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The Impact of Corruption Prevention on Innovation

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Absztrakt
Purpose – Sustainability is a common topic in today's economic literature. The realization of this is unthinkable without effective and successful innovation. Sustainability can be compromised by many factors, such as the emphasis on the short term. Another phenomenon, which also has an adverse effect on sustainability, is less often mentioned. This is the problem of corruption. Corruption is as old as history and still exists today despite all countermeasures. Therefore, it is essential to evaluate how the effectiveness of prevention can be enhanced and what results can be achieved by reducing corruption. This study examines the impact of corruption on innovation.
Design/methodology/approach – The question is relevant because innovation is essential for ensuring sustainability. The study is conducted by the authors using data from public databases and statistical methods. The relationship between the two phenomena was established using a correlation test, and the direction of the relationship between them was determined through a causality test.
Findings – The results confirm the positive effect of corruption control on innovation and infrastructure development. As a result of stronger prevention of corruption, on the one hand, resources intended for innovation can be prevented from being used for other purposes. This may be a consequence of transparency on the one hand, and more effective control on the other.
Originality – The present research focused solely on developed national economies; however, based on the results, it is worth repeating in the future, also in developing economies.

Keywords: corruption, innovation, sustainability, economic development, innovation policy

1. Introduction

One of the central dilemmas of 21st-century economic policy is how to achieve the goals of sustainable development—combining economic competitiveness, social well-being, and environmental considerations—while ensuring that the use of public and private resources remains transparent, efficient, and socially legitimate. Universities, as hubs of knowledge and social responsibility, are expected to lead this transition by integrating sustainability across research, education, and institutional operations (Németh et al., 2023). Innovation is often referred to as the "engine" of sustainability: without new technologies, the energy transition, the circular economy, and comprehensive responses to health and demographic challenges cannot be realized. At the same time, factors that undermine the return on long-term investments—such as short-term political incentives, institutional weaknesses, or various forms of corruption—can directly threaten innovation capacities. Corruption often acts as an "invisible tax," diverting resources, distorting incentives, and eroding trust in rule-based governance, which in the long

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term reduces R&D investments and hampers the diffusion of new technologies (Coleman, 2005; Lambsdorff, 2007; Rose-Ackerman & Palifka, 2018; Wei, 1999).

The global shocks of the past decade—financial crises, geopolitical uncertainties, and the macroeconomic disruptions caused by the COVID-19 pandemic—have highlighted the fragility of economic and social systems. The literature is not entirely consistent on whether corruption always hinders innovation. According to the classic "sand in the wheels" perspective, corruption diverts resources, generates uncertainty, and leads to regulatory evasion, which ultimately suppresses corporate creativity and research and development activities (Mahagaonkar, 2008; Lee, Wang, & Ho, 2020; Sena et al., 2018). Other authors, however, argue that in weak or overly bureaucratic institutional environments, "grease" type corruption may accelerate certain administrative processes in the short term, thus indirectly supporting business innovation—although in the long term it undermines institutional development (Méon & Sekkat, 2005; Arif, Khan, & Waqar, 2023). Lukács & Völgyi (2021) show that in Hungary, for instance, strategic bilateral cooperation and state-backed Chinese investments—framed within initiatives like the Belt and Road or Made in China 2025—have often progressed despite institutional inefficiencies, yet their long-term effects on innovation ecosystems remain uncertain. Because of this duality (sand vs. grease), it is particularly important to empirically distinguish short-term "transactional advantages" from long-term systemic effects. This study focuses specifically on the impact of corruption prevention—that is, measures that strengthen integrity and transparency—on innovation. Our expectation is that the results will align with the "sand" narrative: as the space for corruption narrows, innovation efficiency increases (Arif et al., 2023; Mahagaonkar, 2008; Méon & Sekkat, 2005; Sena et al., 2018). In this study, the authors examine the relationship between corruption and innovation. Within this relationship, they focus on the question of whether more effective corruption prevention promotes innovation. To find the answer, they used a publicly available database. From this data, statistical methods were used to examine the performances of the countries in the fields of corruption prevention and research, innovation and infrastructure, their relationship, and then the causal relationship between the two phenomena. As a first step, after reviewing the literature on the topic, they formulate their hypotheses.

Our research covers 41 advanced economies—member states of the European Union and the OECD. We deliberately chose not to mix different data sources and measurement methodologies; instead, we rely uniformly on the Bertelsmann Stiftung Sustainable Governance Indicators (SGI) database, which provides comparable, expert-based indices and includes "hard data" elements for certain indicators. The choice of the Corruption Prevention (CPR) indicator is partly methodological: it is an intervention-oriented variable that reflects the effectiveness of specific policies, legal instruments, and institutional practices; thus, it is suitable for serving as an independent variable in a causal model. The dependent variable is the Research, Innovation and Infrastructure (RII) composite indicator, which consists of several subcomponents (quality of R&D policy, public and private R&D expenditures, research human resources, revenues from intellectual property licenses, PCT patent activity, and infrastructure quality). This variable pairing allows us to assess the institutional effectiveness of corruption prevention against a broad set of innovation outcomes.

2. Review of Literature and Hypotheses

Corruption is as old as history. For example, the existence of ruling dynasties is also based on nepotism. There are many forms and theories dealing with corruption, as well as detailed historical works on the subject (Engels, 2016). The reader interested in the topic can find useful theoretical knowledge, classifications, social and psychological information in the works of Coleman (2005), Lambsdorff (2007) and Rose-Ackerman & Palifka (2018). The phenomenon has always closely linked two factors: power and material benefits. Corruption is therefore also closely related to the economy (Atsir & Sunaryati, 2018; Cooray et al., 2017; Thornton & Altunbas, 2010; Wei, 1999). Corruption can also be an important barrier

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to sustainability. This can be explained, on the one hand, by redirecting the resources of sustainability into the informal economy, and on the other hand, by obtaining benefits that bypass regulations. Studies have shown that economic disruptions can also have a negative impact on sustainability and innovation (Mura et al., 2022a). Global economic crises often expose the vulnerabilities of organizations, highlighting the need for transparent governance and effective support mechanisms (Mura et al., 2022b). The public is generally inclined to resist new technologies and industrial developments, especially when they are associated with environmental and health risks (Remsei, et al., 2023). The State Audit Office of Hungary assessed corruption risks and the presence of integrity controls in public sector institutions (Németh, Martus, Vargha, 2018), based on data from 3,346 organizations. The study highlights that integrity risks most often arise at the interface between the public and private sectors. 64% of the surveyed institutions provide public services. Key risk factors include fee-based services, discretionary decision-making, and excess demand. Positive findings include the widespread use of official documentation for monetary transactions and adequate regulation of conflicts of interest. However, only one-third of institutions have established complaint and whistleblowing systems. Moreover, in high-demand areas, inadequate regulation of gifts, invitations, and travel poses a serious threat to public sector integrity.

There have also been many studies on the relationship between corruption and innovation. Arif et al. (2023); Mahagaonkar (2008); Méon & Sekkat (2005) and Wei (1999) specifically focus on how corruption affects innovation. Corruption is seen as a potential barrier to innovation processes. At the same time, they also say that under certain circumstances corruption can also have a stimulating effect. According to Mahagaonkar (2008), corruption has a negative effect on innovation in many cases, as the costs of corruption reduce the incentive for businesses to innovate. Several studies have examined the complex relationship between corruption and innovation, with findings suggesting that corruption generally undermines innovation, though some exceptions appear under specific institutional conditions. Mauro's (1995) foundational work highlighted how corruption impedes GDP growth, noting that diminished investment in research and development (R&D) and technological advancement is one mechanism through which this occurs. Similarly, Huang & Yuan (2021) conducted a macro-level panel study across countries, revealing that corruption negatively impacts firms' productivity and innovation outputs.

At the micro-level, Goel & Saunoris ((2020) analyzed country-level patent data and found that both bureaucratic inefficiencies and corruption jointly reduce the incentives for innovation. In certain contexts, however, corruption may temporarily facilitate innovation. For instance, Shirokova et al. (2013) examined Russian small and medium-sized enterprises. They found that managers with greater work experience were more inclined to engage in corrupt practices to overcome bureaucratic barriers. Their study, based on World Bank enterprise survey data and a logit model, showed that in weak institutional environments, such "corruption competencies" may reduce transaction costs associated with innovation. Nonetheless, they emphasized that while corruption might stimulate innovation in the short term, its long-term consequences are detrimental to institutional development and sustainable innovation. At the same time, in certain situations, corruption can act as a "grease" that facilitates business activities in environments where bureaucracy is excessive Pirtea et al. (2019) analyze how corruption affects business innovation in emerging countries. The study found that corruption is a significant barrier to innovation in these regions. The results of Lee et al., (2020) pointed out that a high level of corruption has an adverse effect on the willingness of companies to innovate. Sena et al. (2018) also indicate that corruption generally has an adverse effect on innovation, as it reduces companies' willingness to take risks and develop new products and services.

Statistics primarily examine relationships and correlations. Although researchers are mostly interested in causal relationships, their statistical demonstration is much more difficult and in many cases is subject to a number of conditions (Cox & Wermuth, 2004; Ferreira, 2023; Hoover, 2008; Annus, 2017). Therefore, during the literature review, the authors found relatively few publications that describe the results of a causal investigation. Sena et al. (2018) used structural equation models to investigate the relationship between innovation and corruption, Vadlamannati & Cooray (2017) used the Granger causality test to understand how corruption affects innovation in different countries. The authors of this study also use a causality test,

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the Propensity Score Matching (PSM) study (Guo & Fraser, 2014; Rosenbaum & Rubin, 1983; Tóth, et al., 2024) to find out how corruption control in developed economies is related to innovation and infrastructure development. For this purpose, on the one hand, the closeness of the relationship between the two phenomena is examined, and then the direction of the relationship (cause-effect). Accordingly, two research hypotheses were formulated:

H1: there is at least a moderately strong correlation between corruption prevention and research, innovation and infrastructure.

H2: there is a causal relationship between the two phenomena: the strengthening of corruption prevention makes innovation and infrastructure development more effective.

3. Methodology

The sample comprises 41 countries from the Bertelsmann Stiftung database. These are the member states of the European Union (EU) and the Organization for Economic Co-operation and Development (OECD). Table 1 summarizes the indicators included in the research by the authors.

There are several reasons for selecting Corruption Prevention as the independent variable. It is an intervention-based variable, associated with active policies, measures, legal instruments, and regulations. From a research perspective, it can serve as a causal factor, as it allows for the prediction of potential effects—such as changes in innovation performance—when specific measures are implemented. Another reason is that this variable is available in the Bertelsmann SGI database, which was used for the analysis. We did not intend to combine data collected using different methodologies.

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Table 1: Indexes used by authors

Examined index	Parent index	Weight	Index question	Points	Best score	Base of calculation
Corruption Prevention	Rule of Law	25%	Effectiveness of corruption prevention in the public sector	1 - 10	10	based on expert opinions
Research, Innovation and Infrastructure	Economic policy	16.67%	Does R&D policy help innovation?	1 - 10	10	based on expert opinions
R&I Policy	Research, Innovation and Infrastructure	50%	Does the policy effectively support innovation?	1 - 10	10	based on expert opinions
Public R&D Spending	Research, Innovation and Infrastructure	8.33%	State R&D expenditures in % of GDP	1 - 10	10	based on hard data
Private R&D Spending	Research, Innovation and Infrastructure	8.33%	Private R&D expenditures in % of GDP	1 - 10	10	based on hard data
Total Researchers	Research, Innovation and Infrastructure	8.33%	Number of researchers per 1,000 employees	1 - 10	10	based on hard data
Intellectual Property Licenses	Research, Innovation and Infrastructure	8.33%	Ratio of license revenues and expenses	1 - 10	10	based on hard data
PCT Patent Applications	Research, Innovation and Infrastructure	8.33%	Patent applications for 1M people	1 - 10	10	based on hard data
Quality of Overall Infrastructure	Research, Innovation and Infrastructure	8.33%	Quality of infrastructure (road-rail-water-air transport).	1 - 10	10	based on expert opinions

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Each year, the data for each country is included in full. Every year there are countries with optimal Corruption Prevention (CPR) values, but no country received the most unfavorable score of 1 in any year. The value of the index can be between 1-10, the theoretical average is accordingly 5.5. The actual average is higher than this every year, so the effectiveness of CPR is higher than statistically expected, which is a favorable result. The average of the RII is also higher than the theoretical average, which is good news in this case as well as for the CPR. However, the maximum value never reaches 90% of the possible value. So it seems that there are still reserves for development in this area. The normality test (Shapiro-Wilk) is significant for CPR in 2014-2015 and for Research Innovation and Infrastructure (RII) between 2014-2017, therefore the authors were forced to use non-parametric methods.

According to the first assumption of the study, there is a correlation between CPR and RII. This hypothesis can be confirmed or refuted by a correlation test. The non-parametric form of this (Spearman correlation) was used by the authors (Spearman, 1904). Kendall's tau (Kendall, 1938) would have been more appropriate in many respects, however, due to the presence of tied ranks in the sample, the authors rejected its use (Puth et al., 2015).

According to hypothesis H2, there is a causal relationship between CPR and RII. The existence and direction of this is shown by the Propensity Score Matching (PSM) test (Guo & Fraser, 2014; Rosenbaum & Rubin, 1983), which the authors performed using the Causal Inference with R program package of the R programming language. This study examines the impact of improving corruption prevention on innovation results. The essence of the PSM is that two groups are created from the sample countries. One group (Treat) includes the countries in which CPR, which is assumed to be the cause, was characterized by improved performance during the examined period. In the countries of the other (Control) group, the CPR did not change. The next step examines the evolution of RII, which is assumed to be the cause, in both groups. Comparing the difference in means proves or disproves the existence of a causal relationship and enables the identification of cause and effect.

Mediation/moderation analysis enables a deeper understanding of how and when the independent variable—the effectiveness of anti-corruption measures (CPR)—impacts the dependent variable, namely innovation (RII). The analysis examines both mediator and moderator variables. The mediator variable plays an intermediary role, explaining the nature of the effect. The moderator variable, on the other hand, influences the strength or direction of the relationship.

Mediation analysis uses regression to compare the direct effect of CPR on RII with the indirect effect (CPR → M → RII), where M is the mediator variable. This second path is examined in two steps. First, the CPR → M relationship indicates whether effective corruption prevention leads to an increase in the mediator variable. If so, the M → RII relationship is then examined using regression to assess the strength of M's impact on RII. The strengths of these effects are characterized using regression coefficients (β). The significance of the mediated effect is determined using the Sobel Z test. Statistical software calculates the Z value. If $|Z| > 1.96$, then $p < 0.05$—indicating that the mediated effect is statistically significant. The potential mediator variables examined were as follows:

- RDI policy (Research, Development, and Innovation policy) – Improved corruption control may encourage the development of better innovation strategies.
- Total researchers – As corruption decreases, a scientific career may become more attractive.
- PCT patent applications – This is debatable, as the level of international patent activity may reflect an end result rather than a mediating factor.
- Public R&D expenditures – As state revenues increase (due to better corruption control), more funding may become available for research and development.

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- Quality of overall infrastructure – Reduced corruption may lead to improvements in infrastructure, which in turn can support innovation.
- Private R&D expenditures – This may only be relevant if corruption directly affects these expenditures.
- IP licences – Revenues from intellectual property could be a potential mediating factor, though it might also represent an outcome variable.

Using moderation analysis, we examined whether certain structural characteristics influence the strength of the effect that anti-corruption measures have on innovation. Moderation identifies the conditions that either amplify or weaken the effect of the independent variable (CPR) on the dependent variable (RII). Unlike a mediator, a moderator does not transmit the effect—it alters the direction or intensity of the relationship between the two variables. In this analysis, we tested the moderating role of the following variables:

- RDI (Research, Development, and Innovation) policy,
- Quality of overall infrastructure
- Total researchers
- Public R&D expenditures

Moderation analysis was conducted using interaction regression, based on the following general equation:

$$RII_i = \beta_0 + \beta_1 \cdot CPR_i + \beta_2 \cdot MOD_i + \beta_3 \cdot (CPR_i \times MOD_i) + \varepsilon_i$$

where:

- CPR is effectiveness of anti-corruption measures,
- MOD – is the selected moderator variable (e.g., quality of infrastructure),
- CPR × MOD is the interaction term testing for moderation,
- β_0 is the intercept,
- β_3 is the regression coefficient of the interaction effect,
- ε is the error term.

In the interaction regression models, we examined the statistical significance of the interaction term (CPR × Moderator), calculated as the product of CPR and each moderator variable. The moderating effect was evaluated based on the statistical significance of the β_3 coefficient. If the interaction was significant, it indicated that the given moderator meaningfully altered the CPR → RII relationship. The direction of the interaction (i.e., whether it strengthened or weakened the effect) was interpreted based on the sign and magnitude of the coefficient.

4. Results and Implications

According to hypothesis H1 of the research, there is a correlation between CPR and RII. Based on the results of the Spearman correlation ($\varrho=0.662$, $p<0.001$), there is a strong positive (Selala et al., 2019) correlation between the two variables. This means that the strengthening of the effectiveness of Corruption Prevention is associated with an increase in the success of innovation. Table 3 shows the results of the PSM examining the causal relationship between the two variables (Hypothesis H2).

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Table 3 Outputs of Propensity Score Matching (PSM)

Matching Summary:

Number of treated units	7
Number of control units	7

Balance Summary (Before Matching):

Variable	Mean (Treated)	Mean (Control)	Std. Mean Diff (SMD)
Corruption Prevention	6.08	7.57	(0.09)
Research, Innovation and Infrastructure	5.40	7.29	(0.12)

Balance Summary (After Matching):

Variable	Mean (Treated)	Mean (Control)	Std. Mean Diff (SMD)
Corruption Prevention	7.29	7.00	0.02
Research, Innovation and Infrastructure	5.79	6.43	(0.05)

Treatment Effect on the Treated (ATT):

Estimate	0.29
Standard Error	0.07
p-value	0.01
95% CI	[0.21, 0.36]

Source: authors own

The data in the table can be interpreted as follows. During the matching procedure, 7 units were matched in both the treatment and control groups, which indicates that during the matching, an adequate number of control units were found for the treated units. Before matching, the averages of the variables "Corruption Prevention" and "Research Innovation and Infrastructure" differed between the treated and control groups. The values of SMD are -0.09 and -0.12, which indicates a moderate difference between the two groups. SMD values around 0 indicate the balance of covariates, so there was some imbalance between the two groups before matching. After matching, the averages of the two groups became much closer to each other. The values of the SMD (0.02 and -0.05) show that after matching, there is hardly any difference between the two groups in terms of covariates. This indicates that the matching was successful and the two groups were balanced.

The estimated value of the Treatment Effect on the Treated (ATT) is 0.29, which means that the "Research, Innovation and Infrastructure" variable in the treatment group is on average 0.29 units higher than in the appropriately matched control group. The p-value is 0.01, which indicates that the result is statistically significant, meaning that the treatment effect may actually exist. The 95% confidence interval is between [0.21, 0.36], indicating that the treatment effect is within a narrow range and is likely to be a positive effect.

Before matching, there was a moderate difference between the variables "Corruption Prevention" and "Research, Innovation and Infrastructure" in the treated and control groups. After matching, the balance of covariates improved significantly, which indicates that the matching process was successful. The ATT value of 0.29 shows that the increase in the efficiency of Corruption Prevention has a positive effect on the "Research, Innovation and Infrastructure" variable in the treated group. The statistical significance (p=0.01) and the narrow confidence interval confirm that the result is reliable.

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Based on the analysis, it can be concluded that "Corruption Prevention" probably has a positive effect on the "Research, Innovation and Infrastructure" variable, and this effect was reliably detected using the PSM method. The obtained results support the findings of the studies cited in the literature review and confirm the causal relationship between corruption prevention and research, innovation and infrastructure.

The aim of the mediation analysis (Table Table **4**.) was to explore through which intermediary variables anti-corruption measures (CPR) influence innovation performance (RII). We examined seven potential mediators that may indirectly affect innovation outcomes. For each mediator, we identified a statistically significant indirect effect ($p < 0.05$). The total effect ($c' + a \times b$) was consistent across all models (0.590), representing the overall impact of CPR on RII. The strongest mediated effect was observed for the quality of Research, Development, and Innovation (RDI) policy (indirect effect: 0.561; Sobel $Z = 15.457$). This suggests that reducing corruption can enhance strategic governance, which in turn directly boosts innovation capacity.

The number of researchers (0.377) and PCT patent applications (0.384) also showed similarly high mediated effects. These results indicate that human capital and technological output play a crucial role in linking anti-corruption efforts to innovation. Government R&D expenditures (0.318) were also identified as strong mediators, supporting the hypothesis that more effective and targeted use of public funds can directly improve innovation performance. Infrastructure quality (0.275) and private sector R&D spending (0.259) were found to be moderately strong mediators. Intellectual property licensing revenues had a weaker, yet still significant, mediated effect (0.191). These findings suggest that anti-corruption policy promotes innovation not only directly, but also through several interrelated structural factors. The most important channels include the quality of government innovation policy, public and corporate R&D financing, and the development of human and technological capacities.

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Table 4. Results of mediator analysis

Mediator (M)	a (CPR -- M)	b (M -- RII)	c' (Direct CPR -- RII)	Indirect effect (a*b)	Total effect	Sobel Z	p
RDI policy	0.639	0.878	0.029	0.561	0.590	15.457	<0.05
Total number of researchers	0.606	0.622	0.213	0.377	0.590	11.509	<0.05
PCT patent applications	0.759	0.506	0.206	0.384	0.590	11.151	<0.05
Public R&D expenditures	0.513	0.618	0.272	0.318	0.590	10.240	<0.05
Quality of overall infrastructure	0.403	0.681	0.315	0.275	0.590	9.371	<0.05
Private R&D expenditures	0.451	0.573	0.331	0.259	0.590	7.918	<0.05
IP licensing agreements	0.513	0.373	0.399	0.191	0.590	6.964	<0.05

Table 5 Moderation analysis output

Moderator	Interaction coef (β3)	p
RDI policy	0.020	0.025
Public R&D expenditures	-0.044	0.018
Total number of researchers	-0.019	0.134
Quality of general infrastructure	0.045	0.058

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The results indicate that the quality of RDI policy has a positive and statistically significant moderating effect ($\beta_3 = 0.020$; $p = 0.025$). This suggests that the impact of anti-corruption efforts on innovation is stronger in countries with more developed policy environments for research, development, and innovation. Well-designed policies likely capitalize more effectively on the benefits of reduced corruption. For government R&D expenditures, a negative but significant moderating effect was found ($\beta_3 = -0.044$; $p = 0.018$). This implies that with higher public R&D spending, the relative impact of anti-corruption measures may diminish. One possible explanation is that a greater share of public funds increases vulnerability to inefficiency or waste, and only under certain levels of control can innovation actually improve. No significant interaction effects were found for the number of researchers ($p = 0.134$) or infrastructure quality ($p = 0.058$). Although the p-value for infrastructure is near the significance threshold, the result should be interpreted with caution. Further investigation is necessary to clarify whether these variables genuinely moderate the relationship between CPR and RII. The findings suggest that a well-developed innovation policy strengthens the positive impact of anti-corruption measures on innovation, while excessive government R&D funding may actually weaken that effect.

5. Conclusion

The present study by the authors confirmed the existence of a strong correlation and causality between corruption and innovation in countries with developed national economies using statistical methods. Strengthening corruption control has been shown to make innovation more efficient and contribute to the promotion of infrastructure development. Curbing corruption promotes the efficient implementation of investments, as it ensures that the resources are really used for the desired purpose, and also enables control and transparency. The results of the present study contribute to increasing the efficiency of innovation and infrastructure development in developed countries.

This research focused on 41 developed national economies. However, based on the results, the authors consider it worthwhile to extend the research to less developed and emerging economies as well.

Conflict of interest:

The authors declare no conflict of interest.

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