmet sunumunun iyileştirilmesi gibi idari faydaları geniş bir biçimde incelenmiş olsa da, demokratik yönetim üzerindeki daha kapsamlı etkileri görece daha az araştırılmıştır. Bu makale, literatürdeki bu boşluğu ele alarak, E-Devletteki ilerlemelerin demokratik performansı güçlendirip güçlendirmedini sormaktadır. Özellikle, Birleşmiş Milletler E-Devlet Gelişim Endeksi (EGDI) ile Economist İstihbarat Birimi'nin (Intelligence Unit) Demokrasi Endeksi (EIU) arasındaki ilişkiyi incelemektedir. Analiz, birden fazla kuramsal çerçeveye dayanmaktadır. "Kurumsal Teori", dijital reformların çoğunlukla meşruiyet arayışıyla şekillendirildiğini ve daha geniş yönetim yapıları içinde kurumsallaştığını vurgularken; "Teknoloji Kabul Modeli" ve "Yeniliklerin Yayılımı" gibi kullanıcı merkezli yaklaşımlar, vatandaşların e-devlet hizmetlerini nasıl benimsediğini ve onlarla nasıl etkileşime girdiğini açıklamaktadır. Bu çerçeveler birlikte ele alındığında, e-devletin demokrasiye etkisinin yalnızca kurumsal tasarıma değil, aynı zamanda vatandaşların güvenine, dijital okuryazarlığa ve toplumsal kapsayıcılığa bağlı olduğunu göstermektedir. Yöntemsel olarak, çalışma panel veri yaklaşımını benimsemekte ve yatay kesit bağımlılığı, birim kök, eğim homojenliği, eşbütünleşme, Dumitrescu-Hurlin ve Panel Granger nedensellik testleri gibi çok sayıda ekonometrik test uygulamaktadır. Bulgular, açık bir tek yönlü ilişki ortaya koymaktadır: e-devletteki ilerlemelerin, özellikle şeffaflık, hesap verebilirlik ve vatandaş katılımı boyutlarında demokratik kalitedeki artışların istatistiksel bir öncülü ve öngörücüsü olduğu ortaya konulmuştur. Ters yönde ise bir nedensellik bulunmamıştır. Bu sonuçlar hem akademi hem de politika için önemli çıkarımlar sunmaktadır.

Bulgular, dijital dönüşümün demokratik güçlenme için öngörücü bir itici güç işlevi görebileceğini; ancak bunun esasen OECD ülkelerinde görülen katılımcı ve kurallara dayalı sistemlerin bulunduğu bağlamlarda geçerli olduğunu ampirik olarak ortaya koymaktadır. Öte yandan, daha zayıf kurumlara, düşük dijital okuryazarlığa veya sembolik dijital reformlara sahip OECD dışı bağlamlarda benzer sonuçların ortaya çıkmayabileceği vurgulanmaktadır. Bu nedenle politika yapıcılar, salt teknolojik uygulamaların ötesine geçerek katılımı ve kapsayıcılığı öncelleyen dijital stratejilere yönelmelidir. Kuramsal yaklaşımları sağlam ampirik kanıtlarla birleştiren bu araştırma, literatürdeki önemli bir boşluğu doldurmakta ve dijital yönetişimin demokratik direnci nasıl güçlendirebileceğine dair uygulanabilir içgörüler sunmaktadır.

Anahtar Kelimeler: E-devlet gelişim endeksi, demokrasi endeksi, OECD dijital dönüşüm, Dumitrescu ve Hurlin testi, panel veri, Granger nedensellik testi

Introduction

Over the past two decades, digital technologies have fundamentally reshaped the interaction between governments and citizens. Among these developments, e-government—defined by the European Commission (2003) as the use of information and communication technologies (ICTs) in public administrations, combined with organizational change and new skills, to improve public services and democratic processes—has emerged as a transformative force in public administration. It has gained increasing relevance as a policy instrument aimed at improving efficiency, transparency, and participatory governance, helping to strengthen democratic values through active citizen engagement.

While the administrative benefits of e-government, such as increased efficiency, cost reduction and improved service delivery are well documented (Joshi and Islam, 2018; Scholta et al., 2019; Thompson et al., 2020), its broader implications for democratic governance have received relatively less attention. As digital technologies become increasingly integrated into public administration, this study asks whether the expansion of e-government contributes to strengthening democracy. It seeks to address this question by investigating the causal impact of e-government development on democratic performance across 38 OECD countries over the period 2006–2024. Applying panel data econometric methods such as cointegration and Granger causality tests, this study examines whether increases in the United Nations E-Government Development Index (EGDI) are associated with measurable improvements in the Economist Intelligence Unit's Democracy Index (EIU).

In particular, the analysis considers how different dimensions of democratic quality—such as political participation, civil liberties, and the functioning of government—may be differentially associated with the expansion of e-government.

The study contributes to the literature by empirically testing the assumed relationship between e-government development and democratic quality, using panel data from OECD countries. It also situates this relationship within institutionalized democratic settings, using OECD countries as a reference context for exploring how digital governance may align with democratic norms.

In terms of structure, the paper first outlines the key theoretical frameworks—primarily Institutional Theory, the Technology Acceptance Model (TAM), and the Diffusion of Innovations (DOI) that offer different perspectives on the relationship between e-government and democracy.

In the section "Methodology, Data, and Sample," the indices used to measure e-government and democracy are defined. Specifically, the United Nations' E-Government Development Index (EGDI) is employed to assess e-government performance, while the Economist

Intelligence Unit's Democracy Index is used as a measure of democratic quality. This section provides the theoretical and methodological rationale for focusing on OECD countries, emphasizing their institutional homogeneity and democratic maturity as essential conditions for examining the e-government-democracy nexus.

After presenting the average values and rankings of the indices across the selected countries and time periods, the study proceeds to the analysis phase. In this phase, a series of preliminary tests essential for causality analysis—namely, cross-sectional dependency, unit root, slope homogeneity, and cointegration tests are conducted. Based on the outcomes of these diagnostics, the Dumitrescu and Hurlin panel Granger causality test is applied to examine the causal relationship between e-government and democracy.

Finally, the conclusion translates these findings into actionable policy recommendations, emphasizing the need for digital transformation strategies that align with democratic objectives, institutional contexts, and equity considerations.

1. Theoretical Background

Understanding the relationship between e-government and democracy requires acknowledging both the state's role in building and maintaining digital public infrastructure and the citizen's experience in engaging with these services. E-government operates as a digital interface that links governments and citizens—enhancing administrative efficiency on one side and promoting accessibility, transparency, and citizen participation on the other. Its design, scope, and implementation reflect not only technological capacity but also the institutional commitment to public service delivery and the government's accountability.

This study draws on both institution-centered and user-centered theoretical perspectives to examine how such e-government initiatives are adopted and how they may influence democratic outcomes. Taken together, these frameworks allow for a more comprehensive understanding of how digital governance evolves within institutional structures while simultaneously responding to citizen needs and behaviors. User-oriented models such as the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DOI) offer insights into individual-level drivers of adoption, including perceived usefulness, ease of use, and social influence. In contrast, Institutional Theory provides a state-centered lens by focusing on how organizational structures, norms, and external pressures shape the adoption and evolution of e-government systems. Building on this theoretical foundation, the next section examines Institutional Theory in more detail to explore the structural and organizational factors shaping e-government adoption.

1.1. The Institutional Foundations of E-Government Adoption

To understand more clearly why and how governments adopt e-government systems and what this means for democratic governance, Institutional Theory offers a useful analytical lens. From an institutional perspective, the development and implementation of e-government can be interpreted as a response to both internal organizational dynamics and external societal pressures. Institutional Theory helps to explain why public institutions adopt digital technologies not only for efficiency gains but also to conform to wider expectations of legitimacy, modernization, and good governance.

Building on this, Institutional Theory identifies three mechanisms through which institutions adopt innovations—regulative, normative, and mimetic—that influence organizational

behavior (DiMaggio and Powell, 1991; Scott, 1995; Zucker, 1987). In the context of e-government, the regulative mechanism refers to formal rules, laws, or policies that require public institutions to adopt digital service models. The normative dimension encompasses professional values, administrative norms, and shared expectations among actors. Meanwhile, mimetic processes describe how governments, when facing uncertainty or ambiguity, often model themselves on other, more advanced or reputed nations to signal modernity and competence (DiMaggio and Powell, 1983, p.151). As Zhang and Kaur (2024: 20) note, Institutional theory “addresses how established norms, values, and practices within institutions can either support or hinder the implementation of new technologies”. This perspective suggests that understanding a country’s institutional configuration is essential to evaluating the success or failure of e-government initiatives.

Additionally, e-government reflects a global institutional trend—widely recognized as a symbol of modernity across nations. For many countries, particularly within the OECD, embracing such digital initiatives is not just about improving functional efficiency, but also about reinforcing institutional legitimacy through the projection of a modern, values-based government that capitalizes on long-term digital investments (OECD, 2021, p.4). Governments risk appearing outdated and inefficient if they lag behind in adopting digital governance tools. This dynamic helps explain why states often feel compelled to adopt and maintain e-government systems as part of their legitimacy-building strategies.

However, while these institutional pressures often drive adoption, they do not guarantee effective implementation. Governments may invest in sophisticated digital infrastructures, yet differ significantly in how they utilize or embed them within administrative routines. In many cases, organizations establish formal e-government structures without fully integrating them into actual practice. Such gaps may result from symbolic compliance with international norms or domestic political expectations, rather than from deep institutional transformation. This perspective challenges simplistic views that frame e-government solely as a technical innovation. Instead, Institutional Theory conceptualizes it as a socially embedded process shaped by broader power relations, cultural norms, and institutional logics. Information systems innovation is sustained not only by its functional utility but also by institutional pressures that promote its adoption and continuity, often independently of actual organizational change (Avgerou 2000, p.234).

While such theoretical perspectives highlight the potential of e-government to strengthen democratic engagement, critics have cautioned that digitization may also pose risks. Fisher (2012), for example, warns that digital reforms can prioritize administrative efficiency over participatory values, potentially exacerbating democratic deficits. Such concerns underscore the importance of human-centric design in e-government systems, ensuring that digital transformation complements rather than replaces traditional participatory mechanisms and democratic deliberation.

Thus, Institutional Theory provides a robust explanatory framework for understanding e-government not just as a technological upgrade, but as a product of institutional convergence, legitimacy-seeking behavior, and culturally conditioned governance strategies. It also clarifies why democratic gains linked to e-government are more likely in institutionalized environments—such as OECD countries—where digital reforms are embedded in rule-based, participatory, and institutionally trusted governance systems.

1.2. Individual-Level Approaches to E-Government Adoption

Complementing the Institutional Theory perspective, the functionality and success of e-government can also be analyzed through user perceptions and behaviors. In this regard, the Technology Acceptance Model (TAM) offers a valuable framework. According to Davis (1989, p.319), the perceived usefulness and ease of use of a digital system are critical in determining whether individuals are willing to engage with it. Notably, ease of use may also shape perceptions of usefulness, suggesting that users often find a system more beneficial when they experience it as easy to operate. Applied to e-government, this means that the extent to which citizens adopt digital services is directly influenced by their perception of the technology's reliability, accessibility, and relevance to their needs.

The TAM has been widely applied to study e-government adoption across various contexts. Empirical research consistently shows that perceived usefulness and perceived ease of use are key determinants of adoption (Aswar et al., 2022, p.400). In addition, Nasri (2019, p.38) identifies further influential factors such as social influence, awareness, and the quality of internet connection.

Aranyosy (2022, p.481) builds upon TAM by incorporating elements of the DeLone and McLean Information System Success Model (1992) to develop a citizen-centric concept of net benefit, which helps to clarify the notion of perceived value. This integrated approach is valuable as it connects system usage, user satisfaction, and overall benefit from the citizen's perspective. It offers a unified model to analyze both adoption and the outcomes of e-government services.

Moreover, citizens' willingness to use e-government platforms can also serve as an indicator of trust in government, as these platforms are state-provided (Bélanger & Carter, 2008, p.165). In this regard, Balaskas et al. (2022, p.20) emphasize that trust plays a vital role in encouraging both initial and ongoing use of e-services, especially in periods of crisis such as the COVID-19 pandemic. Their findings also highlight the importance of social and political context, as well as the values citizens attach to these digital systems, in shaping e-government adoption.

The citizen-oriented approach to e-government adoption also aligns with the Diffusion of Innovations (DOI) theory developed by Rogers (1962, p.5), which explains how technological innovations such as e-government spread within societies. The theory identifies innovation, communication channels, time and the social system as the four main elements of the diffusion process (Rogers, 1962, p.10). According to Rogers (1962, p.238), the rate of adoption is influenced by five attributes: relative advantage, compatibility, complexity, trialability, and the degree of interconnectedness in a social system.

In the context of e-government, DOI offers insights into how such technologies can achieve broader acceptance, particularly through communication networks, social dynamics, and the time required for adoption to take place (Zhang and Kaur, 2024, p.20). Nevertheless, its empirical application in e-government research remains relatively limited. As Rana et al. (2013, p.) argue, based on a review of 87 studies on citizen-centric e-government, TAM is more widely used and better suited to explaining adoption behavior. Despite its popularity, the DOI model is only partially applied in e-government research, with some key elements like trialability and observability often neglected.

While these frameworks primarily explain individual-level adoption dynamics, their implications extend beyond user behavior and can be interpreted in relation to broader dimensions of democratic governance. The EIU Democracy Index captures these dimensions through components such as political participation, civil liberties, and the functioning of government, which reflect the institutional outcomes of citizen–state interaction. In this sense, patterns of digital engagement are not merely behavioral phenomena but constitute observable channels through which democratic practices are enacted and reproduced.

From a TAM perspective, higher levels of perceived usefulness and ease of use increase the likelihood that citizens will engage with digital public services. This engagement is most likely to manifest in the dimension of political participation, as digital platforms lower barriers to interaction, facilitate access to public services, and expand opportunities for civic involvement. In parallel, the Diffusion of Innovations (DOI) framework suggests that as e-government practices become socially embedded and widely adopted, they contribute to the normalization of digital civic engagement, thereby shaping political culture over time.

Moreover, the expansion of accessible and transparent digital services can reinforce civil liberties by improving citizens' access to information and strengthening administrative accountability. At the same time, sustained interaction with reliable digital government platforms may enhance institutional trust, which is closely associated with the functioning of government. Taken together, these dynamics illustrate how individual-level adoption processes can generate cumulative macro-level effects, providing a theoretically grounded explanation for how e-government development may translate into measurable improvements across specific dimensions of democratic quality.

These theoretical linkages also provide an interpretive framework for the empirical analysis, particularly in understanding which dimensions of democratic quality are more responsive to changes in e-government development.

To summarize, combining Institutional Theory with TAM and DOI allows for a multidimensional understanding of e-government, as both a top-down mechanism of legitimacy-building and a bottom-up channel of civic empowerment. However, the relationship between digital governance and democratic quality remains only partially understood. The effectiveness of e-government in strengthening democracy depends on how these two dimensions interact: the state's willingness to institutionalize digital openness and the citizen's readiness and trust to engage with such tools. While the role of technology in democratic governance is broadly acknowledged, the causal dynamics between e-government development and democratic outcomes still need to be explored.

Yet, the potential of e-government to foster democratic reform is not guaranteed. In some cases, its adoption may serve more symbolic than substantive purposes. When governments introduce digital tools to signal modernization rather than to create meaningful change, their adoption may remain largely symbolic. This is particularly evident in authoritarian regimes that tend to use ICTs for surveillance rather than participation (Karpa and Rochlitz, 2024, pp.2-3).

These concerns underscore the importance of situating e-government initiatives within their broader institutional and political contexts. While the theoretical frameworks presented highlight the potential for e-government to enhance democratic governance, they also reveal

that this outcome is far from automatic. The democratic impact of digital transformation depends not only on technology adoption, but on how such systems are embedded within rule-based, participatory, and trust-driven institutions.

The following section outlines the study's methodological approach, including the data sources, operationalization of key variables, and econometric techniques used to assess the causal dynamics between e-government development and democratic quality across OECD countries.

2. Methodology, Data and Sample

This section outlines the variables employed in the study, articulates the rationale for selecting OECD countries as the sample, and presents descriptive statistics spanning ten biennial periods between 2006 and 2024. The section begins with conceptual definitions of the primary variables; e-government development and democracy indices. This is followed by a concise overview of the OECD countries to contextualize the sample. Finally, the analysis provides average index values and relative rankings for the countries across each of the ten observed periods.

2.1. E-Government Index

The intangible nature of E-Government has prompted institutions and organizations to develop measurement tools. Among these, the United Nations' E-Government Development Index (EGDI) is the most widely recognized.

The United Nations Department of Economic and Social Affairs has consistently released its E-Government Research report biennially since 2008, with additional reports being published for the years prior to 2008, namely 2001, 2003, and 2004. In order to enhance the temporal dimension of our sample, the report from 2005 published in October 2006, was also included in our analysis (United Nations Department of Economic and Social Affairs, 2025).

The analysis encompassed ten time intervals extending from 2006 to 2024, during which we examined the EGDI, which constitutes an arithmetic mean of three different indices: the Online Services Index (OSI), the Telecommunication Infrastructure Index (TII), and the Human Capital Index (HCI):

1. Online Services Index (OSI): Measures the scope and quality of online public services provided by governments, including features such as information availability, transactional services, and citizen engagement tools (e.g., digital portals for tax filing, permits, health services).
2. Telecommunication Infrastructure Index (TII): Assesses the state of ICT infrastructure within a country by evaluating indicators such as the number of internet users, fixed broadband subscriptions, mobile cellular subscriptions, and related connectivity metrics.
3. Human Capital Index (HCI): Reflects the level of education and digital literacy of the population, typically measured through indicators like adult literacy rate and gross enrolment ratios in primary, secondary, and tertiary education.

2.2. Democracy Index

As with e-government, democracy is a complex and multidimensional construct that cannot be directly observed. Among the various indices available, this study utilizes the Democracy Index developed by the Economist Intelligence Unit (EIU), selected for its conceptual clarity,

comprehensive scope, and consistent methodology. The index evaluates the state of democracy in 167 countries based on five key dimensions:

1. Electoral Process and Pluralism
2. Functioning of Government
3. Political Participation
4. Political Culture
5. Civil Liberties

Based on these dimensions, countries are classified as full democracies (8–10), flawed democracies (6–7.9), hybrid regimes (4–5.9), and authoritarian regimes (less than 4). The analysis covers ten biennial periods from 2006 to 2024, corresponding to the availability of EGDI data and enabling longitudinal comparisons between digital governance and democratic performance (Economist Intelligence Unit, 2025). To ensure temporal alignment between the biennial EGDI and the annual EIU Democracy Index, we utilized specific year snapshots of the EIU data that directly correspond to each EGDI release year (i.e., 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, and 2024).

2.3. Sample Selection and Justification

The selection of OECD countries as the primary sample for this study is theoretically grounded in Institutional Theory, which suggests that the democratic impact of digital governance is deeply embedded within existing governance structures. While a global analysis of 163 countries was initially considered to provide a broad perspective, such highly heterogeneous samples often introduce significant "institutional noise"—where digital tools may be utilized for surveillance in some contexts and civic empowerment in others—thereby masking the underlying relationship.

To ensure a rigorous and reliable testing ground for the e-government-democracy nexus, the analysis focuses on a controlled institutional environment. The 38 OECD member nations (as of August 2025) were prioritized because they maintain a relatively high degree of economic and political homogeneity, possessing stable democratic institutions and advanced digital infrastructure. According to the World Bank's 2023 classification, most member states are high-income economies, which minimizes confounding factors such as extreme political instability or connectivity gaps that often bias results in broader global samples.

Furthermore, while broader cohorts of high-income nations were evaluated, the inclusion of certain countries with high digital scores but divergent institutional frameworks revealed significant structural outliers. These nations exhibit structural divergences from the democratic patterns typically found in the OECD, and their inclusion could potentially distort the empirical findings. By focusing on the OECD, whose foundational principles—such as the promotion of social equity and human development—align with the study's core variables, we can more clearly isolate the predictive influence of e-government on democratic development. Complementary assessments across other income categories (upper-middle, lower-middle, and low-income) reinforced this decision, as the investigated relationship was found to be most theoretically and empirically coherent within the institutional maturity of the OECD context.

2.4. Descriptive Statistics of the Democracy and E-Government Indices

The Democracy Index, which ranges from 0 to 10, and the E-Government Development Index, which ranges from 0 to 1, were used to evaluate countries across ten periods. As presented in Table 1, countries are ranked based on their average index scores. The arithmetic mean of the 10-year values was calculated for both indices, and countries were then ranked based on these average scores. Notably, Scandinavian and Northern European countries consistently occupy the top positions in both indices, reflecting their advanced democratic structures and high levels of digital governance.

The Pearson and Spearman correlation coefficients between the two indices are 0.72 and 0.73, respectively, indicating a strong and consistent positive relationship. However, it is important to emphasize that these correlation coefficients measure the strength of association between the variables and do not, by themselves, imply a causal relationship.

Table 1. Average Scores and Rankings of OECD Countries Based on the Democracy Index and EGDI (2006–2024)

Rank	Countries	Democracy	Rank	Countries	E-Government
1	Norway	9.81	1	South Korea	0.91
2	Iceland	9.56	2	Denmark	0.90
3	Sweden	9.55	3	Australia	0.89
4	Denmark	9.33	4	UK	0.89
5	New Zealand	9.30	5	USA	0.88
6	Finland	9.17	6	Sweden	0.88
7	Switzerland	9.09	7	Netherlands	0.88
8	Netherlands	9.07	8	Norway	0.86
9	Canada	9.05	9	Finland	0.86
10	Australia	9.03	10	New Zealand	0.85
11	Ireland	8.98	11	Canada	0.84
12	Luxembourg	8.88	12	France	0.84
13	Germany	8.65	13	Japan	0.84
14	Austria	8.42	14	Estonia	0.83
15	UK	8.30	15	Germany	0.82
16	Spain	8.17	16	Iceland	0.82
17	Japan	8.16	17	Austria	0.81
18	Costa Rica	8.09	18	Switzerland	0.80
19	USA	8.04	19	Spain	0.80
20	Czech Republic	7.99	20	Israel	0.79
21	South Korea	7.99	21	Ireland	0.78
22	France	7.96	22	Luxembourg	0.78
23	Portugal	7.96	23	Belgium	0.77
24	Chile	7.89	24	Italy	0.75
25	Belgium	7.87	25	Slovenia	0.75
26	Estonia	7.82	26	Lithuania	0.75
27	Italy	7.78	27	Portugal	0.73
28	Greece	7.72	28	Chile	0.72
29	Israel	7.66	29	Hungary	0.71
30	Slovenia	7.66	30	Poland	0.71
31	Lithuania	7.38	31	Greece	0.71
32	Latvia	7.31	32	Latvia	0.71
33	Slovakia	7.30	33	Czech Republic	0.70
34	Poland	7.10	34	Slovakia	0.67
35	Hungary	6.91	35	Colombia	0.65
36	Colombia	6.64	36	Mexico	0.65
37	Mexico	6.33	37	Türkiye	0.63
38	Türkiye	5.05	38	Costa Rica	0.59

3. Analysis

Consistent with expectations, a positive association between democracy and e-government was observed. Specifically, the Pearson and Spearman correlation coefficients were found to be 0.72 and 0.73, respectively, suggesting a strong linear and monotonic relationship.

In our study, our objective is to investigate the causal relationship between e-government and democracy. Due to the inclusion of both time series and cross-sectional dimensions in the dataset, panel data analysis techniques and tests have been utilized. Consequently, the causality analysis may yield four potential outcomes:

- 1- There is no Granger causality between the two variables.
- 2- Democracy Granger causes e-government.
- 3- E-government Granger causes democracy.
- 4- Both variables Granger cause each other.

In order to select the appropriate causality test, cross-sectional dependence, unit root status, homogeneity of slope parameters, and the presence of cointegration should also be tested in the data. Therefore, prior to conducting the causality test, these tests were applied first.

3.1. Cross Section Dependency Test

Before conducting panel data modeling and tests such as unit root and cointegration, it is essential to test for cross-sectional dependency between countries. The presence or absence of cross-sectional dependency can significantly impact the results obtained. Cross-sectional dependency tests have two hypotheses: H_0 , stating that there is no cross-sectional dependence for the relevant variable in the countries included in the panel data, and H_a , stating that there is cross-sectional dependence for the relevant variable.

If the cross-sectional dependency is rejected, first-generation unit root tests are conducted. In contrast, the use of second-generation unit root tests is recommended in case of dependency for more accurate estimation. To measure cross-sectional dependence, four tests are commonly used in the literature: the Breusch-Pagan Lagrange Multiplier (LM) test (Breusch and Pagan, 1980), the Cross-Section Dependence (CD) and CDLM tests (Pesaran, 2004), and the Bias-Adjusted Cross-Section Dependence Lagrange Multiplier (LMadj) test (Pesaran et al., 2008). The unit and time dimensions of the panel must be considered when testing for cross-sectional dependence. For instance, if the time dimension is greater than the cross-section dimension ($T > N$), the LM test is applicable (Breusch and Pagan, 1980). If the dimensions are equal ($T = N$), the CD test is used (Pesaran, 2004). Finally, if the cross-sectional dimension exceeds the time dimension ($T < N$), the CDLM test applies (Pesaran, 2004).

The test to be used may also vary depending on whether the panel is balanced or not. The test results are typically presented in Table 2:

Table 2. Cross Section Dependency Test Results

	E-Government		Democracy	
	Statistic	Prob.	Statistic	Prob.
Breusch-Pagan LM	4410.719	< 0.001	1746.189	< 0.001
Pesaran scaled LM	98.881	< 0.001	27.820	< 0.001
Bias-corrected scaled LM	96.770	< 0.001	25.709	< 0.001
Pesaran CD	64.649	< 0.001	4.407	< 0.001

Note: The results were calculated using EViews 12

The tests conducted revealed a significant cross-sectional dependence in both variables, with p-values close to zero. Hence, second-generation unit root tests are recommended since both variables display cross-sectional dependence.

3.2. Unit Root Test

When variables containing unit roots are used in econometric time series analyses, it is possible to encounter misleading results since the necessary assumption of stationarity is not met for most analyses. In such cases, nonexistent causal relationships may erroneously appear to exist. Additionally, regression parameters that should be statistically insignificant can turn out to be significant. In panel data analyses as well, models should be applied to stationary data that do not contain unit roots.

Table 3. Unit Root Test Results

Democracy			E-Government		
Statistic	t-stat	p-value	Statistic	t-stat	p-value
CIPS	-2.566	<0.01	CIPS	-2.633	<0.01
Truncated CIPS	-2.326	<0.05	Truncated CIPS	-2.582	<0.01

Note: The results were obtained using EViews 12

To address the confirmed cross-sectional dependency, we employ the CIPS test (Pesaran, 2007), a widely used second-generation unit root test. The results of the CIPS test are provided in Table 3, along with the critical values in Table 4.

Table 4. Critical Values for Unit Root Test

Level	CIPS	Trunc. CIPS
1%	-2.47	-2.41
5%	-2.23	-2.2
10%	-2.1	-2.08

Note: The results were obtained using the Stata "xtcips" command

According to the provided information, the null hypothesis of a unit root has been rejected at a significance level of 5% for both variables based on the critical values and test results.

3.3. Homogeneity: Pesaran-Yamagata Test (2008)

In panel data analysis, it is important to assess the homogeneity of long-term slope coefficients before proceeding with the estimation process. To evaluate this homogeneity, the application of the delta (Δ) test, formulated by Pesaran and Yamagata (2008) drawing on the Swamy (1970) test, is considered appropriate and effective. The test has two versions: The $\tilde{\Delta}$ statistic for large samples and the $\tilde{\Delta}_{adj}$ statistic for small samples. The null hypothesis of the Delta (Δ) test assumes that slope coefficients are homogeneous across cross-sectional units.

According to the test results, the calculated $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ values are 6.93 and 8.283, respectively, with a significance level of less than 0.001 for both.¹ These findings lead to the rejection of the null hypothesis (homogeneity of the slope coefficients), indicating the presence of heterogeneity in slope coefficients.

¹ The results were obtained using the Stata "xtst" command.

3.4. Cointegration: Westerlund Cointegration Test

Cointegration analysis investigates whether a linear combination of two non-stationary variables results in a stationary series. The existence of cointegration is an important characteristic in time series analysis, as it indicates a long-term equilibrium relationship between the variables. In panel data settings, testing for cointegration is a crucial preliminary step in identifying long-run associations among variables.

In this context, Westerlund (2007) suggested four tests with their critical values and limit distributions after many tests developed. The characteristics of these tests can be summarized as being successful in small samples, stronger than their counterparts, and can be used in cross-section dependency and non-homogeneity situations.

For all four tests, the null hypothesis is that there is no cointegration. These tests are developed based on the error correction model. The first two tests are group-based, utilizing group means. The latter two tests are panel-based, allowing for the parameters to differ across cross-sections. The results of the tests for our variables are presented in Table 5.

Table 5. Westerlund Cointegration Tests Results.

Statistic	Value	z-value	p-value
Gt	-8.748	-48.223	< 0.001
Ga	5.497	1.938	0.974
Pt	-22.832	-13.566	< 0.001
Pa	-14.715	-13.917	< 0.001

Note: The test results were generated with the Stata "xtwest" command.

The insignificance of the G_a statistic in our results requires a nuanced methodological interpretation. According to Persyn and Westerlund (2008), the G_a statistic can be highly sensitive to the choice of parameters, such as lag/lead lengths and kernel width, particularly in small datasets. They explicitly note that even with a larger time dimension ($T=32$), restricting short-run dynamics can cause G_a to fail in rejecting the null hypothesis of no cointegration. Given that our study operates with an even smaller time dimension ($T=10$), the non-rejection by G_a is likely a consequence of limited sample power and parameter sensitivity rather than an absence of a long-term relationship. Since the other three statistics (G_t , P_t , P_a) strongly reject the null, we follow the guidance of Persyn and Westerlund (2008) and Azmi et al. (2023, p.5170) in concluding that a robust long-run equilibrium exists between e-government and democracy across the panel.

3.5. Causality (Dumitrescu and Hurlin Test)

Granger Causality Analysis was proposed by Granger (1969) for the analysis of time series data. Unlike regression, Granger causality analysis goes one step further than estimating the parameters of a linear relationship and aims to detect the causal relationship between variables. If the lagged values of variable X can predict the values taken by dependent variable Y, then X is said to Granger-cause Y. Multiple versions of the test exist for panel data analysis.

The Dumitrescu and Hurlin (2012) test is commonly preferred due to its ability to be used in cases of cross-sectional dependence in panel data. They have developed the test using the Wald statistic. This statistic is preferred when $N > t$. They have also developed the statistic for situations where the time series dimension is small (with the requirement that the time

dimension must be greater than 8 for the test to be applied). Even in cases where both n and t are small, the test exhibits good finite sample properties.

The null hypotheses of the test are as follows:

H_0 : Democracy does not Granger-cause E-Government Index

H_0 : E-Government Index does not Granger-cause Democracy

Based on the test results shown in Table 6, the null hypothesis was rejected in the second case but not in the first. This indicates that e-government causes democracy, whereas democracy does not cause e-government.

Table 6. Dumitrescu and Hurlin Test Results.

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
Democracy does not homogeneously cause E_government_index	2.373	1.640	0.108
E_government_index does not homogeneously cause Democracy	3.178	3.085	0.002

Note: The results were obtained with EViews 12 and cross-checked using the Stata "xtgcause" command.

Conclusion

This study examined the causal relationship between e-government development and democracy across 38 OECD countries from 2006 to 2024. Building upon Institutional Theory, the Technology Acceptance Model (TAM), and Diffusion of Innovations (DOI), the analysis approached e-government as both a top-down tool of institutional modernization and a bottom-up mechanism of civic engagement. Panel data analysis using cointegration and Granger causality tests revealed a unidirectional Granger-causality: advancements in e-government, as measured by the United Nations EGDI, are found to precede measurable improvements in democratic quality, particularly in transparency, accountability, and citizen participation, as captured by the EIU Democracy Index. These findings are theoretically most consistent with dimensions such as political participation and civil liberties, where digital engagement mechanisms directly lower barriers to access, enhance information availability, and strengthen citizen–state interaction.

The theoretical frameworks applied in this study highlight that the democratic impact of e-government is not automatic, but conditional on both institutional structures and citizen engagement. While institutional pressures may drive governments to adopt digital tools, their democratic potential depends on how these tools are embedded in participatory, rule-based, and trust-driven systems. This helps explain why meaningful democratic gains are more likely in OECD countries, which share relatively stable institutional environments and high digital capacity. In contrast, the findings show no consistent causal relationship in broader samples, including middle- and low-income countries, where weaker institutions, lower digital literacy, or ceremonial adoption may limit democratic outcomes.

The findings have important implications. First, they affirm that technological innovation can support democratic governance, however only when aligned with institutional legitimacy and citizen trust. Second, they underscore the need to move beyond mere technological deployment toward socially embedded, inclusive, and participatory digital governance models. To ensure that e-government serves as a catalyst for inclusive and resilient democracies, policymakers should prioritize investing in digital literacy programs to reduce

participation gaps, establishing safeguards against the misuse of digital tools for surveillance, and designing e-government platforms that reflect local governance cultures and citizen expectations.

While this study offers robust empirical insights, it also faces limitations. The focus on OECD countries limits the generalizability of the findings, and the democracy indicators used may not fully capture the complexities of democratic life. Future research should expand the scope to include non-OECD countries, incorporate qualitative methods, and explore the long-term trajectories of digital reform. Further theoretical development is also needed to clarify the institutional, cultural, and political conditions under which digital transformation strengthens rather than undermines democracy. In this regard, the underlying factors behind the absence of significant results in causality tests for non-OECD countries can be further investigated, particularly in relation to institutional capacity, digital infrastructure gaps, or authoritarian governance patterns that may suppress democratic effects of digitalization.

As discussed earlier, the democratic impact of e-government depends not only on institutional design and citizen engagement, but also on ensuring that digital systems do not unintentionally reinforce exclusion or reduce participation. Addressing these concerns requires deliberate efforts to promote digital inclusion and equitable access, especially among vulnerable or underserved populations.

In conclusion, while e-government is not a panacea, its strategic application in OECD countries demonstrates measurable democratic benefits. By embedding digital transformation in participatory principles and equitable access, governments can harness technology to strengthen rather than undermine democratic resilience. Future efforts must strike a balance between innovation and vigilance, ensuring that the digital public sphere remains inclusive, transparent, and accountable, while mitigating the risks of democratic backsliding.

This research supports the notion that technology can meaningfully shape democratic processes and provides a strong foundation for future studies in this area. For practical implementation, it is crucial that upcoming e-government projects go beyond technical deployment to explicitly promote democratic values balancing innovation with inclusion, participation, transparency and accountability.

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