

## **E-governance and economic growth: measurement and impact**

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**Abstract.** E-governance and e-government both refer to the digitalization of government and the use of ICT to serve citizens. However, the concept of e-governance is broader than e-government. It can be defined as a dynamic approach to conducting State activities that aims to set up a digitalized, evolving system connecting State services with their internal (G2G and G2E) and external (G2C and G2B) users, with the purpose of improving the State-society relationship and offering better-quality services. Several authors have shown the positive impact of e-government on economic growth, but most of these studies ignore this difference between e-governance and e-government. Thus, to include different aspects of e-governance, we created a composite e-governance index (EGOVI) using the principal components analysis method (PCA) before studying the impact of the created index on economic growth using a panel standard corrected errors fixed effect model (PCSE) on a panel data set of 76 countries from 2012 to 2020. This study provides empirical evidence of the positive impact of e-governance on economic growth. It was demonstrated that a one unit increase in the e-governance index (EGOVI) leads to a 13,6% increase in GDP per capita.

**Keywords:** *E-governance, Economic growth, Principal component analysis, Panel data.*

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### **1. Introduction**

The macroeconomic landscape is often shaped by the incorporation of minor microeconomic changes. Whether this impact is positive or negative, one cannot deny that digitalization within businesses, administrations, and in the daily lives of individuals has influenced the macroeconomic level. Huang (2018) and Zhang (2021) argued that the positive repercussions of digitalization at the microeconomic level extend to the macroeconomic sphere, contributing significantly to a nation's economic growth.

One of the main manifestations of these technological transformations is e-governance, defined in a limited and simplistic way as the use of ICT in government activities. The implementation of this e-governance seems expensive, which is impacting public funds. Thus, it is crucial to study the impact of this e-governance on the economy, particularly on economic growth.

Existing research often ignores the difference between e-government and e-governance, overlooking several dimensions of this concept. E-government typically emphasizes the digitization of governmental processes, whereas e-governance goes beyond the simple dematerialization and digitization of procedures and encompasses a global strategy involving a total change in the entire governance ecosystem. In fact, e-governance can be defined as a dynamic approach to conduct the State's activity that aims to set up a digitalized and evolutive system connecting State services with their internal (G2G and G2E) and external (G2C and G2B) users, to improve the State/society relationship and offer better quality services.

This study fills this gap by accounting for the nuances among the different notions of e-governance and aims to analyze the correlation between e-governance and economic growth. Existing indicators ignore this difference. Thus, we will create a new indicator measuring e-governance, a composite index (EGOVI) that captures not only government digitalization but also its effective impact. Therefore, we will use the principal components analysis method (PCA). To study the nexus between our new indicator and economic growth, we will use a panel standard corrected errors fixed effect model (PCSE) on a panel data set of 76 countries from 2012 to 2020.

Thus, beyond the new indicator, which constitutes an important contribution of the study, analyzing the impact of EGOVI on economic growth through the PCSE method is a second considerable added value of the paper.

To present the results, our article will be structured into two sections as follows: the first section provides a concise overview of the theoretical literature and existing empirical studies analyzing the link between e-governance and economic growth. The second section outlines our empirical study, detailing the research methodology and presenting the results related to the EGOVI creation and its impact on economic growth.

## **2. Literature Review**

### **a. E-governance and economic growth: theoretical overview**

Many studies have proved the positive impact of e-governance on economic growth; the divergence among these studies revolves around the causal relationship

between these variables. Globally, e-governance has been shown to improve the management within administration and to enhance service quality, serving as a key driver of overall performance and economic growth.

*i. E-governance enhances management within administration*

In terms of effectiveness and efficiency, research by Islam and Ahmed (2007) suggests that e-governance can reduce operational costs and rationalize government processes. Efficiency gains in e-governance are evident in the optimization of input/output ratios, achieved through the substantial impact of information and communication technology on reducing costs, especially by substituting costly manpower with digital solutions, and on expediting task completion (Heeks, 2001). Moreover, e-governance increases productivity, optimizing public expenditures by implementing new work methods and encouraging telecommuting, as highlighted by OBERDORF (2006). Johansen and Elias (2023) further support these findings, emphasizing how digitization optimizes expenses by diminishing labor costs and improving task efficiency.

Furthermore, digitalization contributes significantly to process optimization by eliminating inefficiencies. E-governance provides improved visibility and information, thereby positively impacting government processes (Heeks, 2001). Additionally, it enables enhanced control and supervision of government activities, fostering both administrative efficiency and economic growth (Ma, Chung, & Thorson, 2005). Moreover, e-governance enhances connectivity, facilitating the efficient dissemination of information, which positively impacts overall efficiency (Grimes et al., 2012). It also facilitates collaboration and coordination among government activities, thereby improving intergovernmental and organizational processes (Obodo & Anigbata, 2018).

Otherwise, e-governance strengthens decentralization, promoting not only efficiency but also a more equitable distribution of resources and responsibilities, thereby reducing costs (Heeks, 2001). The digitalization process accelerates decentralization by facilitating coordination and communication among various entities involved. The digital transformation is deemed essential for local authorities for effective management and improved citizen engagement (HERVIER, 2014).

In addition to efficiency, e-governance enables better decision-making by promoting innovation and connectivity. In fact, innovation aids in creating efficient tools of data management, which helps significantly in making better decisions. To illustrate, e-payment methods have been shown to positively impact accountability, as demonstrated by Islam & Ahmed (2007) and Onuigbo & Eme (2015).

Furthermore, minimising human intervention enhances the management of operational risks, which can significantly impact public funds. In fact, the correlation between e-governance and corruption, explored by various authors, confirms its positive impact on transparency and accountability (Mauro, 1995; Shim and Eom, 2008; Martha and Ortega, 2010).

*ii. E-governance improves service quality*

Beyond improving and optimizing the management within administration, e-governance contributes to the improvement of service quality, thereby serving to stimulate both economic supply and demand.

The efficiency achieved within public administration enables a suitable climate and environment for investment through reducing social transaction costs, improving risk prediction, promoting innovation, and improving productivity (Huang et al., 2018). These factors strengthen firms' competitiveness and investors' attractiveness and stimulate, consequently, economic supply.

Furthermore, innovation, constituting both a result and a catalyst for e-governance, has an important impact on economic growth. In fact, e-governance influences innovation, while the evolution of innovation, in turn, impacts e-governance. Consequently, the development of e-governance improves investments in this domain and impacts economic growth.

Concerning economic demand, it can be affected by the promotion of confidence within society and connectivity.

In fact, e-governance enhances access to public services and service quality through optimizing processes and offering digital services, which increases citizen satisfaction, fostering a positive impact on the trust between citizens and the government.

In addition to improving service quality, e-governance enhances confidence by reducing corruption and promoting transparency, which has a positive influence on public policies (Titah and Barki, 2006). Confidence increases citizen participation and commitment in both policymaking and the economy.

E-governance also has a positive impact on the rule of law and democracy, reinforcing citizen participation and efficiency (Al Kibsi et al., 2001; Von Haldenwang, 2004; West, 2004). Furthermore, in addition to promoting participation, e-governance serves as an efficient tool for citizens to monitor and control government actions, fostering positive relations between citizens and the government (Shim and Eom, 2008).

Similarly, Shim and Eom (2008) and Sabani et al. (2019) argue that e-government enables citizens to participate in public administration, making them more aware and better informed about government programs. Furthermore, Obodo and Anigbata (2018) stipulate that e- governance enhances government transparency.

Moreover, increased trust in governance can also encourage citizen participation in the financial market. Individuals are more likely to invest in financial instruments if they trust the government's regulation and supervision, as well as the stability of the market.

Otherwise, E-governance plays a crucial role in enhancing human capital by improving government accessibility, social inclusion, and resource optimization. In addition, e- governance provides better services, particularly in education and healthcare, and contributes, in that way, to human capital development.

These factors collectively contribute to economic development by empowering human capital, fostering citizen contributions to the economy through increased employment, productivity, and consumption.

Beyond the various theories mentioned, the impact of e-governance has been empirically proven by numerous researchers. Information and Communication Technologies (ICT) have fundamentally transformed the way societies operate and progress. In this part, we will highlight diverse effects of adopting ICT and, subsequently, e-governance on economic growth through analyzing different empirical studies.

Two distinct categories of studies emerge: those that specifically delve into the public sector's use of ICT, exploring its influence on economic growth, and those that investigate the relationship between e-government and economic growth.

## **b. E-Governance and economic growth nexus: empirical studies**

### *i. The use of ICT and economic growth: empirical studies*

Several authors have demonstrated a positive correlation between the use of Information and Communication Technologies and economic growth.

Choi and Yi (2009) have shown that a one-point increase in internet subscriptions leads to a 0.05% growth, especially through the share of information and knowledge. Thus, Choi and Yi argue that the main effect of internet usage is spreading information between countries. Choi and Yi analyzed the correlation between the internet usage ratio (number of internet users on total population) and the annual per capita GDP growth rate using panel data of 217 countries from 1991 to 2000. gross domestic investment, government consumption ratio, and inflation rate were used as control variables.

Holt and Jamison (2009) found a positive economic impact of broadband in the United States. However, quantifying this impact remains challenging in the absence of specific data.

Czernich et al. (2011) proved that a 10-point increase in broadband leads to a 0.9% to 1.5% annual per capita growth using an instrumental variable model on OECD countries' data between 1996 and 2007. They demonstrated that broadband infrastructure facilitates the generation and distribution of information in an economic market that is highly dependent on information. This study has shown that GDP per capita has increased from 2.7% to 3.9% due to broadband.

A study by Atif, Syed Muhammad, and Endres, James and Macdonald (2012) also supported the positive impact of broadband on economic growth, demonstrating that after broadband introduction, GDP per capita increased by 2.7% to 3.9%, and a 10% increase in broadband contributed to a 0.9% to 1.5% annual growth.

Using a static fixed effects model and a basic linear dynamic model on panel data of 31 OECD countries from 1998 to 2010, the study highlighted broadband's significant contribution to strengthening economic activity, fostering employment growth, particularly in information technology sectors, and improving real estate values. However, broadband doesn't have a significant impact on wages

Regarding fixed and mobile phones, Andrianaivo and Kpodar (2011) demonstrated their positive impact on the economic growth of 44 African countries between 1988 and 2007. They asserted that ICT positively influences capital accumulation, financial inclusion, rural development, and market efficiency.

Similarly, Mahyideen et al. highlight the positive impact of phone subscriptions on economic growth through enhancing productivity, improving inputs, and reducing production costs. Their study is based on five ASEAN countries from 1976 to 2010.

In 2013, a study focusing on ICT impact on economic growth in Singapore between 1990 and 2008 confirmed a positive correlation between ICT and marginal labor productivity, contributing to 1% of Singapore's GDP.

While many authors focus on the positive economic impact of ICT use, some studies show a weak correlation or an absence of correlation. Solow paradox (1950-1960), highlighting the paradoxical situation of weak economic growth despite major technological advancements and innovation; significant technological inventions did not automatically lead to a substantial increase in a country's productivity. This paradox prompted researchers to identify the additional factors needed to fully benefit from technological advancements.

For instance, Brynjolfsson and Hitt's (2000) explore the link between ICT, productivity, and organizational transformations and have proved that the performance of information technology depends on complementary investments to enhance intangible aspects of production. This study highlights the significant role of computers in business performance and economic growth by facilitating calculations, the development of new products, and improving service quality. Additionally, computers have reduced costs related to coordination, communication, and information processing.

*ii. E-governance and economic growth: empirical studies*

Several authors have empirically explored the link between e-government and economic growth, revealing a positive impact through various channels of economic growth transmission.

In 2010, Bhuiyan studied this link in Kazakhstan and demonstrated that e-government enhances transparency, accountability, and economic development. The research showed that e-government can streamline administrative procedures, reduce corruption and "hidden unemployment" defined as an underutilization of human capital, optimize government administration costs, and control costs of public officers. Moreover, e-government improves economic functioning by strengthening relations between administrations and international communities, promoting economic growth, and reinforcing social cohesion.

Similarly, Krishnan, Teo, and Lim studied in 2013 the relation between e-governance, economic growth, corruption, and environmental degradation based on cross-sectional data for 105 countries from 2004 to 2008 and a structural equation model. They found a positive impact, particularly through the reduction of corruption and improvement in environmental quality.

Beyond corruption and transparency, Vu identified three transmission channels based on 85 countries from 1996 to 2005, namely technological progress and innovation, efficiency in decision-making for businesses and households, growth in demand for goods, and reduced production costs.

In a more recent study in 2019, Tariq MAJEED and Amna MALIK investigated the impact of administrative digitalization on economic growth, using an empirical model developed from the Cobb-Douglas production function by Mankiw, Romer, and Weil (1992) based on a panel data of 154 countries between 2003 and 2010. The correlation study between e-government development index (EGDI) and GDP per capita demonstrated a positive correlation between e-governance, economic growth, physical capital, human capital, trade opening, and a negative correlation between e-governance, labor force, inflation, and government consumption. The

negative correlation between e-governance and the labor force may be explained by the mitigation of overemployment in organizations.

Considering country-specific differences, the authors used the fixed-effects model. The results showed that an additional point of the e-governance standard deviation produces a growth of 0.12% in GDP per capita. The correlation study between different components of EGDI demonstrated that human capital and online services contribute significantly to GDP per capita growth, while telecommunications infrastructure negatively impacts GDP per capita, potentially due to repatriation of profits by foreign telecommunications companies. However, the coefficient is not highly significant.

Nevertheless, the fixed-effects model may exacerbate the collinearity problem, leading to the use of the random-effects model, which the authors argue is more relevant when the sample size exceeds the number of periods. The model confirmed the fixed-effects model conclusions. Additionally, the authors confirmed the possibility of reverse causation between e-governance and GDP per capita. Thus, e-governance installation may depend on a country's GDP.

In their second study on the same theme, the authors addressed the issue of reverse causation from economic growth to e-governance using the instrumental variable technique by introducing variables related to e-governance but not directly to economic growth, such as the number of fixed telephone lines per 100 inhabitants, the urban population share, and the initial value of e-governance as instruments for e-governance. The study used panel data from 147 countries between 2003 and 2012, employing the Cobb-Douglas function through three empirical techniques: OLS, 2SLS, and GMM to ensure the study's relevance and verify the sensitivity of the results. The study demonstrated a positive impact of e-governance on economic growth and recommended substantial government budget allocation for transitioning to e-governance. The e-governance coefficient indicated that a 1% increase in e-governance quality would lead to a 1.9% to 2.7% increase in economic growth.

Similarly, Farzana Naheed Khan and Tariq MAJEED studied in 2019 the relationship between ICT and economic growth and the relationship between e-governance and economic growth through various estimation methods, including OLS, fixed-effects model, random-effects model, 2SLS, and GMM.

Regarding the correlation between ICT and economic growth, the study focused on mobile and fixed telephone subscriptions, internet users, fixed broadband subscriptions, the telecommunications infrastructure index, and the online services index.

The study proved the positive impact of mobile phone subscriptions on economic growth, specifically on per capita income. An increase of 1% in mobile phone subscriptions resulted in a 0.133% increase in per capita income. Several authors admit the positive impact of mobile phone subscriptions on economic growth (Majeed et al, 2006; Aker et Mbiti, 2010) and state that mobile phone subscriptions help mitigate the problem of information asymmetry in transaction markets and facilitate access to global markets.

In addition to mobile phones, the study demonstrated that a 1% increase in internet users leads to a 0.05% increase in GDP per capita through improved information dissemination in the market and reduced transaction costs. This result aligns with the findings of Choi and Hoon-Yi in 2009. Moreover, internet usage increases the utilization of online services, ensuring more efficiency and, consequently, economic growth. Furthermore, Majeed and Khan demonstrated in 2019 that internet usage improves the health index and, thus, labor productivity.

Regarding fixed phones, the study showed that a 1% increase in fixed telephone subscriptions leads to a 0.397% increase in economic growth. Similarly, a 1% increase in fixed broadband subscriptions results in a 0.082% increase in economic growth. The strong impact of fixed phones can be explained by their ease of management compared to broadband (Aker and Mbiti (2010), Choi and Hoon-Yi (2009), and Vu (2011)). Additionally, the study demonstrated a positive but not significant correlation between the telecommunications infrastructure index and economic growth. However, Kaur and Malhotra showed in 2014 the positive impact of this index on economic growth. Moreover, the study proved the positive impact of the online services index on economic growth.

Based on these elements, an ICT index was constructed, and the study demonstrated a positive correlation between this index and economic growth. A 1% increase in the ICT index leads to a 0.293% increase in economic growth. Additionally, the study also demonstrated a significant impact of e-governance on economic growth; a 1% increase in e-governance leads to a 2.8% increase in GDP per capita.

In the Moroccan context, Johansson studied the impact of the e-fez project on the attributes of good governance set by the UNDP in 1997. The study showed a positive impact on organization, functioning, relation with citizens, and decision-making attributes through transparency, efficiency, equity, the rule of law, response rate, and accountability.

The e-fez project improved transparency through real-time monitoring of request processing, favoring accountability. Furthermore, open access to the platform

promoted equity and reduced the risk and opportunity for corruption, supporting the rule of law and law enforcement.

Moreover, the e-fez project reduced citizen request processing time and optimized citizen resources, including waiting time and public resources, through enhancing efficiency and responsiveness, instant response to citizen requests, and reduced dependence on administrative officials.

Both empirical and theoretical studies show a positive impact of e-government on economic growth. However, most of these studies analyze the economic impact of e-government, which is different from e-governance. More than just digitizing processes, e-governance involves using information technology throughout every step of decision-making and allows for the involvement of all stakeholders through connected and interactive systems.

So, how can we measure e-governance? And what is the impact of e-governance on economic growth?

### **3. E-governance and economic growth: empirical study**

“E-governance is the public sector’s use of information and communication technologies to improve information and service delivery, encouraging citizen participation in the decision-making process and making government more accountable, transparent, and effective.” (UNESCO)

Thus, e-government and e-governance have to be considered as two distinct abstractions (Sheridan and Riley, 2006). E-government is an institutional approach consisting of the development of online services for citizens, whereas e-governance is a procedural approach to cooperative administrative relations. It is a wider concept that measures and defines the impacts of technologies on administration and on citizens (Grigalashvili, 2022).

Therefore, to capture these specificities and study the economic impact of e-governance. It seemed necessary to create a composite index, e-governance index (EGOVI), including different aspects of e-governance (Figure 1).

#### **a. E-governance index (EGOVI): methodology and results**

##### ***i. E-governance index: Sub-indicators***

By analyzing different definitions of e-governance, two aspects can be distinguished. The first aspect is e-government, which consists of providing online services to citizens.

It could be measured through secure technology access, technology use, and technology skills to capture the ability of citizens to use ICT.

In that way, two indicators are used:

- **Secure Internet Server (SIS)**, which reflects the number of servers using encryption technology to secure Internet transactions.
- **ICT index** that estimates the information and communication level of a country through 11 sub-indicators:
  - **ICT access:**
    - Fixed telephone subscriptions per 100 inhabitants;
    - Mobile-cellular telephone subscriptions per 100 inhabitants;
    - International internet bandwidth (kbit/s) per internet user;
    - Percentage of households with a computer;
    - Percentage of households with internet access.
  - **ICT use:**
    - Percentage of individuals using the internet;
    - Fixed-broadband subscriptions per 100 inhabitants;
    - Active mobile-broadband subscriptions per 100 inhabitants.
  - **ICT skills:**
    - Mean years of schooling;
    - Secondary gross enrolment ratio;
    - Tertiary gross enrolment ratio.

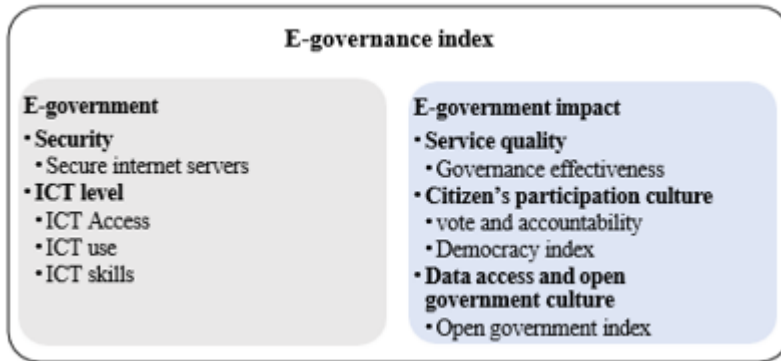
The second aspect is the impact of e-governance on service quality and citizen participation, measured by service quality, citizen participation culture, open government culture, and data access:

- **Service quality:** This aspect is measured by Governance effectiveness (GE) that reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
- **Culture of citizens' participation:**
  - Voice and Accountability (VA) that captures perceptions of the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.
  - The Democracy Index (DI), which is based on 60 indicators, grouped into five categories: electoral process and pluralism, civil liberties, functioning of government, political participation, and political culture.
  - Data access and culture of open government: measured through Open Government Index (OGI), which is organized around four dimensions of

government openness: publicized laws and government data, right to information, civic participation, and complaint mechanisms.

The following figure summarizes the sub-indicators included in EGOVI:

**Figure. 1: EGOVI sub-indicators**



The methodology used by ITU to estimate the ICT index was changed after 2017, and the data from 2014 is not available. Therefore, we estimated the ICT index for 2014, 2017, 2018, and 2020 using the following methodology published by the ITU (Figure. 2):

**Figure 2: ICT index components and methodology**

ICT access	Reference value	(%)
1. Fixed-telephone subscriptions per 100 inhabitants	60	20
2. Mobile-cellular telephone subscriptions per 100 inhabitants	120	20
3. International Internet bandwidth (bit/s) per internet user	2'158'212*	20
4. Percentage of households with a computer	100	20
5. Percentage of households with Internet access	100	20
ICT use	Reference value	(%)
6. Percentage of individuals using the Internet	100	33
7. Fixed-broadband subscriptions per 100 inhabitants	60	33
8. Active mobile-broadband subscriptions per 100 inhabitants	100	33
ICT skills	Reference value	(%)
9. Mean years of schooling	15	33
10. Secondary gross enrolment ratio	100	33
11. Tertiary gross enrolment ratio	100	33

**ICT Development Index**

Note: \*This corresponds to a log value of 6.33, which was used in the normalization step.  
Source: ITU.

**Data source:**

- **ICT:** International Telecommunication Union
- **SIS:** World Development Indicators
- **GE:** World Development Indicators
- **VA:** World Development Indicators
- **DI:** Our World in Data
- **OGI:** World Justice Project

After collecting and processing data, we create the E-governance index using the principal components analysis method (PCA).

*ii. Methodology: Principal analysis method*

The use of composite indices offers both advantages and disadvantages. According to Saisana and Tarantola, a composite index can simplify and analyse multidimensional issues, providing a clear overview, allowing a better interpretation to identify trends in a multidimensional concept. However, if not carefully constructed or interpreted, composite indices can cause misleading or unstable messages, highlighting the importance of using robust models.

The PCA method involves grouping collinear sub-indicators to form a synthetic indicator that captures the maximum amount of shared information from these sub-indicators. Each factor, typically estimated through PCA, identifies the set of indicators with the strongest association. The goal of this method is to account for the maximum variance in the indicator set using the fewest number of factors.

Let  $X$  be a matrix with  $p$  variables and  $n$  observations:

$$X = \begin{bmatrix} X_{1,1} & \cdots & X_{1,p} \\ \vdots & \ddots & \vdots \\ X_{n,1} & \cdots & X_{n,p} \end{bmatrix}$$

PCA allows replacing the original variables ( $X_1, \dots, X_p$ ) with a smaller number of uncorrelated components ( $C_1, \dots, C_k$ ) where  $k$  is the number of principal components retained.

Before applying PCA, it's essential to evaluate the suitability of the dataset by examining the correlation between the components using a correlation matrix and statistical tests as Bartlett's test of Sphericity and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (Table 1).

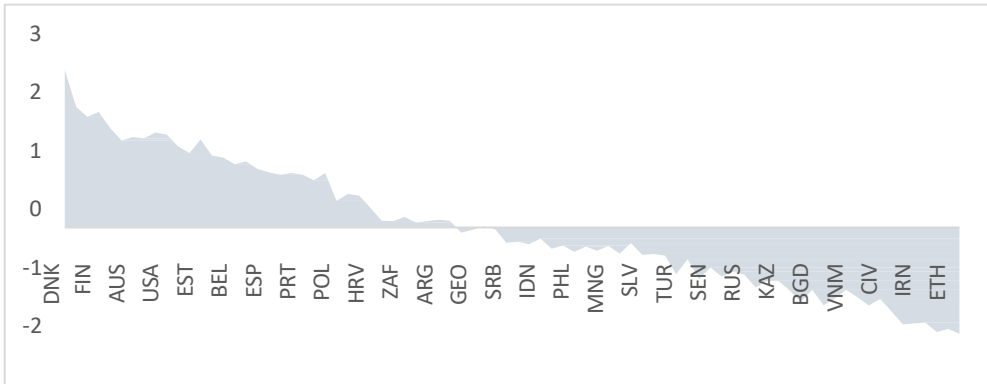
**Table 1: data adequacy tests for using PCA**

Test	Result
Correlation matrix	Our correlation matrix reveals a strong correlation between different components. The indicators are related and can be effectively combined in PCA to capture underlying dimensions of e-governance. The high correlations observed among several key indicators demonstrate that these variables share substantial common variance. By confirming these strong correlations, we ensure that PCA will be effective in reducing the dimensionality of our data while retaining significant informational content (Appendix 1)
Bartlett's test of sphericity	Bartlett's test of sphericity tests the null hypothesis that the correlation matrix is an identity matrix, indicating that the variables are uncorrelated. The alternative hypothesis is that the correlation matrix significantly differs from the identity matrix, suggesting meaningful correlations among variables. In all cases, we reject the null hypothesis (p-value = 0.000), which means that correlation matrices are not identity matrices, and we can conclude that there are sufficient correlations among variables to justify proceeding with PCA (Appendix 2).
Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy	The KMO Measure evaluates the sampling adequacy for factor analysis, with values ranging from 0 to 1. A KMO value closer to 1 suggests that the variables are suitable for factor analysis, while values closer to 0 indicate that the variables are not well-suited for such analysis. All KMO values exceed the recommended threshold of 0.6, indicating that the data is adequate for PCA (Appendix 2).

**iii. E-Governance Index: Results**

European countries consistently show strong positive scores and African countries exhibit persistently low scores, reflecting weaker performance (Figure. 3).

**Figure 3: E-governance index (2020)**



The PCA results reveal notable variations in performance among 80 countries from 2012 to 2020 (Appendix 3).

The first component consistently explains the majority of the variance. For example, in 2012, the first component accounts for 83,13% of the variance (Appendix 4).

**b. Impact of e-governance on economic growth**

*i. Methodology*

Economic growth can be explained by two key factors: capital and labor. Over time, several other factors show their impact on economic growth. The Cobb-Douglas production function was developed to include these factors.

The general form of a Cobb-Douglas production function for a set of inputs is:

$$Y = f(x_1, x_2, \dots, x_n) = \beta \prod_{i=1}^n x_i^{\alpha_i}$$

Where Y is the output (production),  $x_i$  are production factors,  $\beta$  and  $\alpha$  are parameters determining the overall efficiency of production, and how output responds to changes in the input quantities.

The Cobb-Douglas function was first applied by the mathematician Charles Cobb and the economist Paul Douglas to assess the role of labor and capital in manufacturing output in the United States from 1899 to 1922.

The productive capacity of a country depends on capital (Lucas, 1988). Otherwise, the impact of labor on production dates back to Adam SMITH. It enhances the

marginal productivity of physical capital and stimulates economic growth (Mankiw et al, 1992). Human capital also has a significant impact on economic growth.

Thus, an empirical framework was developed from Cobb Douglas production function. The production function includes these three inputs that are: physical capital, human capital, and labor.

$$Y = AL^\alpha K^\beta HC^\gamma \quad (1)$$

Where L is labor, K is capital, HC is human capital, and A is the state of technology in a country. Taking the natural log of the equation:

$$\log(Y) = \log(A) + \alpha \log(L) + \beta \log(K) + \gamma \log(HC) \quad (2)$$

Following Czernich et al. (2011), it was supposed that technology is exponentially evolving, which can be expressed as:

$$A_i = A_0 e^\theta \quad (3)$$

Taking the log of the equation:

$$\log(A_i) = \log(A_0) + \theta \quad (4)$$

$\theta$  shows the technological growth of the country.

In terms of e-governance,  $\theta$  can be defined as:

$$\theta = \alpha_1 + \alpha_2 EGOVI_i \quad (5)$$

Putting equation 5 in equation 4:

$$\log(A_i) = \alpha_0 + \alpha_1 + \alpha_2 EGOVI_i \quad (6)$$

Where  $\alpha = \alpha_0 + \alpha_1$

$$\log(A_i) = \alpha + \alpha_2 EGOVI_i \quad (7)$$

Putting equation 7 in equation 2:

$$\log(Y_i) = \alpha + \alpha_2 EGOVI_i + \beta_1 \log(L_i) + \beta_2 \log(K_i) + \beta_3 \log(HC_i) \quad (8)$$

The “convergence theory” proposes that countries with lower initial income tend to grow faster than those with higher income (SOLOW, 1956). A country that starts with a lower income has a greater potential to grow quickly, which is why it may eventually reach the same income level as rich countries. Following Barro (1991), an initial level of per-capita income is inserted into equation (8)

$$\log(Y_i) = \alpha + \alpha_1 Y_{initial} + \alpha_2 EGOVI_i + \beta_1 \log(L_i) + \beta_2 \log(K_i) + \beta_3 \log(HC_i)$$

The impact of inflation on economic growth was proved by several authors (De Gregorio, 1992; Barro, 1991). Similarly, trade and government consumption influence economic growth (Barro, 1991; Majeed and Ahmad, 2006; Majeed, 2016).

To catch the impact of these variables and to check the sensitivity of empirical findings, inflation, trade, and government consumption were considered as control variables.

The equation becomes:

$$\log(\text{GDP\_PC}_i) = \alpha + \alpha_1 \text{GDP\_PC}_{\text{initial}} + \alpha_2 \text{EGOVI}_i + \beta_1 \log(\text{Lab}_i) + \beta_2 \log(\text{FBCF}_i) + \beta_3 \log(\text{HC}_i) + \beta_4 \log(\text{X}_i) + \text{U}_i$$

Where

- **GDP\_PC:** GDP per capita (the initial value of GDP\_PC is the GDP\_PC of 2000);
- **EGOVI:** E-governance index;
- **Lab:** share of labor ages above 15 years in the total population;
- **FBCF:** gross fixed capital formation as a percentage of GDP;
- **HC:** human capital measured by secondary gross enrollment ratio;
- **X:** control variables matrix;
- **U:** error term.

To estimate the impact of e-governance on economic growth, we will use panel data of 76 countries between 2012 and 2020.

The sample was chosen based on data availability and to ensure diversity in order to select a representative sample, including countries from different regions and with different economic levels. The period 2012-2020 is also explained by data availability. 2020 was chosen as the ending year to avoid capturing COVID-19 shock, which could bias the results.

There are many models for estimating this relationship between e-governance and economic growth: fixed effect, random effect, ordinary least square etc. The fixed effects model allows studying the impact of an explanatory variable on a dependent variable, focusing on specific characteristics that remain constant across observations. In contrast, the random effects model is used to account for variability and differences between different entities or subjects within a larger group.

To choose the suitable model between pooled OLS and Random effect, we use the Breusch and Pagan Lagrangean multiplier test. Then we used the Hausman test to choose the appropriate model between fixed and random effects. According to the

following results, the fixed effect model is the most appropriate test to analyse the data (Table 2).

**Table 2: Tests to choose the suitable model**

Model	Random effect and OLS	Random effect and fixed effect
Test	Breush and Pagan Lagrangian multiplier test	Hausman test
Result	Chi2 = 1882.24 Prob>F = 0.0000	Chi2 = 296.00 Prob>F = 0.0000
Final selection	Random effect	Fixed effect

Source: Authors from Stata results

Autocorrelation test through Wooldridge, cross-sectional dependence test using the Pesaran, and heteroskedasticity test through the Wald test show a presence of autocorrelation, cross-sectional dependence, and heteroskedasticity (Table 3).

**Table 3: Autocorrelation, cross-sectional dependence, and heteroskedasticity tests**

Test	Results	Model Consistency
<b>Wooldridge test for autocorrelation</b>	F(1, 75)=351.396 Prob>F = 0.0000	Presence of autocorrelation in the model
<b>Pesaran abs test of cross-sectional independence</b>	Chi2 = 38.059 Prob > F = 0.000	Cross-sectional dependence
<b>Wald test for heteroskedasticity</b>	Chi2(76) = 5242,30 Prob> F = 0.000	Presence of heteroskedasticity

Source: Authors from Stata results

Therefore, we used the PCSE (panel standard corrected errors) fixed effect model. This method corrects heteroskedasticity, autocorrelation, and cross-panel dependence. According to Beck and Katz (1995), the PCSE method provides consistent and efficient estimates by adjusting these issues.

This method is particularly suitable when the time dimension is smaller than the cross-sectional dimension. Our study covers 76 countries over 9 years, so we can use the PCSE fixed effect model.

*ii. Results*

The PCSE model exhibits the highest R-squared value (0.992). The Random effects and fixed effects models show lower R-squared values, suggesting that the PCSE model is better at capturing the variation in GDP per capita across countries (Table 4).

**Table 4: Regression results using OLS, Random effect, fixed effect, and PCSE**

<b>Models</b>	<b>OLS</b>	<b>Random effect</b>	<b>Fixed effect</b>	<b>PCSE</b>
<b>EGOVI</b>	0,1410897 (0.000)	0,1147591 (0.001)	0,0561497 (0.046)	0,1356316 (0.000)
<b>Capital</b>	0,2620798 (0.000)	0,2845283 (0.000)	0,2792996 (0.000)	0,2001109 (0.000)
<b>Labor</b>	0,6031301 (0.000)	0,5427147 (0.000)	0,1020621 (0.427)	0,6578779 (0.000)
<b>GDP_CAP_i</b>	0,5419878 (0.000)	0,3953894 (0.000)	Omitted*	0,5121088 (0.000)
<b>Cons_Gov</b>	0,0348154 (0.000)	0,3568234 (0.000)	0,6633401 (0.000)	0,0955648 (0.000)
<b>Inflation</b>	0,0198293 (0.000)	-0,0095629 (0.43)	0,0202926 (0.029)	-0,0240125 (0.114)
<b>Trade</b>	0,1221804 (0.000)	-0,0057303 (0.883)	0,0509046 (0.12)	0,1316436 (0.000)
<b>HC</b>	0,8217344 (0.000)	0,1599246 (0.009)	-0,0812522 (0.105)	0,8217344 (0.003)
<b>Cte</b>	-3,73229 (0.000)	-6,54349 (0.000)	-8,108744 (0.000)	-4,225267 (0.000)
<b>Number of countries</b>	76	76	76	76
<b>Observations</b>	684	684	684	684
<b>R-squared</b>	0,957			0,992
<b>Adjusted R-squared</b>	0,9565			
<b>R-squared within</b>		0,6042	0,6733	
<b>R-squared between</b>		0,8299	0,4848	
<b>R-squared overall</b>		0,8272	0,486	
<b>Prob &gt; F</b>	0.000	0.000	0.000	0.000

The OLS model demonstrates that E-governance has a positive and significant impact on GDP per capita, with a coefficient of 0.1411 (p-value = 0.000). This finding suggests that a one-unit increase in E-governance leads to a 14,1% increase in GDP per capita. However, the Random Effects model reveals a slightly lower coefficient of 0.1148 (p-value = 0.001), but still indicates a positive relationship.

In the fixed effects model, the coefficient of E-governance decreases to 0.0561 (p-value = 0.046). We can conclude that country-specific factors explain part of the variation in economic growth.

According to the PCSE model, a one-unit increase in e-governance generates 13,6% increase in GDP per capita (p-value = 0.000). This finding confirms the significant economic impact of e- governance.

Otherwise, Capital and Labor have a positive and significant impact on GDP per capita across all models. Government consumption also has a positive impact in most models, while inflation shows mixed results, with no significant effect according to OLS and PCSE models, but a significant negative effect in the fixed effects model.

#### **4. Conclusion**

This study provides empirical evidence of the positive impact of e-governance on economic growth. To include different aspects of e-governance, which differ from e- government, a composite e-governance index (EGOVI) was created using the principal components analysis method, and to study the impact of EGOVI on economic growth, a PCSE fixed effect model was used on a panel data set of 76 countries from 2012 to 2020.

It was demonstrated that a one-unit increase in the e-governance index (EGOVI) leads to a 13,6% increase in GDP per capita. The analysis further revealed that capital and labor remain the strongest drivers of economic growth, with coefficients of 0.2001 and 0.6578, respectively. The initial GDP per capita has been shown to significantly influence economic growth, with a coefficient of 0.51. Government consumption and trade have been found to have a positive effect on economic growth, while inflation has been found to have a mixed effect.

Overall, these results confirm that e-governance is a significant catalyst for economic growth. However, this study can be developed by including, particularly, additional sub-indicators in the EGOVI to better capture the complexity of the e-governance concept.

## 5. References

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**Appendices:**

**Appendix 1. Correlation matrix**

Sub-indicators	Year	ICT	SS	GE	VA	DI	OGI
ICT	2012	1,000	,692	,852	,749	,699	,816
SS		,692	1,000	,781	,679	,632	,811
GE		,852	,781	1,000	,854	,812	,909
VA		,749	,679	,854	1,000	,955	,869
DI		,699	,632	,812	,955	1,000	,821
OGI		,816	,811	,909	,869	,821	1,000
ICT		2013	1,000	,680	,838	,723	,674
SS	,680		1,000	,778	,673	,622	,812
GE	,838		,778	1,000	,859	,823	,909
VA	,723		,673	,859	1,000	,960	,858
DI	,674		,622	,823	,960	1,000	,814
OGI	,799		,812	,909	,858	,814	1,000
ICT	2014		1,000	,641	,852	,653	,639
SS		,641	1,000	,777	,658	,627	,791
GE		,852	,777	1,000	,782	,782	,900
VA		,653	,658	,782	1,000	,953	,841
DI		,639	,627	,782	,953	1,000	,833
OGI		,772	,791	,900	,841	,833	1,000
ICT		2015	1,000	,671	,859	,675	,666
SS	,671		1,000	,781	,647	,616	,738
GE	,859		,781	1,000	,767	,770	,842
VA	,675		,647	,767	1,000	,955	,908
DI	,666		,616	,770	,955	1,000	,887
OGI	,802		,738	,842	,908	,887	1,000
ICT	2016		1,000	,612	,850	,640	,636
SS		,612	1,000	,733	,552	,543	,660
GE		,850	,733	1,000	,770	,789	,842
VA		,640	,552	,770	1,000	,955	,901
DI		,636	,543	,789	,955	1,000	,884
OGI		,755	,660	,842	,901	,884	1,000
ICT		2017	1,000	,603	,850	,638	,644
SS	,603		1,000	,718	,522	,530	,621
GE	,850		,718	1,000	,770	,793	,854
VA	,638		,522	,770	1,000	,963	,910
DI	,644		,530	,793	,963	1,000	,902

OGI		,759	,621	,854	,910	,902	1,000
ICT	2018	1,000	,581	,848	,636	,629	,745
SS		,581	1,000	,686	,517	,513	,609
GE		,848	,686	1,000	,774	,782	,837
VA		,636	,517	,774	1,000	,968	,914
DI		,629	,513	,782	,968	1,000	,899
OGI		,745	,609	,837	,914	,899	1,000
ICT	2019	1,000	,507	,846	,613	,620	,727
SS		,507	1,000	,614	,453	,447	,553
GE		,846	,614	1,000	,755	,776	,841
VA		,613	,453	,755	1,000	,955	,907
DI		,620	,447	,776	,955	1,000	,896
OGI		,727	,553	,841	,907	,896	1,000
ICT	2020	1,000	,520	,780	,617	,626	,718
SS		,520	1,000	,627	,472	,467	,586
GE		,780	,627	1,000	,758	,780	,844
VA		,617	,472	,758	1,000	,955	,911
DI		,626	,467	,780	,955	1,000	,904
OGI		,718	,586	,844	,911	,904	1,000

Source: SPSS

**Appendix 2. Bartlett's test of sphericity and KMO**

		2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>Mesure de précision de l'échantillonnage de Kaiser-Meyer-Olkin.</b>		,877	,873	,853	,847	,838	,846	,845	,843	,861
<b>Test de sphéricité de Bartlett</b>	Khi-deux approximé	621,656	621,543	588,330	609,723	582,655	603,182	598,765	555,638	542,522
	ddl Signification de Bartlett	15,000								

*Source: SPSS*

**Appendix 3. E-governance index**

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020
DNK	1,97339	1,95533	1,88841	1,96412	2,22818	1,96505	2,32386	2,52691	2,47415
NLD	2,2247	2,21637	2,20548	2,24426	2,14187	2,20517	2,07792	1,88855	1,89099
NOR	2,00192	1,96158	1,94591	1,89787	1,7929	1,77949	1,69684	1,71665	1,73674
FIN	1,82987	1,79143	1,78139	1,64837	1,59403	1,68533	1,75278	1,77118	1,81499
SWE	2,01007	1,96085	1,81802	1,81207	1,60858	1,58954	1,56448	1,57815	1,56484
NZL	1,82633	1,79013	1,80878	1,73288	1,6028	1,53997	1,43176	1,40294	1,36771
AUS	1,83247	1,78806	1,71877	1,58614	1,49499	1,48424	1,4985	1,44499	1,42221
CAN	1,62529	1,61044	1,63345	1,49957	1,57614	1,62026	1,48181	1,43279	1,39739
DEU	1,38377	1,39598	1,51264	1,55082	1,56113	1,61804	1,56052	1,47147	1,49279
USA	1,6221	1,6052	1,56097	1,54309	1,35874	1,33613	1,43587	1,45106	1,46068
GBR	1,52629	1,52367	1,52141	1,59775	1,49476	1,44971	1,3499	1,31688	1,27053
AUT	1,41272	1,39448	1,3969	1,29333	1,17836	1,1157	1,12009	1,14322	1,16873
EST	0,9508	0,97805	1,08394	1,18769	1,30469	1,27554	1,34214	1,35414	1,38348
JPN	1,20092	1,24466	1,32905	1,08712	1,01153	0,99242	1,09782	1,0888	1,12939
FRA	1,05601	1,08629	1,05606	1,1218	1,17343	1,16944	1,14028	1,1474	1,09689
BEL	1,08308	1,1173	1,17029	1,14239	1,0278	1,02169	1,02599	1,03038	0,99221
SGP	0,90619	0,92842	0,95888	0,81012	1,15905	1,22125	1,20773	1,06418	1,03738
KOR	0,92147	0,88445	0,94252	0,77676	0,74782	0,79109	0,80579	0,88254	0,92071
ESP	0,72156	0,73554	0,71749	0,82547	0,85686	0,83483	0,83339	0,89397	0,86788
SVN	0,78895	0,79608	0,69832	0,7423	0,79522	0,87968	0,85283	0,7951	0,82621
CZE	0,57647	0,57295	0,68496	0,85807	1,04059	0,88193	0,83961	0,78716	0,85759
PRT	0,64036	0,65667	0,64276	0,73977	0,78944	0,90034	0,8545	0,86518	0,82781
CHL	0,61496	0,64685	0,63586	0,61494	0,62864	0,68229	0,73821	0,76166	0,7437
URY	0,46651	0,4791	0,60178	0,61402	0,61843	0,6366	0,70866	0,78874	0,85592
POL	0,48123	0,46156	0,58157	0,61435	0,53022	0,39748	0,51414	0,45706	0,4194
ITA	0,34985	0,3813	0,38637	0,52915	0,52666	0,57484	0,52279	0,47525	0,5291
GRC	0,25139	0,26258	0,19176	0,26148	0,22007	0,28978	0,3537	0,43753	0,49723
HRV	0,26639	0,27482	0,19353	0,25932	0,2215	0,40486	0,32519	0,26728	0,29982
HUN	0,28311	0,29985	0,17489	0,19122	0,17296	0,19582	0,13005	0,05091	0,10263
BGR	0,02594	0,02923	-0,08325	0,09817	0,17943	0,41803	0,28591	0,18877	0,09771
ZAF	0,12848	0,17563	0,14815	0,04819	0,07489	0,14316	0,15255	0,18422	0,16315
ROU	-0,12257	-0,05944	-0,07586	0,10965	0,20012	0,22177	0,15113	0,08546	0,07635
PAN	0,12546	0,08869	0,03627	-0,04641	-0,03554	-0,03881	0,0287	0,06194	0,10016
ARG	-0,14922	-0,16827	-0,11279	-0,00772	0,10869	0,19659	0,17359	0,15184	0,11991
JAM	-0,22315	-0,19366	-0,14226	-0,05016	0,07902	0,10258	0,08353	0,08728	0,10761

<b>BRA</b>	-0,02943	-0,03137	-0,02152	-0,02067	-0,01459	-0,03251	-0,1049	-0,05514	-0,08027
<b>GEO</b>	-0,24564	-0,20078	-0,14027	-0,12386	-0,0216	-0,06968	-0,05389	0,02844	-0,03982
<b>MYS</b>	-0,11466	-0,11262	-0,03309	-0,37251	-0,32208	-0,23659	-0,05383	-0,02222	0,01641
<b>COL</b>	-0,26533	-0,24347	-0,28571	-0,15393	-0,11177	-0,15102	-0,09655	-0,01104	-0,0258
<b>SRB</b>	-0,26767	-0,18472	-0,0902	-0,10503	-0,08371	-0,13944	-0,1658	-0,20026	-0,24082
<b>IND</b>	-0,32185	-0,30815	-0,26295	-0,14507	-0,08683	-0,19301	-0,14651	-0,21656	-0,22361
<b>MEX</b>	-0,14014	-0,14911	-0,22188	-0,2126	-0,23304	-0,24872	-0,29008	-0,26772	-0,26325
<b>IDN</b>	-0,34536	-0,33419	-0,25509	-0,33074	-0,25757	-0,34539	-0,26336	-0,23111	-0,17582
<b>GHA</b>	-0,32838	-0,27285	-0,39736	-0,28245	-0,28271	-0,29842	-0,32655	-0,35626	-0,33583
<b>PER</b>	-0,42185	-0,42746	-0,42792	-0,33503	-0,28564	-0,27752	-0,28394	-0,23766	-0,28265
<b>PHL</b>	-0,38945	-0,35409	-0,30631	-0,25585	-0,29196	-0,33279	-0,37237	-0,33715	-0,38355
<b>TUN</b>	-0,49244	-0,46353	-0,31655	-0,33749	-0,34809	-0,3717	-0,31716	-0,24269	-0,30302
<b>MDA</b>	-0,45068	-0,38908	-0,35285	-0,29607	-0,33472	-0,29518	-0,36804	-0,3689	-0,36812
<b>MNG</b>	-0,60874	-0,57382	-0,56744	-0,41441	-0,30705	-0,35512	-0,34296	-0,25244	-0,28897
<b>ALB</b>	-0,48278	-0,47945	-0,42085	-0,34841	-0,43993	-0,4059	-0,43246	-0,41007	-0,40781
<b>UKR</b>	-0,55076	-0,58071	-0,51285	-0,50611	-0,42146	-0,39766	-0,40031	-0,29504	-0,24556
<b>SLV</b>	-0,54306	-0,53884	-0,49833	-0,42641	-0,47241	-0,49476	-0,55206	-0,51791	-0,43519
<b>THA</b>	-0,36546	-0,35088	-0,51464	-0,62474	-0,64678	-0,69337	-0,66521	-0,42639	-0,41534
<b>LKA</b>	-0,61358	-0,63139	-0,65024	-0,50876	-0,50461	-0,51913	-0,51317	-0,48348	-0,44168
<b>TUR</b>	-0,28349	-0,29911	-0,41374	-0,52379	-0,6585	-0,6617	-0,74296	-0,75878	-0,73534
<b>ECU</b>	-0,66098	-0,64094	-0,62048	-0,57668	-0,67049	-0,54994	-0,49029	-0,46451	-0,50018
<b>BIH</b>	-0,49716	-0,50566	-0,57858	-0,59649	-0,58477	-0,67384	-0,68302	-0,71309	-0,81675
<b>SEN</b>	-0,71056	-0,68449	-0,63196	-0,61545	-0,59977	-0,68397	-0,67671	-0,63935	-0,62868
<b>BOL</b>	-0,61653	-0,62244	-0,75623	-0,71377	-0,75905	-0,69008	-0,6675	-0,88723	-0,77484
<b>MAR</b>	-0,69809	-0,71042	-0,7705	-0,78412	-0,80379	-0,84288	-0,8077	-0,73012	-0,693
<b>RUS</b>	-0,80127	-0,81365	-0,7658	-0,80095	-0,8446	-0,81102	-0,80565	-0,73985	-0,73775
<b>JOR</b>	-0,73327	-0,77054	-0,77935	-0,82576	-0,77325	-0,7636	-0,83802	-0,919	-0,94523
<b>KEN</b>	-0,84417	-0,78891	-0,80413	-0,80231	-0,80476	-0,83959	-0,88691	-0,85673	-0,83881
<b>KAZ</b>	-1,01873	-1,06366	-0,93948	-0,97068	-0,90065	-0,87985	-0,90166	-0,87236	-0,83589
<b>MWI</b>	-0,78435	-0,81778	-0,9479	-0,92013	-0,92899	-0,99007	-1,02634	-1,04378	-0,98634
<b>ZMB</b>	-0,76966	-0,78426	-0,76514	-0,89438	-0,9687	-1,00095	-0,98513	-1,10734	-1,17372
<b>BGD</b>	-0,97157	-0,99104	-1,01625	-0,98779	-1,01187	-1,04704	-1,01371	-0,9872	-0,97975
<b>BLR</b>	-1,15319	-1,13385	-0,94783	-0,94158	-0,9687	-1,06051	-1,06172	-1,08758	-1,22329
<b>BFA</b>	-1,11976	-1,0664	-1,10158	-1,0569	-1,02344	-1,0016	-1,01323	-1,15422	-1,11894
<b>VNM</b>	-1,19147	-1,16352	-1,06976	-1,17813	-1,15617	-1,15855	-1,09047	-1,04381	-0,97988
<b>MDG</b>	-1,19055	-1,16504	-1,25958	-1,28043	-1,18764	-1,19662	-1,20253	-1,13737	-1,09692
<b>PAK</b>	-1,18175	-1,19355	-1,26298	-1,18128	-1,19142	-1,18626	-1,24046	-1,24683	-1,22693
<b>CIV</b>	-1,34091	-1,3371	-1,29303	-1,30846	-1,23119	-1,20686	-1,12185	-1,10846	-1,12449

<b>NGA</b>	-1,24002	-1,26911	-1,28942	-1,139	-1,2013	-1,17402	-1,23035	-1,30485	-1,31852
<b>EGY</b>	-0,82819	-1,03205	-1,17523	-1,39646	-1,48073	-1,45186	-1,46543	-1,50011	-1,52349
<b>IRN</b>	-1,33902	-1,3796	-1,40086	-1,46904	-1,35978	-1,26299	-1,27832	-1,39684	-1,50618
<b>KHM</b>	-1,11683	-1,19362	-1,16132	-1,46325	-1,50416	-1,58022	-1,51756	-1,45956	-1,49547
<b>CMR</b>	-1,45482	-1,47983	-1,41954	-1,44582	-1,5331	-1,54083	-1,58669	-1,65502	-1,64622
<b>ETH</b>	-1,40556	-1,468	-1,45018	-1,59313	-1,73543	-1,75613	-1,68035	-1,67521	-1,59558
<b>ZWE</b>	-1,68396	-1,67111	-1,71552	-1,63202	-1,7152	-1,71297	-1,69884	-1,65877	-1,67113

**Appendix 4. Explained variance by the first component**

	<b>% of explained variance by the first component</b>
2012	83,131
2013	82,533
2014	80,777
2015	81,222
2016	78,850
2017	78,706
2018	78,004
2019	75,940
2020	76,159

*Source: SPSS*