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The effect of democracy and corruption paradox on economic growth: MINT countries

Asiye Tutuncu[1] · **Yasar Bayraktar**[2]

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Abstract

This study examines the impact of democracy and corruption on the economic growth of Mexico, Indonesia, Nigeria, and Turkey over the 1975–2022 period. Utilizing the Fractional Frequency Flexible Fourier Panel Cointegration and Dynamic Ordinary Least Squares coefficient estimator, two models are employed to test hypotheses regarding economic growth. The findings reveal that democracy plays an upgrading role in the economic growth of all MINT countries, while the effect of corruption varies. In Indonesia and Mexico, corruption has a positive impact on growth, reflecting the effect of democracy, whereas Nigeria and Turkey experience a negative impact. The democracy model supports the compatibility hypothesis for all countries, asserting a positive link between democracy and economic growth. However, the corruption model yields divergent results, with Nigeria and Turkey aligning with the "grease in the wheels" hypothesis, implying that corruption can facilitate economic growth by bypassing bureaucratic obstacles, while Indonesia and Mexico support the "sand in the wheels" hypothesis, indicating that corruption hinders economic growth. This highlights the need for governments to strengthen institutions through transparency, accountability, and credibility via robust oversight and governance mechanisms. Therefore, democratic advancement, streamlined bureaucracy, and anti-corruption policies are imperative for sustainable economic growth and welfare.

Keywords Democracy · Corruption · GDP · MINT · Fractional frequency flexible Fourier panel cointegration

JEL Classification D72 · D73 · C33

✉ Yasar Bayraktar
yasar.bayraktar@bcu.ac.uk

Asiye Tutuncu
ttncasiye@gmail.com

[1] Faculty of Economics and Administrative Sciences, Kastamonu University, Kastamonu, Turkey

[2] College of Accountancy, Finance and Economics, Birmingham City Business School, Birmingham City University, Birmingham, UK

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1 Introduction

How do democracy and corruption, frequently seen as conflicting concepts, affect economic growth in complex and occasionally contradictory ways? While democracy refers to the system for the government of the people, by the people, and for the people's welfare (Haney 1944), corruption represents the exploitation of entrusted public power for political or private purposes (Transparency International 2023). Both concepts have opposing influences on public authorities' decision-making process. Therefore, exploring the relationship between the contradictory concepts and economic growth is crucial to implementing sustainable policies and, in turn, achieving steady economic growth (Saha and Sen 2021).

In the literature, this relationship was supported by various hypotheses. *The compatibility hypothesis* is based on the idea that upgrading democracy will lead to more transparent and accountable policymaking, and thus positively impact economic growth (Lopes and Rivera-Castro 2017; Mohammadi et al. 2023). Advanced democracies' success is based on freedom of speech, expression, free media, public debates, the strong rule of law, free-frequent-fair elections, human rights protections, transparency, and the principle of separation of powers (Colagrossi et al. 2020; Ghardallou and Sridi 2020; Trinugroho et al. 2023). In contrast, *the conflict hypothesis* argues that economic resources might be used to get re-elected in pluralist democracies, thereby impeding economic growth (Saha ad Sen 2021; Trinugroho et al. 2023).

On the other hand, *the grease-the-wheels hypothesis* argues that corruption might boost economic growth by avoiding inefficient regulation, speeding up approval, and accessing scarce resources (Bitterhout and Simo-Kengne 2020). In economies with poor governance mechanisms, heavy bureaucracies, and inefficiencies, corruption facilitates bypassing any encountered obstacles, thus enabling economic growth (Sharma and Mitra 2019; Malanski and Póvoa 2021; Nguyen et al. 2022a, b). In contrast, *the sand-the-wheels hypothesis* conjectures that corruption decreases economic growth by impeding innovation and productivity (Das et al. 2020). Indeed, supporters of this hypothesis assert that economic growth decelerates in corruption-ridden economies as it breeds unfairness, inequality, rent-seeking, and institutional distrust (Mahmood et al. 2018; Malanski and Póvoa 2021).

In countries in which corruption is widespread, the downfall of institutionalization undermines democracy and decreases international credibility (Shabbir 2017; Spyromitros and Panagiotidis 2022; Chatterjee 2022). Consistent with the Transparency International (2022) report, corruption is seen particularly in developing countries. For instance, the MINT countries—Mexico, Indonesia, Nigeria, and Turkey—have high economic growth rates alongside high corruption rates (Huo et al. 2022; Adebayo et al. 2023). In accordance with Freedom House's (2023) data, despite high economic growth rates, the democratic structure, and freedom index of countries do not appear to have improved over the years. Mexico and Nigeria are Partly Free countries, while Turkey has been classified as Not Free since 2018. Indonesia was classified as Free until 2013 and Partly Free after that. Additionally, The Worldwide Governance Indicators' (2022) control of corruption and Transparency

International's (2022) corruption perceptions index indicate that whereas the corruption levels of these countries are generally high, corruption is lowest in Turkey and highest in Nigeria.

Nigeria, a non-G20 member, has a higher economic growth rate than member countries Mexico, Indonesia, and Turkey (World Bank 2023). In addition to the MINT countries' rapid economic growth, the deterioration in democracy and increment in corruption levels raises questions about whether the economic development observed by these countries is viable or not. To our best knowledge, this study is the first to examine the effect of the level of democracy and corruption on MINT's economic growth. We contribute to the literature through the investigation of a unique set of countries (MINT), the usage of two different models[1] to assess the robustness of the results and the consideration of structural changes in the data over time[2] by using a panel cointegration test.

The rest of the paper is structured as follows: Sect. 2 provides a detailed literature review, Sect. 3 explains the research methodology, and Sect. 4 presents the data and findings. Sections 5 and 6 deal with the discussion and conclusions, respectively.

2 Literature

Democracy is mostly regarded as the influential and proposed form of governance, assuming it will benefit a country's politics, economy, people, and welfare (Chatterjee 2022). However, early theoretical studies underline that the opposite is valid. Empirical studies conducted in the late 1990s confirm the assumption that democracy hampers the policymakers' decision-making process, impacting economic development negatively, especially in developing and least developed countries, validating *the conflict hypothesis* (Rao 1985; Barro 1996). Olson (1996) and Rodrik (1997) disagree that this is not universally factual. They assume that politicians might undertake beneficial public activities through political bargaining to win elections. This reveals the importance of strong democracy to achieve sustainable economic growth. However, subsequent empirical studies do not agree on the effect of democracy on economic growth. The literature review regarding this context is summarized in Table 1.

The theoretical literature surrounds contradictions on whether the relationship between corruption and economic growth differs concerning autocracies and democracies, and if so, whether the difference is negative or positive (Anh et al. 2016; Bitterhout and Simo-Kengne 2020; Nguyen et al. 2022a, b; Afonso and De Sá Fortes Leitão Rodrigues 2022). The initial debates on the corruption and economic growth nexus commenced with studies by Mauro (1995), Davoodi and Tanzi (1997). Like

[1] Numerous studies (Rachdi and Saidi 2015; Lopes and Rivera-Castro 2017; Sharma and Mitra 2019; Trinugroho et al. 2023) examine the relationship between variables using various control variables *(innovation, public expenditures, openness,* etc.*)*; however, the result varies as the control variable changes.

[2] Considering the Freedom House (2022) and the Worldwide Governance Indicators (2022), the changes in the democratic structure increase corruption levels, especially after 2018, World Bank (2022) changes in economic growth after the COVID-19 pandemic, etc.

Table 1 Summary of the literature on democracy and economic growth

Researcher/s	Period	Countries	Method	Hypothesis
Barro (1996)	1960–1990	100 countries	OLS	The conflict
Feng (1997)	1960–1980	16 countries	OLS and 3SLS	The compatibility
Gupta et al. (1998)	1965–1971 1972–1979 1980–1986	120 countries	OLS	The compatibility
Tavares and Wacziarg (2001)	1970–1989	65 countries	3SLS	The compatibility
De Haan and Sturm (2003)	1075–1990	Developing countries	OLS	The compatibility
Fidrmuc (2003)	1990–2000	25 transition economies	OLS	The compatibility
Kisangani (2006)	1960–1998	37 African countries	VAR model and GMM	No relationship
Krieckhaus (2006)	1960–2000	Latin America, Asia, and African countries	OLS	Mixed results
Aghion et al. (2007)	1963–2003	28 ISIC Manufacturing Sectors	Fixed effect	The compatibility
Acemoglu et al. (2008)	1960–2000	High-income and low-income countries	Fixed effect and OLS	No relationship
Doucouliagos and Ulubaşoğlu (2008)	–	84 papers	Meta-analysis	The compatibility
Libman (2012)	2000–2004	Russia regions	OLS and 3SLS	The conflict
Piątek et al. (2013)	1990–2008	25 post-socialist countries	Granger casualty	No relationship
Jaunk (2013)	1980–2005	23 sub-Saharan African countries	Nyblom-Harvey, panel cointegration, GMM, panel casualty, FMOLS, and DOLS	The compatibility
Masaki and Van de Walle (2014)	1982–2012	43 sub-Saharan African countries	OLS, fixed effect, and random effect	The compatibility
Salahodjaev (2015)	1970–2013	Developed and developing countries	OLS and IV GMM	The compatibility
Rachdi and Saidi (2015)	1983–2012	17 MENA countries	Fixed effect, random effect, and GMM	The conflict
Colagrossi et al. (2020)	–	118 papers	Meta-analysis	The compatibility
Qasim (2022)	1984–2018	Pakistan	Johansen cointegration and VECM	The conflict
Mohammadi et al. (2023)	1990–2020	OECD and developing countries	Panel VAR method	Mixed results
Trinugroho et al. (2023)	2010–2020	34 Indonesia Provinces	Fixed effect	The conflict

the democracy and economic growth literature, the findings indicate that corruption negatively affects economic growth. Conversely, studies especially later in the 2000s claim that the effect is reversed, i.e., positive (Acemoglu and Verdier 2000; Méon and Sekkat 2005; Chakravorty 2019; Bitterhout and Simo-Kengne 2020). Table 2 presents an empirical literature review to provide an overview of this contradictory relationship.

Although the countrie's democracy level and/or political regime have an influential role in the corruption–economic growth relationship (Alon et al. 2016; Trabelsi and Trabelsi 2021), upon examining the empirical literature mainly based on developing countries, no study investigating the effect of democracy and corruption on economic growth within the same sample could be found. This study aims to fill this gap in the literature by examining the effect of institutional structure in MINT countries undergoing a rapid economic development process. In addition, structural changes are considered in investigating the relationship between the variables.

3 Methodology

3.1 Cross-sectional dependence and homogeneity tests

With expanding trade owing to globalization, a shock appearing in one country can have various effects on others. Panel data analyses through the cross-sectional dependence tests were conducted by Breusch and Pagan (1980), considering the Lagrange multiplier (LM) test to investigate the shock effects by using the correlation of error terms of the units. Pesaran (2004) determined that the cross-sectional dependence test struggles with small samples and proposed two new tests (CD_{LM1}, CD_{LM2}) that provide robust results even in small samples. Moreover, these tests can be used in the occurrence of structural breaks, and when the time dimension shows different slopes. The CD_{LM1} test offers more robust results as $T \rightarrow \infty$, while the CD_{LM2} test does so when $N \rightarrow \infty$. Ultimately, Pesaran et al. (2008) developed the cross-sectional dependence test presenting robust results as both T and $N \rightarrow \infty$.

In addition to determining the effect of shocks between units, the homogeneity of individual features of units is essential. To do so, Pesaran and Yamagata (2008) introduced the $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ test statistics based on Swamy (1970) tested with the seemingly unrelated regressions equation. The null hypothesis of the homogeneity tests proposes that individual feature of units is homogeneous.

3.2 Panel unit root test

The long-term relationship between democracy and economic growth for MINT countries was examined by determining the unit root process of the variables. To test for unit roots, Pesaran (2007) cross-sectionally augmented Dickey–Fuller (CADF) panel unit root test was used, which accounts for cross-sectional dependence by augmenting the IPS unit root test of Im et al. (2003). Initially, unit root processes are determined for each unit through the ADF unit root test, and then, the arithmetic

mean of the CADF statistics is taken. The aim is to be able to calculate the presence of a panel unit root through the CIPS statistic. To test the null hypothesis that the variable has a unit root, the obtained CADF and CIPS statistics are compared with Pesaran (2007) table critical values.

3.3 Fractional frequency flexible Fourier panel cointegration test

There are several cointegration tests in the literature. While traditional cointegration tests do not account for structural changes, Perron (1989) indicated that results might change when structural changes are considered. Thereafter, numerous econometric methods addressing structural changes through dummy variables have been introduced. However, using dummy variables can lead to incorrect specifications for structural changes (Olayeni et al. 2021). In this context, for nonlinearity in data, robust econometric tests have recently been developed. These are based on the smooth break feature proposed by Enders and Lee (2012), do not require a trimming rate, and use an unknown number and form of breaks with a Fourier function. However, they have limited use in panel data whereas widely used in time-series analyses. Olayeni et al. (2021) propose a new approach enabling the use of Fourier functions in panel data analyses, considering the studies by Palm et al. (2011), Omay (2015), and Emirmahmutoglu and Omay (2011).

The panel cointegration test proposed by Olayeni et al. (2021) provides robust results in cases of nonlinearity and cross-sectional dependence. It also allows fractional computation of frequency values. Christopoulos and León-Ledesma (2010) state that allowing fractional frequencies in determining structural changes enables the identification of permanent rather than transitory changes. Olayeni et al. (2021) use the equations below to examine the cointegration relationship between two variables.

$$X_{i,t} = \beta_{0,i} + \beta_{1,i} Z_{i,t} + v_{i,t}. \tag{1}$$

The residuals ($\tilde{v}_{i,t}$) are obtained through ordinary least squares (OLS) from this regression equation. Then, these residuals are re-estimated through OLS using the equation below:

$$v_{i,t} = \rho_i v_{i,t} + \epsilon_{i,t} \tag{2}$$

Olayeni et al. (2021) add Fourier functions to this equation to account for structural changes and express it as follows:

$$\tilde{v}_{i,t} = \hat{v}_{i,t} - \hat{\alpha}_i - \hat{X}_i \sin\left(\frac{2\pi kt}{T}\right) - \hat{\varphi}_i \cos\left(\frac{2\pi kt}{T}\right). \tag{3}$$

In this equation, $\hat{X}$ and $\hat{\varphi}$ are estimated coefficients, sin and cos are trigonometric terms, k is the number of fractional frequencies, t is the trend value, T is the sample size, and $\pi = 3.141$. Thus, the residuals in Eq. 2 for the linear functions are calculated as follows:

Table 2 Summary of the literature on corruption and economic growth

Researcher/s	Period	Countries	Method	Hypothesis
Mo (2001)	1960–1996	54 countries	Regression analyses	Sand in the wheels
Del Monte and Papagni (2001)	1963–1991	Italy, 20 regions	LSDV, 2SLS, and random effect	Sand in the wheels
Gyimah-Brempong (2002)	1993–1996	African countries	2SLS	Sand in the wheels
Méon and Sekkat (2005)	1970–1998	63 countries	Regression analyses	Sand in the wheels
Podobnik et al. (2008)	1999–2004	All countries	Regression analyses	Grease in the wheels
Mobolaji and Omoteso (2009)	1990–2004	7 transitional economies	Fixed effect and random effect	Sand in the wheels
Ugur and Nandini (2011)	–	72 empirical studies	Meta-analysis	Mixed results
Swaleheen (2011)	1984–2007	117 countries	GMM and fixed effect	Sand in the wheels
Dridi (2013)	1980–2002	83 developing and developed countries	2SLS and 3SLS (transmission channels)	Sand in the wheels
Farooq et al. (2013)	1987–2009	Pakistan	The VECM Granger causality and ARDL bound test	Sand in the wheels
Ibrahim et al. (2015)	1998–2011	Sub-Saharan Africa	EGLS and 2SLS	Sand in the wheels
Huang (2016)	1997–2013	Asia–Pacific countries	Panel Granger causality	Mixed
Campos et al. (2016)	–	460 estimates from 41 studies	Meta-analysis	Sand in the wheels
Anh et al. (2016)	2000–2012	Vietnam	OLS (the transmission channels)	Sand in the wheels
Ertimi et al. (2016)	2003–2010	14 countries	2SLS	Sand in the wheels
Mahmood et al. (2018)	1979–2015	Iraq	Regression analyses	Sand in the wheels
Awan et al. (2018)	1996–2014	5 SAARC countries	Fixed effect	Sand in the wheels
Shittu et al. (2018)	1990–2015	Sub-Saharan African	Panel cointegration, panel causality, FMOLS, and DOLS	Grease in the wheels
Alfaza (2019)	2004–2015	India	Threshold model and 2SLS	Sand in the wheels
Sharma and Mitra (2019)	1996–2015	Lower, lower–middle, and middle–high-income countries	GMM	Grease in the wheels
Gründler and Potrafke (2019)	2012–2018	175 countries	Regression analyses	Sand in the wheels
Chakravorty (2019)	2000–2011	119 countries	OLS, fixed effect, and GMM	Grease in the wheels
Sbaouelgi (2019)	1990–2017	MENA	Simultaneous equations model	Sand in the wheels

Table 2 (continued)

Researcher/s	Period	Countries	Method	Hypothesis
Das et al. (2020)	2009–2018	13 emerging Asian economies	OLS, quantile regression, GMM, and threshold regression	Sand in the wheels
Bitterhout and Simo-Kengne (2020)	1996–2014	BRICS	GMM and fixed effect	Grease in the wheels
Spyromitros and Panagiotidis (2022)	2012–2018	83 developing countries	Fixed effect and FMOLS	Mixed results
Malanski and Póvoa (2021)	2000–2017	Latin America and Pacific Asia	System GMM	Mixed results
Trabelsi and Trabelsi (2021)	1984–2011	84 countries	Threshold model	Sand in the wheels
Nguyen et al. (2022a, b)	2002–2019	10 ASEAN countries	The Bayesian method	Grease in the wheels
Afonso and De Sá Fortes Leitão Rodrigues (2022)	2012–2019	48 countries	GMM, OLS, and fixed effect	Sand in the wheels
Kesar and Jena (2022)	2002–2018	BRICS	Panel ARDL	Grease in the wheels
Rotimi et al. (2022)	1995–2019	Nigeria	Johansen cointegration and Granger causality	Grease in the wheels
Dokas et al. (2023)	2010–2018	109 countries	Panel causality and FMOLS	Sand in the wheels
Kırşanlı (2023)	1996–2020	18 MENA countries	Fixed effect	Sand in the wheels

$$\hat{\varphi}_{i,t} = \hat{v}_{i,t} - \hat{\rho}_i \hat{v}_{i,t-1} \tag{4}$$

The null hypothesis of the panel cointegration test claims that there is no cointegration relationship between the variables and the equation, $H_0 : \hat{\rho}_i = 1$. The major disadvantage of this test is that it works with a single independent variable.

3.4 Panel bootstrap causality test in rolling window

To analyze time-varying interaction with subperiods considering political and economic developments in MINT countries, the relationship between variables over time was examined using the Panel Bootstrap Causality Test (Kónya 2006). This does not require a pre-test bias (Yilanci and Ozgur 2019), addresses cross-sectional dependence, and takes heterogeneity into account for individual units regarding causality. Kónya (2006) developed the Granger causality test by utilizing the seemingly unrelated regressions (SUR) model proposed by Zellner (1962). The set of equations is as follows:

$$\begin{aligned}
y_{1,t} &= a_{11} + \textstyle\sum_{l=1}^{ly_1} \delta_{1,1,l} y_{1,t-l} + \sum_{l=1}^{lx_1} \delta_{1,1,l} x_{1,t-l} + \varepsilon_{1,1,t} \\
y_{2,t} &= a_{12} + \textstyle\sum_{l=1}^{ly_2} \delta_{1,2,l} y_{2,t-l} + \sum_{l=1}^{lx_2} \delta_{1,2,l} lx_{2,t-l} + \varepsilon_{1,2,t} \\
&\vdots \\
y_{N,t} &= a_{1N} + \textstyle\sum_{l=1}^{ly_N} \delta_{1,N,l} y_{N,t-l} + \sum_{l=1}^{lx_N} \delta_{1,N,l} x_{N,t-l} + \varepsilon_{1,N,t}
\end{aligned}$$

and

$$\begin{aligned}
x_{1,t} &= a_{21} + \textstyle\sum_{l=1}^{ly_1} \delta_{2,1,l} y_{1,t-l} + \sum_{l=1}^{lx_1} \delta_{2,1,l} x_{1,t-l} + \varepsilon_{2,1,t} \\
x_{2,t} &= a_{22} + \textstyle\sum_{l=1}^{ly_2} \delta_{2,2,l} y_{2,t-l} + \sum_{l=1}^{lx_2} \delta_{2,2,l} x_{2,t-l} + \varepsilon_{2,2,t} \\
&\vdots \\
x_{N,t} &= a_{2N} + \textstyle\sum_{l=1}^{ly_N} \delta_{2,N,l} y_{N,t-l} + \sum_{l=1}^{lx_N} \delta_{2,N,l} x_{N,t-l} + \varepsilon_{2,N,t}
\end{aligned} \tag{5}$$

l stands for the optimal lag length. The Wald test statistic is compared with the bootstrap table critical values to test the null hypothesis of non-causality. To indicate the hidden causality relationship within the periods, a rolling window approach can be used (Yilanci and Ozgur 2019).

4 Dataset

In this study, we aim to examine the impact of MINT's (Mexico, Indonesia, Nigeria, and Turkey) democracy and corruption levels on economic growth over the 1975–2022 period.[3] MINT was chosen as these countries have high economic growth potential after the BRICS. To examine the relationship between the

[3] The start and end dates of the study consist of the dates when the variables could be obtained homogeneously.

variables, real GDP per capita[4] calculated by the World Bank, the absence of corruption index (COR), and the direct democracy index (DEM) obtained from the Global State of Democracy Indices were utilized. COR displays the received scores based on public administration (executive branch) not abusing its office for personal gain, while the DEM is based on observable variables relating to the actual use of different formal instruments for direct democracy at the national level and the general existence of mechanisms for elections. The evaluation of variables for MINT is shown in Figs. 1, 2, and 3.

The COR and DEM indices reveal that the improvement *(deterioration)* appears for each country in similar periods. For instance, in Indonesia, a rapid improvement in democracy and corruption was observed in 1999 after the general election and the subsequent victory of a new democratic party *(Indonesian Democratic Party of Struggle)* (Liddle 2001; Bhakti 2004). Thanks to the new anti-corruption commission which pursues more transparent policies to empower democracy, corrupt ministers and individuals were penalized (Diprose et al. 2019). In Mexico, before the 2000s, particularly in 1983, 1989, and 1994, developments in democracy and corruption were observed. In 1983, the election was regulated (Dimoski 2008), and the 1988 elections were regarded as the beginning of the political competition (Tovar 2013); in 2000, the country held its most democratic election considering the past 70 years (Camp 2015). However, this did not affect improvements in corruption, and it increased among the officials after the 2000s as shown in Fig. 1 (Dimoski 2008; Camp 2015). The lowest values considering the indices belong to Nigeria. Although there was an improvement in democracy *(the first democratic presidential election)* during the 1979 elections, which were referred to as the second republic period, the civil war and extravagance increased corruption (Hoffmann and Wallace 2022). Similar to Mexico, in 1999, there was an important transition process for democracy in Nigeria, coinciding with the fourth republic (Ashindorbe and Danjibo 2022). However, this did not mitigate corruption due to the endemic corruption problem (Kwaja 2023). Unlike other countries, Turkey has failed to indicate improvement in its democracy and corruption values, except for 1989. After the 1980 military coup, various initiatives were made for civil rights and freedoms; however, in the 1990s, Anatolia-based businessmen began to strengthen along with Islamic movements. In 2002, these were managed by the government *(Justice and Development Party -AKP),* leading to an increase in corruption (Esen and Gumuscu 2021). During the years 2010–2011, when democracy began to decline and corruption increased, the judiciary's democratic reforms were abolished, and media freedoms were strictly restricted (Corke et al. 2014). Then, both index values decreased rapidly since the corruption scandals on December 17, 2013, were revealed, and the first presidential election *(so-called democracy)* was held in 2014 (Kirisci and Sloat 2019; Esen and Gumuscu 2021). Lastly, Fig. 3 displays the increasing GDP per capita of MINT countries over the years. While Mexico indicates the highest average development, Nigeria is the lowest.

The descriptive statistics are shown in Table 3. $\text{Nigeria}_{\text{GDP}}$, $\text{Turkey}_{\text{GDP}}$, $\text{Mexico}_{\text{DEM}}$, and $\text{Nigeria}_{\text{COR}}$ are positively skewed, while the others are negatively

[4] GDP in the US dollars is used in logarithmic form.

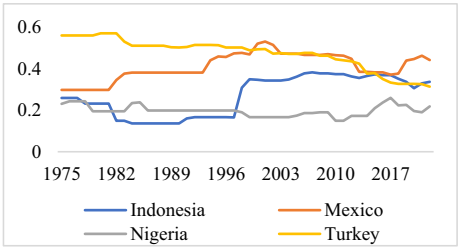

Fig. 1 The absence of corruption index

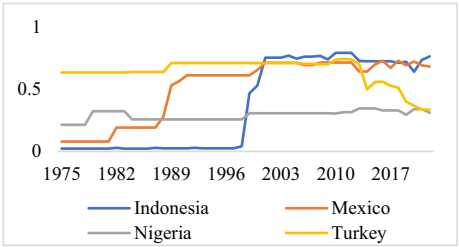

Fig. 2 The direct democracy index

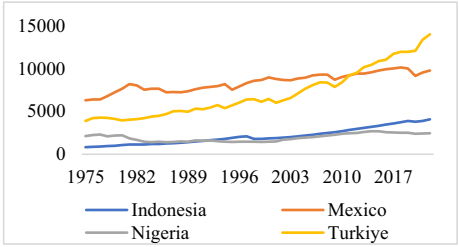

Fig. 3 The real GDP per capita

skewed. Considering the kurtosis values, $\text{Turkey}_{\text{DEM}}$ exhibits leptokurtic distribution while the others exhibit platykurtic distribution, and the standard deviation values of the series are also close to zero. Lastly, considering the Jarque–Bera (JB) statistics of the variables for countries, they exhibit a normal distribution except $\text{Nigeria}_{\text{GDP}}$, $\text{Nigeria}_{\text{DEM}}$, $\text{Mexico}_{\text{DEM}}$, $\text{Turkey}_{\text{DEM}}$, $\text{Indonesia}_{\text{COR}}$, and $\text{Turkey}_{\text{COR}}$.

5 The findings

To examine the impact of MINT countries' democracy and corruption levels on economic growth, two different models are employed. The first model examines the effect of the direct democracy index on economic growth (GDP = f(DEM)), determining which of *the compatibility* and *conflict* hypotheses are valid, while the second investigates the impact of the absence of corruption index on economic growth (GDP = f(COR)), explores which of the *sand in the wheels* or *grease in the wheels* hypotheses are valid. Based on the findings, it is aimed to compare the results found in both models.

Table 3 Descriptive statistics

Variables	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	JB	p-value
$Indonesia_{GDP}$	7.547	7.552	8.312	6.716	0.459	−0.013	1.952	2.2	0.333
$Mexico_{GDP}$	9.028	9.061	9.222	8.746	0.127	−0.420	2.341	2.282	0.320
$Nigeria_{GDP}$	7.547	7.558	7.893	7.250	0.230	0.041	1.388	5.21	0.074
$Turkey_{GDP}$	8.794	8.734	9.546	8.265	0.381	0.366	1.926	3.38	0.184
$Indonesia_{DEM}$	0.374	0.255	0.791	0.022	0.038	−0.460	2.098	3.319	0.190
$Mexico_{DEM}$	0.290	0.307	0.345	0.214	0.357	0.056	1.053	7.609	0.022
$Nigeria_{DEM}$	0.514	0.612	0.729	0.079	0.248	−0.882	1.998	8.237	0.016
$Turkey_{DEM}$	0.641	0.700	0.744	0.336	0.104	−1.695	5.135	32.11	0.000
$Indonesia_{COR}$	0.270	0.307	0.383	0.137	0.095	−0.284	1.377	5.916	0.052
$Mexico_{COR}$	0.411	0.385	0.531	0.298	0.065	−0.260	2.150	1.983	0.371
$Nigeria_{COR}$	0.198	0.198	0.260	0.149	0.026	0.406	2.750	1.446	0.485
$Turkey_{COR}$	0.474	0.499	0.571	0.314	0.074	−0.856	2.760	5.972	0.050

The reason for conducting econometric analyses with a single independent variable in the study is that upon examining the literature, it is determined that the change in control and/or instrumental variables leads to differing results even within the same country/country group. Therefore, we utilized the models where democracy and corruption are the single independent variables, as expressed in the hypotheses regarding the variables.

Panel data analysis tests are divided into first-generation *(disregarding cross-sectional dependence)* and second-generation *(regarding cross-sectional dependence)* tests. To determine which generation of tests to use, cross-sectional dependence tests are performed for the variables and model. The results of the test are presented in Table 4.

Table 4 indicates the rejection of the null hypothesis in all CD tests. The variables exhibit cross-sectional dependence. Therefore, the variables' unit root process should be analyzed through a test considering cross-sectional dependence. In the study, the panel cointegration test proposed by Olayeni et al. (2021) is applied to determine the relationship between variables. This test is important in specifying the unit root level of the variables. Additionally, Pesaran (2007) CADF unit root test was used to analyze the variables' unit root process as the results in Table 4 support the cross-sectional dependence. CADF unit root test results are presented in Table 5.

As stated previously, in addition to the variables, the applied econometric models are required to be tested for cross-sectional dependence and homogeneity to determine which cointegration tests and coefficient estimators are used. The results of the cross-sectional dependence and homogeneity tests are provided in Table 6.

The null hypothesis which proposes no cross-sectional dependence and homogeneity between units was rejected. It indicates that a shock occurring in any unit will affect other units, and heterogeneity between units exists.

The political issues in MINT countries have induced various changes in their democratic structures and indicators of corruption (Freedom House 2023).

Table 4 Cross-sectional dependence test results

CD tests	DEM		COR		GDP	
	Test Stat	p-value	Test Stat	p-value	Test Stat	p-value
Breusch and Pagan (1980)—LM	48.123	0.000	32.923	0.000	28.492	0.000
Pesaran (2004)—scaled LM	12.16	0.000	7.772	0.000	6.493	0.000
Pesaran (2004)—CD	−4.997	0.000	−4.955	0.000	−5.209	0.000
Pesaran et al. (2008)—LM_{adj}	9.241	0.000	24.692	0.000	58.892	0.000

Therefore, structural changes were examined to reveal the relationship between variables. Perron (1989) shows structural changes by incorporating external breakpoint dates. Zivot and Andrews (1992) support this, however, simulation result demonstrates that more effective outcomes are obtained when breakpoint dates are internally determined. In subsequent research, Enders and Lee (2012) express that structural breaks in macroeconomic variables occur smoothly, and this change was captured using Fourier functions. In this study, the Fractional Frequency Flexible Fourier Panel Cointegration test (Olayeni et al. 2021) was used as structural changes occur in different periods across multiple units in panel data. Also, the Fourier approach does not require determining the form and number of breakpoints (Enders and Lee 2012), thus enabling the evaluation of each unit individually.

By examining structural changes through Fourier functions allows for smooth breaks. Olayeni et al. (2021) state that GLS and PP test statistics can be used to decide on cointegration. Based on Becker et al. (2006) stating that $k=1$ or $k=2$ values are sufficient in observing breaks for macroeconomic variables, Olayeni et al. (2021) verify that the upper limit for k needs to be 2 in their study. Also, they state that 1000 bootstraps would be sufficient. The results for maximum $k=2$ and 1000 bootstraps are presented in Table 7.

As shown in Table 7, the test statistics are greater than critical values in both models, the null hypothesis stating democracy and the absence of corruption do not have an impact on economic growth which are rejected by the GLS and PP test statistics for each country. On the other hand, to determine which of *the compatibility* and *conflict* hypotheses for democracy and *sand in the wheels* and *grease in the wheels* hypotheses for corruption are valid, coefficient estimators are employed. To that end, the DOLS estimator, also utilized by Koç and Gülmez (2021), is used, and the results are provided in Table 8.

The null hypothesis proposing the coefficients are statistically insignificant is rejected. Thus, it is determined that the direct democracy index has a positive effect on economic growth, meaning that *the compatibility hypothesis is valid*. Additionally, the absence of corruption provides a negative contribution to economic growth in the countries except for Indonesia and Mexico. These results indicate that democracy is essential for stable economic growth for the MINT. However, it might be stated that corruption has a positive effect on economic growth as bureaucratic procedures constitute an impediment.

Table 5 CADF unit root test results

Countries	DEM		COR		GDP	
I(0)	L	CADF Stat	L	CADF Stat	L	CADF Stat
Indonesia	1	−1.101	1	−1.225	1	−0.708
Mexico	1	−1.304	1	−2.197	1	−1.85
Nigeria	1	−2.937	1	−3.908	3	−2.176
Turkey	1	0.39	1	0.772	2	−1.611
CIPS Stat		−1.238		−1.64		−1.956
I(1)						
Indonesia	1	−3.233***	1	−4.915***	1	−5.473***
Mexico	1	−3.549***	1	−4.765***	1	−3.33**
Nigeria	1	−4.868***	1	−4.502***	1	−4.003**
Turkey	1	−4.061***	1	−3.721**	1	−4.41***
CIPS Stat		−3.928***		−4.476***		−3.934***

L refers to the optimal lag length, and *** and * indicate 1% and 5% statistical significance levels, respectively

Table 6 Cross-sectional dependence and homogeneity test results

	GDP = f(DEM)		GDP = f(COR)	
CD test	Test Stat	*p*-value	Test Stat	*p*-value
Breusch and Pagan (1980)—LM	12.055	0.061	38.847	0.000
Pesaran (2004)—scaled LM	1.748	0.04	9.232	0.000
Pesaran (2004)—CD	2.788	0.003	4.553	0.000
Pesaran et al. (2008)—LM_{adj}	16.636	0.000	12.604	0.000
Homogeneity test				
Pesaran and Yamagata (2008)—$\tilde{\Delta}$	15.135	0.000	21.549	0.000
Pesaran and Yamagata (2008)—$\tilde{\Delta}_{adj}$	15.621	0.000	22.241	0.000

The Panel Bootstrap Causality Test in rolling window test was employed to determine how the relationship between variables in MINT countries changes over time. Pesaran and Timmermann (2005) revealed through Monte Carlo experiments that having a small subperiod size could lead to uncertain predictions in determining the size and persistence of breakpoints. Accordingly, the subperiod size has been set to 25. The results are shown in Figs. 4 (DEM → GDP) and Fig. 5 (COR → GDP) along with *p*-value (0.10).

The Panel Bootstrap Causality Test in rolling window test results (DEM → GDP) indicate that the null hypothesis, suggesting no bootstrap causality from DEM to GDP, was rejected in Mexico during 2008–2011 and 2013–2022; in Indonesia during 2005–2006, 2008, and 2019–2020; in Nigeria during 1992–2002, 2009–2016, and 2021–2022; and in Turkey during 2011 and 2021–2022 periods.

Table 7 Results for GDP = f(DEM) model and GDP = f(COR) model

GDP = f(DEM) model									
	GLS				PP				
(a) Individual statistics									
	Test Stat	%1	%5	%10	Test Stat	%1	%5	%10	k
Indonesia	−5.583	−2.872	−1.872	−0.057	−5.558	−3.082	−2.302	−0.825	1.9
Mexico	−4.007	−3.030	−1.998	−0.659	−5.036	−3.83	−2.206	−0.543	0.1
Nigeria	−4.385	−2.814	−1.484	−0.038	−4.371	−3.365	−2.428	−0.593	1.9
Turkey	−5.71	−2.619	−1.509	−0.155	−6.123	−3.211	−1.958	−0.584	1.9
(b) Group statistics									
Mean	−4.921	0.000			−5.272	0.007			
Maximum	−5.71	0.000			−6.123	0.003			
Median	−5.583	0.001			−5.558	0.005			
GDP = f(COR) model									
	GLS				PP				
(a) Individual statistics									
	Test Stat	%1	%5	%10	Test Stat	%1	%5	%10	k
Indonesia	−5.522	−2.604	−1.755	−0.209	−5.909	−3.562	−2.452	−0.258	1.1
Mexico	−5.643	−2.594	−1.574	−1.384	−6.348	−3.051	−1.592	−0.834	1.1
Nigeria	−5.345	−2.701	−1.266	−0.908	−5.983	−3.039	−1.702	−0.345	0.8
Turkey	−4.693	−4.693	−1.887	−0.716	−6.310	−3.398	−2.268	−0.849	1.7
(b) Group statistics									
Mean	−4.577	0.003			−6.137	0.000			
Maximum	−5.522	0.000			−6.348	0.000			
Median	−5.345	0.000			−6.31	0.000			

The causality results (COR → GDP) show that for Mexico, close time intervals to DEM results were identified, specifically during 2007–2022. Conversely, for Indonesia, it was determined that the causality relationship is more significant in recent periods, specifically during 2015–2017 and 2019–2022. Similar to Mexico, statistically significant relationships in recent years were identified in Nigeria in subperiods, particularly during 1999–2001, 2008–2010, and 2019–2022. In Turkey, the null hypothesis suggesting no bootstrap causality COR → GDP was rejected during the 2008–2011 period.

6 Discussion

The study examines how MINT countries' democracy and corruption levels, which have an important role in the governance of public authorities, affect economic growth through two different models using the Fractional Frequency Flexible Fourier Panel Cointegration. Both models are cointegrated considering the structural

Table 8 DOLS coefficient estimator results

	DEM			COR		
Country	Coefficient	Test statistics	*p*-value	Coefficient	Test statistics	*p*-value
Indonesia	1.061	7.299	0.000	3.676	4.898	0.000
C	7.175	95.334	0.000	6.574	31.174	0.000
Mexico	0.225	2.514	0.018	0.942	2.321	0.028
C	8.963	149.593	0.000	8.858	49.559	0.000
Nigeria	8.031	5.723	0.000	−2.849	−0.962	0.009
C	5.163	12.657	0.000	8.048	14.081	0.000
Turkey	4.391	3.263	0.003	−6.713	−12.437	0.000
C	5.724	6.270	0.000	12.058	42.239	0.000

changes. The DOLS coefficient estimator is used to determine which hypothesis is valid for economic growth. The findings indicate that while democracy plays an upgrading role in MINT's economic growth, the effect of corruption on economic growth is as positive as democracy in Indonesia and Mexico, but negative in Nigeria and Turkey.

In terms of the relationship between democracy and economic growth, the empirical findings support *the compatibility hypothesis*, similar to the studies by Feng (1997), Gupta et al. (1998), Tavares and Wacziarg (2001), De Haan and Sturm (2003), Fidrmuc (2003), Aghion et al. (2007), Doucouliagos and Ulubaşoğlu (2008), Jaunk (2013), Masaki and Van de Walle (2014), Salahodjaev (2015), and Colagrossi et al. (2020). It reveals that advancement in democratic governance will positively influence economic growth. However, the opposite might occur when corruption exists. *The sand-the-wheels hypothesis* is valid for Indonesia and Mexico, while *the grease-the-wheels hypothesis* is valid for Nigeria and Turkey. Thus, in Nigeria and Turkey, the economy is positively affected as corruption grows. This finding resembles the studies of Podobnik et al. (2008), Shittu et al. (2018), Sharma and Mitra (2019), Chakravorty (2019), Bitterhout and Simo-Kengne (2020), Nguyen et al. (2022a, b), Kesar and Jena (2022), and Rotimi et al. (2022). The findings for Indonesia and Mexico similarly indicate that corruption decreases economic growth, as in the studies of Alfada (2019), Gründler and Potrafke (2019), Sbaouelgi (2019), Das et al. (2020), Trabelsi and Trabelsi (2021), Afonso and De Sá Fortes Leitão Rodrigues (2022), Dokas et al. (2023), and Kırşanlı (2023).

The literature commonly focuses on the assumption that democratic advancement will mitigate corruption and increase economic growth. The empirical findings prove it for democracy; however, the opposite is valid for corruption. The findings from both models do not support each other for the countries. One of the main reasons for this might be based on Nigeria and Turkey whihc are governed by electoral autocracies, while Mexico and Indonesia have electoral democracies (V-Dem Institute 2022).

The variations in the results might be justified by the findings of Saha and Sen (2021), Afonso and De Sá Fortes Leitão Rodrigues (2022), and Chatterjee (2022).

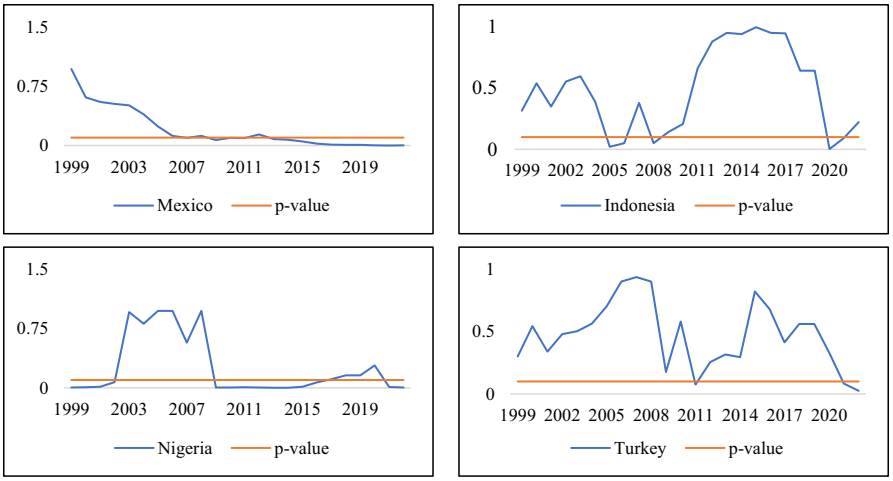

Fig. 4 Bootstrap p-values for causality in rolling window estimation (DEM → GDP)

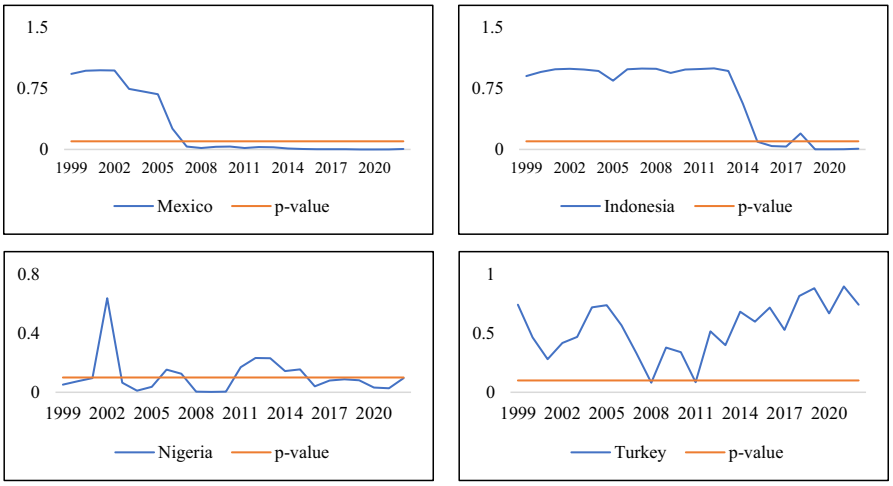

Fig. 5 Bootstrap *p*-values for causality in rolling window estimation (COR → GDP)

Afonso and De Sá Fortes Leitão Rodrigues (2022) conclude that in advanced democracies with mature institutions, additional resources are largely allocated to anti-corruption efforts to prevent it and foster economic development. Saha and Sen (2021) find that corruption's growth-enhancing effect is greater in autocracies compared to democracies. In autocracies, corruption is inclined to be extra covert but still apparent in public and private investments whereas, in democracies, accountability pressures hamper corruption in the form of uncertain investments. Chatterjee (2022) determines that corruption indirectly improves growth for undemocratic countries

but damages growth in democracies. Alternatively, Rachdi and Saidi (2015), Trinugroho et al. (2023), and Mohammadi et al. (2023) put forward that politicians obtain financing from several interest groups in return for promises made during elections. Such support might lead to corruption by being used against them. Hence, bureaucratic obstacles might be eliminated easily in doing business, and economic growth might be increased (Malanski and Póvoa 2021).

7 Conclusion and policy recommendations

The role of institutions in promoting economic growth matters in terms of societies' welfare and sustainable development. In this study, we aim to contribute to the literature by examining how the institutional structures of MINT countries, indicating rapid economic growth, affect their economic growth under structural changes. The empirical findings verify that *the compatibility hypothesis* is valid for all countries in the GDP = f(DEM) model, as generally expected in the literature. This shows that advancement in democratic structures will have a positive impact on countries' economic growth. As stated by Acemoglu et al. (2008), the positive relationship between economic growth and democracy indicates that political and economic development paths are intertwined. On the other hand, regarding GDP = f(COR) model, *the grease in the wheels hypothesis* is found to be valid for Nigeria and Turkey, while *the sand in the wheels hypothesis* is effective for Indonesia and Mexico. Thus, the same hypotheses are valid for countries considering democracy; however, the results differ by country when corruption is regarded.

The results of the Panel Bootstrap Causality Test in rolling windows suggest a statistically significant relationship between DEM → GDP, notably across most subperiods in Mexico and Nigeria, in fewer subperiods for Indonesia and Turkey. Similar results were identified for COR → GDP. However, particularly in Indonesia, a statistically significant relationship was found in more subperiods in recent periods. The countries' governance mechanism has a vital role in the differing results. Electoral autocracy (Nigeria and Turkey) and electoral democracy (Mexico and Indonesia) validate that institutions' structure is significant in corruption policies. While Mexico and Indonesia pursue economic development through democracy and economic growth, Nigeria and Turkey achieve economic development along with corruption activities that weaken institutions' structure. Although the results for Nigeria and Turkey show corruption increases economic growth, policies to increase corruption are not recommended as it is unsustainable in the long run. Corruption leads to inefficient use of public resources, a lack of confidence in the economy, and social and political tensions. Therefore, policymakers need to seek solutions to have sustainable economic growth. For instance, strengthening institutions through democratic advancement will increase transparency, trust, and credibility, contributing to economic growth as well as social welfare. On the other hand, the results for Indonesia and Mexico indicate that democracy has a significantly positive effect on economic growth, but corruption reduces it. This reveals that governments' efforts are lacking in preventing corruption. Consequently, auditing particularly in public processes needs to be tightened through a deterrent punishment system.

Considering the election policy executed in Indonesia and Mexico leads to a more democratic process compared to Nigeria and Turkey, it might deter political leaders from poor policies that would impede their re-election in the following election. Thus, governments might be encouraged toward viable policies by implementing a system of governance based on fundamental values such as democratic institutions, the rule of law, accountability, and media freedom to get re-elected. At this point, Nigeria and Turkey need to strengthen these fundamental values to establish steady advancement in the long term. Additionally, educating future generations on the importance of democracy and the negative effects of corruption is vital to maintaining economic development and welfare.

Based on the findings, several practical implications and policy recommendations can be derived to sustain economic growth and welfare in MINT countries. In this respect, governments must prioritize the strengthening of institutions through democratic advancement. The success is primarily based on transparency, accountability, and credibility via robust oversight and governance mechanisms (Alhassan and Kilishi 2019; Acemoglu et al. 2019). By doing so, nations can create an environment conducive to long-term economic prosperity while minimizing the detrimental effects of corruption. Moreover, policymakers should tailor approaches to mitigate corruption based on the specific dynamics observed in each country. For instance, in Nigeria and Turkey, where corruption appears to *"grease the wheels,"* efforts should focus on streamlining bureaucratic processes and reducing red tape to diminish the incentives for corrupt practices (Omoteso and Mobolaji 2014). Conversely, in Indonesia and Mexico, where corruption acts as *"sand in the wheels,"* a more aggressive stance against corruption is warranted, coupled with specific policies to increase transparency and accountability. Lastly, governments should collaborate with international organizations *(International Corruption Hunters Alliance,* etc.*)*, civil society, and the private sector to develop and implement comprehensive strategies that promote democratic values, combat corruption, and foster inclusive economic development (World Bank 2022; OECD 2024).

The study includes specific limitations. Corruption and democracy variables are conceptualized and measured in various ways by several institutions (The Worldwide Governance Indicators, Transparency International, V-Dem Institute, Freedom House, World Bank, etc.), which constrains the analyzed period. As such, we use the data from the Global State of Democracy Indices to maximize conceptual consistency and the period. Although different sources explain both variables, also, the relationship between the variables could not be explored with different control variables, as the panel cointegration test allows only a single independent variable. As a result, future studies could evaluate the reliability of various corruption and democracy indices calculated by different institutions across countries. Moreover, the variables' sub-items could be determined in terms of effectiveness for each country through various econometric analyses to recommend country-specific policies. Ultimately, the BRICS could be analyzed to determine the extent to which institutional structure is significant, allowing comparison with the MINT.

Author contributions All authors contributed to the study conception and design. Asiye Tutuncu helped in material preparation, data collection, and analysis. Asiye Tutuncu and Yasar Bayraktar contributed to writing the first manuscript draft. Yasar Bayraktar contributed to review and editing. All authors read and approved the final manuscript.

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Data availability The datasets generated during and analyzed during the current study are available in the [real GDP per capita, the absence of corruption index, the direct democracy index, control of corruption, corruption perceptions index] repository, [https://databank.worldbank.org/source/world-development-indicators; https://www.transparency.org/en/cpi/2022; www.govindicators.org; https://www.idea.int/gsod-indices/dataset-resources].

Declarations

Conflict of interest The authors declare that they have no financial interests.

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