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Decline of Interest Rates under Inflation Targeting and Previous Regimes: Evidence from Latin America and Developed Countries

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Abstract. This study empirically investigates the impact of *Inflation Targeting* (IT) on nominal interest rates over the past 40 years, focusing on 10 advanced and emerging economies. By using a Binary Regime Model embedded within a Backward-Looking Taylor, our findings confirm that IT adoption has significantly contributed to reducing interest rates, with the strongest effects observed in Latin American countries. To reinforce these results, we incorporate *Smooth Transition Regression* (STR) models, with and without instrumental variables, allowing for a more suitable representation of gradual policy transitions. The STR estimates consistently support our main findings, validating the robustness of the observed impacts. Furthermore, we show that, both before and after IT implementation, central banks display a stronger emphasis on responding to inflation than to the output gap, with this focus intensifying under IT regimes.

Keywords: Monetary policy, inflation targeting, interest rates, Taylor Rule, Smooth Transition Regression.

1. Introduction

In the last 40 years, interest rates have exhibited a clear decreasing trend in both developed and emerging economies¹ (Li, 2012; Bernanke, 2022). Despite the global economy going through various expansionary and contractionary phases, even with significant fluctuations in short-term interest rates, the long-term trend remains intact. Many arguments have been put forth regarding the factors behind this reduction.

Bernanke (2022) emphasizes that the decline in inflation could have been a decisive factor, as lenders tend to demand lower premiums (interest rates) when inflation is re-

¹ See Figure 1.

duced. This observation underscores the importance of understanding the mechanisms that have led to a decrease in inflation as a relevant contributing factor. Moreover, the literature shows that the determinants of interest rates have an important relationship with the monetary policy framework (Bambe, 2023).

Empirical studies have shown that inflation targeting regimes have been successful in maintaining low, stable, and less volatile inflation levels (Mishkin and Schmidt-Hebbel, 2007; Vega and Winkelried, 2005; Visokaviciene, 2010; Stojanovikj and Petrevski, 2020; Arsić et al., 2022; Bhalla et al., 2023). Therefore, while there is substantial literature on the effectiveness of inflation targeting in stabilizing inflation, there are no studies that directly explore its impact on nominal interest rates. Our study seeks to fill this gap by examining the role of inflation targeting in reducing interest rates, focusing on the pre- and post-IT periods in both emerging and advanced economies. This comparative analysis of the periods before and after the adoption of IT is a key innovation of our research, offering new insights into the mechanisms behind interest rate dynamics.

The transmission mechanism is quite intuitive. If inflation targeting (IT) generates a climate of trust and credibility, it will anchor inflation expectations and result in lower long-term inflation, thereby leading to a reduction in interest rates. Additionally, the adoption of IT may encourage a greater fiscal discipline (Apeti et al., 2024), which could, in turn, contribute to lowering both inflation and interest rates.

Understanding whether IT has been an important factor in the falling rates becomes fundamentally important because it would demonstrate the effectiveness of inflation targeting as a monetary policy tool to promote not only price stability but also more favorable financial conditions. Practically, this could support the credibility and confidence in the monetary policies implemented by the central banks that adopt these targets.

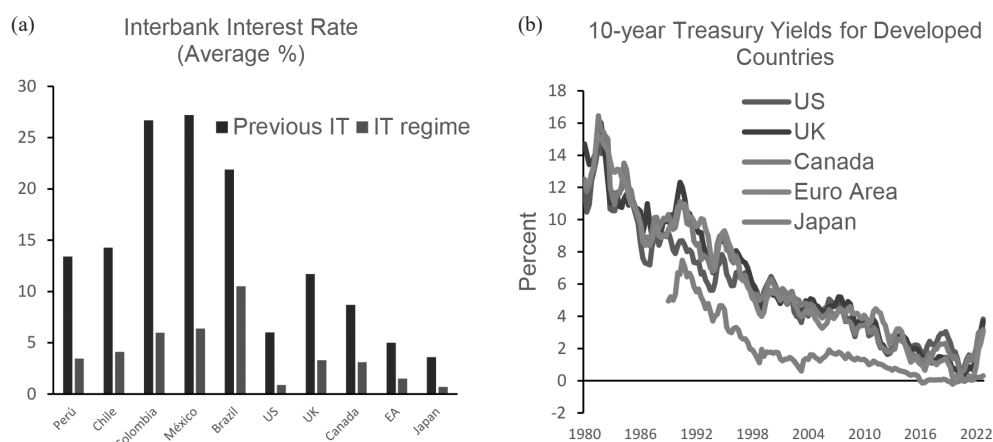


Figure 1. Interbank interest rate and Treasury Yields

Note: Figure 1 (a) shows the average of the interbank interest rate in IT the regime and before. The total sample covers from 1962Q2 to 2022Q4 (the start date varies among countries), whereas the periods in IT start from 1992 to 2022 (see Table 1). For Brazil, periods with atypical interest rates are omitted, and the sample from 1995Q3–1999Q2 is considered as pre-IT. The rate for Japan is 0.36 before IT and 0.07 in IT; for graphical purposes, we multiply these values by 10. Source: *Federal Reserve Economic Data (FRED)*.

The objective of this study is to explore whether Inflation Targeting (IT) has played a role in the historical decline of interest rates observed across a sample of representative economies from both emerging and advanced countries. Also, we study if inflation and the output gap play any role in the process of pursuing the inflation target by central banks. To address this issue, we estimate a binary switching regression embedded within a backward-looking Taylor Rule while using the *ordinary least squares* (OLS) regression model.

Table 1. Inflation Targeting Adoption

Country	Date I.T. adopted	Current Target
Canada	February 1991	1% – 3%
Chile	September 1999	1% – 3%
Colombia	October 1999	2% – 4%
Mexico	2001	1% – 3%
Peru	January 2002	1% – 3%
United Kingdom	October 1992	2%
United States	January 2012	2%
Japan	January 2013	2%
Brazil	June 1999	1.5% – 4.5%
Euro Area	1999	2%

Note: The length of the inflation target varies among nations. In the cases of Peru and the United Kingdom, the target is established indefinitely, encompassing all periods. Chile's inflation target spans approximately two years. Meanwhile, Colombia and Mexico employ a medium-term target, while Brazil opts for a yearly target. Lastly, Canada's inflation target extends over a period of six to eight quarters. The inflation targets of 2022 are considered as current targets. Sources: *Bank of England* and *Reuters*.

The use of a backward-looking Taylor Rule is justified by several considerations. First, forward-looking rules rely on expectations of inflation and output gaps, which are often subject to measurement errors and unreliable real-time data (Mankiew et al., 2004; Reid and Siklos, 2021). Backward-looking rules, by focusing on observed historical data, minimize these issues and reduce the potential endogeneity concerns. Additionally, such rules help ensure determinacy in structural models, as highlighted in the literature (Carlstrom and Fuerst, 2000), where backward-looking rules contribute to stable and unique equilibria. While an extension of this analysis could involve the consideration of a forward-looking rule, the backward-looking approach remains robust for the purposes of this study and aligns with empirical evidence in historical contexts.

We utilize a simple regression model estimated under OLS since there is recent evidence that this estimation method performs better in estimating Taylor-type rules (Carvalho et al., 2021). The analysis is conducted for a set composed of Advanced economies and of Latin American economies (US, UK, Canada, Japan, Euro Area, Peru, Chile, Colombia, Mexico, and Brazil) that have adopted Inflation Targeting (see Table 1). Additionally, to analyze and compare the variations of the rates in both periods, elasticities are calculated in both regimes.

Our article contributes to the literature by expanding empirical evidence on the effect of Inflation Targeting (IT) in reducing the interest rates, particularly in emerging Latin American economies. It further contrasts these experiences with those observed in the developed countries, thus providing a comparative analysis which is bound to highlight differences and similarities in the impact of IT across varying economic contexts.

The empirical results show that the adoption of IT has played a substantial role in lowering the interest rates in recent years, particularly with a stronger impact being observed in Latin American economies. Also, our analysis reveals that central banks have exhibited a more pronounced response to inflation compared to the output gap, both prior to and following the implementation of inflation targeting (IT), and the response of central banks to inflation has shown an upward trend after the adoption of IT.

The following sections proceed as follows. Section 2 provides a brief literature review. Section 3 demonstrates the methodology applied in this study. Section 4 presents the obtained results and discusses the relevant considerations and facts. Finally, in Section 5, conclusions are presented.

2. Literature Review

The relationship between inflation targeting (IT) and interest rates has been the subject of extensive research, yet the evidence remains mixed. For instance, Fouejieu and Roger (2013) explore how IT influences cross-country interest rate spreads in both emerging and advanced economies. By using a dynamic panel data approach and system GMM to address endogeneity, they find that IT leads to a decline in country risk premium spreads, particularly under conditions of a reduced political uncertainty.

Similarly, De Mendoça and Souza (2009) examine the relationship between the monetary policy credibility and interest rates. By constructing a novel credibility index based on expert surveys, they demonstrate through OLS regression that, during the IT period, interest rates exhibited less variability due to an enhanced monetary policy credibility.

Alternatively, Gehringer and Mayer (2019) investigate the factors driving nominal long-term interest rates. By using a VAR model with a DOLS procedure, they conclude that, in major industrialized economies, central banks' monetary policies have significantly contributed to maintaining low interest rates. They argue that the close connection between short-term rates (controlled by central banks) and long-term rates is more reflective of central bank perceptions than those of the market participants.

The studies supporting a positive effect of IT on interest rates generally argue that IT fosters a climate of confidence and expectation management, leading to consistent reductions in interest rates. Additionally, other research highlights a strong link between the inflation control and lower interest rates. For example, Fazlollahi and Ebrahimijan (2022) provide econometric evidence of a bidirectional causality between interest rates and inflation rates in Canada, thereby supporting Bernanke's (2022) premise that inflation rates significantly influence historical interest rates.

However, not all research supports the hypothesis that IT has a substantial impact on interest rates. Lin and Ye (2007), by using Propensity Score Matching, find that IT does not significantly affect inflation or inflation variability in industrialized countries. Similarly, Ball and Sheridan (2005), by employing a difference-in-differences model, find that IT does not exert significant effects on long-term interest rates in advanced economies. They attribute the observed inflation decline to a mean-reversion phenomenon rather than to IT itself.

Beyond IT, other factors have been identified as influencing the decline in real interest rates. For instance, research by Dell’Erba and Sola (2016), Barnejee et al. (2022) and Kregzde and Murauskas (2015) points to a strong relationship between fiscal policy management and interest rates. The above-listed authors argue that reducing spreads can lower other interest rates in the economy. However, Dautovic (2017) claims that the relationship between fiscal policy variables – such as government spending or budget deficits – and long-term interest rates tends to weaken or even disappear once the persistent nature of interest rates has been accounted for in econometric models. Another crucial factor is the ‘global saving glut’, a concept introduced by Bernanke (2005a), which refers to a worldwide increase in savings, leading to reduced interest rates. Bernanke identifies demographic changes and income growth as the key drivers of this global savings increase. While supporting this view, Barsky and Easton (2021) argue that the global saving glut hypothesis explains the decline in long-term real interest rates from 2002 to 2006 but may not fully account for the further decrease observed after the Great Recession.

Upon reviewing the literature, several considerations emerge. First, studies relying on expectation data may be flawed. In this context, Reid and Siklos (2021) highlight that measuring inflation expectations is challenging due to their unobservable nature and the respondents’ misunderstanding of economic concepts, leading to biased and inconsistent data. Second, much of the empirical literature focuses on advanced industrialized countries, thereby limiting the generalizability of the findings. These countries had a low inflation and more efficient institutions even before adopting IT. Finally, studies using treatment effects may be biased. For example, difference-in-differences models that do not account for time-varying treatment effects can introduce bias (Goodman-Bacon, 2021). Moreover, if countries in the sample are not genuine inflation targeters but behave as such, the estimated treatment effects may be misleading.

This research seeks to fill these gaps by providing evidence for emerging Latin American countries. Instead of relying on expectation data, we adopt a more straightforward and methodologically robust approach to address these issues.

3. Method

3.1. Research Model

3.1.1. Binary Regime Model

We estimate regressions of the Backward-Looking type Taylor Rule for ten different countries as follows:

$$r_t = \theta_0 + \theta_1\pi_{t-1} + \theta_2\hat{y}_{t-1} + \theta_3D_t + \varepsilon_t \quad (1)$$

where r_t is the nominal interbank interest rate, π is the inflation rate gap, while $\hat{y}$ is the output gap (defined as the percentage difference between the output and its long-term trend level). Central to our analysis is the introduction of a dummy variable, D_t , which takes the value of ‘1’ during the inflation targeting period and ‘0’ otherwise. This allows us to capture the effects of both the inflation targeting period and the preceding monetary policy regimes.

We use the Ordinary Least Squared (OLS) method to estimate the coefficient of the regressions for both Latin American and developed countries. We capture the estimator for the two monetary policy regimes as follows:

$$E(r_t|\pi_{t-1}, \hat{y}_{t-1}, D_t = 1) = \hat{\theta}_0 + \hat{\theta}_1\pi_{t-1} + \hat{\theta}_2\hat{y}_{t-1} + \hat{\theta}_3; \text{ I.T. regime}$$

$$E(r_t|\pi_{t-1}, \hat{y}_{t-1}, D_t = 0) = \hat{\theta}_0 + \hat{\theta}_1\pi_{t-1} + \hat{\theta}_2\hat{y}_{t-1}; \quad \text{previous regimes}$$

Endogeneity in structural models like the Taylor Rule can lead to biased estimators. The common approach in the literature is to use Instrumental Variables (IV) or GMM (Maher et al., 2022; Horvath et al., 2022). However, ensuring the exogeneity and validity of instruments, especially in time series, is challenging. Empirical evidence suggests that Ordinary Least Squares (OLS) provides a better performance as well as a smaller endogeneity bias in reasonably sized samples (Carvalho et al., 2021). Following Miles and Schreyer (2012) and Carvalho et al. (2021), we opt for OLS instead of 2SLS². To address serial correlation, heteroskedasticity, and autocorrelation, we use HAC standard errors and bootstrap techniques.

3.1.2. Smooth Transition Regression (STR)

The smooth transition model captures gradual changes in the structural parameters of an equation, as opposed to abrupt shifts, thus making it particularly useful for analyzing policies with potential regime changes. In this context, the model incorporates a transition dynamic which depends on a threshold variable (such as the temporal distance from the implementation date of a regime). We estimate the model both without and with instrumental variable (IV) estimation to address potential endogeneity issues. The general form of the model is:

$$r_t = \beta_0 + \beta_1\bar{\pi}_t + \beta_2\bar{y}_t + \gamma G(\tau_t; \kappa) + \varepsilon_t \quad (2)$$

In this model, r_t represents the interbank interest rate, $\bar{\pi}_t$ is the inflation rate relative to its target, and $\bar{y}_t$ is the output gap. $G(\tau_t; \kappa)$ is the transition function, which depends on the threshold variable τ_t (in this case, representing the temporal distance from the date of IT adoption), and κ is the smoothness parameter. In this framework, two types of transition functions are feasible, as follows:

² To enhance the robustness of our results, we also estimate Equation (1) by using Instrumental Variables (IV).

Logistic function

$$G(\tau_t; \kappa) = \frac{1}{1 + e^{-k\tau_t}}$$

Exponential function:

$$G(\tau_t; \kappa) = e^{(-k|\tau_t|)}$$

The selection between the two functions is made by minimizing the sum of squared residuals (SSR) for different values of the smoothness parameter κ^3 . To address potential inference issues caused by severe autocorrelation, Bootstrap was used to estimate the standard errors of the model⁴. Therefore, under this specification, the aim is to address (i) the gradual nature of the effects of IT adoption, (ii) potential endogeneity issues, and (iii) possible autocorrelation problems by providing a more robust estimation of the standard errors, thereby enhancing the reliability of the results.

3.2. Data and Variables

We collected quarterly data on the interbank interest rate, inflation and output for the ten countries included in our sample. The specific variables employed were dictated by the best data available. We follow Miles and Schreyer (2012), who used a measure of short term interest rates⁵. For the developed economies and Brazil, we use the 3-month interbank rate⁶. For Mexico, we use the '28 days interbank rate', while for Peru, Chile and Colombia, we refer to the 1-day interbank rate. The interbank rate, the inflation, and the real output were taken from the Federal Reserve Economic Data (FRED), Economic Commission for Latin America (CEPAL) the International Monetary Fund (IMF) and the central banks websites of each country to be analyzed. We consider the inflation rate as the year-to-year variation of the Consumer Price Index (CPI). This measure includes the interannual variation of the quarterly average⁷ of CPI $\pi = \left(\frac{QACPI_t - QACPI_{t-4}}{QACPI_{t-4}} \right) * 100$. The output gap was obtained by the Hodrick-Prescott filter⁸.

According to the sample, Canada has the largest data series, running from 1962Q1 to 2022Q4. It is followed by the United States, with the data spanning the period from 1964Q3 to 2022Q2. The United Kingdom's data run from 1986Q1 to 2022Q2. The Euro Area provides data from 1995Q1 to 2022Q4, while Japan's data run from 2002Q2 to 2022Q4.

³ Values from 0.1 to 10 were used with an increase rate of 0.20.

⁴ 2000 simulations were considered.

⁵ In our analysis, we employ the same dependent variable, namely, the interbank rate, across all countries. However, we vary the terms associated with the interbank rate, specifically considering intervals of 1, 28 and 30 days.

⁶ Quarterly data are obtained from the 3-month average of monthly data.

⁷ The CPI is the monthly average index, while the QACPI is the quarterly average of CPI.

⁸ The value of λ considered in this analysis was 1600. However, the Hodrick-Prescott filter (1997) is known to have weaknesses, including sensitivity to the choice of λ , end-point bias that affects estimates near the sample edges (Cogley and Nason, 1995; Ravn and Uhlig, 2002), and its inability to account for structural breaks or economic shocks, which may lead to misleading results in volatile contexts (Hamilton, 2018).

Table 2. Summary statistics on inflation and interbank interest rate (% annual rates)

		Perú	Chile	Colombia	Mexico	Brazil	U.S.	U.K.	E.A.	Canada	Japan
Inflation	Before	Mean	8.3	5.9	18.3	21.2	587.9	4.3	1.5	5.5	-0.2
		Median	8.2	5.7	19.5	17.6	14.0	3.4	1.5	4.6	-0.2
		S.D.	2.7	1.4	3.6	12.1	1273.8	2.9	0.3	3.4	0.8
	Inflation Targeting	Mean	2.9	3.6	5.1	4.4	6.4	2.4	2.0	2.0	0.6
		Median	2.8	3.0	4.8	4.1	6.1	1.8	1.9	1.7	0.5
		S.D.	1.7	2.6	2.4	1.2	2.7	2.1	1.3	1.6	1.0
	Full period	Mean	3.7	3.9	7.2	8.2	111.7	3.9	1.9	3.7	0.2
		Median	3.1	3.4	5.3	4.7	6.2	3.2	1.8	2.5	0.0
		S.D.	2.7	2.6	5.5	9.1	576.9	1.4	1.6	3.2	0.9
Interbank Rate	Before	Mean	13.4	14.3	26.7	27.2	131.3	6.0	5.0	8.7	0.4
		Median	12.8	14.5	25.6	22.4	23.8	5.6	4.5	8.5	0.3
		S.D.	4.6	3.7	5.7	12.0	242.6	3.4	1.2	3.5	0.3
	Inflation Targeting	Mean	3.5	4.1	6.0	6.4	10.5	0.9	1.5	3.1	0.1
		Median	3.7	3.5	5.5	6.6	10.8	0.3	1.0	2.7	0.0
		S.D.	1.4	2.5	2.6	2.0	4.5	0.9	1.8	2.3	0.1
	Full period	Mean	5.7	5.4	9.4	11.0	32.3	5.0	2.0	5.8	0.2
		Median	4.2	4.3	6.3	7.6	11.8	5.5	2.0	5.1	0.1
		S.D.	4.9	4.4	8.3	10.5	111.5	3.7	2.1	4.0	0.2

Note: The data in this table are presented in quarterly frequency. The sample prior to inflation targeting was chosen based on the availability of data. The data sample for each country corresponds exactly to the one specified in the data section. Sources: *Federal Reserve Database* (FRED) and Central Banks of each country.

For the Latin American economies, Brazil runs data from 1994Q4 to 2022Q4, while Mexico and Colombia can be sourced from 1995Q2 to 2022Q4. Peru's data run from 1995Q4 to 2022Q4, and, finally, Chile offers data from 1996Q1 to 2022Q4.

Table 2 shows the main patterns followed by both inflation and interest rates. In general, the average inflation levels have fallen for all the countries analyzed that adopted IT with the exception of the Eurozone and Japan. In terms of magnitude, emerging countries have maintained the highest levels of average inflation compared to the developed economies, both before and after the implementation of the inflation targeting (IT) frameworks. Likewise, the volatility levels after the adoption of IT have been reduced for the majority of the countries in the sample (with the exception of the Eurozone and Japan, from 0.32 to 1.7, and 0.76 to 1, respectively), which would indicate that the adopted monetary policy regime or rule has had an impact on maintaining a stable level of inflation. Similarly, it is noteworthy that both inflation and interest rates consistently exhibit medians that are lower than their respective averages in both regimes. This provides insights into the data distribution and suggests a rightward bias that may be influenced by outliers.

Correspondingly, interest rates have followed the same pattern as inflation. All countries analyzed have shown both a reduction in average rates and a drop in volatility after the adoption of IT. The emerging countries of Latin America are those that have had a greater reduction in rates compared

to the developed countries. Thus, the data would preliminarily show that the IT regime could have influenced these downward trends in the interest rates and their volatility (Rossetti et al., 2017).

4. Results

The results reported in Table 3 provide empirical evidence that the adoption of IT has played a significant role in reducing the interest rates in both advanced and Latin American economies. The estimated coefficient of dummy variables included in the model (capturing the inflation targeting regime) are negative and statistically significant at a confidence level of 99% for all the countries considered in our sample.

The negative signs are as expected, indicating that the adoption of IT has generated an effect in the reduction of the rates. Based on the magnitudes, the estimated coefficients for the dummy variables represent to what extent the adoption of IT has contributed to the reduction of the interest rates in percentage points. Therefore, it can be observed that the estimated coefficients of the dummy variables for the Latin American economies range from -11.10 to -8.36, which correspond to Brazil and Mexico, respectively. In contrast, for advanced economies, the range varies from -7.56 to -0.34, representing the UK and Japan, respectively. This result implies that the monetary policy strategy under IT has played a more significant role in the emerging economies.

The implication of these results can be appreciated through the model's estimates of the interbank interest rate at the inflation target level and the output at its potential level, as shown in Figure 2. Figure 2 illustrates the model's estimates of the interbank interest

rate. For this, we base our analysis on the assumption that inflation is at its target level and that the output is at its potential level. Prior to the adoption of inflation targeting (IT), the estimated interest rates for the Latin American countries, except for Brazil, do not exceed 15%. However, following the implementation of IT, the rates for the countries in this group do not exceed 5.6%. The estimates for the developed countries exhibit a similar pattern as, prior to the adoption of inflation targeting (IT), interest rates did not exceed 11%. However, following the implementation of IT, the rates for these countries do not exceed 3.3%. It is of importance to note that the difference in the interest rates between these two periods is captured by the coefficients of the previously estimated dummy variables.

One advantage of the proposed model is that it enables us to understand the behavior of central banks in their role of maintaining inflation at its target level and minimizing the output gap. This allows us to assess whether central banks exhibit a stronger response to inflation or to the output gap, as well as whether they adhere to a backward-looking rule.

To ensure the robustness of our findings, we also estimated the model using instrumental variables IV, as shown in Table 9. However, the IV results were less reliable, with larger standard errors and some counterintuitive coefficient signs. These limitations are likely due to weak instruments, as the lags of inflation and output gaps used as instruments may fail to adequately explain the endogenous variables. Consequently, the baseline model remains the preferred specification.

Table 3 displays the statistical significance of inflation for the Latin American countries, where Peru, Chile, Colombia, and Mexico exhibit significant results. Among these countries, only Peru, Chile, and Colombia maintain statistical significance for the output gap as well. It is evident from the analysis that the central banks of these countries have displayed a stronger response to inflation compared to the output gap within the sample considered. The central bank of Colombia has exhibited the highest response to inflation with a coefficient of 0.89, whereas Chile has shown the highest response to the output gap with a coefficient of 0.35.

On the other hand, within the group of the developed economies, the United States, Canada, and Japan exhibit significance in relation to inflation, whereas only Canada displays significance in terms of the output gap. This finding aligns with the results observed in the emerging economies, as Canada (representing the developed economies) also demonstrates a stronger response to inflation than the output gap. Furthermore, it is noteworthy that the Federal Reserve (Fed) demonstrated the most robust response to inflation among the countries in this group, with a coefficient of 0.75.

Taking a broader perspective, when considering both the advanced and the Latin American economies that displayed statistical significance in either inflation or the output gap, it becomes evident that Colombia exhibited the strongest response to inflation, while Canada demonstrated the most significant response to the output gap.

Therefore, considering estimations with at least one variable with statistical significance between inflation and the output gap, for 7 of the ten countries, central banks adhere to a backward-looking Taylor Rule (Equation (1)). Within these seven countries, the Taylor Rule shows significance for both variables for Peru, Chile, Colombia, and Canada. For

the other three countries, estimations show significance for only inflation for Mexico, the United States and Japan. Notably, there is no country with only significance for the output variable, beside the dummy. As mentioned above, Brazil, UK, and the Euro area show no significance with the backward-looking Taylor Rule, but the significance of their dummies, indeed, shows the influence of the targeting rule in their interest rate levels.

The coefficient of determination is examined for those countries which adhere to a backward-looking rule or maintain statistical significance in at least one variable. Upon analysis, it is observed that Latin American countries exhibit a high level of adjustment, with an explanatory range ranging from 0.75 to 0.92. This suggests that both inflation and the output gap were the most influential variables considered by their central banks. However, in the case of Brazil, where significance is not maintained in any variable except for the dummy variable, it indicates that the central bank may have responded to other macroeconomic variables which are not included in our model.

In the case of developed economies, the coefficient of determination values is lower compared to those of Latin American countries, with an adjustment range measuring between 0.44 and 0.68. Regarding Brazil, the United Kingdom, and the Euro Area, it is possible that other variables could account for the behavior of their central banks.

Table 3. O.L.S estimation of Equation (1)

	Intercept	Inflation	Output Gap	Dummy	R²
Peru (1996Q1-2022Q4)	10.88*** (1.45)	0.41*** (0.15)	0.11*** (0.04)	-8.57*** (1.26)	0.78
Chile (1996Q2-2022Q4)	11.34*** (0.85)	0.50*** (0.08)	0.35*** (0.09)	-8.92*** (0.85)	0.75
Colombia (1995Q3- 2021Q4)	9.95*** (2.09)	0.89*** (0.10)	0.30* (0.18)	-8.41*** (1.86)	0.92
Mexico (1995Q3-2022Q4)	12.05*** (2.62)	0.62*** (0.10)	0.15 (0.09)	-8.36*** (2.30)	0.89
Brazil (1996Q2-2022Q4)	20.13*** (2.02)	0.22 (0.22)	-0.08 (0.35)	-11.10*** (1.43)	0.45
United States (1964Q4-2022Q4)	2.81*** (0.54)	0.75*** (0.12)	0.33 (0.20)	-3.71*** (0.58)	0.67
United Kingdom (1986Q2-2022Q4)	10.40*** (1.51)	0.23 (0.25)	0.17 (0.10)	-7.56*** (1.16)	0.64
Euro Area (1997Q2-2022Q4)	3.81*** (0.49)	0.25 (0.29)	0.18 (0.16)	-2.78*** (0.36)	0.23
Canada (1962Q2-2022Q4)	5.24*** (0.74)	0.62*** (0.13)	0.41** (0.17)	-3.29*** (0.67)	0.68
Japan (2002Q2-2022Q4)	0.38*** (0.07)	0.07** (0.03)	0.02 (0.03)	-0.34*** (0.09)	0.44

Notes: Standard errors are given in parentheses. The asterisks denote statistical significance at the 1 (***), 5 (**), and 10 (*) percent levels. Standard errors were calculated by the HAC robust estimator.

Moreover, we calculate the elasticities of both the inflation and the output gap for all the countries in our sample. Table 4 presents the inflation and output elasticities (see Appendix A) for countries with statistical significance before and after the adoption of IT, considering the economy operating at its potential level and with inflation in its target level. It is of importance to note that, in both regressions (pre- and post-IT), the slope remains constant within each country. What differs is the interest rate level, that is, the intercept.

Table 4. Inflation and output Elasticity under inflation target and potential GDP

	Before IT		IT period	
	ε_{π}	ε_y	ε_{π}	ε_y
Peru	0.07	0.01	0.27	0.03
Chile	0.11	0.03	0.37	0.09
Colombia	0.14	0.03	0.36	0.07
Mexico	0.14	-	0.34	-
US	0.35	-	2.50	-
Canada	0.20	0.06	0.33	0.13
Japan	0.28	-	0.70	-

Notes: this section considers the target of inflation as an average weight by the dwell time of the target. The ratio is the division between the IT period and before IT. For output elasticities, we consider the average of the potential output. All the ratios are shown in absolute values.

$$\hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1 \pi^* + \hat{\theta}_3 \text{Dummy}(1) \quad (3)$$

$$\hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1 \pi^* + \hat{\theta}_3 \text{Dummy}(0) \quad (4)$$

$$\text{Elasticity of inflation} = \frac{\partial r}{\partial \pi} \times \frac{\pi}{r} \big|_{\pi=\pi^*} \quad (5)$$

$$\text{Elasticity of output gap} = \frac{\partial r}{\partial y} \times \frac{y}{r} \big|_{\pi=\pi^*; y=\bar{y}} \quad (6)$$

In general, the inflation elasticities of the emerging economies in Latin America before the IT regime range from 0.07 to 0.14, while, under the inflation targeting regime, the range of elasticities is from 0.27 to 0.37. A similar pattern is observed in the developed economies, with the United States, Canada, and Japan experiencing the greatest relevance of inflation in magnitude. Overall, it is evident that, in the Latin American economies, Colombia and Mexico demonstrate a stronger response to inflation prior to the adoption of IT (see Table 4). However, after the implementation of IT, Chile emerges with the highest response to inflation, by virtue of exhibiting an elasticity of 0.37. Similarly, among the developed economies, the United States shows a greater response to inflation compared to its counterparts prior to and after the introduction of IT. These findings corroborate previous results, indicating that central banks in both advanced and emerging economies have exhibited a more pronounced reaction to inflation than to the output gap. Finally,

we can infer two crucial points. Firstly, the central banks in our sample have exhibited a stronger response to inflation compared to the output, both before and after the adoption of information technology (IT). Secondly, following the implementation of IT, the response to inflation has experienced a significant increase.

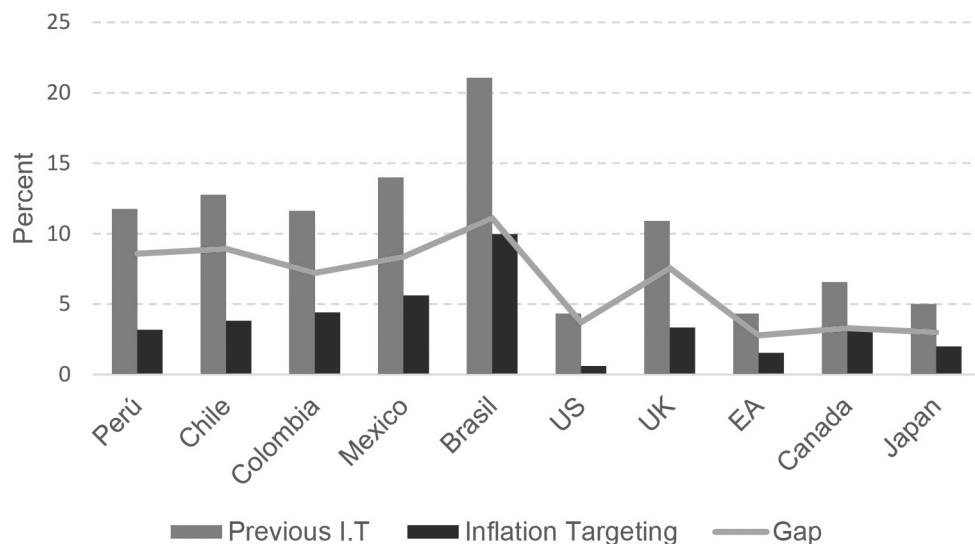


Figure 2. Interbank rate estimation under inflation targeting and previous regimes

Notes: The estimates in Figure 2 come from regressions (Equations (5) and (6)). The interest rate for Japan before IT is 0.5, and after IT is 0.2. For graphical reasons, we multiply them by 10.

The results presented above rely on the assumption that the implementation of inflation targeting (IT) had immediate effects rather than gradual ones. While these earlier results align well with the data, it is worth evaluating whether the policy change was indeed gradual, as this would allow us to validate our previous findings.

For this purpose, Equation (2) is estimated by using Smooth Transition Regression (STR). Given that the Taylor Rule applied here is backward-looking, endogeneity issues are unlikely to arise. Nevertheless, in order to enhance the robustness of our analysis, we estimate an additional model by using instrumental variables (IV).

The inflation gap and the output gap variables are treated as endogenous, and their lags are used as instruments. Table 6 presents the baseline model results without considering instrumental variables. The findings indicate that the transition variable, which captures the gradual effect of the policy shift, is statistically significant and negative across all the countries under investigation. This supports the hypothesis that the transition to IT was gradual, and that IT contributed to the reduction of nominal interest rates. The intercepts, which represent the average nominal interest rates in the absence of cyclical fluctuations, show a significant decline following the adoption of IT.

Figure 5 addresses potential endogeneity issues. The results reveal considerable variation in parameter estimates and their standard errors, thus suggesting potential endogeneity in the baseline model. Only in Peru, Chile, the UK, Canada, the Euro Area, and Japan there exists the transition variable, representing the gradual effect of IT adoption, which is statistically significant and negative. Furthermore, some parameter signs appear counterintuitive – for instance, in Japan, the UK, and Canada – although these coefficients are not statistically significant.

These findings can be summarized as follows: there is evidence suggesting the existence of endogeneity, which implies that the most reliable results are those in Table 5. In countries where a smooth transition is not observed, the earlier results (Table 3) indicate that an abrupt transition explains the data better. This could be due to the fact that, although countries have an official IT implementation date, they may have already maintained an implicit target range before the official announcement⁹. This would mean that the smooth transition occurred prior to the official IT date, while the stronger effects were captured as an abrupt change. Conversely, in countries where smooth transitions are evident, it is likely that they did not adopt preemptive measures akin to an IT regime before its formal implementation. Transitions may vary in magnitude and speed across countries, as shown in Figure 3. In all cases, the evidence supports the premise that IT contributed to reducing the interest rates.

If the IT regime has contributed to the reduction of the nominal interest rates, it likely indicates a stronger anchoring of inflation expectations, leading to more stable and lower inflation rates. This, in turn, can help reduce risk premiums, bring down the borrowing costs, and stimulate economic activity. The successful implementation of inflation targeting in reducing interest rates may also encourage its adoption by other countries, thereby reinforcing its global appeal and contributing to more stable economic environments.

However, as nominal interest rates approach their lower bound, the effectiveness of the traditional monetary policy tools diminishes. With limited room to reduce rates further, central banks may struggle to stimulate economic activity during downturns. This could force central banks to rely on unconventional measures, such as quantitative easing or forward guidance, which may have uncertain and potentially destabilizing long-term effects on financial markets and inflation expectations.

5. Robustness Check

As a robustness check, we re-estimate the Taylor Rule by using three specifications: (i) the baseline model with the IT regime dummy, (ii) the model without the dummy, and (iii) the model estimated separately for pre- and post-IT periods. This approach allows us to assess the stability of coefficients and the appropriateness of the dummy variable. A comparison of subsample estimates helps identify if there are significant changes in parameters, thus

⁹ For example, Chile announced an inflation objective in 1990 and implemented IT-like policies before formally adopting inflation targeting in 1999. Similarly, Israel began implementing IT-like policies in 1992 and transitioned to a full IT framework in 1997.

Table 5. Smooth transition regression model estimated using instrumental variables (IV)

	Peru	Chile	Colombia	Mexico	Brazil	U.S.	U.K.	Canada	E.A.	Japan
Intercept	12.62*** (2.42)	23.00*** (6.30)	11.02 (8.89)	6.66 (12.9)	44.99** (20.59)	6.47*** (0.54)	17.76*** (4.03)	12.21*** (2.42)	20.27*** (5.17)	0.89*** (0.17)
Output gap	0.17 (0.33)	0.56** (0.26)	0.24 (0.98)	1.00* (0.58)	0.61 (0.74)	0.40 (0.27)	0.52** (0.24)	0.74*** (0.27)	0.31 (0.24)	-0.02 (0.04)
Inflation gap	0.61** (0.24)	0.52*** (0.19)	1.03 (0.64)	0.96 (0.65)	0.43 (0.58)	0.54*** (0.16)	-0.14 (0.35)	-0.12 (0.37)	0.21 (0.17)	0.15 (0.09)
Transition	-10.93*** (5.13)	-22.38*** (8.64)	-6.73 (11.21)	1.34 (14.09)	-39.99 (25.93)	-18.58 (11.66)	-14.38*** (5.33)	-14.25*** (6.17)	-21.8*** (6.33)	-0.89*** (0.16)
Intercept – pre-IT	12.624*** (2.42)	23.00*** (6.30)	11.02 (8.89)	6.66 (12.87)	44.985** (20.59)	6.47*** (0.54)	17.76*** (4.04)	12.21*** (2.42)	20.27*** (5.17)	0.89*** (0.17)
Intercept – post-IT	1.72 (2.89)	0.63 (2.43)	4.29** (2.38)	7.99*** (1.49)	4.99 (5.48)	-12.12 (11.45)	3.39** (1.36)	-2.03 (3.80)	-1.54 (1.27)	-0.00 (0.24)

Notes: The smooth transition regression model used a continuous logistic function in all cases, after evaluation of the nonlinear test based on Teräsvirta (1994). The model uses estimates under instrumental variables (IV), where the instruments were the lags (2) of the independent variables. It is worth noting that the results are subject to the possible weakness of the instruments. The standard error in parentheses was estimated by using the bootstrap method with 2000 iterations.

Table 6. Smooth transition regression model estimated by OLS

	Peru	Chile	Colombia	Mexico	Brazil	U.S.	U.K.	Canada	E.A.	Japan
Intercept	10.10*** (0.94)	16.45*** (1.20)	8.04*** (1.06)	17.85*** (2.11)	29.20*** (0.95)	4.61*** (0.17)	13.99*** (0.80)	7.43*** (0.26)	7.61*** (0.45)	0.53*** (0.07)
Output gap	0.10 (0.09)	0.28*** (0.09)	0.06 (0.13)	0.11 (0.18)	-0.16 (0.26)	0.20* (0.12)	0.15* (0.08)	0.36*** (0.10)	0.17 (0.10)	0.00 (0.02)
Inflation gap	0.62*** (0.13)	0.52*** (0.08)	1.19*** (0.11)	0.72*** (0.12)	-0.05 (0.11)	0.73*** (0.06)	0.22 (0.13)	0.54*** (0.08)	0.16 (0.15)	0.07*** (0.02)
Transition	-7.54*** (0.94)	-13.67*** (1.26)	-4.60*** (1.20)	-13.18*** (2.11)	-20.20*** (1.24)	-5.08*** (0.39)	-11.17*** (0.88)	-4.60*** (0.33)	-6.66*** (0.54)	-0.38*** (0.05)
Intercept – pre-IT	10.10*** (0.94)	16.45*** (1.20)	8.04*** (1.06)	17.85*** (2.11)	29.20*** (0.95)	4.61*** (0.17)	13.99*** (0.80)	7.43*** (0.26)	7.61*** (0.45)	0.53*** (0.08)
Intercept – post-IT	2.57* (1.33)	2.79 (1.73)	3.43** (1.60)	4.67 (3.00)	8.98*** (1.56)	-0.46 (0.43)	2.83** (1.20)	2.83*** (0.41)	0.95 (0.71)	0.15 (0.09)

Notes: The smooth transition regression model used a continuous logistic function in all cases, after evaluation of the nonlinear test based on Teräsvirta (1994). The standard error in parentheses was estimated by using the bootstrap method with 2000 iterations.

indicating a structural shift consistent with a regime change. Additionally, comparing the baseline model to the one without the dummy reveals whether the inclusion of the dummy improves the explanatory power. A higher R^2 and significant coefficients in the baseline model suggest that the dummy effectively captures regime-specific dynamics.

Table 10 shows substantial changes in parameters across subsamples for the 10 countries, thus indicating a potential regime shift. All regressions, except for the Euro Area, display a higher R^2 value in the baseline model, thus suggesting that the model with the dummy is robust and captures regime-specific dynamics better in most cases.

6. Conclusions

This study aims to answer the question whether the inflation targeting (IT) regime and its variation have contributed to the historic reduction in interest rates experienced by both developed and emerging economies. Furthermore, it examines whether the output gap and the inflation level have played a significant role in this process of rate reduction. A Binary Regime Model embedded within a Backward-Looking Taylor and STR was estimated to capture the monetary policy regime, and it has been found that the inflation targeting regime has played a crucial role in the historic reduction of interest rates in the emerging economies of Latin America and the developed economies of our sample. The empirical results show that this effect has had a stronger impact in Latin American economies. These results are consistent with the assertions made by Bernanke (2022) and Fazlollahi and Ebrahimijan (2022).

However, while the evidence indicates that the adoption of IT has been an important factor in explaining the decline in interest rates, in Brazil, the United Kingdom, and the Eurozone, inflation and the output gap would not have played a significant role, and other mechanisms would be behind this reduction (e.g., the real exchange rate, terms of trade, etc.). Regarding the output gap, the evidence shows that it has only been a significant factor in Peru, Chile, Canada, and Colombia.

Additionally, two key conclusions emerge from our findings. First, the elasticity of inflation has notably increased over time. Second, in both pre- and post-IT periods, the magnitude of inflation elasticities exceeds that of the output gap. These results suggest that central banks, adhering to a backward-looking Taylor Rule, have consistently responded more strongly to inflation than to the output gap, with this response intensifying after the adoption of IT.

The reduction in nominal interest rates under the IT regime suggests better inflation expectation anchoring, leading to lower inflation and borrowing costs. However, as rates approach their lower bound, the traditional monetary policy becomes less effective, thereby forcing central banks to rely on unconventional measures with uncertain long-term impacts.

Given the use of post-pandemic data, the results may be subject to structural breaks due to significant changes in the global economy. An extension of this study could involve addressing these breaks, possibly through techniques like Markov-switching models, so that to better capture the impact of the pandemic on monetary policy.

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Appendices

Appendix A. Econometric Methods and Estimations

1. Growth rate of Natural Output Estimation

Table 7. Potential GDP growth rate

Country	Sample	Average potential GDP growth rate (%)
Peru	1997Q1 – 2022Q4	4.0
Chile	1997Q1 – 2022Q4	3.5
Colombia	1996Q2 – 2022Q4	3.0
Mexico	1996Q2 – 2022Q4	2.1
Brazil	1997Q1 – 2022Q4	2.1
US	1965Q3 – 2022Q4	2.8
UK	1987Q1 – 2022Q4	1.8
Canada	1963Q1 – 2022Q4	2.9
Euro Area	1996Q1 – 2022Q4	1.4
Japan	1995Q1 – 2022Q4	0.6

Note. The trend of output gap obtained by the HP filter is considered as the potential GDP. Source: Own elaboration.

2. Weight Average of Inflation Target

In order to compute the inflation elasticities presented in Table 5, we employ a weighted average of the inflation target, where the weighting is determined by the duration for which the target was maintained. The Formula used for this calculation is as follows:

$$\text{Average of } \pi^* = \sum_{j=1}^K \sum_{i=1}^N \pi_i^* w_j \quad (7)$$

where π_i^* is the inflation target, and $i = 1, 2, 3, \dots, N$ indicates the number of objectives that each country has had. w_j indicates the period of time that said objective has been maintained, thus $j = 1, 2, 3, \dots, K$ indicates the quarters. Details are given in Table 6.

Table 8. Average target inflation

	Peru	Chile	Colombia	Mexico	Brazil	U.K.	Canada
Target (%) (time frame in quarters)	2.5 (13Q)	3.5 (4Q)	5.5 (4Q)	4 (7QQ)	8 (3Q)	2.5 (47Q)	3 (5Q)
	2 (64Q)	3 (56Q)	4.5 (3)	3 (69Q)	6 (4Q)	2 (77Q)	2.5 (7Q)
	-	2.5 (24Q)	4 (16)	3.75 (3Q)	4.5 (53Q)	-	2 (108Q)
	-	2.4 (10)	3.5 (8)	3.5 (5Q)	4 (12Q)	-	-
	-	-	3 (41)	-	3.75 (5Q)	-	-
	-	-	-	-	3.5 (8Q)	-	-
	-	-	-	-	3.25 (4Q)	-	-
	-	-	-	-	3 (6Q)	-	-
Average	2.1	2.8	1.8	3.1	4.3	2.2	2.1

Notes: US, Japan and EA have had an inflation target of 2% since the adoption of IT. ‘Q’ represents quarters. Source: Own elaboration.

3. Interbank Interest Rate Estimation

We estimate the regression by assuming that inflation is at its targeted level and the output gap is zero. The rationale behind this estimation approach stems from our objective of comparing periods during which the economy operated at its natural level.

$$\text{After IT: } \hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1\pi^* - \hat{\theta}_3\text{Dummy}(1) = \hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1\pi^* - \hat{\theta}_3 \quad (8)$$

$$\text{Before IT: } \hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1\pi^* - \hat{\theta}_3\text{Dummy}(0) = \hat{r}_t = \hat{\theta}_0 + \hat{\theta}_1\pi^* \quad (9)$$

where the parameters are those that we obtain from the model, whereas the average target inflation level parameters (π^*) are the ones we estimate in Figure 2.

4. Elasticities for Inflation and Output

For reference purposes, we estimate the elasticities of inflation and the output gap in both periods (pre- and post-IT). The estimate is as follows (Table 4):

$$\text{Elasticity of inflation} = \frac{\partial r}{\partial \pi} \times \frac{\pi}{r} \Big|_{\pi=\pi^*} = \hat{\theta}_1 \times \frac{\pi^*}{\hat{r}_t} \quad (10)$$

$$\text{Elasticity of output gap} = \frac{\partial r}{\partial y} \times \frac{y}{r} \Big|_{\pi=\pi^*; y=\bar{y}} = \frac{\hat{\theta}_2}{\bar{y}} \times \frac{\bar{y}}{\hat{r}_t} = \frac{\hat{\theta}_2}{\hat{r}_t} \quad (11)$$

where the only thing that changes is $\hat{r}_t$ for both periods (estimate is obtained from Equations (11) and (12), $\bar{y}$ is the growth rate of natural output for each country (Table 5).

Appendix B. Tables and Figures

Table 9. Results with IV estimation (Equation (1))

	Intercept	Inflation	Output Gap	Dummy	R ² (pseudo)
Peru (1996Q1-2022Q4)	13.43*** (0.97)	1.18*** (0.20)	-0.03 (0.22)	-10.67*** (1.02)	0.47
Chile (1996Q2-2022Q4)	20.17*** (2.12)	0.58*** (0.11)	0.34** (0.16)	-16.9*** (2.12)	0.42
Colombia (1995Q3-2021Q4)	2.75* (1.66)	2.09*** (0.19)	-0.74** (0.25)	-1.01 (1.58)	0.70
Mexico (1995Q3-2022Q4)	12.15*** (1.71)	1.00*** (0.21)	0.71*** (0.24)	-8.57*** (1.58)	0.68
Brazil (1996Q2-2022Q4)	22.15*** (4.20)	0.09 (0.17)	-0.16 (0.38)	-12.13** (4.44)	0.41
United States (1964Q4-2022Q4)	4.05 (7.84)	0.69*** (0.15)	0.02 (0.19)	1.42 (7.59)	0.25
United Kingdom (1986Q2-2022Q4)	22.90*** (3.53)	-1.07** (0.44)	0.13 (0.22)	-19.00*** (3.50)	0.14
Euro Area (1997Q2-2022Q4)	-92.80 (87.83)	-0.42 (1.15)	0.42 (1.39)	94.21 (87.82)	0.03
Canada (1962Q2-2022Q4)	12.49*** (1.25)	-0.16 (0.19)	0.80*** (0.20)	-9.73*** (1.33)	0.26
Japan (2002Q2-2022Q4)	0.35*** (0.10)	0.00 (0.04)	0.04* (0.02)	-0.29*** (0.06)	0.37

Notes: Standard errors are reported in parentheses. Asterisks denote statistical significance at the 1% (*), 5% (**), and 10% (***) levels. Standard errors were calculated by using the HAC robust estimator. The instruments used were the own lags of each variable. The *Akaike Information Criterion* (AIC) was used to determine the optimal number of lags, with a maximum of 12 lags (6 for the Euro Area to avoid rank issues). For individual countries: for Peru, we used 10 lags for inflation and 1 lag for the output gap; for Chile, we used 4 lags for the output gap and 10 lags for inflation; for Colombia, we used 10 lags for inflation and 5 lags for the output gap; for Mexico, we used 12 lags for inflation and 1 lag for the output gap; for Brazil, we used 2 lags for inflation and 3 lags for the output gap; for Canada, we used 9 lags for inflation and 1 lag for the output gap; for the U.K., we used 9 lags for inflation and 4 lags for the output gap; for the U.S., we used 10 lags for inflation and 4 lags for the output gap; for Japan, we used 5 lags for inflation and 1 lag for the output gap; and, for the Euro Area, we used 6 lags for inflation and 1 lag for the output gap.

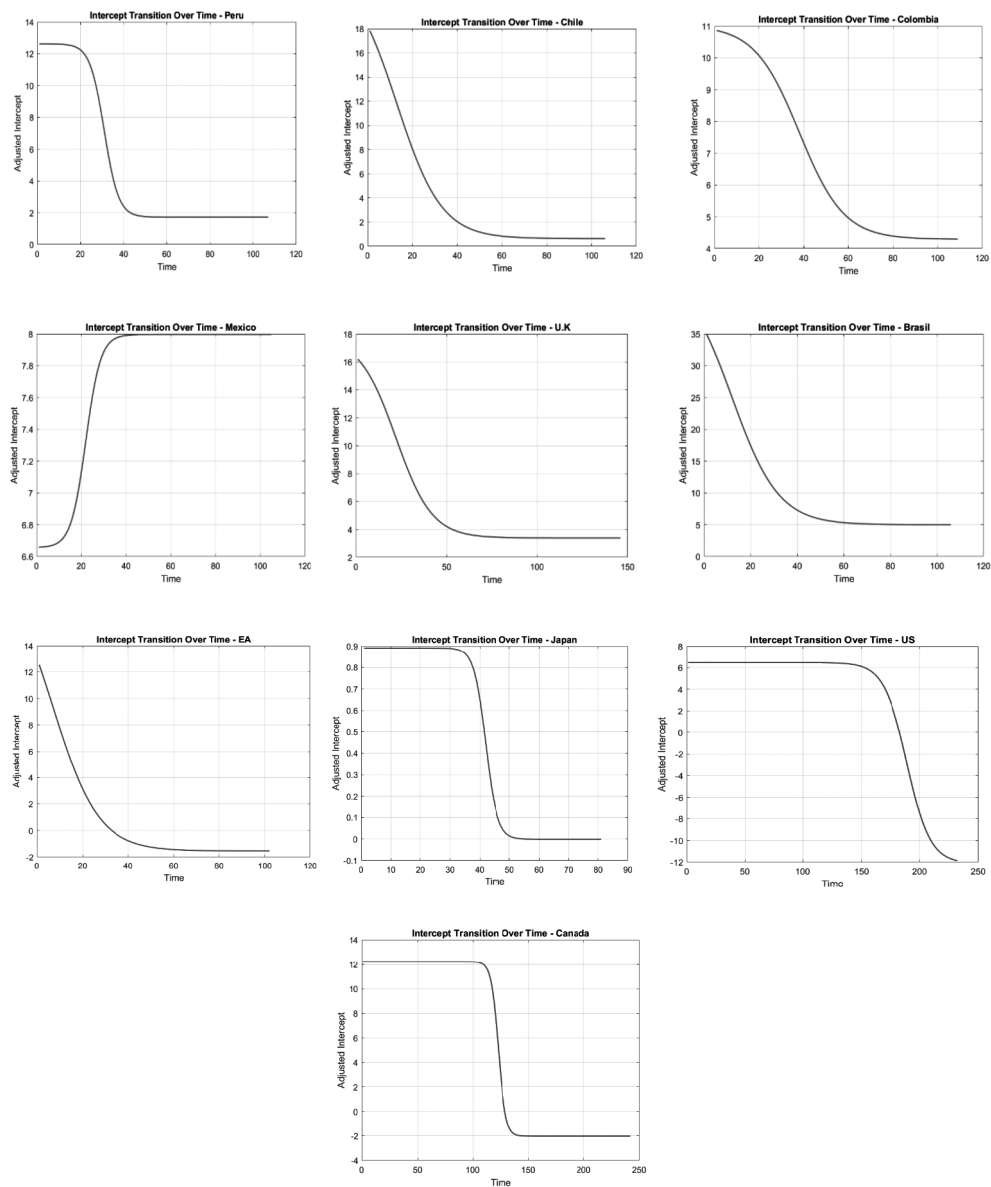


Figure 3. Transition functions

Notes: Dynamic of logistic transition functions for each country are presented. These results are derived from the estimation of Equation (2).

Table 10. Robustness check

Country	Model	Intercept	Inflation gap	Output gap	Dummy	R ²
Peru	Complete	10.88*** (1.45)	0.41*** (0.15)	0.11*** (0.04)	-8.57*** (1.26)	0.78
	No dummy	4.23*** (0.46)	1.00*** (0.15)	0.05 (0.12)	-	0.30
	Before IT	9.07*** (1.10)	0.81*** (0.24)	0.31 (0.49)	-	0.30
	After IT	3.04*** (0.16)	0.42*** (0.08)	0.09** (0.04)	-	0.34
Chile	Complete	11.34*** (0.85)	0.50*** (0.08)	0.35*** (0.09)	-8.92*** (0.85)	0.75
	No dummy	4.60*** (0.39)	0.80*** (0.15)	0.21 (0.15)	-	0.27
	Before IT	12.38*** (2.37)	0.59 (0.75)	0.60 (0.41)	-	0.19
	After IT	3.76*** (0.23)	0.48*** (0.09)	0.19** (0.09)	-	0.32
Colombia	Complete	9.95*** (2.09)	0.89*** (0.10)	0.30* (0.18)	-8.41*** (1.86)	0.92
	No dummy	4.19*** (0.38)	1.44*** (0.06)	-0.04 (0.12)	-	0.85
	Before IT	4.76*** (1.27)	1.45*** (0.12)	0.53 (0.42)	-	0.84
	After IT	4.73*** (0.23)	0.55*** (0.11)	0.10 (0.08)	-	0.36
Mexico	Complete	12.05*** (2.62)	0.62*** (0.10)	0.15 (0.09)	-8.36*** (2.30)	0.89
	No dummy	5.89 (0.49)	1.08 (0.05)	0.24 (0.17)	-	0.83
	Before IT	23.65 (4.70)	0.35 (0.21)	-3.67 (1.42)	-	0.70
	After IT	5.33 (0.38)	1.05 (0.24)	0.16 (0.09)	-	0.22
Brazil	Complete	20.13*** (2.02)	0.22 (0.22)	-0.08 (0.35)	-11.10*** (1.43)	0.45
	No dummy	12.12*** (0.62)	-0.15 (0.16)	-0.13 (0.30)	-	0.59
	Before IT	21.80*** (0.48)	-0.05 (0.08)	0.64 (0.39)	-	0.28
	After IT	10.24*** (0.56)	0.10 (0.16)	-0.27 (0.24)	-	0.45

Country	Model	Intercept	Inflation gap	Output gap	Dummy	R ²
U.S.	Complete	2.81*** (0.54)	0.75*** (0.12)	0.33 (0.20)	-3.71*** (0.58)	0.67
	No dummy	3.34*** (0.20)	0.90*** (0.06)	0.16 (0.11)	-	0.50
	Before IT	4.13*** (0.21)	0.84*** (0.06)	0.26** (0.11)	-	0.55
	After IT	0.83*** (0.14)	0.14** (0.07)	0.15* (0.09)	-	0.18
U.K.	Complete	10.40*** (1.51)	0.23 (0.25)	0.17 (0.10)	-7.56*** (1.16)	0.64
	No dummy	4.22*** (0.31)	1.08*** (0.16)	0.04 (0.12)	-	0.24
	Before IT	9.67*** (0.59)	0.69*** (0.17)	0.34* (0.18)	-	0.54
	After IT	3.52*** (0.25)	-0.00 (0.17)	0.08 (0.09)	-	0.00 (0.73)
Canada	Complete	5.24*** (0.74)	0.62*** (0.13)	0.41** (0.17)	-3.29*** (0.67)	0.68
	No dummy	4.77*** (0.20)	0.89*** (0.07)	0.32*** (0.12)	-	0.45
	Before IT	6.97*** (0.26)	0.68*** (0.06)	0.52*** (0.14)	-	0.53
	After IT	2.73*** (0.17)	-0.30** (0.12)	0.42*** (0.11)	-	0.13
Japan	Complete	0.38*** (0.07)	0.07** (0.03)	0.02 (0.03)	-0.34*** (0.09)	0.44
	No dummy	0.20*** (0.06)	-0.01 (0.03)	0.02 (0.02)	-	0.01
	Before IT	0.66*** (0.14)	0.14** (0.06)	-0.00 (0.02)	-	0.14
	After IT	0.12*** (0.02)	0.04*** (0.01)	0.01 (0.00)	-	0.19
Euro Area	Complete	3.81*** (0.49)	0.25 (0.29)	0.18 (0.16)	-2.78*** (0.36)	0.23
	No dummy	1.71*** (0.18)	0.11 (0.12)	0.17* (0.10)	-	0.05
	Before IT	4.68*** (0.11)	0.80*** (0.15)	0.21* (0.12)	-	0.85
	After IT	1.50*** (0.18)	0.14 (0.11)	0.19** (0.09)	-	0.08

Notes: The dates before and after IT correspond to a specific date for each country. Standard errors are reported in parentheses. Asterisks denote statistical significance at the 1% (*), 5% (**), and 10% (***) levels. Standard errors were calculated by using the HAC robust estimator.

Debt Trapped: Analysing the Impact of IMF on Economic Growth and Human Development in Highly Indebted Countries, with a Focus on Corruption

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Abstract. Being indebted represents significant risks associated with global financial instability in a world where financial stability hangs precariously between debt and economic growth. The *International Monetary Fund* (IMF) casts a critical eye over countries navigating the perilous seas of fiscal responsibility, aiming to improve their economic performance. Hence, evaluating the connection between IMF loans and sustainable growth in highly indebted countries is crucial. This study aims to examine the impact of IMF loans on real GDP and human development in a panel of the 13 most indebted countries from 1997 to 2020, by using pooled OLS and fixed-effect estimators. The article contributes to the existing literature in two ways. On the one hand, a broad set of human development indicators is analysed. On the other hand, corruption is incorporated into the analysis, explicitly measuring the simultaneous effects of IMF loans and corruption. It has been found that IMF loan growth tends to lower GDP growth, human development, and mortality. IMF loans often come with conditions that may lead to austerity measures. While these measures can negatively impact economic growth in the short term, they might also redirect resources toward social programs which improve health outcomes, thereby reducing mortality rates. When corruption is considered, a reduction in corruption leads to more effective IMF loans, increased human development, and decreased mortality even further. Therefore, it is recommended that IMF loans should always be accompanied with incentives to reduce corruption.

Keywords: IMF loans, HDI, indebted countries, corruption, economic growth, life expectancy, mortality, education.

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Introduction

Human development is widely recognized as one of the key drivers of a country's economic growth. Improved education and health lead to the acquisition of skills, particularly the ability to innovate, which can boost economic growth. Moreover, human development enhances people's choices and diversifies them in a way that enables them to lead longer, healthier, and more fulfilling lives. Given its importance, the United Nations has addressed human development extensively in its *Sustainable Development Goals* (SDGs), with seven of the 17 goals focusing on different aspects of human development, such as reducing poverty, improving health and education, and promoting gender equality. However, most countries fail to develop balanced debt management policies that can help them to achieve growth even if they receive external assistance from institutions such as the *International Monetary Fund* (IMF) and the *World Bank* (Elkhalfi et al., 2024).

The IMF plays a critical role in developing countries, where corruption can misdirect the use of IMF loans, with funds getting wasted on projects that do not actually benefit the country. This study aims to examine the impact of IMF loans on economic growth and human development in the most indebted countries. Some scholars have expressed concern that the engagement is a debt trap, a ruse towards modern neo-colonization and resource extinction in Africa. However, others have documented the significance of such investments in attaining SDGs (Bo et al., 2024)

This article extends previous research in the literature in two ways. First, it starts with measuring the effects of IMF loans on a broad set of dependent variables. These are, on the one hand, the real GDP growth as the common proxy for economic growth, and, on the other hand, the Human Development Index (HDI), secondary school enrollment, life expectancy, and mortality rate, which are used to measure human development. Second, a new dimension is added to the literature by adding corruption to the analysis. With this factor being considered, we can verify whether IMF loans have different effects in high- and low-corruption economies. This study focuses on the transmission channels and discusses various factors that might mediate the indebtedness-mortality link. For example, we note that higher levels of debt accumulation result in increased austerity. The following section discusses the literature review, followed by an overview of the data used. Finally, the results, conclusion and policy recommendations are outlined.

Literature Review

The classical school, in contrast with Keynesian economists, believed in the Government's role in regulating the market and correcting imbalances through public borrowing as part of Government intervention in the economy to ensure upward economic evolution. They believed that accumulation of debt led to a crowding-out effect, thereby decreasing private investments, which deteriorated economic growth. The Debt Overhang Theory, established by Krugman in 1988, explains the situation in which the accumulated loans and debt make the country unable to repay them, thus decreasing its expenditure ability on public

projects such as infrastructure, social programs, or financing the recurrent expenditure. In 1964, Gary Becker explored how education and training contribute to economic success, and explained why developed countries accumulate wealth while developing countries remain poor due to labour (under)productivity. The model states that a higher investment in capital per worker leads to a higher output, with investment per worker being the main variable positively impacting changes in capital per worker. Therefore, debt should be directed to finance education, improve infrastructure, and develop healthcare services so that to improve human capital and technology, which are considered the main sources for the country's future income generation.

The effectiveness of IMF programs and loans on the countries receiving help has already been investigated extensively. This also holds, among other points, for the empirical response to economic growth and human development. Barro and Lee (2005) found that IMF loans reduce economic growth rates in their sample of 130 countries between 1975 and 1999. Meanwhile, Bird and Rowlands (2017) discovered that the impact of IMF loan programs on economic growth in low-income countries is generally positive, however, it depends on the country's performance, debt and aid dependency, IMF resources, and the recent history of IMF engagement. Later, Hackler et al. (2020) estimated empirically for 93 countries between 2000 and 2014 what effects the compliance to IMF loan conditions tends to have on economic growth. The authors established that meeting the IMF conditions can change the economic growth rate either way depending on the nature of the condition.

Siddique et al. (2021), by using panel data covering 70 countries during the period of 1980–2018, determined that IMF loans had a positive impact on economic growth for upper-middle-income countries. Kuruc (2022) used a synthetic control analysis of IMF interventions in 399 different crisis periods between 1970 and 2013. With this approach, he could show that IMF programs led to higher economic growth than in a situation without a program in place.

Another strand of literature focuses on the role of IMF programs for human development. Easterly (2003), by using data from 1980 to 1998, established that IMF and World Bank programs have no significant direct effect on poverty rates. However, he found that the growth elasticity of poverty is significantly negative, which means that the poor segment of the population benefits less from economic expansion under a program. Muhamed and Gaas (2016) discovered that IMF programs had a negative impact on human development in developing countries. Bird et al. (2021) determined that IMF programs did not significantly increase poverty or income inequality by using a sample of 48 countries in the years ranging from 1990 to 2015. Stubbs et al. (2021) focused on the austerity policies often associated with IMF programs and their effects on poverty and income inequality. In a sample covering 79 countries between 2002 and 2018, they ascertained that stricter austerity policies in IMF programs led to more poverty and higher income inequality.

Biglaiser and McGauvran (2022) found that IMF loans reduce human development in developing countries in a sample of 81 countries between 1986 and 2016. This result holds in particularly concerning poor nations. Corruption is a factor that may affect the effectiveness of IMF loans and is associated with lower growth and more poverty. A

recent strand of the literature emphasizes the importance of e-government in combating corruption and promoting transparency (Seiam and Salman, 2024). Apeagyei et al. (2024) showed that many sub-Saharan African countries suffer from poverty and income inequality, deteriorating public health, educational outcomes, increasing child mortality, and corruption. The IMF provides financial assistance to countries facing balance of payments problems, and numerous sub-Saharan nations have engaged with the IMF through various lending programs.

This study contributes to the ongoing discussion on the effectiveness of IMF loans. First, we are one of the few studies that estimate the effects of IMF loans on economic growth and human development simultaneously. Second, to the best of the researchers' knowledge, they are the first to investigate the role of corruption in IMF programs and their effect on growth and development. Third, we focus on a unique database with 13 highly indebted countries in the years ranging between 1997 and 2020. The study's main hypotheses are:

- IMF loans tend to lower the GDP growth and human development (e.g., life expectancy, education) in the short term.
- The effectiveness of IMF loans improves when corruption is reduced, thus leading to enhanced human development and decreased mortality.

Methodology and Data

Our panel dataset is comprised of 13 countries which received IMF loans during the period from 1997 to 2020. These countries are Angola, Argentina, Ecuador, Egypt, Ghana, Ivory Coast, Kenya, Morocco, Nigeria, Pakistan, South Africa, Tunisia, and Ukraine. For each of these countries, we gathered data on five dependent variables, representing measures of either economic growth or human development. Economic growth is approximated by the real *gross domestic product* (GDP). Additionally, we incorporated two of the three sub-indices used in the HDI calculation. Thus, the second measure represents the share of secondary school enrollment, while the third measure represents life expectancy. The fourth measure is the mortality rate, which is expected to negatively correlate with life expectancy.

As for independent variables, we collected data on the two primary variables of interest: the amount of money received through IMF loans, and the country's corruption index. For the corruption index, we utilized the *Corruption Perception Index* issued by Transparency International¹. It is of importance to note that an increase in this index indicates a reduction in corruption within the country. Furthermore, we included a set of six additional control variables in all the estimation equations. These include *Gross capital formation* (GCF), Government expenditures on education (as a percentage of the total Government expenditures), trade in services, consumer price index, *foreign direct investments* (FDI), and the size of the population. To ensure the stationarity of the underlying time-series

¹ <https://www.transparency.org/en/cpi/2022>

data, all the variables were transformed into growth rates. For example, the price index was transformed into the inflation rate. Descriptive statistics along with unit root tests for all variables are presented in Table 1 in the Appendix.

Correlation Analysis

The analysis reveals a strong positive correlation between IMF loans and GDP in the studied countries, thereby indicating that as IMF loans increase, GDP also rises. There are several other significant correlations: a weak negative correlation exists between the mortality rate and both IMF loans and corruption. Secondary school enrollment shows a weak positive correlation with GDP, IMF loans, and corruption, along with a strong negative correlation with the mortality rate. Human development exhibits a weak positive correlation with GDP, IMF loans, and corruption, but strong negative correlations with the mortality rate and positive correlations with secondary school enrollment. Government expenditure on education has weak negative correlations with GDP and IMF loans, but weak positive correlations with corruption, mortality, secondary school enrollment, and human development. Inflation negatively correlates with GDP, corruption, secondary school enrollment, and human development. Foreign direct investment (FDI) shows weak negative correlations with GDP, IMF loans, secondary school enrollment, and human development, while strongly correlating positively with inflation. Gross capital formation has weak negative correlations with GDP and IMF loans, and trade in services negatively correlates with GDP. Population growth is weakly negatively correlated with GDP, IMF loans, corruption, secondary school enrollment, and Government expenditure. For detailed correlations, refer to Table 2 in the Appendix.

Estimation Methodology

The study used a cross-dependence test to determine the suitability of pooled versus random effects models. The model includes five dependent variables, and employs two estimation methods: pooled *ordinary least squares* (OLS), assuming a common intercept for all the countries under analysis, and fixed-effects estimation, allowing for individual country intercepts. Detailed findings are presented in Tables 3 to 7 in the Appendix. Two different types of estimation are employed: first, a pooled *ordinary least squares* (OLS) estimation, which assumes that all countries have the same intercept (see Equation (1)); and second, a fixed-effects estimation, which allows each country to have an individual intercept (see Equation (2)).

$$y_{it} = \alpha + \beta_1 IMF_{it} + \gamma_x Z_{it} + \varepsilon_{it} \quad (1)$$

$$y_{it} = \alpha_i + \beta_1 IMF_{it} + \gamma_x Z_{it} + \varepsilon_{it} \quad (2)$$

In both equations, the index i signals the country and t stands for the time period (years in our case). y denotes one of the five dependent variables (GDP, HDI, School,

Life, or Mortality). α represents the common or individual intercept, while β_1 and γ_x are the coefficients for IMF loans and the control variables (GCF, Education, Trade, Price, FDI and Population), respectively. It should be noted that x ranges from 1 to 6 in line with the responses to be estimated for each of the six control variables. Finally, ε_{it} measures the error term.

$$y_{it} = \alpha + \beta_1 IMF_{it} + \beta_2 Corruption_{it} + \beta_3 IMF_{it} \cdot Corruption_{it} + \gamma_x Z_{it} + \varepsilon_{it} \quad (3)$$

$$y_{it} = \alpha_i + \beta_1 IMF_{it} + \beta_2 Corruption_{it} + \beta_3 IMF_{it} \cdot Corruption_{it} + \gamma_x Z_{it} + \varepsilon_{it} \quad (4)$$

In Equations (1) and (2), the effect of corruption is not included. This is deliberate to first demonstrate the overall effects of IMF loans on the dependent variables. In a subsequent step, however, we incorporate corruption. This is done in two ways: firstly, by adding corruption as an additional regressor. Secondly, by adding the product of IMF and corruption, we demonstrate how the dependent variable changes concerning IMF loans and changes in corruption. Equations (3) and (4) depict these adjusted specifications using pooled OLS and fixed-effects, respectively.

Results

This section presents and discusses the empirical results. It begins with the specifications that do not consider the influence of corruption, as outlined in Equations (1) and (2). The results are presented in Table 8.

The response of GDP growth was found to be significantly negative in both specifications (2.1 and 2.2), although the effect tends to be small. This suggests that an increase in IMF loans is associated with lower economic growth in the short term, possibly due to the stringent reform packages typically associated with IMF support. This finding reinforces the results of previous studies by Barro and Lee (2005). However, there are three exceptions worth noting. Firstly, gross capital formation shows a positive and significant effect on economic growth. A one percent increase in gross capital formation leads to an increase of 0.15% in economic growth. This result is logical as gross capital formation is a component of GDP. Secondly, GDP growth reacts negatively to an increase in the price index, thereby indicating that higher inflation rates reduce economic growth, with everything else being equal. This result is expected as increased prices diminish product demand. Thirdly, population growth appears to positively influence economic growth, as expected, thus indicating that countries with larger populations tend to produce more goods and services.

Concerning the response to HDI growth (2.3 and 2.4), the results suggest a weakly negative effect of IMF loan growth on HDI growth, which becomes significant in the pooled OLS Equation (2.3). This implies that, at least in the short term, IMF loans and the austerity programs often associated with them tend to reduce human development. This finding is consistent with previous studies by Muhamed and Gaas (2016) and Biglaiser and McGauvran (2022). The control variables tend to be predominantly significant in these specifi-

Table 8. Baseline results

	GDP		HDI		School		Life		Mortality	
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)	(2.9)	(2.10)
	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects
IMF	-0.004** (0.002)	-0.003** (0.002)	-0.001* (0.000)	-0.001 (0.000)	0.001 (0.007)	0.003 (0.007)	0.000 (0.000)	0.000 (0.000)	-0.002** (0.001)	-0.001** (0.001)
GCF	0.150*** (0.015)	0.147*** (0.015)	0.013*** (0.004)	0.014*** (0.003)	0.099* (0.060)	0.117* (0.061)	0.002 (0.002)	0.002 (0.002)	-0.000 (0.007)	-0.004 (0.006)
Education	0.006 (0.015)	0.002 (0.015)	0.008** (0.004)	0.007** (0.003)	-0.112* (0.062)	-0.121* (0.063)	-0.000 (0.002)	0.000 (0.002)	-0.001 (0.007)	0.002 (0.006)
Trade	0.011 (0.012)	0.010 (0.012)	0.008*** (0.003)	0.009*** (0.003)	0.091* (0.049)	0.103** (0.050)	0.001 (0.002)	0.002 (0.002)	-0.001 (0.006)	-0.001 (0.005)
Price	-0.022* (0.013)	-0.020** (0.015)	0.006** (0.003)	0.005 (0.003)	-0.078 (0.050)	-0.122** (0.059)	0.000 (0.002)	-0.000 (0.002)	-0.007 (0.006)	0.001 (0.006)
FDI	0.001 (0.001)	0.001 (0.001)	0.000 (0.000)	-0.000 (0.000)	-0.008** (0.003)	-0.009*** (0.003)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)
Population	0.633*** (0.202)	-0.937 (0.789)	0.296*** (0.049)	0.597*** (0.177)	2.417** (0.941)	7.486* (4.22)	0.274*** (0.031)	0.443*** (0.106)	0.143 (0.096)	-0.713** (0.328)
C	2.152*** (0.411)		0.340*** (0.100)		-2.300 (1.774)		0.117* (0.065)		-3.658*** (0.194)	
Adj. R²	0.382	0.400	0.266	0.396	0.067	0.053	0.241	0.475	0.006	0.256
N	249	249	249	249	189	189	249	249	249	249

Notes. C stands for the constant (only for pooled OLS. Fixed effects constants are available from the authors upon request), N denotes the number of observations, whereas Adj. R² is the adjusted R² value. All other abbreviations are explained in the main text. Standard errors are given in parentheses, ***/**/* stands for the significance of the coefficients at 99%, 95% and 90% levels, respectively.

cations. Gross capital formation (GCF) growth exhibits a robust positive effect on HDI growth, which is reasonable as investments may occur in sectors that enhance human development, such as education or healthcare. Unsurprisingly, the response of HDI growth to the Government's schooling expenditure increases is significantly positive, as this directly contributes to human development. Additionally, increasing international trade growth was found to increase HDI growth, likely due to the broader range of goods and services available *via* imports, which can improve access to items such as medication. Interestingly, the inflation rate initially appears to have a significantly positive effect on HDI growth in the pooled OLS Equation (2.3). This result is puzzling, as one might expect a negative response, given that higher inflation rates could deter investments aimed at improving human development. However, the significance diminishes once fixed effects have been incorporated into the estimation (2.4). Finally, according to the results, human development growth increases with population growth. One possible explanation for this is that an increasing population necessitates the development of critical infrastructure, leading to improvements in healthcare and education systems.

When examining the first factor contributing to HDI, which is School growth, we find that growth in IMF loans tends to have no effect (3.5 and 3.6). This suggests that, in the short term, an IMF credit does not significantly contribute to the development or improvement of the schooling system. This finding aligns with the expectations, as establishing or enhancing a schooling system is typically a medium- to long-term endeavour. Regarding the control variables, we observe similar significantly positive reactions to school growth as we found concerning HDI growth for variables such as gross capital formation (GCF), trade, and population growth. Thus, it can be inferred that HDI growth, particularly in terms of school growth, is partly driven by these factors. Moreover, we now find that the response of school growth to the inflation rate has the expected significantly negative impact, as higher prices tend to discourage investments in the schooling system. However, the result regarding Government expenditures on education is puzzling, as it is found to have a significantly negative effect on school growth. One possible explanation is that the effects of these expenditure increases do not materialize immediately, and may even hinder schooling improvement due to factors such as renovations of school buildings.

Lastly, we find a significantly negative effect of foreign direct investment (FDI) growth on school growth. One explanation for this could be that, in many of the countries under investigation, which are predominantly low-income countries, FDI investments are mainly directed towards sectors requiring unskilled labour. Consequently, an increase in FDI may lead to a greater demand for unskilled workers, thus prompting individuals to forgo or reduce their education. When examining the effects on growth in life expectancy, the results are presented in columns 2.7 and 2.8 of Table 8. Finally, when examining the response of mortality growth (2.9 and 2.10), we find the expected significantly negative response, which corresponds to the significantly positive effect we found regarding growth in life expectancy. This suggests that, as the population grows, mortality rates tend to decrease, which is consistent with the notion that larger populations may lead to an improved access to healthcare and other life-saving resources.

Table 9. Results of the main contribution; corruption is added to the estimation equations

	GDP		HDI		School		Life		Mortality	
	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)	(3.8)	(3.9)	(3.10)
	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects	Pooled OLS	Fixed effects
IMF	-0.002 (0.002)	-0.002 (0.002)	-0.000 (0.001)	-0.000 (0.000)	-0.009 (0.010)	-0.009 (0.010)	0.000 (0.000)	0.001* (0.000)	-0.003*** (0.001)	-0.004*** (0.001)
Corruption	0.253 (0.547)	2.015 (1.491)	-0.159 (0.129)	-0.079 (0.327)	-1.151 (2.255)	4.102 (6.144)	-0.283*** (0.084)	-0.807*** (0.189)	0.068 (0.252)	1.051* (0.591)
IMF · Corruption	0.004 (0.004)	0.005 (0.005)	0.002* (0.001)	0.002* (0.001)	-0.026 (0.020)	-0.033 (0.020)	0.001 (0.001)	0.001 (0.001)	-0.005** (0.002)	-0.006*** (0.002)
GCF	0.146*** (0.015)	0.144*** (0.015)	0.012*** (0.004)	0.012*** (0.003)	0.108* (0.061)	0.135** (0.064)	0.001 (0.002)	0.001 (0.002)	0.001 (0.007)	-0.002 (0.006)
Education	0.000 (0.016)	-0.003 (0.015)	0.007* (0.004)	0.007** (0.003)	-0.115* (0.065)	-0.122* (0.066)	-0.000 (0.002)	0.000 (0.002)	-0.003 (0.007)	0.000 (0.006)
Trade	0.013 (0.012)	0.011 (0.012)	0.009*** (0.003)	0.009*** (0.003)	0.090* (0.051)	0.095* (0.052)	0.002 (0.002)	0.003 (0.002)	-0.001 (0.006)	-0.001 (0.005)
Price	-0.024 (0.017)	-0.031* (0.019)	0.008** (0.004)	0.009** (0.004)	-0.117* (0.066)	-0.169** (0.076)	-0.001 (0.003)	0.000 (0.002)	-0.012 (0.008)	-0.004 (0.007)
FDI	0.001 (0.001)	0.001 (0.001)	-0.000 (0.000)	-0.000 (0.000)	-0.011*** (0.004)	-0.013*** (0.004)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Population	0.769*** 0.225	-0.753 (0.871)	0.318*** (0.053)	0.692*** (0.191)	2.371** (0.997)	8.486* (4.345)	0.254*** (0.035)	0.449*** (0.110)	0.117 (0.103)	-0.677* (0.345)
C	2.105*** (0.484)		0.203* (0.114)		-2.351 (1.970)		0.001 (0.075)		-3.511*** (0.223)	
Adj. R ²	0.376	0.396	0.289	0.456	0.082	0.071	0.271	0.528	0.029	0.304
N	237	237	237	237	181	181	237	237	237	237

Notes. C stands for the constant (only for pooled OLS. Fixed effects constants are available from the authors upon request), N denotes the number of observations, and Adj. R² is the adjusted R² value. All other abbreviations are explained in the main text. Standard errors are given in parentheses, ***/**/* stands for the significance of the coefficients at 99%, 95% and 90% levels, respectively.

The coefficients for the impact of IMF loans on GDP growth and HDI growth are notably small, thereby suggesting that while there is a statistically significant relationship, its practical significance may be limited. For instance, a negative coefficient for GDP growth implies that an increase in IMF loans leads to a slight decline in growth rates, which could be critical in economies where even marginal declines can have adverse effects on the overall economic stability (3.1 and 3.2). The responses of the control variables are largely unchanged from those observed in Table 9, thus indicating that the explanations provided there remain valid.

Given the short-term nature of these coefficients, it is crucial to analyse whether these effects change over a longer horizon. The immediate negative impact on GDP growth suggests that austerity measures associated with IMF loans may hinder growth in the short run, potentially leading to a cycle of dependency on loans without fostering sustainable development.

When incorporating corruption into the equations, the effects on HDI growth manifest some change (3.3 and 3.4). Firstly, no significant effect of IMF loan growth on HDI growth is observed any more. Secondly, if an increase in IMF loans is accompanied by a reduction in corruption, this has significantly positive effects on HDI growth. Thirdly, the effects of the additional control variables remain broadly unchanged compared to those observed in Table 9. Finally, concerning mortality growth (3.9 and 3.10), we still find the significantly negative influence of IMF loan growth, as observed in Table 9. Moreover, this effect is strengthened if IMF loans are accompanied by a reduction in corruption. This underscores the importance of accompanying IMF loans with obligations or incentives to reduce corruption, as it can have a significant impact on mortality rates.

Random Effects Model with Control of Corruption

The analysis of the real GDP model reveals several key findings: a 1% increase in IMF loans is associated with a 0.129% increase in real GDP, which is significant at the 1% level. Enhancing the control of corruption by one unit correlates with a substantial 31% increase in real GDP, which is also significant at the 1% level. A one-unit increase in gross capital formation (GCF) results in a 0.702% increase in real GDP, which is significant at the 5% level. The inflation rate shows significance at a 10% level.

The *Human Development Index* (HDI) model indicates that a 1% increase in IMF loans leads to a decrease in HDI by 0.00022 units, which is significant at the 1% level. Gross capital formation (GCF) and education are significant at the 5% level. If all independent variables are held constant at zero, HDI is projected to be 0.198. In the mortality rate model, a 1% increase in IMF loans correlates with a 0.04828 units reduction in the mortality rate (significant at the 1% level). A one-unit increase in corruption control results in a 6.636 units decrease in the mortality rate (significant at the 5% level).

Table 10. Estimated random effects model with control of corruption

	RGDP	HDI	MORT	SCEI
IMF	0.129	0.022	-4.828	2.240
	(11.75)***	(10.49)***	(10.03)***	(3.10)**
Corruption	0.271	0.005	-6.636	-4.908
	(3.67)***	(0.37)	(2.07)**	(1.08)
IMF - Corruption	0.006	0.001	0.188	0.324
	(1.87)*	(2.70)***	(1.69)*	(1.59)
GCF	0.007	0.001	-0.041	0.136
	(2.30)**	(2.60)**	(0.30)	(0.74)
Education	-0.001	0.007	-0.200	0.729
	(0.07)	(3.43)**	(0.41)	(1.09)
Trade	0.001	-0.0001	-0.053	0.061
	(0.27)	(0.28)	(0.35)	(0.33)
Price	-0.003	-0.001	0.196	-0.036
	(1.78)*	(3.02)**	(4.23)***	(0.29)
FDI	-0.005	-0.002	0.504	-0.143
	(0.90)	(2.13)*	(2.13)**	(0.43)
Population	-0.204	-0.034	7.229	-1.965
	(4.80)***	(5.05)**	(3.92)***	(1.14)
_cons	23.243	0.198	127.836	37.327
	(67.32)**	(3.76)**	(9.28)**	(2.09)*
N	192	227	215	192
R²	0.60	0.51	0.50	0.09
Prob > chi²	0.0000	0.0000	0.0000	0.0592

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Source: based on the author's calculations.

Generalized Method of Moments (GMM) with Control of Corruption

The model exhibits dynamic characteristics, showing a significant positive effect of the previous year's GDP on the current GDP. Specifically, a 1% increase in last year's GDP leads to a 0.989% increase in the current GDP. When independent variables are set to zero, the estimated real GDP is 0.340. Regarding *Human Development Index* (HDI), IMF loans positively impact it; a 1% increase in loans corresponds to a 0.002% increase in HDI, which is converted to 0.00002 units.

The mortality rate model shows dynamic characteristics, where the previous year's mortality rate significantly influences the current year's rate. Specifically, a 1-unit increase in the last year's rate results in a 0.946-unit increase in the current year's rate at the 1% significance level. Additionally, IMF loans have a significant negative effect on mortality; a 1% increase in loans leads to a 0.140% decrease in the mortality rate, also significant at the 1% level. In the school enrollment model, the previous year's enrollment positively affects the current year's enrollment. A 1-unit increase in last year's

enrollment results in a 0.474-unit increase in the current year's enrollment at the 1% significance level. Furthermore, a 1% increase in IMF loans correlates with a 1.587% increase in school enrollment, significant at the 5% level.

Table 11. Generalized method of moments (GMM) with control of corruption

	RGDP	HDII	MORT	School
IMF	0.989			
	(179.47)**			
Corruption		0.965		
		(189.30)**		
IMF - Corruption			0.946	
			(465.10)**	
GCF				0.474
				(5.36)**
Education	-0.002	0.002	-0.140	1.587
	(0.89)	(7.84)**	(5.93)**	(2.08)*
Trade	0.025	0.002	-0.133	-6.462
	(1.28)	(1.20)	(0.80)	(1.09)
Price	-0.002	0.0001	-0.032	0.382
	(1.77)*	(1.80)*	(4.43)**	(1.45)
FDI	0.0001	0.0001	-0.054	0.332
	(0.82)	(3.65)**	(12.18)**	(2.19)*
Population	-0.002	0.001	-0.117	0.292
	(1.21)	(6.21)**	(6.22)**	(0.45)
IMF	-0.001	0.0001	-0.052	0.056
	(1.10)	(5.05)**	(13.37)**	(0.43)
Corruption	-0.001	0.00001	0.002	-0.034
	(3.26)**	(1.72)*	(1.24)	(0.31)
IMF - Corruption	0.004	0.00009	0.073	-0.039
	(5.04)**	(1.18)	(7.93)**	(0.13)
GCF	0.011	0.0004	0.103	0.295
	(3.64)**	(1.37)	(3.05)**	(0.33)
_cons	0.340	-0.015	5.420	4.015
	(2.34)*	(3.38)**	(9.69)**	(0.23)
N	180	216	203	180
F-statistic	0.000	0.000	0.000	0.000
Sargan Test	0.000	0.000	0.000	0.424
AR(2)	0.088	0.894	0.187	0.018

* p<0.05; ** p<0.01

Source: based on the author's calculations.

Conclusion

In this paper, we empirically estimated the effects of IMF loans on economic growth and human development, by using various indicators. Additionally, we incorporated the role of corruption into the analysis to explore whether IMF loans become more or less effective under different levels of corruption. The small coefficients indicate that the influence of IMF loans on economic indicators is subtle and may require further investigation. This raises questions about the effectiveness of IMF interventions and whether they are sufficient to stimulate substantial economic growth in highly indebted countries. Policymakers should consider these findings when designing loan conditions and reform packages to ensure that they are really impactful.

The results suggest that IMF loans negatively impact economic growth while reducing mortality rates. This dual effect raises concerns for policymakers, as short-term austerity measures linked to IMF loans can hinder economic activity, potentially leading the public to blame the IMF for downturns. To maintain public support for the necessary reforms, the IMF should consider easing down short-term consolidation efforts so that to foster growth. Additionally, the interaction between IMF loans and corruption indicates that *Human Development Index* (HDI) growth improves with both IMF loans and reduced corruption, while further lowering mortality rates. This suggests that IMF programs should prioritize anti-corruption measures in order to enhance human development.

The study focuses on short-term effects, highlighting the need for further research into the medium- to long-term impacts of IMF loans and corruption. Future studies could utilize panel vector autoregression to explore these dynamics, although data limitations in developing countries may pose challenges. Such research would be crucial for understanding the lasting impacts of IMF loans on economic and human development.

Policy Recommendations

- The findings urge the IMF to re-evaluate the conditions attached to loans. If the coefficients remain small, it may suggest that the current policies are ineffective in promoting growth. The IMF might need to incorporate more flexible and supportive measures that would facilitate growth while still addressing the fiscal challenges of borrowing countries.
- IMF loans should always be accompanied with measures tailored to reduce corruption. Lower corruption levels increase the effectiveness of these loans, especially in improving human development and reducing mortality.
- The IMF should consider relaxing short-term austerity measures to help indebted countries maintain economic growth while implementing the necessary reforms.

Limitations

One limitation of this study is the relatively small sample size of 13 countries, which may affect the robustness and generalizability of the findings. Additionally, the sample

is unbalanced, potentially introducing bias and limiting the ability to draw definitive conclusions about the relationships among the variables.

Data Availability Statement

All data will be made available upon reasonable request.

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Appendix

Table 1. Descriptive statistics and unit root tests

	GDP	HDI	School	Life	Mortality	IMF	Corruption	GCF	Education	Trade	Price	FDI	Population
Descriptive Statistics													
Mean	3.51	0.90	1.47	0.53	-3.38	34.26	-0.62	3.50	0.32	4.24	13.29	33.04	1.80
Maximum	15.33	4.40	128.27	2.49	2.07	985.04	0.64	57.12	97.03	186.45	325.00	2873.16	3.76
Minimum	-15.14	-3.82	-33.33	-2.01	-10.70	-95.20	-1.50	-47.12	-67.71	-55.80	-1.20	-2182.55	-1.05
Standard Deviation	4.10	0.95	11.04	0.65	1.61	132.20	0.46	14.65	13.81	21.43	7.01	304.87	1.04
Panel Unit Root Tests													
Levin et al. (2002)	-3.90 (0.00)	-3.95 (0.00)	-8.09 (0.00)	-7.03 (0.00)	-2.32 (0.01)	-9.81 (0.00)	-2.40 (0.01)	-9.44 (0.00)	-11.64 (0.00)	-10.48 (0.00)	-2.81 (0.01)	-10.72 (0.00)	-1.68 (0.05)

Notes. Panel unit root test testing for a common unit root as introduced by Levin et al. (2002). For the unit root tests, we show the corresponding p-values in parentheses.

Table 2. Pairwise correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) GDP	1											
(2) IMF	0.501*	1										
(3) Corr	0.037	-0.104	1									
(4) Mortality	-0.175*	-0.205*	-0.493*	1								
(5) School	0.287*	0.129*	0.207*	-0.587*	1							
(6) HDI	0.382*	0.310*	0.443*	-0.880*	0.604*	1						
(7) GEI	-0.188*	-0.058	0.398*	-0.475*	0.273*	0.383*	1					
(8) price	-0.187*	-0.068	-0.209*	0.361*	-0.119*	-0.235*	-0.043	1				
(10) FDI	-0.172*	-0.115*	0.130*	0.136*	-0.015	-0.080	0.189*	0.560*	1			
(11) GCF	-0.281*	-0.361*	-0.059	0.086	0.045	-0.102	0.068	0.120*	0.147*	1		
(12) Trade	-0.511*	-0.205*	-0.029	0.032	-0.062	-0.127*	0.221*	0.403*	0.440*	0.289*	1	
(13) POP	-0.207*	-0.298*	-0.377*	0.713*	-0.336*	-0.712*	-0.381*	0.220*	-0.011	0.109	0.023	1

Source: based on the author's calculations

Table 3. Cross dependence test

$RGDP [CountryID,t] = Xb + u[CountryID] + e[CountryID,t]$ Estimated results: $ \quad Var \quad sd = \sqrt{Var}$ -----+----- logReal~P .7390468 .8596783		
	VIF	1/VIF
FDI	1.699	.589
INF	1.695	.59
TISI	1.459	.686
POP	1.369	.731
GEI	1.321	.757
LIMFL	1.229	.814
GCFI	1.168	.856
Mean VIF	1.42	.
$e .0247097 .1571933$ $u 1.502486 1.225759$ Test: $Var(u) = 0$ $chibar2(01) = 1708.87$ Prob > $chibar2 = 0.0000$		

Table 4. Hausman Test

Hausman (1978) specification test

	Coef.
Chi-square test value	2.33
P-value	.969

Table 5. Normality Test

Jarque-Bera normality test: 28.59 Chi(2) 6.2e-07
Jarque-Bera test for Ho: normality:

Table 6. VIF Test

	VIF	1/VIF
FDI	1.699	.589
INF	1.695	.59
TISI	1.459	.686
POP	1.369	.731
GEI	1.321	.757
LIMFL	1.229	.814
GCFI	1.168	.856
Mean VIF	1.42	.

Table 7. Breusch-Pagan for Heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroscedasticity Ho: Constant variance Variables: fitted values of LRGDP $\chi^2(1) = 0.09$ Prob > $\chi^2 = 0.76$

Examining the Financial Development Channels Affecting Economic Growth in Turkey

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Abstract. In the early 1980s, Turkey took steps towards financial liberalization. Accordingly, policymakers have implemented policies for the development of the financial system. Since then, developments in the banking sector have driven economic growth and met the private sector's demand for funds. The research problem involves analyzing the relationship between financial development and economic growth in Turkey, which is crucial in determining the effectiveness of policies implemented for financial development. Determining the source through which financial development is vital for economic growth is also critical in designing these policies. This research examines the channels through which financial development impacts economic growth in Turkey. By using data from 1974 to 2023 for Turkey, this study conducted a Granger causality test based on VECM and the Toda Yamamoto method to analyze the causal relationship between economic growth and financial development. The analysis also included impulse response functions. Our study reveals that financial development contributes to economic growth. Policymakers should implement policies that prioritize the development of the financial system.

Keywords: Financial development, economic growth, VECM, Toda-Yamamoto, impulse response function, Turkey.

1. Introduction

Have Turkey's financial development efforts over the years contributed to economic growth? If so, which components of the financial system play a role in this contribution? In 1980, the financial system began to advance in Turkey. The early 1980s witnessed significant measures implemented, including the development of the capital and interbank money markets. Furthermore, the Government implemented measures to liberalize foreign exchange legislation. These developments enhanced the efficiency of the financial system and had a positive effect on the real economy. Turkey adopted an open economy approach and liberalized its financial sector by implementing significant reforms since the 1980s. The process aimed to target the liberalization of capital flows on a domestic and international level and the expansion of trade volumes and foreign investment (Pamuk, 2019; Firat, 2009).

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Many studies on the relationship between financial development and economic growth use Turkish data. Studies analyzing the relationship between financial development and economic growth have mainly used time series methods. Examples of these studies are Kuzucu (2022), Coşkun and Kuloğlu (2022), Aşık (2023), Kılıç et al. (2019), and Eroğlu and Yeter (2021). These studies used loans to the private sector as an indicator of financial development. On the other hand, they did not analyze the development of the capital market. In addition, although the studies conducted by using quarterly data cover the data for 2023, the studies conducted using annual data include the latest data for 2019 only. Finally, the studies that used annual data did not incorporate significant structural changes in the Turkish economy into their models. Our study differs from recent studies in that it considers the development of the capital market, covers a more extended period, and examines structural changes in the Turkish economy. Therefore, the research problem in this study is whether the financial development policies implemented in Turkey for a long time contribute to economic growth. Another research problem is to determine the channels through which these policies contribute to economic growth. In other words, we aim to assess the contribution of the components of the financial system.

This study set out to answer the following questions: (1) *Has financial development in Turkey since the 1980s impacted economic growth?* (2) *If so, what is the source of this impact?* We expect the development of the Turkish banking system and capital markets to facilitate the transfer of savings to investments and boost consumption expenditures. Therefore, the study hypothesizes that financial development positively affects economic growth. Furthermore, given the high level of development in Turkey's banking system, the study also hypothesizes that the source of financial development comes mainly from the banking system.

This study aims to investigate the channels through which financial development affects economic growth in Turkey. In this context, we will determine whether the banking system or the capital market is more effective for economic growth. For this purpose, we will frequently use time series methods, as used in the literature. First, we will apply VECM and impulse-response functions for our analyses. Next, we will conduct Toda-Yamamoto analysis to provide methodological support. We will also determine short-term and long-term effects by using these methods.

This study examines the causal relationship between financial development and economic growth in Turkey from 1974 to 2023. This study makes various contributions to the existing literature. First, this research analyzes the relationship between financial development and economic growth over a very long period, considering the structural breaks in the Turkish economy. The financial system in Turkey has undergone significant development since the 1980s; therefore, this study provides a long-term perspective on the consequences of the combinations of financial development. Secondly, the study uses components of financial development in Turkey in econometric models. In this framework, we will determine the effects of the banking system and the capital market on economic growth separately.

We organize the rest of the article as follows: Section 2 presents the theoretical and empirical literature. Section 3 describes the model specification and data. Section 4 includes the empirical estimations. Section 5 presents the robustness check. Section 6 presents a discussion, and the final section comprises the concluding remarks.

2. Theoretical and Empirical Literature Review

The financial system transfers surplus funds from economic units to those in need. This leads to an increased investment and economic growth. Current developments in the financial system enhance its positive impact on economies. The fact that the total value of all financial assets and liabilities exceeds that of the entire economy demonstrates the financial system's critical role in the modern world. The significance of financial tools to economic growth is evident during the economy's up and down cycles (Rutkauskas, 2015). King and Levine (1993) found a strong correlation between financial development, real *per capita* GDP growth, physical capital accumulation, and improvements in physical capital efficiency.

Schumpeter (1911) conducted the first study of the correlation between financial development and economic growth, thereby marking the beginning of theoretical explanations on this subject. According to the prevailing viewpoint, supported by Schumpeter's seminal study in 1911, the stock market's growth benefits the economy by providing liquidity and a method for distributing while minimizing risks. Furthermore, it facilitates the effective distribution of resources toward profitable projects, minimizes expenses related to information and transactions, and eventually empowers organizations to pursue successful ventures (Ibrahim, 2011). According to the Schumpeter's model, the financial sector's growth is one of the main factors that trigger economic growth.

Many economists have recognized the crucial role of financial markets in economic development. Schumpeter (1934) noted the role of financial intermediaries in directing resources toward more productive investments, while Bagehot (1873) and Hicks (1969) emphasized the significance of financial development for the economy. The authors believed that the presence of financial markets and institutions played a crucial role in facilitating the industrial revolution. This was achieved by enabling enterprises to borrow and lend, encouraging the adoption of new technologies, and pursuing riskier yet potentially more profitable investments (Capasso, 2004). Moreover, McKinnon (1973) and Shaw (1973) describe financial liberalization as establishing higher interest rates that equalize the demand and supply of savings. According to the two authors, higher interest rates will enhance savings and financial intermediation while improving savings efficiency (Balassa, 1990).

Patrick (1966) provided two definitions of the connection between financial development and economic growth. Economic growth closely correlates with the increasing demand for financial services. Financial development enables the effective transformation of savings into investments, which supports economic growth. Moreover, according to Robinson (1952), there is a correlation between the growth of the financial system and

economic development. Certain viewpoints argue that financial development does not impact economic growth. The pioneer of these investigations, Lucas (1988), highlighted that physical and human capital and technological advancements drive economic progress.

Several analyses in the literature on the relationship between financial development and economic growth employ time series techniques for a specific country, while others rely on estimating panel data models that combine data from many countries. Some studies in the literature on financial development and economic growth employ time series techniques that focus on a particular country, while others combine data from multiple countries to construct panel data models. While several of these models focus on the influence of financial development on economic growth, others examine the causal relationship between these two variables.

Recent studies that conduct causality analyses based on panel data models demonstrate the relationship between economic growth and financial development. Mtar and Belazreg (2021) can be given as an example of these studies. Once more, recent studies (e.g., Nguyen et al., 2022; Pradhan et al., 2013; Çınar et al., 2024) have proven a two-way causality relationship between economic growth and financial development.

The relationship between financial development and economic growth in countries may also depend on their income levels. Canbaloglu and Gürgün (2019) conducted a study where they found that there was no relationship between financial development and economic growth in countries in the upper-middle and high-income categories. Despite this, they discovered a unidirectional causality, indicating that financial development drives economic growth in countries classified as low- and lower-middle income.

Several studies have examined the relationship between financial development and economic growth by employing panel data techniques and combining data for country groups. For instance, the studies conducted by Ibrahim and Alagidede (2018) and Asante and Takyi (2023) have determined that the development of financial systems supports economic growth in sub-Saharan countries. Ahmed (2016) conducted another study on countries in sub-Saharan Africa, which found that international financial integration positively impacts economic growth by enhancing financial development. Bist (2018) demonstrates that financial development in low-income countries positively influences economic growth. In their study, Ekanayake and Thaver (2021) employed a large dataset to determine various panel relationships that exhibit differences across various country groups within developing countries. According to Abbas et al. (2022), financial development in middle-income countries contributes to economic growth, with a particularly significant impact in upper-middle-income countries. While most of the literature indicates that financial development has a positive effect on economic growth, some studies suggest that financial development has a negative impact on economic growth, as shown by Wen et al. (2022).

In addition to the impact of financial development on economic growth, some studies examine the consequences of financial reforms. For instance, Boikos et al. (2022) determined that financial reforms have a greater impact on economic growth than financial development in developed and developing countries. Furthermore, researchers have ex-

amined the relationship between financial development and economic growth on a sectoral basis. Ustarz et al. (2021) conducted a study that demonstrated the positive influence of financial development on the growth of the agriculture and service sectors. After a certain point, financial development begins to influence the industry sector.

Furthermore, researchers have conducted studies in the literature by using the panel data technique, employing data from industrialized countries. Swamy and Dharani (2019) found a long-term inverted U-shaped relationship between financial development and economic growth. Financial development facilitates firms' financing of private investment, thereby supporting economic growth. Castro et al. (2015) used firm-level data to demonstrate how financial development in Brazil influences investments of firms.

Many studies have been conducted in Turkey to investigate the causal relationship between economic growth and financial development. Studies examining the causal connection between financial development and economic growth in Turkey have produced different findings. While some studies, such as Aşık (2023), Acaravcı et al. (2007), Eroğlu and Yeter (2021), and Şeyranlıoğlu (2024), indicate that financial development leads to economic growth, other studies, such as Aslan and Küçükaksoy (2006), Kandır et al. (2007), Taşseven and Yılmaz (2022), Atay (2020), and Özcan and Arı (2011), suggest that economic growth leads to financial development. Some studies (Demirhan et al., 2011; Kuzucu, 2022; Coşkun and Kuloğlu, 2022; Kılıç et al., 2019) have found a bidirectional causal relationship. Moreover, Atgür (2019) demonstrates that financial development does not significantly impact economic growth.

Furthermore, several studies in the literature indicate that there is no causal relationship between financial development and economic growth. Such studies include Nur (2021) and Tekin et al. (2024), Shahzadi et al. (2023), Çetin et al. (2023), Alhassan et al. (2022), and Li et al. (2021) have all recently conducted studies which undertook to estimate the relationship between financial development and variables such as energy consumption and air pollution. Moreover, Sghaier (2023), Asteriou et al. (2024), and Emara and Said (2021) have conducted research indicating that the influence of financial development on economic growth is dependent on trade openness, fiscal policy, and governance. Studies such as those performed by Younsi and Bechtini (2020) have investigated the influence of financial development on income inequality.

3. Data and Model Specification

3.1. Data

Econometric estimations cover the years 1974 to 2023. The reason for selecting this period was the availability of data. The models use annual time series data. The data used for the models is a yearly time series dataset. Financial development indicators were based on two variables. The first variable is the total bank credit to the private sector, expressed as a percentage of GDP (*cre*); the second is the share of the broadly defined money supply in GDP (*m2*). We depicted that previous studies frequently used these indicators. Since our research covered an extended period, we were able to obtain these indicators consistently.

The dependent variable, economic growth, is defined as the natural logarithm of the real GDP (*gdp*). The control variable, trade openness, is the sum of exports and imports of goods and services expressed as a percentage of GDP (*open*). We sourced all variables from the *World Bank* (2024). After 1980, outward-oriented policies were implemented in the Turkish economy, and financial liberalization began. This situation made significant contributions to financial development. In addition, the Turkish economy faced two major crises in 1994 and 2001, independent of the global crises. In this context, we included dummy variables in the econometric models for the period after 1980 and the 1994 and 2001 crises. The Appendix displays summary statistics and correlation matrix in Tables A1 and A2.

3.2. Econometric Model

The first step in analyzing the relationship between financial development and economic growth is to determine if the series has unit roots. This study employs the *Augmented Dickey-Fuller* (ADF) and *Phillips-Perron* (PP) unit root tests to determine whether the series in question has a unit root (Dickey and Fuller, 1979 and 1981; Phillips, 1987; Phillips and Perron, 1988). We will proceed with our investigation by applying cointegration tests if we find a unit root, or $I(1)$, in the series. This study employs the *Johansen* multivariate cointegration technique, as Johansen (1988) and Johansen and Juselius (1990) suggested. This method offers two likelihood ratio tests, employing trace and maximum eigenvalue statistics. In the trace and maximum eigenvalue tests, the null hypothesis is that the number of cointegrating vectors is less than or equal to r , where r is 0, 1, or 2. In the λ_{trace} and λ_{max} tests, the null hypothesis is tested against at least $r + 1$ cointegrating vector and $r + 1$ cointegrating vector, respectively.

We will perform the causality test after the cointegration test. According to Engle and Granger (1987) and Granger (1988), the cointegration of two time series variables results in at least a unidirectional Granger causality. Granger (1988) asserts that when cointegration exists between $I(1)$ variables, the Granger causality test necessitates the incorporation of the error correction term derived from the cointegration equation. When there is a long-term relationship between the variables, we apply the causality analysis using VECM, as shown below.

$$\Delta gdp_t = \alpha_1 + \sum_{i=1}^p \beta_{1i} \Delta gdp_{t-i} + \sum_{i=1}^p \phi_{1i} \Delta cre_{t-i} + \sum_{i=1}^p \lambda_{1i} \Delta open_{t-i} + \psi_1 z_{t-1} + \varepsilon_{1t} \quad (1)$$

$$\Delta cre_t = \alpha_2 + \sum_{i=1}^p \beta_{2i} \Delta gdp_{t-i} + \sum_{i=1}^p \phi_{2i} \Delta cre_{t-i} + \sum_{i=1}^p \lambda_{2i} \Delta open_{t-i} + \psi_2 z_{t-1} + \varepsilon_{2t} \quad (2)$$

$$\Delta open_t = \alpha_3 + \sum_{i=1}^p \beta_{3i} \Delta gdp_{t-i} + \sum_{i=1}^p \phi_{3i} \Delta cre_{t-i} + \sum_{i=1}^p \lambda_{3i} \Delta open_{t-i} + \psi_3 z_{t-1} + \varepsilon_{3t} \quad (3)$$

where Δ is the difference operator, ε_t is zero mean, serially uncorrelated random error terms, p represents the number of lags, and z_{t-1} is the error correction term, the lagged values of the error term derived from the estimated long-term cointegration relationship.

The error correction term shows the short-run deviations from the long-run equilibrium, reflecting the speed of adjustment of any disequilibrium to the long-run equilibrium. If there is no cointegration relationship, we estimate Equations (1–3) without using error correction terms. The choice of the model in this study relies on the existing cointegration relationship. We employ dummy variables in VECM to explore the effects of the 1994 and 2001 crises and the period of financial liberalization following 1980. We assign the dummy variable to one during periods of crisis and financial liberalization, and to zero otherwise.

To examine causality from financial development to economic growth, we computed the *Wald* test statistics under the null hypothesis that all coefficients of $\phi_{1i}=0$ as a group. Similarly, when performing the Wald test to determine causation from economic growth to financial development, the null hypothesis being tested is that all coefficients of $\beta_{2i}=0$ as a group. After estimating Equations (1–3), if the null hypothesis of all coefficients of $\phi_{1i}=0$ or the coefficient of $\psi_{1i}=0$ is rejected, then it is concluded that there is a causality from financial development to economic growth. On the other hand, if the null hypothesis of all coefficients of $\beta_{2i}=0$ or the coefficient of $\psi_{1i}=0$ is rejected, then the causality relationship is from economic growth to financial development.

We will also conduct causality analyses using the *m2* variable, a different financial development indicator, instead of the *cre* variable in Equations (1–3). Rejecting the null hypothesis that the explanatory variables as a group are different from zero indicates a short-run causality from the explanatory variables to the dependent variables. The statistical significance of the coefficient ψ_{1i} indicates long-term causality from explanatory variables to dependent variables.

4. Empirical Results

Table A1 in the Appendix presents the descriptive statistics for the variables used in the econometric model. The Jarque-Bera test reveals a normal distribution of all variables at the 5% level. The standard deviation indicates the extent of dispersion in the data from the mean value. The data show the highest variation in *cre*. Table A2 in the Appendix displays the correlation between the variables. Table A2 shows a strong correlation between *gdp*, *cre*, *m2*, and *open*.

Table 1 represents the ADF and PP test results for the levels and first differences of all variables used in the econometric models. According to the ADF and PP tests, all variables are integrated in order one in first differences; thus, all variables are I(1) or non-stationary. We determine the optimal lag by minimizing Akaike's FPE criterion. Since the unit root test results show that all variables are I(1), we can use the Johansen cointegration technique. We will, therefore, perform both short-term and long-term analyses. Table 2 presents the results of the Johansen cointegration test for the *cre* and *m2* variables, which represent financial development indicators. Table 2 indicates that there is a statistically significant cointegration relationship between the variables. Therefore, we conclude that *gdp*, *cre*, and *open* have a long-run relationship. This relationship is also valid when *m2* is considered the financial development variable. Table 2 displays the normalized cointegrating coefficients at the bottom.

Table 1. Unit root tests

<i>Series</i>	ADF	PP
gdp	0.40 (0)	0.68 (5)
Δ gdp	-6.80 (0)***	-6.87 (4)***
cre	-2.19 (0)	-0.94 (3)
Δ cre	-2.06 (2)	-4.71(1)***
m2	1.80 (10)	-0.79 (17)
Δ m2	-5.35 (3)***	-16.03 (47)***
open	-0.74 (2)	-0.71 (7)
Δ open	-6.71(1)***	-7.06 (12)***

Source: the author's computation

PP is the Phillips-Perron, and ADF is the Augmented Dickey-Fuller test.

*** signifies the rejection of the non-stationary null hypothesis at the 1% level.

The optimal lag order for the ADF test is chosen by considering the Akaike Information Criteria, represented in parentheses.

The bandwidth is chosen for PP tests using the *Newey-West* method, and spectral estimation uses the Bartlett kernel, represented in parentheses.

The 1%, 5%, and 10% critical values for the ADF and PP tests are -3.57, -2.92, and -2.60, respectively.

Table 2. Cointegration test results

	(gdp, cre, open)				(gdp, m2, open)		
Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.	Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Prob.
r = 0*	45.74	29.79	0.0009	r = 0*	39.15	29.79	0.0305
r ≤ 1	12.60	15.49	0.3312	r ≤ 1	11.02	15.49	0.7438
r ≤ 2	1.29	3.84	0.5184	r ≤ 2	1.62	3.84	0.2215
gdp= 24.95 + 0.01 cre + 0.04 open (0.001) (0.002)							
gdp= 24.87 + 0.02 m2 + 0.03open (0.005) (0.005)							

Source: the author's computation

* denotes rejection of the hypothesis at the 5% level.

The optimal lag order for the cointegration test is determined as 3, chosen by considering the Akaike Information Criteria. Standard errors of the coefficients in the cointegration equations are shown in parentheses.

Below Table 2, we display the results of the cointegration equation showing the long-term effect of financial development indicators on economic growth. The first equation shows that the effect of credit to the private sector on economic growth is positive. The second equation shows that the broadly defined money supply contributes positively to economic growth. According to the cointegration equation, both financial development indicators positively affect economic growth in the long run.

The Granger causality test based on VECM investigated the causal relationship between financial development and economic growth. The test results indicate that the credit

supply to the private sector is the leading cause of short-term and long-term economic growth. Using money supply growth as the indicator for financial development revealed no causal relationship. The causality test results show a short-term causality from the openness indicator to bank credits given to the private sector. In addition, there is a two-way causality between the openness indicator and broadly defined monetary growth in the short term. Table 4 presents diagnostic tests at the bottom to assess the robustness of the model. Diagnostic tests include the *Breusch-Godfrey* serial correlation LM test, the *Breusch-Pagan-Godfrey* heteroskedasticity tests, and *Jarque-Bera* normality tests. The diagnostic test results show the absence of serial correlation, the absence of heteroskedasticity, and the presence of normality.

We apply the *CUSUM* and *CUSUM-square* tests to determine the structural stability of Equations (1–3). The CUSUM test is based on the cumulative sum of the recursive residuals, whereas the CUSUM-square test is based on the squared recursive residuals. According to the test results, the models have structural stability in general. CUSUM and CUSUM square tests for models where the dependent variables are *gdp*, *cre*, and *m2* are shown in the Appendix in Figures (A1–A6).

Table 3. Causality test results (*gdp*, *cre*, *open*)

Dependent Variable	Δgdp	Δcre	$\Delta open$	$z_{t-1}(t)$
Δgdp	-	8.16**	1.73	-0.10**
Δcre	4.60	-	11.98***	-
$\Delta open$	3.47	4.01	-	-
Diagnostic Tests				
Dependent Variable	J.B.	LM(2)	B-P-G	
Δgdp	0.11	0.75	0.90	
Δcre	0.52	0.36	0.55	
$\Delta open$	0.65	0.57	0.34	

Source: the author's computation

Table 4. Causality Test Results (*gdp*, *m2*, *open*)

Dependent Variable	Δgdp	$\Delta m2$	$\Delta open$	$z_{t-1}(t)$
Δgdp	-	3.07	1.84	-0.10**
$\Delta m2$	0.92	-	15.29***	-
$\Delta open$	10.87**	20.45***	-	-
Diagnostic Tests				
Dependent Variable	J.B.	LM(2)	B-P-G	
Δgdp	0.15	0.32	0.92	
$\Delta m2$	0.71	0.90	0.71	
$\Delta open$	0.19	0.10	0.70	

Source: the author's computation

Impulse response function analyses were conducted to determine the relationship between financial development and economic growth. Impulse response functions describe the response of other variables to a one-standard deviation shock in the variables. Figures 1 and 2 display the impulse response functions. It is observed that economic growth responds positively to loans to the private sector, which is an indicator of financial development, in every period (first row, third chart in Figure 1). Furthermore, the response of bank credits to the private sector to economic growth is positive in all periods (second row, third chart in Figure 1). The response of economic growth to the broadly defined money supply, one of the financial development indicators, fluctuates but is generally positive (first row, third chart in Figure 2). On the other hand, the broadly defined response of the money supply to economic growth also shows an up-and-down trend (second row, third chart in Figure 2).

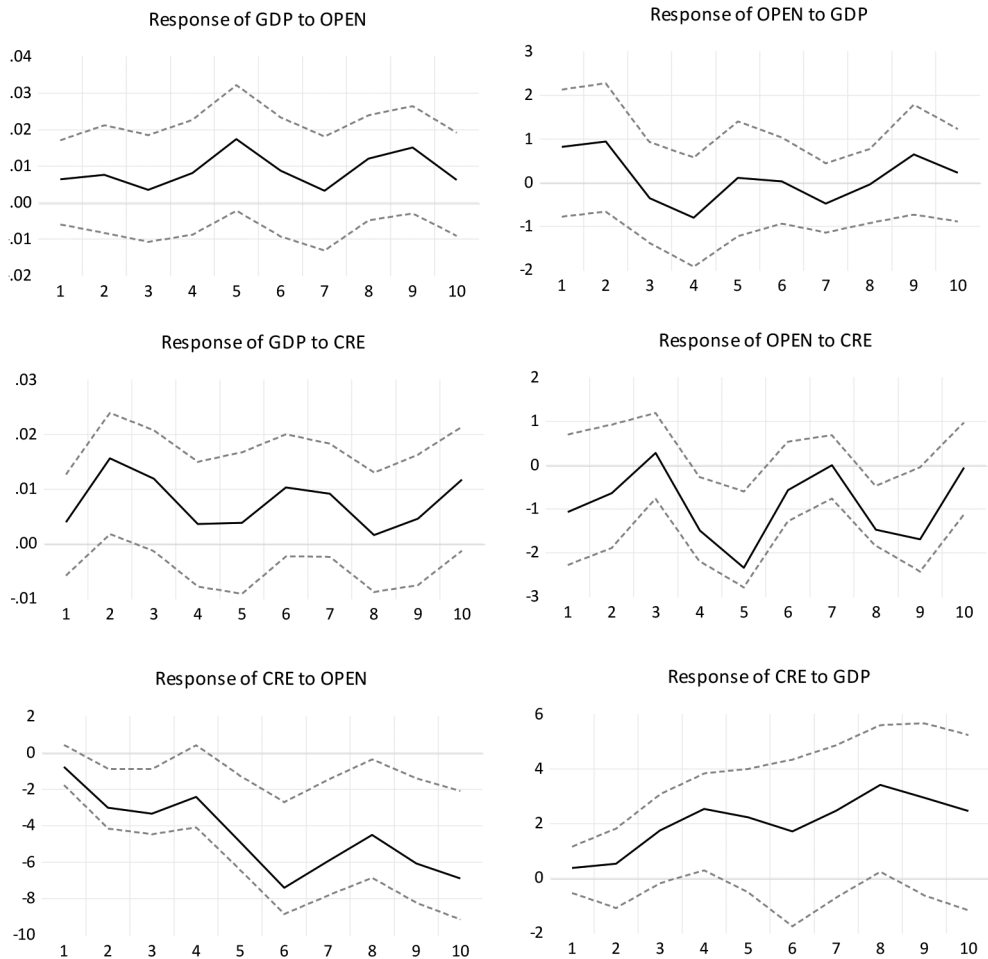


Figure 1. Impulse response functions (*gdp*, *cre*, *open*)

Source: the author's computation

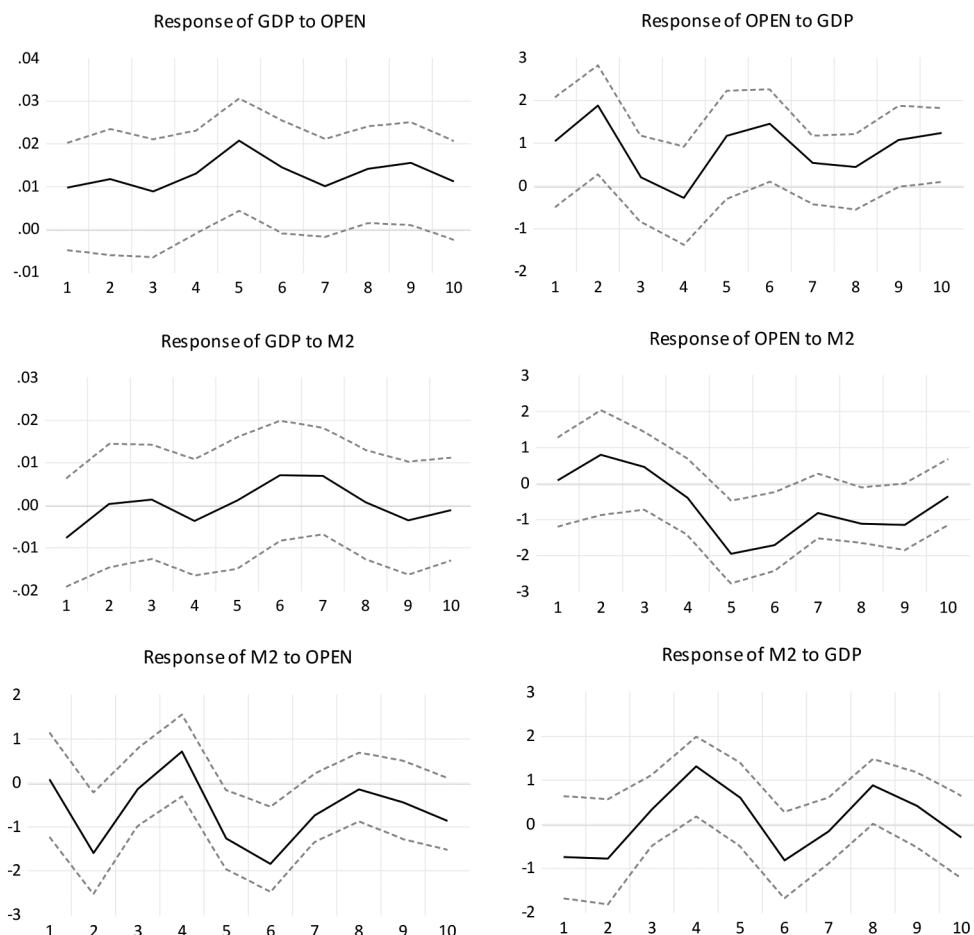


Figure 2. Impulse response functions (*gdp*, *m2*, *open*)

Source: the author's computation

5. Robustness Check

In the first part of the study, we carried out the causality relationship between financial development and economic growth based on VECM. In this part, we carried out two robustness checks to determine the reliability and validity of the findings obtained. Firstly, we conducted a Toda-Yamamoto (1995) (TY) causality analysis to ascertain the causal relationship between the variables. Second, we used market capitalization as the financial development indicator (*cap*) for the robustness check. In TY causality analyses, the variables do not need to be stationary at the same degree and have a cointegration relationship. We determine the maximum integrated degree ($d_{\max}$) of the variables and the appropriate VAR model lag (k) when performing the Toda-Yamamoto causality test. Equations (4–6) show the models to which the Toda-Yamamoto causality test will apply.

The stationarity test results (Table 1) showed that all variables were I(1). The optimal lag of the VAR model was determined according to the AIC criterion, which was 4. To estimate Equations (4–6), we used 5 lags ($dmax=1+k=4$).

$$gdp_t = \alpha_1 + \sum_{i=1}^{k+dmax} \beta_{1i} gdp_{t-i} + \sum_{i=1}^{k+dmax} \phi_{1i} cre_{t-i} + \sum_{i=1}^{k+dmax} \lambda_{1i} open_{t-i} + \varepsilon_{1t} \quad (4)$$

$$cre_t = \alpha_2 + \sum_{i=1}^{k+dmax} \beta_{2i} gdp_{t-i} + \sum_{i=1}^{k+dmax} \phi_{2i} cre_{t-i} + \sum_{i=1}^{k+dmax} \lambda_{2i} open_{t-i} + \varepsilon_{2t} \quad (5)$$

$$open_t = \alpha_3 + \sum_{i=1}^{k+dmax} \beta_{3i} gdp_{t-i} + \sum_{i=1}^{k+dmax} \phi_{3i} cre_{t-i} + \sum_{i=1}^{k+dmax} \lambda_{3i} open_{t-i} + \varepsilon_{3t} \quad (6)$$

Tables 5 and 6 show the Toda-Yamamoto causality analysis results for the variables $m2$ and cre representing financial development indicators. The test results indicate a causality from the cre variable to the gdp variable, as in the VECM-based causality analysis (Table 3). In the Toda-Yamamoto causality analysis, unlike the VECM-based causality analysis, there is a causality from gdp to both cre and $m2$ variables. According to the Toda-Yamamoto analysis, these results indicate a two-way causality between cre and gdp . Diagnostic tests show that the models are generally acceptable. CUSUM and CUSUMSQ tests also show that there was no structural break during the period examined. The results of these tests are not given due to space constraints. They can be provided upon reasonable request.

Table 5. Toda-Yamamoto causality test results (gdp , cre , $open$)

Dependent Variable	gdp	cre	open
gdp	-	15.97***	5.78
cre	11.41**	-	31.36***
open	4.17	6.29	-
Diagnostic Tests			
Dependent Variable	J.B.	LM(2)	BPG
gdp	0.01	0.24	0.86
cre	0.49	0.01	0.64
open	0.60	0.01	0.46

Source: the author's computation

The optimal lag order (k) is determined as 4, chosen by considering the Akaike Information Criteria. The Wald test is applied to k -lagged variables to determine whether there is causality.

Table 6. Toda-Yamamoto causality test results (gdp , $m2$, $open$)

Dependent Variable	gdp	m2	open
gdp	-	2.75	9.02*
m2	16.40***	-	22.99***
open	8.96*	21.02***	

Dependent Variable	gdp	m2	open
Diagnostic Tests			
Dependent Variable	J.B.	LM(2)	BPG
gdp	0.62	0.49	0.30
m2	0.59	0.11	0.73
open	0.11	0.12	0.76

Source: the author's computation

The optimal lag order (k) is determined as 4, chosen by considering the Akaike Information Criteria. The Wald test is applied to k-lagged variables to determine whether there is causality.

In the second robustness check, we use market capitalization as a percentage of GDP (*cap*) as a proxy for financial development. Since we obtained market capitalization data between 1993 and 2022 from the World Bank, we conducted the causality analysis for this period. We detected that the market capitalization variable is stationary at the level $I(0)$. Since the economic growth and openness variables are stationary in their first differences, the Toda-Yamamoto test was performed in the causality analysis. We estimated Equations (4–6) by using the *cap* variable as the financial development indicator instead of the *cre* variable. The optimal lag of the VAR model was determined according to the AIC criterion, which was 2. We estimated Equations (4–6) with 3 lags ($dmax=1 + k=2$). Table 7 displays the results of the Toda-Yamamoto causality analysis for the variable *cap* representing the financial development indicator.

Table 7. Toda-Yamamoto causality test results (*gdp*, *cap*, *open*)

Dependent Variable	gdp	cap	open
gdp	-	19.45***	1.13
cap	0.73	-	0.70
open	4.24	1.15	-
Diagnostic Tests			
Dependent Variable	J.B.	LM(2)	BPG
Gdp	0.63	0.20	0.09
Cap	0.44	0.29	0.56
open	0.84	0.10	0.45

Source: the author's computation

The optimal lag order (k) is determined as 2, chosen by considering the Akaike Information Criteria. The Wald test is applied to k-lagged variables to determine whether there is causality.

Table 7 indicates a one-way causality from the *cap* variable to *gdp*. The results of the causality analyses (Table 3), which used loans to the private sector to indicate financial development, are consistent with this finding. As seen in Table 7, there is no causality from economic growth to the *cap* variable. This finding is also consistent with the results presented in Table 3. Diagnostic tests show that the models are generally acceptable. CUSUM and CUSUMSQ tests also show that there was no structural break during the period

under examination. The outcomes of these tests are not given due to space constraints. They can be provided upon reasonable request. Robustness check results generally show that the causality from financial development to economic growth is valid. These results confirm the findings based on VECM.

6. Discussion

This study aimed to analyze the relationship between financial development and economic growth in Turkey. The results indicate a unidirectional causal relationship from financial development to economic growth, both in the short and long term, over the period under investigation in Turkey. The results of our research demonstrate that financial development contributed to economic growth in Turkey. Considering the TY method, we find a causality from economic growth to financial development.

The causality from financial development to economic growth is valid for loans provided to the private sector and market capitalization. This result shows that economic growth is quite sensitive to developments in the banking system and capital market. The broadly defined money supply, representing financial development, does not cause economic growth. This is because the expansion in the money supply could lead to high inflation, negatively affecting economic growth. Moreover, the impact of economic growth on financial development is mainly due to the banking system. In periods of economic growth, the increasing investment appetite can increase the loans provided to the private sector by the banking system. Additionally, financing increased consumption expenditures, mainly through individual loans, during economic growth may have contributed to this outcome. The results show that capital markets in Turkey can be more sensitive to foreign capital inflows and political developments than to the development of the economy.

These results confirm the validity of the Schumpeterian theory, which posits that financial development is a causal factor in Turkey's economic progress and corroborates Patrick's (1966) supply-leading approach. On the other hand, Robinson's (1952) 'demand following hypothesis' corroborates the findings from the TY method. In this context, the results run in parallel with the theoretical explanations in this field.

Turkey has implemented policies for developing and stabilizing financial markets for many years. The findings are essential because they provide evidence that Turkey's financial development and financial stability policies have yielded positive results. The possible results of the findings can be explained as follows: (1) The development of the financial system in Turkey will positively affect the economy in the future. (2) Giving more weight to the development of the banking system compared to the capital market will significantly impact the economy. (3) Bank loans are a tool for implementing policies to stimulate the economy. (4) There will be an acceleration in bank loans during periods of economic growth.

The results of our research support the findings of previous studies (Aşık, 2023; Acaravcı et al., 2007; Şeyranlıoğlu, 2024; Eroğlu and Yeter, 2021), which showed that financial development led to economic growth. Moreover, the finding that economic growth causes

financial development, obtained by using the TY method, confirms the studies of Özcan and Arı (2011) and Atay (2020).

Policymakers can benefit from the significant policy recommendations provided by the empirical findings. The research findings indicate that the financial system's growth in Turkey since the 1970s contributed to economic growth. Implementing policies to enhance the financial system is crucial to sustaining an average growth rate of 4.5 percent. The empirical results suggest that the financial system is vital for economic growth in Turkey, which is an economy with a robust banking system. Policymakers must prioritize policies designed to eliminate constraints on the financial system's development and ensure financial stability. High inflation has been an ongoing problem in Turkey for a long time. To prevent inflation, policymakers limit the credit possibilities of the financial system, which, in turn, restricts the financial system's influence on economic growth. In this context, it is favorable to implement fiscal and monetary policies rationally so that to ensure that the financial system can perform its functions to the highest level.

Further studies are needed to investigate whether the impact of financial development on economic growth is sensitive to monetary and fiscal policies. Monetary and fiscal policies can play a role in the effect of financial development on economic growth. Implementing monetary policies that effectively reduce inflation will decrease uncertainty and stimulate the private sector's demand for credit, thereby fostering economic growth. Furthermore, the establishment of fiscal discipline will be the foundation for allocating additional resources to the private sector, thereby supporting economic growth. Considering the current implementation of economic policies in Turkey which prioritize price stability and financial stability, further study is necessary to investigate the relationship between the financial system and monetary policies. Moreover, further studies will provide more detailed information on the effects of financial development on sectoral growth rates.

Certain limitations of this study could be addressed in future research. Firstly, we performed analyses with limited data, as we only obtained the annual data. Second, significant economic and political developments affected the Turkish economy during the period examined. Our models incorporate structural changes and crises but do not include economic policies implemented since 2021. This is due to the unavailability of time data necessary to measure the impact of these policies. Despite all these limitations, the study findings provide important information about the relationships between financial development and economic growth.

7. Conclusions

Analyzing the relationship between financial development and economic growth, as well as determining the source of financial development in Turkey, is crucial for assessing the effectiveness of policies implemented for financial development. This study analyzed Turkey's data of 1974–2023 with various time series methods. The results show that financial development contributed to economic growth during the discussed period. This

contribution comes mainly from the banking system. The results show a unidirectional causal relationship from financial development to economic growth in Turkey in the short and long term. Although economic growth affects financial development, methodological differences are observed. The results confirm the validity of the Schumpeterian theory that financial development is a trigger factor in economic growth. The results also support Patrick's (1966) supply-leading approach.

Policymakers in Turkey have long encouraged financial market development and stability. Evidence suggests that Turkey's financial development and stability measures are working. In this context, the development of the financial system in Turkey will significantly impact economic growth in the future. In particular, the development of the banking system will increase this impact. Empirical evidence supports the argument that policies aimed at enhancing financial development in Turkey yield gains by stimulating economic growth. In this context, it is beneficial to continue implementing policies to develop the financial system and ensure financial stability. These policies will enable the private sector to access the funds it needs and increase economic growth.

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Appendix

Table A1. Summary statistics

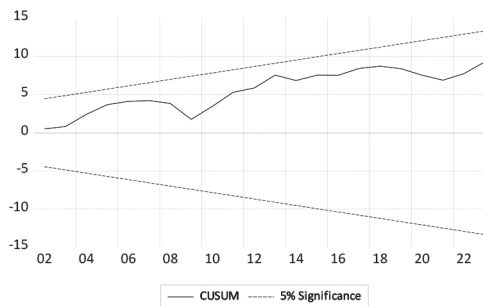
	gdp	cre	m2	open
Mean	26.72	29.99	37.47	41.42
Median	26.69	20.67	33.73	45.19
Maximum	27.85	70.90	71.60	81.17
Minimum	25.69	13.59	18.03	9.10
Std. Dev.	0.63	18.27	13.73	16.15
Skewness	0.14	1.06	0.55	-0.07
Kurtosis	1.85	2.53	2.25	2.69
Jarque-Bera	2.93	9.82	3.73	0.23
Probability	0.23	0.01	0.15	0.89
Obs.	50	50	50	50

Source: the author's computation

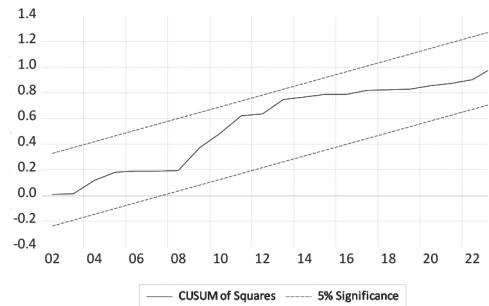
Table A2. Correlation matrix

	gdp	cre	m2	open
gdp	1			
cre	0.81	1		
m2	0.94	0.88	1	
open	0.93	0.67	0.87	1

Source: the author's computation

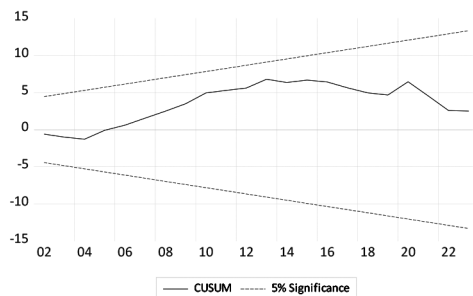


Source: the author's computation

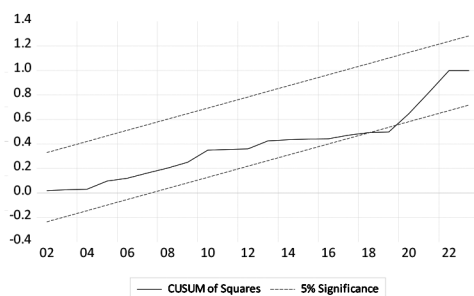


Source: the author's computation

Figure A1. CUSUM and CUSUMSQ tests (dependent variable: *gdp*, independent variables: *cre* and *open*)

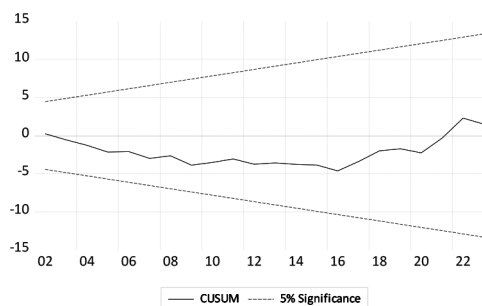


Source: the author's computation

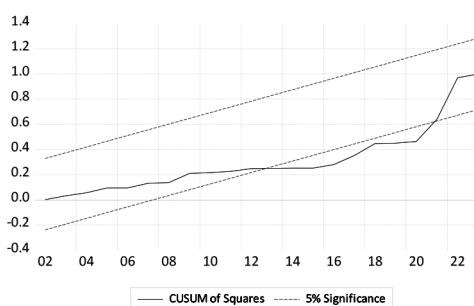


Source: the author's computation

Figure A2. CUSUM and CUSUMSQ tests (dependent variable: *cre*, independent variables: *gdp* and *open*)

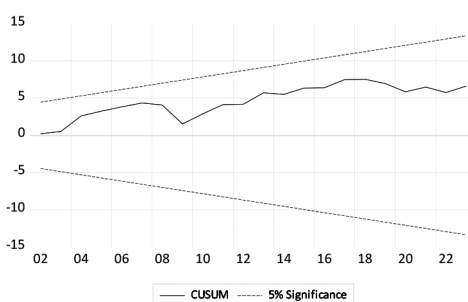


Source: the author's computation

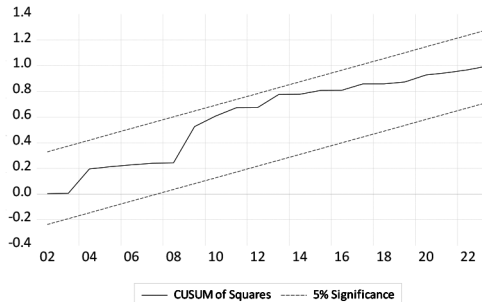


Source: the author's computation

Figure A3. CUSUM and CUSUMSQ tests (dependent variable: *open*, independent variables: *cre* and *gdp*)

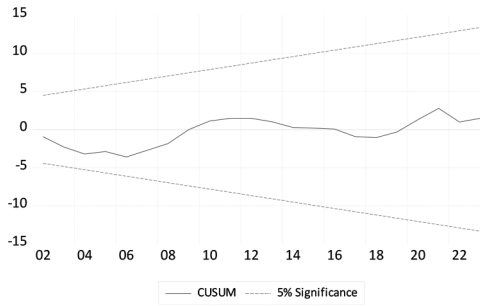


Source: the author's computation

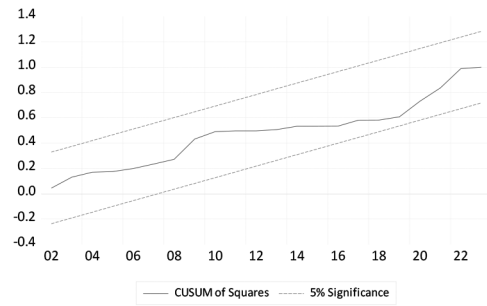


Source: the author's computation

Figure A4. CUSUM and CUSUMSQ tests (dependent variable: *gdp*, independent variables: *m2* and *open*)

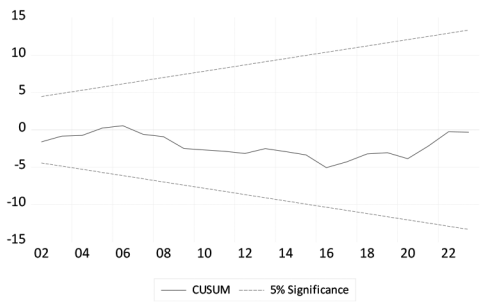


Source: the author's computation

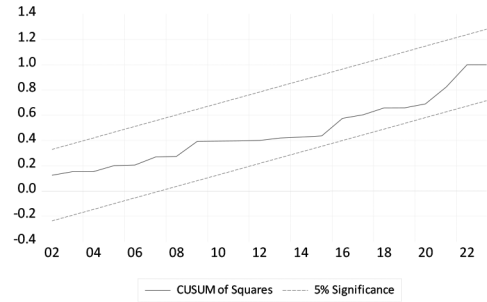


Source: the author's computation

Figure A5. CUSUM and CUSUMSQ tests (dependent variable: $m2$, independent variables: gdp and $open$)



Source: the author's computation



Source: the author's computation

Figure A6. CUSUM and CUSUMSQ tests (dependent variable: $open$, independent variables: $m2$ and gdp)

Perceptions of Public Debt Management Offices on The Impact of Public Debt On Economic Growth in Low and Middle-Income Countries

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Abstract. This study explores perceptions of public debt management among Debt Management Offices (DMOs) in low- and middle-income countries. Based on a survey conducted in October 2023 covering 27 countries, it examines DMOs' views on the relationship between public debt and economic growth, the practices shaping these perceptions, and the key variables influencing debt dynamics through regression modelling.

The study findings highlight that DMOs generally perceive debt as negatively impacting growth, with perceptions shaped more by professional experience than internal economic studies. Four critical variables – debt cost, economic growth, primary deficit, and governance – emerge as key influences. Notably, DMOs conducting in-house studies show more cautious assessments than those relying solely on experience or external studies. These insights provide a nuanced understanding of debt dynamics, incorporating the subjective yet practical perspectives of debt managers.

Keywords: perception of debt, public debt management, low- and middle-income countries, debt management offices, regression model.

I. Introduction

Public debt management has become a critical concern for governments worldwide. With debt levels reaching a record \$91 trillion by the end of 2022, equivalent to 92% of the global GDP (World Bank, 2023), effective management is essential so that to maintain financial stability and support economic development. Public debt management not only affects a government's ability to fund public services and stimulate growth but also influences long-term financial and economic security.

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Understanding the perceptions of debt management agencies is crucial, as these bodies act as key advisors to governments and shape the strategic options available to policymakers (Chavanne, 2022). Although final decisions on public debt are inherently political, they are profoundly influenced by the analyses and recommendations of these administrative bodies. The perceptions held by debt managers about debt levels, economic priorities, and risk factors are therefore not only informative but also impactful. The understanding of these views provides insight into how public debt strategies are formed and implemented, thereby highlighting the indirect yet substantial influence of debt management offices on national economic decisions.

Decisions are shaped by both rational factors and cognitive influences (Schinckus, 2009), drawing on perceptions formed from the available information and knowledge (Renaut, 2006). Key questions remain: *What is the perception of debt managers regarding the impact of public debt on economic growth? What are the perceived main elements influencing the debt dynamic?*

These questions remain largely unexplored in the existing literature, thus making this article a new contribution to the field. As an exploratory study, it opens the way for further research and future developments to deepen our understanding of debt managers' perceptions and their implications for public debt management.

To address these questions, this study employs a mixed-methods approach, combining a survey conducted in October 2023 with statistical and econometric analyses. By integrating descriptive insights and regression modelling, the paper provides a comprehensive understanding of DMOs' perceptions and the variables shaping their views on public debt dynamics.

The paper is divided into four main sections. The first section outlines the theoretical and empirical framework, based on a comprehensive literature review. The second section details the methodology used in the study. The third section presents the main findings, including an attempt to model DMOs' perceptions of the factors influencing public debt dynamics. Finally, the fourth section summarises the main conclusions and offers practical recommendations to assist governments and DMOs in refining their debt management policies and practices.

II. Literature Review

The management of public debt is a political choice that is unique to each country (Blancheton, 2019). It is guided by public debt management policy, which reflects the government's priorities in fiscal policy (whether expansionary, austere, or balanced) and forms a core part of a broader economic strategy. In the field of debt management, while data and analysis are of great importance, the interpretation of these figures is significantly influenced by the perspectives of the individuals (Bearfield et al., 2024) and institutions involved, particularly in the absence of consensus on definitions such as debt sustainability (Laskaridis, 2021), sustainable levels, and optimal debt-to-GDP ratios (Pescatori, 2014). Without clear standards, these interpretations frequently rely on subjective perceptions as much as on objective, quantitative elements.

Debt Management Offices (DMOs) are the bodies responsible for public debt management. The function of DMOs depends on each country's legal framework, which defines their specific responsibilities. While the specific responsibilities of DMOs may vary from one country to another, there are certain core principles that are common to all of them. As stated by the *International Monetary Fund* (IMF Staff, 2002), the responsibility of formulating debt management strategies and presenting them to political authorities for approval falls upon the shoulders of DMOs. The key roles of a DMO include the formulation of strategies based on risk and cost analysis, the financing of government needs, the execution of related transactions, and the consolidation and monitoring of debt operations (IMF, 1997).

Most DMOs are organised into three segments – front, middle and back offices – each with specialised functions. While typically located within the Ministry of Finance, some DMOs operate autonomously and may also provide advice to governments and produce public debt reports, depending on the legal framework and level of development of the country.

The concept of *Evidence-Based Policymaking* (EBPM) advocates for the utilisation of data-driven decision-making processes, as opposed to the reliance on political beliefs (Demir, 2020). The aim of EBPM is to ground policy in evidence and rational analysis, while countering partisan or arbitrary decisions that might negatively impact the State's welfare and global interests (Carney, 2016). This is highly relevant in public debt management, where quantitative data align well with the principles of evidence and transparency.

However, it is evident that academic research is not yet fully integrated into the policy-making process (Landry et al., 2003). Nevertheless, only a small proportion of academic insights inform policy, despite the recent growth in the use of EBPM, particularly in Europe, Australia, and the United States. These developments have been driven by the frequency of crises and a desire to depoliticise public action.

In the context of public debt management, perceptions play a pivotal role in influencing strategic decision-making processes. Nobel Laureate Daniel Kahneman (2011) reveals the pervasive influence of intuitive impressions on our thinking and behaviour, and the profound impact of cognitive biases on every decision, with important implications for business strategy and economic decision-making. Hoogduin, Öztürk, and Wierds (2010) analyse the behaviour of public debt managers and explore how their actions interact with macroeconomic policies, while emphasising the significant role they play in ensuring consistency between the fiscal and monetary objectives. Gigerenzer and Gaissmaier (2011) highlight that decision-makers frequently rely on heuristics – cognitive shortcuts that simplify complex decisions – to navigate environments characterised by uncertainty or incomplete information. While these heuristics facilitate decision-making, they also influence the perception of risks and opportunities, thereby affecting the strategic directions pursued by debt management entities. This approach is particularly pertinent for debt management offices, where managers, frequently operating with incomplete data or information and economic uncertainty, are therefore required to rely on their own perceptions to inform their recommendations to government authorities. Gigerenzer and Gaissmaier's insights demonstrate how heuristics-driven perceptions can indirectly influence economic policy

decisions through the advice provided to governments, by emphasising the significance of understanding debt managers' perceptions within this field.

Notwithstanding the insights offered by the literature review, the specific area of focus of this research remains underexplored in the currently existing studies. While a substantial body of empirical research rooted in macroeconomic econometric models has extensively analysed the impact of debt on economic growth (Gómez-Puig et al., 2018) and the determinants of debt dynamics (Cifuentes-Faura, 2024), these studies largely prioritise quantitative data and statistical interpretations. They often overlook the qualitative dimensions, such as the subjective perspectives of debt managers (Schalck, 2019), which can significantly influence policy decisions.

This research seeks to address this gap by incorporating a qualitative perspective to complement the established empirical findings. To enhance clarity and foster a deeper discussion, we shall briefly present a comparative analysis between data derived from the subjective perceptions of Debt Management Offices and econometric findings on public debt and economic growth. To ensure a comprehensive approach, the following part of the literature review will delve into specific econometric studies that have shaped our understanding of the relationship between public debt and economic growth.

For centuries, policymakers, executives, and economists have debated the evaluation of public debt and its effects on economic growth. Theoretical literature generally suggests a negative relationship between public debt and economic growth, with neoclassical growth models indicating that debt issuance to finance consumption or capital goods often slows growth. Modigliani (1936), building on Buchanan (1958), argued that national debt diminishes the private capital stock, reducing future income flows and potentially burdening future generations. While the long-term intergenerational effects remain debated, debt's legacy – either positive or negative – depends on the applied economic theory (Keynesian or neoclassical) and influences the income redistribution predictably.

The U-shaped curve concept, describing a non-linear relationship between debt and growth, is widely acknowledged. Reinhart and Rogoff (2010) highlighted a critical 90% debt-to-GDP threshold, beyond which, debt harms growth, shaping fiscal correction policies during the financial crisis. However, their findings have been contested due to issues like sample heterogeneity. Ghosh et al. (2013), Law et al. (2021), and Makhoba et al. (2022) demonstrated that this tipping point varies based on the structural characteristics of specific countries. Markus and Rainer (2016) further emphasised that institutional features like fiscal flexibility and efficiency influence fiscal uncertainty and investment climates, contributing to the heterogeneity in how high public debt levels affect long-term growth.

The direction of the causal relationship between debt and growth has also been debated. In contrast to Reinhart and Rogoff's view, Nersisyan and Wray (2011) argue that it is not the absolute level of public debt above a certain threshold that negatively affects growth, but rather the context of declining growth in which a weak GDP growth generates deficits and thus increases debt (Panizza, 2018).

Despite the abundance of empirical studies aiming to measure the actual impact of public debt on economic growth, the results do not provide a clear consensus. In addition

to that, the influence of political and human decision-making based on perception (Cohen, West, and Aiken, 2003) adds another layer of complexity.

Given the multitude of empirical studies, and the complexity of the process of debt management, it is essential to survey those directly involved in daily debt management and responsible for it, notably, the DMOs.

III. Methodology

To investigate debt managers' perceptions of the impact of debt on economic growth, a quantitative study was conducted. A questionnaire with multiple sections addressing our research objective was constructed.

A. Research Instrument

The sample is constituted by countries that are characterised by comparable economic issues and/or similar debt management challenges. The selection criteria were based on the World Bank's classification of countries by income, focusing on lower-middle-income and low-income countries. A preliminary selection was then conducted based on an in-depth analysis of the economic characteristics of the aforementioned countries. European countries were excluded due to significant economic divergences and the implementation levels of their DMOs. The final sample was randomly selected by using a statistical sampling formula, with a 95% confidence interval and a 5% margin of error, resulting in an expected response count of 68 (Royer and Zarlowski, 2014).

$$\frac{z^2 \times p(1-p) / e^2}{1 + (z^2 \times p(1-p)) / e^2 N} \quad (1)$$

A total of 27 responses were received 'Tab. II', providing a solid analysis base. Accordingly, the actual margin of error for this study is 14.75% at a 95% confidence level. It is recommended that the results should be projected to the entire population of lower-middle-income and low-income countries, with due consideration of the actual margin of error. The respondents, representing DMOs of the sampled countries, were managers or officials with comprehensive knowledge of their offices' various functions.

The questionnaire was structured by using the hourglass technique. For this study, only parts 3 and 5 were utilised, consisting of 27 questions pertaining to the economic approach to debt management (Q23 to Q49), and 13 questions on the respondent demographics, including their country profile (Q74 to Q86) were also considered (Flower Floyd, 2009).

To ensure a uniform and unbiased understanding of the key concepts, certain definitions were clarified for the respondents. To prevent the occurrence of anchoring effects, which are often observed in online questionnaires, the response options were randomly displayed for all questions with more than four answer choices:

- Number of Observations: 27
- Number of Variables: 40

B. Data

This study employed the use of *Sphinx Declic* software to design and distribute the questionnaire for 55 days and to analyse the results. Distribution was facilitated through personal emails and messaging apps, allowing us to reach DMO managers directly and streamline the data collection process. The questionnaire was written in French and in English in order to accommodate the official languages of the target countries. The questionnaire was pre-tested with four professionals working in a DMO, and an academic researcher, individually in face-to-face sessions. The purpose of this intermediate step was to assess the comprehension and the relevance of the questions and proposed answers, to measure the response time, and to evaluate the scope of the subject studied. The main objective of this step was to minimise potential biases such as the halo effect and contamination bias.

The respondents to the survey were predominantly managers or officials within DMOs, with a wide range of experience: 26% had less than four years of experience, 37% had between four and nine years, and 22% had over 15 years of experience. The majority held advanced qualifications, with 67% holding Master's degrees, and 96% of the surveyed individuals occupied management roles. The responding countries varied in economic size, with 33% having a GDP below \$15 billion, and 19% exceeding \$120 billion. The size of the DMOs also differed, with 30% having fewer than 10 employees, while 26% operated with over 50 staff members. These characteristics highlight the diversity of the sample and its representation of DMOs operating in various economic contexts.

C. Regression Analysis

In an explanatory model, we seek to quantify the perceived influence of DMOs in terms of certain variables on debt dynamics. To ascertain the notion of perception, we posed the following scaled question: "In your country, how do you assess the sensitivity of debt to the factors that impact it?" We selected this variable as the primary measure of DMOs' perception, which is explained by a set of explanatory variables, rated on the same scale by the respondents. We will adopt an econometric approach based on a multiple linear regression model. The multiple regression model is as follows:

$$Y = \beta_0 + \beta_1.X_1 + \beta_2.X_2 + \dots + \beta_p.X_p + \varepsilon \quad (2)$$

where:

Y is the dependent variable;

β_0 is the constant term;

$X_1, X_2, \dots, X_p$ are the independent variables (factors affecting debt dynamics);

$\beta_1, \beta_2, \dots, \beta_p$ are the coefficients estimating each variable's contribution;

ε is the error term.

Once the model has been developed, we will assess the model's robustness and parameter estimates by using statistical indicators, such as R^2 , Fisher's F-test, and Student's

t-test, as recommended by econometric texts on model validation (Wooldridge, 2019; Greene, 2018). This approach aligns with the exploratory objectives in which the model is developed not primarily to infer causality, but rather to achieve the best possible prediction of the dependent variable. As is common in such frameworks, the inclusion of variables is justified by empirical evidence on their predictive capacity rather than causal inference (Shmueli, 2010; Harrell, 2015).

In exploratory theoretical frameworks, regression analyses are frequently used without a strict focus on causal interpretation. The primary objective is instead to maximise the predictive accuracy of the dependent variable. In line with econometric practice, a minimum subset of independent variables is often selected to achieve the best possible fit of the model, while balancing simplicity and predictive power (Burnham and Anderson, 2002; Akaike, 1973). This approach allows empirical studies to assess the actual impact of these variables on public debt levels (for example, inflation rates, interest rates, and economic growth) even if they do not directly measure the perception of their influence on debt dynamics (Baum et al., 2013).

The selection of variables was informed by existing literature, particularly by studies by the International Monetary Fund (IMF), which emphasise factors like debt cost, initial debt stock, primary deficit, and economic growth. Other studies that informed the selection of variables include those by Reinhart and Rogoff (2010) on inflation, Olivier Blanchard (2019) on national savings, and Butkus (2018) on the balance of trade. These studies guide our choice of variables, by grounding the model in well-established empirical insights.

$$\text{PERD} = f(\text{DC}, \text{PD}, \text{GDP}, \text{GOV}, \text{DS}, \text{NS}, \text{BOT}, \text{INF}) \quad (3)$$

where:

‘PERD’ captures DMOs’ rating of debt sensitivity to these factors, while DC reflects the perceived impact of debt cost. ‘PD’ measures the influence of the primary deficit, and ‘GDP’ captures the role of economic growth. ‘GOV’ indicates the governance quality’s effect, ‘DS’ measures the initial debt stock’s impact, ‘NS’ reflects national savings, ‘BOT’ refers to the balance of trade, and ‘INF’ represents inflation, with all components rated consistently by DMOs. Each component is rated by DMOs on a scale of 1 to 5, where ‘1’ indicates a ‘very low impact’, and ‘5’ represents a ‘very strong impact’. These ratings reflect the perceived impact of each factor on public debt, as assessed by DMOs, rather than the actual quantitative variable.

IV. Results

Before evaluating the perception of DMOs regarding the influence of public debt on economic growth, it was essential to gain insight into the prevailing practices within DMOs. These practices encompass an economic approach to debt management, the production of economic studies on the impact of debt on economic growth within the DMOs, and a subjective evaluation of this impact.

A. Exploratory Analysis

1) Cautious perception of the link between debt and economic growth

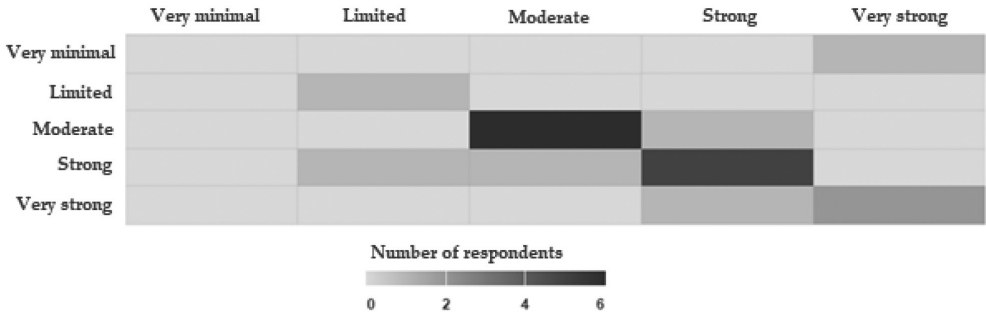
Given the divergent results of empirical studies, the DMO representatives were asked to provide their general perception of the debt/economic growth relationship and this same relationship within the specific context of their country.

A substantial majority (93%) of the DMO representatives surveyed concur that a causal link exists between debt levels and economic growth. This viewpoint is in accordance with the preceding empirical findings. The remaining 7% of the respondents indicated that they do not perceive a link between debt and growth. Furthermore, they proposed an optimal debt level for their respective countries, which exceeded the IMF's recommended level by exceeding the 80% level. This high-risk appetite is contrary to the recommendations of the International Monetary Fund, particularly for countries with low or developing economies.

In terms of country-specific perceptions, 74% of the respondents indicated that they believe that their country's current debt level has an impact on economic growth. This is, the obtained value is approximately 20% less than the general perception. This suggests that some countries have not yet reached the critical threshold identified by these experts and still have scope for manoeuvre before reaching the base of the U-curve. Of the 74% who perceive a correlation between debt and economic growth, 56% view this association as a hindrance to growth. This indicates that the prevailing level of public debt is detrimental to the country's economic growth. A number of factors may account for this, including the absence of a leveraging effect of public debt, a high debt stock and/or high costs absorbing a significant portion of operational expenses, the diversion of debt from investment and the failure to generate the anticipated positive externalities. An alternative explanation for this result is that it reflects the cautious approach characteristic of DMO professionals, particularly with regard to cost and risk management. This could influence their perception of the debt/growth link.

DMO representatives evaluate the influence of debt on economic growth in both the general context and their respective countries, with the assessment falling within the medium to high range, as illustrated in Fig. 1. This is indicative of an impact rating between medium and high. A highly significant positive correlation between the two variables, with a p-value of less than 0.01, demonstrates the rationality and consistency in responses to both questions.

A differentiated view of the impact of debt on economic growth is held by DMOs, contingent on its origin. A majority (59%) of the respondents indicated that external debt has a more significant impact on the country's economic growth (Gaiya et al., 2024). The potential risks associated with this type of debt are well documented. While external debt may initially appear to be an attractive financing source for countries, primarily due to generally lower costs than domestic financing (concessional financing), a smaller crowding-out effect on private sector financing, and a lower inflation risk, these benefits are offset by exchange rate risks, dependence on external financing, impact on reserve assets, and sovereignty, among others. These factors affect the country's economy and growth. The aforementioned arguments provide insight into the prevailing sentiment regarding the impact of external debt among the sample countries.



Note. The relationship is highly significant. p-value = < 0.01; Chi-square = 32.0; df = 12.

Fig. 1. Comparison of DMO estimates of debt impact on economic growth globally and in their countries

It is important to highlight that 44% of the sample reported never having read, consulted, or utilised a study specific to their own country, which would have enabled them to form a well-founded opinion on the debt/growth impact. This is especially common (50%) among DMO representatives from countries with a GDP below \$15 billion. Their perceptions are largely based on professional experience and the adaptation of findings from studies not specific to their country. This observation highlights the need to explore research practices within DMOs further.

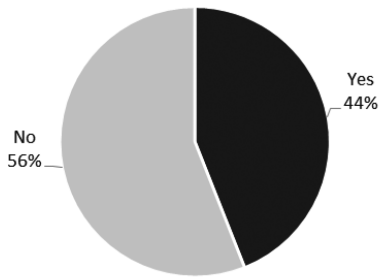
2) Limited conduct of economic studies within DMOs

The practice of conducting economic studies – especially those investigating the link between debt and economic growth – remains uncommon among DMOs. In fact, 56% of the countries surveyed reported that their DMOs do not perform such studies (see Fig. 2). The main reasons cited are a lack of expertise within the DMO (47%) and limited interest in the DMO’s work (33%). While the shortage of expertise, often due to insufficient human resources in both quantity and skill, which is especially manifested in low-income countries’ public administrations, seems a reasonable challenge, the lack of interest poses additional questions. Many DMOs and their teams do not recognise the objectives or benefits of these studies. Additionally, 56% of the respondents whose DMOs do not conduct these studies reported that they are instead undertaken by another department within the Ministry of Finance. As previously noted, DMOs are responsible for both the strategic and operational management of public debt. However, their advice and decision-making for policymakers are significantly shaped by the leadership’s focus, especially regarding the economic perspective on debt management.

While the overall relationship between conducting studies on debt levels and economic growth and a country’s GDP level is not statistically significant, two distinct groups of countries emerge. The first group includes countries with very low GDP and those with strong GDP levels above \$60 billion, categorised as low and high GDP groups. The second group consists of countries with intermediate GDPs, ranging between \$15 billion and \$60 billion. In this intermediate group, the relationship between debt studies and GDP level

is significant, with a p-value of 0.0, supporting the alternative hypothesis and indicating a meaningful relationship between these variables, as outlined in Table I.

Do you conduct studies within the DMO on the relationship between debt level and economic growth?



If no, what are the reasons for not conducting these studies?



Fig. 2. Practices of researches and studies on the debt/growth link within DMOs

Table I. Cross-tabulation of Countries' GDP Levels Grouped into Two Categories and Conducting Economic Studies within DMOs

What is your country's GDP level for the most recent closed year in billions of US Dollars?	Do you conduct studies within the DMO on the relationship between 'debt level and economic growth'?			
	Yes		No	
	N	%	N	%
Low and high GDP countries	<u>6</u>	<u>32%</u>	<u>13</u>	<u>68%</u>
Less than 15 billion USD	3	33%	6	67%
Between 60 and 120 billion USD	2	40%	3	60%
More than 120 billion USD	1	20%	4	80%
Middle-GDP countries	<u>6</u>	<u>75%</u>	<u>2</u>	<u>25%</u>
Between 15 and 30 billion USD	4	80%	1	20%
Between 30 and 60 billion USD	2	67%	1	33%
■ <i>under-represented</i>		■ <i>over-represented</i>		

Note. The relationship is significant. p-value = 0.0; Khi2 = 4.3; ddl = 1

Countries with low GDPs often face a marked shortage of resources within their public administration, partially explaining the limited engagement in debt and economic growth studies. In contrast, countries with GDPs over \$60 billion typically have more structured finance ministries, complete with specialised departments dedicated to conducting and

disseminating such studies. This trend aligns with the increased demand for hyper-specialisation in finance ministries as the country size and its complexity grow. For example, 80% of countries with GDPs exceeding \$120 billion do not conduct these studies within their DMOs, instead relying on a specialised department within the Ministry of Finance.

Countries with intermediate GDP levels (\$15 billion to \$60 billion) show a stronger inclination to conduct studies on debt and economic growth. In these nations, which generally have more resources than lower-GDP countries, there is a conscious effort to add new functions, such as debt studies, to provide sufficient data and analysis. This reflects their priority of debt management for economic growth and transition toward a higher GDP status. Among these countries, more than 75% engage in such studies, while only 25% do not.

Notably, among the DMOs that conduct these studies (comprising 44% of the sample), 67% perform regular reporting and monitoring. This indicates that DMOs see value in these studies, with 63% of the respondents expressing satisfaction with the monitoring processes, thereby showing that these DMOs have effectively integrated this practice into their operations.

B. Regression Model

1) Descriptive statistics of model variables

Table II. Descriptive Statistics of Variables Used in the Analysis

	Mean	Min	Max	Std. Dev.	Skewness	Kurtosis	Std. Dev. Index
<i>Dependent</i>							
PERD	3.963	3	5	0.706	0.046	-1.069	0.36
<i>Explanatory</i>							
DC	4.037	2	5	0.898	-0.375	-1.068	0.349
PD	3.889	2	5	1.013	-0.431	-1.041	0.444
GDP	3.704	2	5	0.775	0.047	-0.718	0.26
GOV	3.963	2	5	1.126	-0.554	-1.213	0.506
DS	3.296	1	5	0.912	-0.289	-0.034	0.216
NS	3.185	1	5	1.21	-0.341	-1.01	0.381
BOT	3.444	1	5	1.188	-0.205	-1.176	0.367
INF	3.815	2	5	1.039	-0.239	-1.29	0.468

Hypothesis tests are necessary for the different variables in the model. The impact of debt cost, primary deficit, and initial debt stock should positively influence the debt growth and thus its sensitivity to these same factors. National savings, trade balance, economic growth, and inflation positively impact debt and contribute to its management. The expected sign for this group of variables is negative; see Table III.

Table III. Expected Signs of Model Variables

Variables	Measures	Coef.	Expected Signs
Perception of debt cost impact	Rating on a scale of 5 (very low to very high)	β_1	Positive (+)
Perception of primary deficit		β_2	Positive (+)
Perception of economic growth impact		β_3	Negative (-)
Perception of governance impact		β_4	Negative (-)
Perception of initial debt stock impact		β_5	Positive (+)
Perception of national savings impact		β_6	Negative (-)
Perception of balance of trade impact		β_7	Positive (+)
Perception of inflation impact		β_8	Negative (-)

2) Regression results

The validation tests for the model estimations are of great importance in order to validate the hypotheses underlying the use of the multiple linear regression model. In order to ensure the robustness of the results obtained, it is essential to verify the absence of correlation between the explanatory variables and to validate the Fisher's and Student's tests.

Table IV. Corelation Matrix

	PERD	DC	PD	GDP	GOV	DS	NS	BOT	INF
PERD	-								
DC	0.67	-							
PD	0.532	0.385	-						
GDP	0.401	0.237	0.152	-					
GOV	-0.292	-0.265	-0.105	0.295	-				
DS	-0.102	-0.014	-0.005	-0.252	-0.438	-			
NS	-0.082	-0.042	0.08	0.102	0.288	0.088	-		
BOT	-0.025	-0.052	-0.277	0.274	0.329	-0.126	0.101	-	
INF	0.148	0.296	0.126	0.263	-0.006	0.101	0.028	0.568	-

It is imperative that explanatory variables should be non-collinear. The correlation matrix above Table V indicates a weak link between the variables. The standardised Cronbach's alpha is low (0.48), which indicates that the conditions of independence of the explanatory variables are well satisfied.

The analysis of the relationship between the perception of public debt sensitivity to influencing factors and the unitary assessment of each factor's impact reveals four key variables influencing the explanatory variable at the 5% threshold. These are, in the order of impact, the debt cost (interest rate), economic growth, primary deficit, and governance; see Table IV.

The specified model explains 69.86% of the variance in the dependent variable. The model quality indicators are indicated in Table V.

Table V. Multiple Linear Regression Model Estimation AND R² Test Results

	Coef.	Student statistic	Std. Coef.	Contribution	VIF
Constant	1.796*	1.914			
DC	0.346**	2.788	0.44	20.236	0.246
PD	0.284*	2.082	0.312	14.359	0.209
GDP	0.271**	2.515	0.389	17.881	0.23
GOV	0.163*	1.424	0.275	12.635	0.185
DS	-0.02	0.246	-0.035	-1.6	0.165
NS	-0.083	0.692	-0.107	-4.939	0.169
BOT	-0.177	1.412	-0.26	-11.972	0.184
INF	-0.223*	2.041	-0.356	-16.378	0.207
R	0.84***				
R ²	0.69				
Fisher	5.21***				

Note. ***, **, * indicate that the corresponding coefficient is significant at the 1%, 5%, and 10% thresholds, respectively.

Based on the above results, the model estimation can be derived as follows:

$$\text{PERD} = 1.796 + 0.346* \text{DC} + 0.284 * \text{GDP} + 0.271 * \text{PD} + 0.163 * \text{BOT} - 0.02 * \text{NS} - 0.083 * \text{DS} - 0.177 * \text{INF} - 0.223 * \text{GOV} \quad (4)$$

V. Discussion and Policy Implication

Based on these observations, there is a strong correlation between four variables and the perception of debt sensitivity by DMOs. The hypotheses concerning the signs of the coefficients β are verified for six out of eight variables. However, the direction of the correlation for economic growth and initial debt stock is not confirmed. This discrepancy may be due to sluggish growth in several countries in the sample, which does not allow for a decrease in the debt ratio or significantly impact it. Indeed, the slowdown in the global economic growth, particularly in the sample countries, may have influenced the DMOs' responses, suggesting that the threshold at which economic growth reduces debt sensitivity is not or is no longer being reached. For the remaining influential variables, the regression results provide nuanced insights into the determinants of public debt sensitivity and align with a substantial body of empirical literature. For instance, the confirmation of the role of the debt cost and the primary deficit corroborates findings by Reinhart and Rogoff (2010), Debrun (2019) and Goodwin et al. (2022), emphasising their critical impact on debt accumulation. The primary deficit is the first budgetary aggregate directly linked to the creation of new debt (Goodwin et al., 2022). Indeed, primary financing needs in State budgets, voted during annual budget or generated during the current year's budget execution, are covered by issuing new debts (domestic and external).

DMOs are aware of the importance of debt management, as they are on the front line in daily debt management and provide their expertise and advice to the political authorities in place. Consequently, they place considerable importance on governance. At this level, debt governance should be understood in a broad sense. This includes a direct link through the legal and regulatory framework in place, transparency and ethical rules, mandates granted to DMOs, and an indirect link through the efficiency of investments financed by debt. This aligns with the results of Betin and Fournier (2018), who demonstrated that government effectiveness, as measured by a general perception indicator, is the main factor of sovereign default (Bolton et al., 2023).

However, other variables that the respondents did not perceive as significantly contributing to public debt sensitivity are aggregates which do not have a direct and intuitive link to public debt, despite substantial macroeconomic evidence suggesting otherwise. In particular, the respondents did not identify variables such as national saving and the trade balance, which have been highlighted as influential in studies such as Blanchard (2019) and Butkus et al. (2018). This discrepancy invites a deeper investigation into why these variables are undervalued in the perceptions of DMOs. Possible reasons could include limited access to or use of advanced economic analysis by certain DMOs, differences in the prioritisation of immediate versus long-term fiscal factors, or a mismatch between theoretical models and practical debt management frameworks. These gaps underscore the importance of bridging empirical research and practical governance to improve the identification and recognition of critical determinants of debt sensitivity.

It is of importance to note a significant disparity in the perception of the impact of certain variables between DMOs who conduct economic studies and follow academic research and those who do not incorporate these mechanisms. The ratings given by the latter are slightly below the sample's average and significantly lower than those of DMOs conducting economic studies; see Fig. 3. As the perception of elements depends on the stimuli received and interpreted by individuals and organisations, it can be posited that the greater is the number of DMOs who conduct, follow, or utilise economic studies, the more they consider that elements affecting public debt to be impactful. This is particularly evident in the case of debt cost, primary deficit, economic growth, and national savings. A number of different interpretations can be made to explain this result. These include the pervasive principle of prudence that underlies most studies, which is also recommended by the World Bank and IMF (Guidelines for Public Debt Management, 2002). Another interpretation is that economic studies provide DMOs on the country's overall macroeconomic situation, which allows for a more inclusive risk approach.

The findings from this study highlight crucial policy implications, especially emphasising the need for policymakers to carefully consider the subjective assessments of Debt Management Offices (DMOs) when designing debt management strategies. Given that DMOs possess specialised expertise and direct oversight in debt operations, their perspectives inevitably shape the debt policy. However, the study reveals that these assessments are largely grounded in experience and practical knowledge rather than systematic research or data-driven analysis. This reliance on subjective judgment can introduce variability

and potential bias, which, if unchecked, might influence national debt strategies in ways that could affect long-term economic stability.

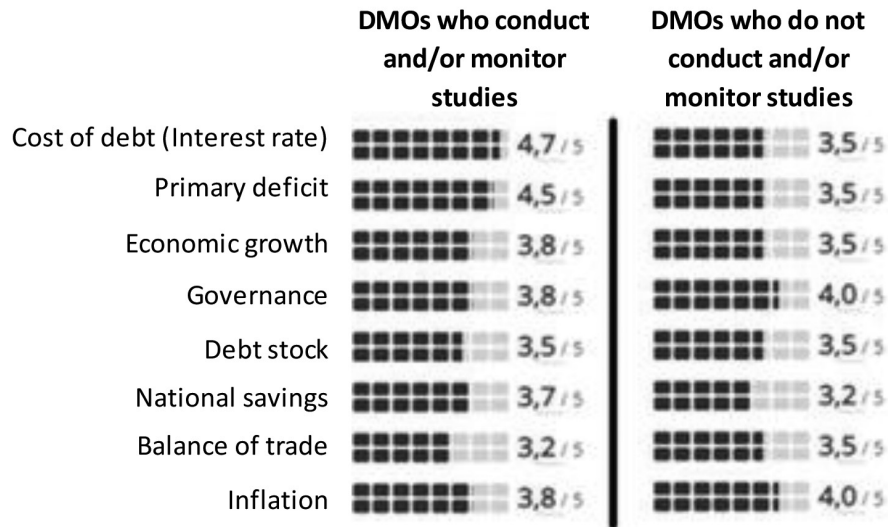


Fig. 3. Evaluation of variables influencing debt dynamics based on the conduct or follow-up of studies by DMOs

Policymakers, therefore, must be vigilant and critically aware of the subjective nature of DMOs' assessments. While DMOs' expertise is invaluable, an over-reliance on personal judgment could skew decision-making, especially in contexts where comprehensive empirical analysis is lacking. To mitigate this, it is essential to strengthen *Evidence-Based Policy-Making* approaches within DMOs, while fostering a systematic reliance on empirical data to guide debt management decisions. Such an approach would enable debt strategies to be more resilient, thus reducing the likelihood of decisions shaped by individual perceptions and biases, which, although unavoidable to some degree, should be minimised. By embedding EBPM practices, DMOs can anchor their assessments in rigorous data, creating a more balanced approach that would combine professional judgment with solid empirical foundations.

Furthermore, the study identifies a perceptual divergence among DMOs which reveals potential inconsistencies in debt management approaches, despite similar economic conditions across low- and lower-middle-income countries. Although countries in these income brackets share many common debt challenges, the study shows that DMOs' perceptions vary significantly. This discrepancy highlights the risk of disparate policy applications in countries where the IMF and World Bank often implement relatively uniform strategies and solutions. Given that these countries are typically treated as a cohesive group, it is critical that their debt policies are informed by a unified understanding of debt dynamics which transcends individual biases within DMOs.

VI. Conclusion

The findings from this exploratory study provide an initial overview of perceptions within public debt management entities in a sample of low- and lower-middle-income countries regarding the economic approach to debt and the relationship between debt and economic growth. Conducted among 27 countries classified by the World Bank as low- or lower-middle income, our study has confirmed that there is a cautious perception within DMOs of the link between debt and economic growth, with a perceived negative impact. This perception is primarily based on the experience and practice of debt managers rather than on studies conducted within the DMOs, as evidenced by the low rate of utilisation or exploitation of such studies by DMOs.

However, the elements considered as impacting the debt dynamics of countries are the main points we find in most empirical studies on the subject. Indeed, four variables strongly explain the DMOs' perception of debt dynamics: the cost of debt, economic growth, the primary deficit, and governance. There is a notable gap between the perception of DMOs that conduct or follow studies on debt and economic growth within their organisations and those who do not perform such studies. The former group tend to be more cautious in their assessments, whereas the latter group tends to be more permissive.

This study represents a preliminary step that should be enriched by further research based on the results obtained. It also presents certain limitations that future research should address to enhance robustness and depth.

Firstly, as an exploratory quantitative study, this research captures broad trends in DMOs' perceptions but lacks the detailed contextual understanding that qualitative methods could provide. Future studies could benefit from incorporating qualitative approaches, such as individual interviews or focus groups, to delve into the reasoning behind certain responses. Engaging directly with the respondents would allow researchers to explore the motivations and contexts influencing their views, thereby uncovering the logic and orientation driving their assessments of debt thresholds and economic growth impacts. This approach would also help clarify any ambiguities in the interpretation of survey questions, particularly where responses may vary according to distinct national or institutional contexts.

Secondly, an expansion of the sample size to include more countries would improve the robustness of the findings, by enhancing both the representativeness and generalisability of the results. A larger sample would reduce the margin of error, ideally reaching the target of a 5% margin of error, thereby enabling the study to approach a level of exhaustiveness that would strengthen its contributions to the field. Such an expanded sample would also allow for more reliable cross-regional comparisons, helping to determine whether DMOs' perceptions differ systematically across varying economic contexts and institutional frameworks.

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Do Green Bonds Impact Sustainable Development? An Empirical Analysis

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Abstract. Trying to meet unlimited human needs with limited resources causes production activities to deplete or pollute natural resources. Ensuring the sustainability of natural resources and the environment is essential to leaving a livable world for future generations. The concept of sustainable development, which emerged from this attitude, has been on the agenda of many countries, especially supranational organisations, especially in recent years. Based on this, the present study aims to examine the impact of green bonds issued worldwide on sustainable development with the help of panel data analysis for 17 countries that issued the most GBs in the period of 2014–2022. In the study, fixed effect, random effect and GMM tests were applied. Empirical findings show that GB issuances positively affect the environmental performance, while the development levels of countries have a negative effect. The findings also show that the impact of COVID-19 positively affects environmental performance. In the selected countries, trade openness was not found to affect environmental performance significantly.

Keywords: sustainable development, green bonds, developed countries, panel data analysis.

1. Introduction

The rapid development in the global economy has brought about significant environmental degradation which becomes more apparent with every passing year. According to the *World Bank* data, the world GDP, which was 1.36 trillion dollars in 1960, has reached 105.44 trillion dollars. While this means that production is increasing worldwide, it also means that natural resources are being depleted rapidly. Therefore, problems related to economic growth and sustainable development are essential issues that attract the attention of almost all countries (Cuaresma et al., 2013). Environmental degradation and environmental concerns, among the most critical problems regarding the achievement of sustainable development, have been in the list of the topics of major interest to aca-

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demics, especially in recent years, in the pursuit to achieve the *sustainable development goals* (SDGs) emphasised by the *United Nations Development Program* (UNDP). In the Brundtland Report, sustainable development is defined as development which meets the needs of the present without compromising the ability of future generations to meet their own needs. This definition emphasises equality between generations and the efficient and effective use of resources (Carvalho, 2001; Munier, 2005).

One of the most important factors of environmental degradation is excessive energy consumption and greenhouse gas emissions from fossil fuels (Saha and Maji, 2023). For this reason, the EA Sustainable Development Scenario (SDS) aims to reduce the fossil fuel use by 40% by 2030 and increase the share of renewable energy in the total energy supply to 60%. At the same time, this target is also compatible with the provisions of the Paris Agreement regarding global warming to be below 2°C in the 21st century (Tolliver et al., 2020). However, in order to achieve this target, a financing of 55 trillion dollars is needed for activities related to environmentally sensitive investments by 2035 (IEA, 2014). Since the traditional financing methods insufficiently fund green projects, the concept of green finance has been developed in this regard.

Green finance is vital in the global financial system as it focuses on investing in projects necessary for environmental sustainability and promoting technologies with low carbon footprints. It is considered an essential innovation in the financial system which aims to promote sustainable growth and address social and environmental challenges. In this context, financial instruments are expected to be critical to achieving the United Nations Sustainable Development Goals by 2030 (Alamgir and Cheng, 2023). Green finance is compatible with the principles of sustainable development. It emphasises the interdependence between human life and the environment. There is a close relationship between green finance and the low-carbon economy. The basis of green finance is to protect the environment and ensure sustainable development by considering potential environmental impacts in making investment and financing decisions (Lee, 2020). Green finance covers various financial instruments, such as green loans, green bonds, green stock indices, green development funds, insurance, carbon finance and policy incentives (Alamgir and Cheng, 2023).

Green bonds (GBs) are one of the green finance products used to support environmentally sensitive or green activities. Globally, green finance applications are dominated by GBs that can provide the necessary financing for green investments by managing expenditures between current and future generations. The issuance of GBs reduces greenhouse gas emissions by implementing environmentally sensitive projects. They can act as a bridge between the financing requirements needed for green projects and funders (Fatica and Panzica, 2021). GBs are defined by the *International Capital Markets Association* (ICMA) *Green Bond Principles* (GBP) as “any bond instrument whose proceeds will be used solely, in whole or in part, to finance or refinance new and/or existing eligible Green Projects” (ICMA, 2018). In recent years, there has been a significant increase in the use of green bonds as a financial instrument. The proceeds of these bonds are allocated to financing environmentally friendly and climate-sensitive projects such as renewable

energy initiatives, green buildings, resource conservation and sustainable transportation. Additionally, GBs allow governments and other institutions supporting their issuance to encourage the flow of capital to the priority sectors with the objective to achieve public policies and goals such as climate change mitigation and adaptation (Thompson, 2021). GBs and their impact on the environmental situation can be linked to financing sustainable projects, reducing the carbon footprint, increasing environmental awareness, protecting the ecosystem, and transitioning to a green economy. GBs are used to finance environmentally friendly projects such as renewable energy, energy efficiency, sustainable transportation, water management, waste recycling, and protection of natural resources. These projects positively change environmental impacts by reducing carbon emissions and ensuring a more efficient use of natural resources. GBs accelerate the transition to a low-carbon economy. For example, the financing of environmentally friendly renewable energy projects reduces the dependence on fossil fuels. This directly contributes to combating climate change by reducing greenhouse gas emissions. The issuance of GBs draws attention to environmental sustainability issues and increases investors' awareness of environmentally friendly financing. Investors turn to these bonds by making environmental impact a priority. Investments in projects aimed at protecting natural resources support the protection of biodiversity and the sustainability of ecosystems. GBs accelerate the implementation of environmentally friendly economic models. This ensures both the reduction of environmental damage in the short term and the establishment of a balance between economic growth and environmental sustainability in the long term.

The *European Investment Bank* (EIB) made the first GB issuance in 2007, and then the *World Bank* (WB) followed with its own issuance in 2008. The issue created by the EIB was under the name of the climate awareness bond and was worth 807 million USD, while the issue made by the WB was under the name of GB and was worth 2.3 billion Swedish Kronor. Since 2008, the WB has made over 200 GB issuances in 28 different currencies, amounting to approximately 18 billion USD (World Bank, 2023). As of the end of 2023, the total GB issuance in the world was estimated as 2.8 trillion USD (Climate Bonds Initiative, 2024). Although this figure is well behind the target, when the development of the GB issuance is examined, it is seen that it will be one of the critical financial instruments in the future. Another important issue regarding the ecological footprint is the COVID-19 pandemic. In fact, due to the pandemic which affected most countries during this period, countries experienced a quarantine process. During this period, production in most sectors either stopped or slowed down. Based on this, it can be stated that there was an ecological recovery in the world during the periods when quarantine was being applied. This situation was modelled by using a dummy variable in the study.

Development is the process of a country reaching a high(er) economic, social and technological development level. However, this level of development can cause side effects, such as intensive use of natural resources and environmental destruction. The increase in the developed countries' consumption rates shows a strong correlation between the ecological footprint and the level of development. As stated in the studies of Turner et al. (2007), the ecological footprint *per capita* in industrialised countries is higher than

in low- and middle-income countries. At the same time, an increase in the production amounts of countries increases environmental degradation. In addition to the level of development, which is one of the factors causing an increase in the production of countries, foreign trade is another factor. As the foreign trade rates of countries increase, the need for more production will arise, which will cause more environmental degradation. In fact, Abdeel-Farooq et al. (2017) and Khan et al. (2022) used *per capita* income and trade openness rates as development indicators in their studies and stated that *per capita* income and trade openness have a negative effect on environmental performance. According to Saha and Maji (2023), highly developed countries negatively impact the environmental performance more than developing countries. At the same time, it has been found that trade openness also has a negative impact on the environmental performance. Therefore, there is a significant relationship between the development levels of specific countries, their trade openness, and ecological footprints.

Since GBs were first issued in 2008, academic studies on their effects have generally been conducted in recent years. When the studies in the literature are examined, the effects of GBs on sustainable development are generally discussed. At the same time, some theoretical studies on GBs in the literature are also available. Among the empirical studies, some researches (Abdeel-Farooq et al., 2017; Tolliver et al., 2020) focus on the effects of renewable energy production on environmental performance, while others (Miroshnychenko et al., 2017; Ren et al., 2020; Zhou et al., 2020; Li and Gan, 2021; Tran, 2021; Mamun et al., 2022; Fang et al., 2022; Khan et al., 2022; Meo and Abd Karim, 2022; Xiong and Sun, 2023) focus on the effects of green finance practices on environmental sustainability. Relatively few studies in the literature focus on the impact of GBs on factors such as sustainable development and environmental degradation. Ehlers et al. (2020) and Sinha et al. (2021) found that environmental and social sustainability decreased on average in the first years following the issuance of GBs but increased later on. Benlemlih et al. (2022) found that, on the contrary, there was no significant decrease in carbon emissions among GB issuers in the short term, while, in the long term, there was a decrease in CO₂ emissions. The study by Kant (2021) concluded that 200 corporate GBs issued did not significantly affect carbon emissions. Similarly, in the study conducted by Bukvic et al. (2023), they examined the relationship between GB issuances and CO₂ emissions in the EU-27 countries in the period between 2013 and 2017 to investigate the validity of the theory that “GBs reduce carbon emissions by financing environmentally friendly projects.” The study concluded that, despite the dramatic increase in GB issuances from €5 billion in 2013 to €75 billion in 2017, there was a slight decrease in total and *per capita* CO₂ emissions of 3.7% and 4.6%, respectively, and no significant relationship was found between GB issuances and CO₂ emissions. Fatica and Panzica (2021) conducted a study on 1,105 entities issuing GBs. They concluded that green issuers decreased the carbon intensity of their assets after borrowing in the green segment. Similarly, the study by Chang et al. (2022) concluded that green financing increased the environmental quality in specific segments of the data distribution in eight of the 10 countries that issued the most GBs. In another study, Saha and Maji (2023) concluded that GBs reduced carbon

emissions for developing countries in 44 countries between 2016 and 2020, while the same effect weakened for developed countries. Alamgir and Cheng (2023) found that GBs had a positive and significant relationship with renewable energy production in 67 countries during the period of 2007–2021, while emissions had a negative relationship with GBs.

The study aims to determine the impact of GB issues on sustainable development with the help of panel data analysis by answering the *research questions* (RQ) stated below.

RQ1: What is the general impact of GB issues on ecological footprint?

RQ2: How does higher development affect the ecological footprint?

RQ3: How do commercial concerns affect the ecological footprint?

The study applied panel fixed effects, random effects, and *Generalized Method of Moments* (GMM) tests for 17 countries that issued the most GBs between 2014–2022. A country limitation is thus involved in the study. Although the first GB issuance was made in 2007, there has not been a regular issuance every year since then. Therefore, when the countries regularly issuing GBs annually are examined, the countries with the highest time interval are 17 developed countries. Based on this, the study sample consists of 17 selected developed countries. The study established a model in which the ecological footprint was the dependent variable indicator of sustainable development, and GB issues, the human development index, trade openness and a dummy variable, which is used to analyse the effect of COVID-19, were independent variables. The studies mainly used CO₂ emissions and the ecological footprint as sustainable development indicators. Independent variables differ under the common roof of green finance. As observed in the literature review, the studies mainly focused on the impacts of variables, such as green finance, renewable energy and energy consumption on sustainable development. The study aims to contribute to the literature in two points. First, by departing from prior works, which only provide some country-specific evidence of the impact of the GB on the ecological footprint, this study investigates the GB ecological footprint relationship for 17 countries which have issued the most GBs after initiating the implementation of the Paris Agreement, adopted in 2015. Second, unlike most of the prior works which examined the effects of GBs on the ecological footprint on a standalone basis, we provide the first evidence that the developed countries' sustainable development moderates the GB and ecological footprint nexus.

The rest of the paper is organised as follows. Section 2 briefly describes the methodology. Section 3 reports empirical results from the Panel regression and GMM tests, and policy implications are summarised in the final section.

2. Methodology and Data

According to the data requirements, the present study uses the traditional panel data models such as the *fixed effect model* (FEM) and the *random effect model* (REM) as well as the *generalized method of moments* (GMM) model. With a small sample size, FEM, REM, and GMM are the most suitable methods for analytical estimation (Gujarati, 2003). In addition, Hausman's specification test (Hausman, 1978) determines which model is suit-

able for analysis. If the P value of Hausman's specification test is less than 0.5 ($P < 0.5$), the fixed effect model is the best option. Otherwise, the random effect model is the best option. The traditional fixed effect, random effect and GMM models are most suitable, especially if the sample panel data is small, covering the period 2014–2022 for seventeen countries, which is the case in the present study. In addition, we complement the fixed effect and random effect estimators by using the robust least squares technique so that to ensure the robustness of the study's results.

2.1. Methodology

In a study conducted to determine the impact of GBs, which are used to finance environmentally friendly projects serving the objective to prevent or reduce environmental degradation, while focusing on sustainable development, annual data between 2014 and 2022 were used. The model created within the scope of the study is given below.

$$ef_{it} = \beta_0 + \beta_1 \ln gb_{(i(t-1))} + \beta_2 \ln hdi_{it} + \beta_3 \ln open_{it} + \beta_4 dummy_{it} + \varepsilon_{it} \quad (1)$$

In the Equation, 'ef' represents the ecological footprint, 'gb' stands for the natural logarithm of GB issues, 'hdi' denotes the natural logarithm of the human development index, 'open' is the natural logarithm of trade openness, 'dummy' represents a variable created to measure the impact of the COVID-19 pandemic, ' β ' is used for the coefficient of the relevant variables, ' ε ' serves as the error term, 'i' stands for the cross-section units, and 't' denotes the time interval. It was also concluded that adding the GB issues variable to the model with a delay of one year would be meaningful since the effects of investments manifest themselves in more than one year.

Among the variables in the Equation, GB issues are expected to have a negative effect on the ecological footprint. As GBs are used to finance environmentally friendly projects, they are expected to reduce environmental degradation and positively affect sustainable development. Another independent variable, the human development index, which represents development, is also expected to have a negative effect on the ecological footprint. As the development levels of countries increase, it is expected that environmentally friendly projects will not be experiencing financing problems, and that their sensitivity to this issue will be high, thus reducing the ecological footprint. The final independent variable, the trade openness data, is expected to affect the ecological footprint positively. Since the increase in the trade volumes of countries means an increase in production amounts, the economic purpose comes to the fore rather than environmental sensitivity. In this case, environmental degradation is expected to increase even more. Based on this, the hypotheses to be tested in the study are formed as follows:

Hypothesis 1: GB issues have a reducing effect on the ecological footprint.

Hypothesis 2: The development levels of countries have an increasing effect on the ecological footprint.

Hypothesis 3: The level of trade openness of countries has an increasing effect on the ecological footprint.

The model estimation phase was started after testing the stationarity of the series used in the study. For this purpose, Breusch Pagan's (1980) test was applied to determine the most appropriate method for estimating the Pooled Least Squares and the panel regression methods. The Pooled Least Squares method is tested against the random effects model in the test. The null hypothesis is that the variance of the unit effects is zero; that is, the Pooled Least Squares method estimation is the most appropriate (Breusch and Pagan, 1980). After determining that the estimation with the panel regression model is appropriate, it is necessary to determine whether the equations have fixed or random effects. For this purpose, the Hausman (1978) test was applied. The null hypothesis in the test is that there is no correlation between the units; that is, that random effects are manifested (Hausman, 1978). Basic assumption tests, namely, heteroscedasticity and autocorrelation, were performed based on the estimation method through the random effects model obtained from the Hausman (1978) test results. Levene-Brown-Forsythe's tests were performed for heteroscedasticity, and Bhargava, Franzini and Narendranathan Durbin-Watson and Baltagi Wu LBI tests were used for autocorrelation. In econometric analyses, the heteroscedasticity problem is mainly encountered in studies conducted with cross-sectional data. The situation where the variance changes according to the units within the cross-sectional units is called heteroscedasticity (Yerdelen Tatoğlu, 2016). The heteroscedasticity problem in the random effects model is analysed by using the Levene-Brown-Forsythe test. According to the test proposed by Levene (1960), robust estimates are also presented in cases where the normal distribution assumption is not realised (Yerdelen Tatoğlu, 2016). The Levene-Brown-Forsythe test null hypothesis is that no heteroscedasticity problem exists according to the units (Greene, 2003). Due to the usage advantages of the Durbin-Watson test statistic, the Durbin-Watson autocorrelation test statistic was developed by Bhargava, Franzini and Narendranathan (1982) using the AR(1) model in order to test autocorrelation in both fixed and random effect models. Accordingly, the null hypothesis is that there is no autocorrelation between units (Bhargava et al., 1982). In addition to the Durbin-Watson test statistic developed by Bhargava et al., the *Locally Best Invariant* (LBI) test developed by Baltagi-Wu (1999) was also applied. The LBI test can be used for both fixed and random effect models. It can also be used for unbalanced models. The null hypothesis is established as no autocorrelation (Baltagi and Wu, 1999).

2.2. Data

Ecological footprint was used as an indicator of sustainable development and a dependent variable; the data related to ecological footprint were obtained from York University, National Footprint and Biocapacity Accounts. The GB issue amounts, used as independent variables, were obtained from the Climate Bonds Initiative database, the development indicator human development index data were sourced from the United Nations Human Development Index database, while the trade openness rates were retrieved from the World Bank database. Figure 1, showing the development of the series, is given below.

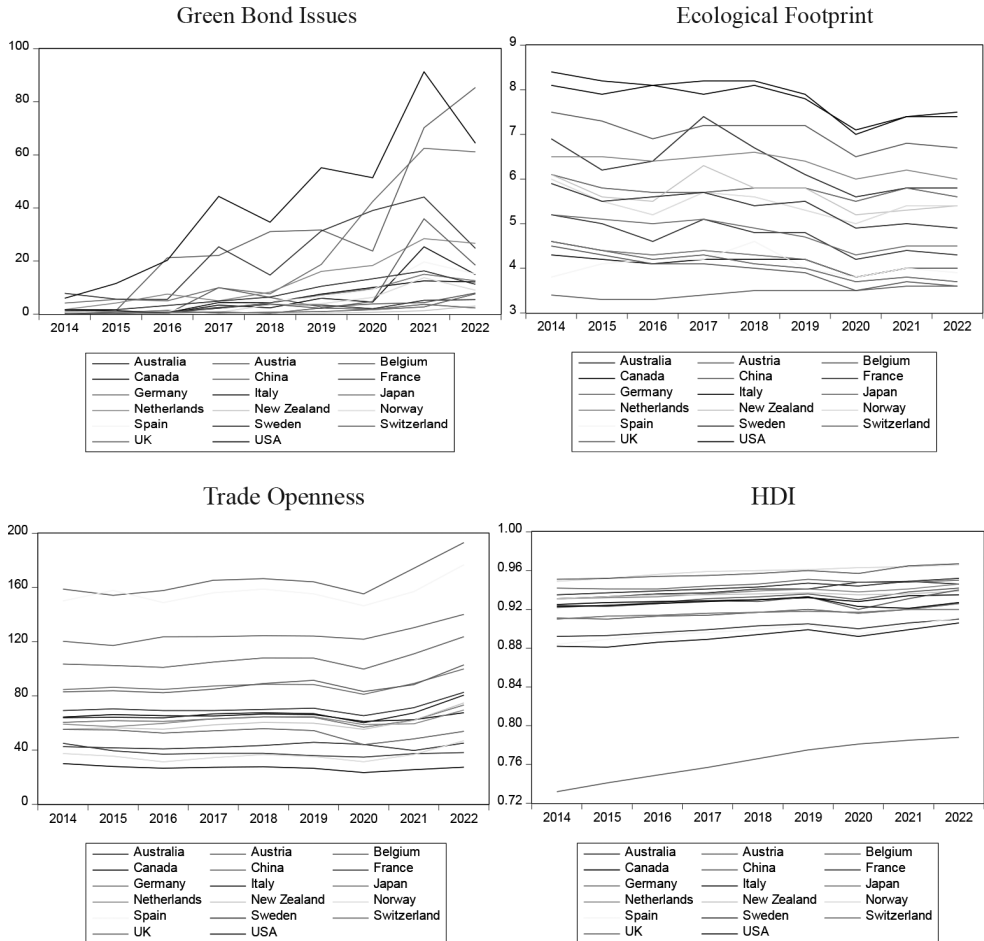


Figure 1. Development of series by country over the years

Note. Adapted from York University, *National Footprint and Biocapacity Accounts*, *Climate Bonds Initiative*, *United Nations* and *World Bank* databases, (2024).

Six components were used to calculate the ecological footprint: the carbon footprint, the agricultural land footprint, the forest footprint, the structured area footprint, the fishing area footprint, and the pasture footprint. A high ecological footprint value means that sustainability is negatively affected. From this point on, as seen in Figure 1, the country with the highest ecological footprint based on the horizontal sections in the panel is the USA, with 7.83. It is followed by Canada with 7.80, Belgium with 7.03, the Netherlands with 6.34, and Australia with 6.32.

When GB issuances are examined, the USA, which has issued GBs worth over 10 billion dollars, is again in the first place whereas China comes in the second place, Germany follows in third place, France is in the fourth place, and the Netherlands finds itself in the fifth place. The striking point here is that the ecological footprint of the USA is still high

despite having the highest GB issuance. This can be interpreted as an assumption that the GB issuances in the USA are not having the expected effect. China, which is given the second place and which has the lowest ecological footprint, is the country that can be interpreted as denoting the effectiveness of GB issuances.

When the HDI scores are examined, it is evident that the development rates of all the investigated countries except for China are close to one. This can be interpreted as a point that the countries in the panel are denoted by high human development.

When the trade openness rate calculated as the share of the total trade volume in GDP is examined, the country with the highest value in terms of trade openness is Belgium, with 165.45%. Meanwhile, Spain comes second with 156.33%, China is third with 125.03%, and Austria ranks fourth with 106.89%. The USA is in the final position with 26.90%. This situation is somewhat remarkable for the USA, which is one of the leading advocates of neoliberal policies towards re-establishing the functioning of the market economy and making free trade the dominant policy in international trade.

3. Results and Discussion

The study examined the effects of GB issues on sustainable development for the 17 countries issuing the most GBs with the help of panel regression analysis. In this context, firstly, Breusch Pagan's (1980) test was applied in order to determine which method would be the most appropriate for estimation between the Pooled Least Squares method and the panel regression method. The results of the Breusch Pagan (1980) analysis are given in Table 1.

Table 1. Breusch Pagan (1980) test results

	Stats.
χ^2 test stats.	423.33
Prob.	0.000*

Note: * shows significance at the 1% level.

According to Table 1, the null hypothesis was rejected at a significance level of 1% for the model tested within the study's scope. It was concluded that the estimate should be obtained by using the panel regression method. Then, the Hausman (1978) test was applied to decide whether the model would be appropriate to estimate with fixed or random effects. The results of the Hausman (1978) test are shown in Table 2.

Table 2. Results of Hausman (1978) Test

	Stats
Hausman test stats	0.530
Prob.	0.971

According to the results in Table 2, the null hypothesis cannot be rejected. It was concluded that the random effects model was more appropriate as an estimation method. The

estimation was continued by using the random effects model, and heteroscedasticity and autocorrelation tests were conducted to determine whether the estimated models meet the basic assumptions. Instead of carrying out the ANOVA on absolute deviations from the mean of each group, it is done on the absolute deviations of observations from either the median or the 10% trimmed mean of each group. Three test statistics are calculated by using the Levene-Brown-Forsythe test. These test statistics are W_0 , W_{50} , and W_{10} . If the calculated test statistics are greater than 0.05, the null hypothesis of no heteroscedasticity problem between the units is rejected. In order to determine the autocorrelation between the units in the model, the Bhargava, Franzini and Narendranathan test and the Baltagi-Wu LBI test were applied. Suppose the Durbin-Watson test statistics calculated as a result of the test are close to 2. In that case, this indicates that there is no autocorrelation problem, and if the test statistics are found to be less than 1, this indicates that there is an autocorrelation problem (Bhargava, Franzini, and Narendranathan, 1982; Baltagi and Wu, 1999).

The results of the Levene-Brown-Forsythe test for heteroscedasticity and the Lagrange multiplier test for autocorrelation are given in Table 3.

Table 3. Results of the Heteroscedasticity and Autocorrelation Test

		Model	Test Stats	Prob.	Result
Heteroscedasticity		W_0	1.4893	0.115	No
		W_{50}	1.2859	0.217	No
		W_{10}	1.4893	0.115	No
Autocorrelation	Bhargava et al.		1.503		No
	Baltagi-Wu LBI		1.770		No

In the findings in Table 3, there is no problem with both heteroscedasticity and autocorrelation in the model tested within the scope of the study because the null hypothesis cannot be rejected in both tests.

A balanced panel of 17 developed countries was used in the study. After estimating the fixed and random effect models, Hausman's specification test was conducted for the decision to use FEM or REM. Based on the Hausman test results, a random effect model was used in the study with a highly significant P value ($P > 0.5$) and a chi-square statistic of 0.53.

In addition, a dynamic panel data analysis type, the 'Two-Stage Generalized Moments (GMM) Estimator', developed by Arellano and Bond (1991), was used in the study. The analysis is also known as the 'Two-Stage Instrumental Variables Estimator'. There are also different versions of the GMM method. The method which Arellano and Bond (1991) used in this study includes some features and conditions. Firstly, this method is used in the panel data; It can be used when T is less than N ($T < N$). It also requires a linear functional relationship and the presence of an endogenous variable which interacts with its previous values. In addition, it can be valid in the presence of independent variables that are not strictly exogenous and in the presence of autocorrelation and heteroscedasticity

depending on the section, although not between the sections (Roodman, 2009). Panel estimation results are given in Table 4.

Table 4. Panel Estimation Results

Dependent Variable (ef)								
Variables	Fixed Effects		Random Effects		GMM Fixed Effects		GMM Random Effects	
	Coefficients	t-ratio	Coefficients	t-ratio	Coefficients	t-ratio	Coefficients	t-ratio
constant	8.716 (0.000*)	4.842	9.180 (0.000*)	6.284	8.531 (0.000*)	6.743	9.180 (0.000*)	6.310
lngb	-0.100 (0.000*)	-4.289	-0.096 (0.000*)	-4.347	-0.101 (0.000*)	-6.900	-0.096 (0.000*)	-4.481
lnhdi	8.763 (0.026**)	2.259	9.005 (0.006*)	2.792	9.257 (0.001*)	3.395	9.005 (0.003*)	3.023
Intop	-0.095 (0.816)	-0.233	-0.219 (0.514)	-0.655	-0.040 (0.891)	-0.138	-0.219 (0.505)	-0.668
dummy	-0.319 (0.000*)	-5.289	-0.331 (0.000*)	-5.794	-0.245 (0.000*)	-5.717	-0.331 (0.000*)	-5.686
R ²	0.975		0.802		0.982		0.802	
Adj. R ²	0.970		0.796		0.979		0.796	
F-stats.	220.357		132.497		6.247		98.627	
Prob. (F)	0.000*		0.000*		0.013**		0.000*	

Note: * and ** show significance at the 1% and 5% levels, respectively.

According to the results of panel fixed effects, random effect and GMM estimation, the effect of explanatory variables, except for trade openness, on the ecological footprint in developed countries is relatively significant. In particular, the results show that GB issues significantly and positively affect the environmental performance indicator ecological footprint in the selected developed countries at 1%. According to the findings, the coefficient of GB issues is negative. Since this means a decreased ecological footprint, GB issues positively affect the environmental performance in the selected developed countries. In other words, a 1% increase in GB issues positively affects the environmental performance by reducing the ecological footprint by 0.1 units. This result shows that GB issues can positively affect the environmental performance, namely, sustainable development, if used within the scope of their purpose. However, although GB export reduces the ecological footprint, this situation cannot be interpreted as having the same effect in the long term when the findings of the studies in the literature are taken into account. There is a possibility that this effect will reverse unless the necessary improvements and arrangements are made in the long term. The low coefficient can be shown as evidence for this situation.

When the relationship between HDI, a development indicator, and ecological footprint is examined, the HDI indicator has a significant and positive effect on the ecological footprint in the selected developed countries at 5% in the fixed effects model and 1% in other models. According to the findings, a 1% increase in the HDI indicator has a negative effect on the environmental performance by increasing the ecological footprint by approximately 9 units. The economic structures of developed countries are based on high consumption, industrialisation, and fossil fuel use, which increase their ecological footprint. However,

developed countries tend to reduce their ecological footprint by investing more in environmentally friendly technologies. However, these investments have not yet fully balanced the consumption of natural resources and the overall impact on the environment. These findings indicate that countries need to re-evaluate their development strategies regarding environmental sustainability. The development of environmentally friendly technologies along with implementation of sustainable development policies can play an essential role in reducing the ecological footprint. The findings confirm this situation.

No statistically significant effect of the trade openness of countries on the environment could be determined. It can be stated that this result is due to the lack of global standards regulating the impact of trade on the environment. At the same time, it can be stated that the indirect effects of trade on the environment are not seen in the short term, and the study's time constraints make the result insignificant.

In addition, the dummy variable added to the model to determine the impact of the COVID-19 pandemic on environmental performance has a statistically significant effect on the environmental performance at the level of 1%. According to the findings, the quarantines implemented during the COVID-19 pandemic and the decreases in production have a 0.3 unit reducing effect on the ecological footprint. Therefore, it can be stated that the pandemic period positively affects the environmental performance. The findings obtained in the study support each other with the findings obtained in the studies conducted by Ren et al. (2020), Li and Gan (2021), Sinha et al. (2021), Khan et al. (2022), Chang et al. (2022), Meo and Karim (2022), Saha and Maji (2023) and Alamgir and Cheng (2023) in the literature.

4. Conclusion

The study examines the impact of GBs on sustainable development in the context of the countries issuing the highest volume of GBs. We used GB data from 2014 to 2022 and examined the impact of GBs on the ecological footprint. Traditional panel data models, fixed and random effects estimators, and the GMM method were used. The empirical findings largely confirm the results of previous studies in the field. Our results show that GB issuances reduce the ecological footprint of the seventeen selected developed countries, i.e., they improve their environmental performance. However, the coefficient of GBs is relatively low. Therefore, for this effect to be sustainable in the long term, countries need to update the necessary legislative infrastructure to encourage the export of GBs and increase the environmental awareness. Otherwise, it seems that the positive effects of GBs on the environment will be meaningless in the long term. In addition, it was established that the development levels of the countries have a negative and significant effect on the environmental performance in these countries. In addition, it was found that the COVID-19 pandemic positively affected the environmental performance. It was also discovered that trade openness rates in the selected countries did not statistically affect the environmental performance. The present study is essential in terms of its results, guiding

policymakers in other countries to develop appropriate policies to address environmental problems, starting from developed countries. The results can also signal the governments about the types of industries that should consider environmental performance in renewing existing enterprises or launching new enterprises. Countries and firms with problems in finding financial resources can apply to GBs in this regard, which can be a priority for governments to encourage them. These findings highlight the instrumental role of GBs in promoting sustainable development and emphasise the importance of their implementation, especially in countries aiming to achieve sustainability goals.

Our study has several limitations that should guide future studies on this topic. The study results are valid for the countries we selected and other regions experiencing GB issues. This study focuses on a specific set of countries (the top 17 GB supporting countries). In contrast, varying groupings of economies or regions may significantly impact the estimates.

5. Policy Implications

Considering that natural resources are being systematically destroyed in the world with each passing day, the importance of sustainable development becomes ever more apparent. In order to ensure sustainable development, the number of environmentally sensitive, as well as environmentally friendly investments must undoubtedly be increased. In this regard, necessary regulations must be adopted by both supranational institutions and individual countries. At this point, the problem of financing the investments to be made comes to mind. In order to increase environmentally friendly projects, it is of importance to reduce the obstacles that have emerged or may arise over time for the development of GBs, one of the green financing instruments. Based on the findings of the present study, the following suggestions can be made for the development of GBs:

1. Countries that issue low GBs can follow in the footsteps of other countries.
2. In addition to the necessary tax incentives, public expenditures should be channelled to the relevant areas through fiscal policies.
3. While GB indexes are currently calculated on 24 country stock exchanges regarding GBs, these indexes should be developed for other countries as well to promote GB issues.
4. GB issuance should be facilitated by providing more incentives in regions and countries where air quality is poor and environmental degradation is high.
5. Since GB, on average, significantly reduces the ecological footprint in the selected countries, regulators and policymakers should follow a strict policy on the maximum use of GBs.
6. Developed countries may consider some other GF instruments besides using GBs to achieve sustainability goals.

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Attitudes of Slovak Consumers towards the Generation of Waste in Tourism

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Abstract. The objective of this study is to analyse the relationship between tourist attitudes towards waste generation in Slovakia and their corresponding behaviours. With an increasing emphasis on environmental responsibility, understanding the behaviours and beliefs of tourists concerning waste management is crucial for promoting sustainable practices within tourism. This research focused specifically on tourists visiting Slovakia, offering valuable insights into their waste management attitudes. A questionnaire was distributed electronically to 324 respondents through platforms such as *MS Teams*, email, and social networks. The questionnaire captured tourist attitudes and behaviours regarding waste generation, responsible consumption, and environmentally sustainable practices. The sample size of 324 responses was validated for representativeness. The statistical method, *principal component factor analysis* (PCA), was used to assess data suitability and identify the underlying patterns. Correlation analysis was conducted to examine the relationships between variables, with a significance check included. The results showed a significant correlation between tourist attitudes towards waste reduction and their environmentally responsible behaviours. This study provides important implications for promoting sustainable tourism practices in Slovakia and enhancing environmental stewardship in the industry. These findings offer insights that can support more targeted interventions so that to improve waste management in tourism, thereby contributing to Slovakia's sustainability goals.

Keywords: tourism, sustainability, waste, consumer attitude, consumption, PCA, correlation.

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Introduction

Consumer attitudes towards tourism waste are crucial for achieving sustainable tourism. Understanding these attitudes helps mitigate negative environmental impacts and develop strategies for better waste management.

Tourism has been one of the most critical sectors of the global economy for decades, and its economic activity continues to grow despite the interference of the COVID-19 pandemic, which interrupted its long-lasting period of constant growth (Herrero et al., 2022).

Handling food waste in tourism challenges the economy, the environment and society. Eating habits, perceptions, attitudes, and behaviours of consumers are essential in the generation of waste in the tourism industry (Amicarelli et al., 2022). As a society, we must take responsibility and act. Sustainable development initiatives are integral to the UN Agenda, and also to tourists who drive sustainable changes (Amundson, 2022).

Tourism brings relaxation, enjoyment, and entertainment to tourists, which may cause their behaviour to be less environmentally friendly than at home, where they are considerate of sustainable activities and the environment (Liu et al., 2022).

Collectivistic associations and group references are related to the expected achievement of a group goal, and the normative motive of being an exception to everyday life in the form of a holiday or vacation may cause tourists to behave less environmentally sustainably (Liu et al., 2022).

The growth of tourism has adverse effects on the environment of the tourism destination. The increase in the numbers of visitors in the tourist sector is also associated with an increase in waste produced by tourists, which affects the ecology, vegetation, soil, and water, thus ultimately disrupting the entire ecosystem, which raises concerns and supports the search for practical solutions for waste sorting. The success of waste sorting in tourist destinations largely depends on tourists' behaviour, culture, and awareness (Cao et al., 2022).

Tourism must be sustainable for the economies of the countries involved so that they could prosper and grow green. A dramatic and excessive increase in the number of visitors has a long-term impact on the lifestyle of residents and leads to adverse effects. Adoption of a sustainable development strategy increases environmental awareness. It points to green tourism, which is considered the future direction of development as it seeks to protect the green environment and ecological principles (Markose et al., 2022).

Consumer attitudes wield substantial influence on sustainable tourism, shaping decisions and actions that directly impact environmental preservation, cultural heritage, economic progress, and waste reduction (Juvan and Dolnicar, 2016).

Examining consumers' attitudes towards waste generation in tourism is essential in the context of scientific outputs.

The first point is that tourism is an industry with an ever-increasing impact on the environment and society. Therefore, it is essential to understand how consumers behave in this area, and how their attitudes affect environmental sustainability.

The second reason is the relative novelty of this topic. Given the growing emphasis on environmental sustainability and responsible travel, there is still much room for research

on consumer attitudes towards waste in the tourism industry. This space allows researchers to discover new knowledge and identify trends and patterns in consumer behaviour. This can lead to a better understanding of this issue and the development of more effective strategies to improve environmental sustainability in tourism.

Moreover, more research indicates the need for further investigation and data collection. New studies can provide new information and insights into the issue of waste in the tourism industry, leading to improved policies and measures to protect the environment. Given these factors, researchers must address this topic and contribute to developing knowledge of consumer behaviour and environmental sustainability in tourism. For this reason, we are interested in this topic.

The study employed various statistical methods. The Kaiser-Meyer-Olkin test was employed to evaluate the appropriateness of factor analysis. Bartlett's Test of Sphericity was administered to ascertain the uniformity of the correlation matrix among the chosen variables, which is a critical prerequisite for effective factor analysis. Factor analysis was used to capture the correlation between variables. Factor Analysis utilising the *Principal Components Method* (PCA) was executed to discern the underlying patterns, subsequently condensing them into principal components, thereby facilitating dimensionality reduction. These methodological approaches collectively yielded insights into the dataset's congruence and structural patterns, thereby enhancing the precision of the interpretation of the research results.

The study objective is to identify the relationship between consumer attitudes towards waste generation in tourism in Slovakia. By understanding whether there is a correlation between attitudes and behaviours related to waste generation in tourism, we want to gain insights into consumer decision-making processes and identify potential areas for promoting sustainable practices within the tourism industry. For behaviours related to waste generation in tourism, we aim to gain insights into consumer decision-making processes and potential areas for promoting sustainable practices within tourism.

Slovakia is known for its stunning natural landscapes, including mountains, forests, and national parks, which attract high numbers of tourists annually. Tourism plays a significant role in the country's economy and regional development. However, the growing influx of visitors brings environmental challenges, such as increased waste production, the degradation of natural resources, and pollution of delicate ecosystems. In response to these challenges, there is a rising emphasis on sustainable tourism which aims to minimise negative environmental impacts. Responsible behaviour by tourists, along with eco-friendly practices implemented by tourism service providers, is crucial for preserving the environment and ensuring that Slovakia's natural treasures remain protected for future generations (Cakoci et al., 2014).

The research on Slovak consumers' attitudes toward waste generation in tourism is expected to provide valuable insights into how tourists perceive the environmental impact of their activities. Additionally, the study will assess the level of environmental awareness among tourists and their willingness to reduce waste in travel destinations. This research could offer important guidance for promoting more sustainable practices in Slovak tour-

ism, ultimately helping to protect the natural environment for future generations (Štrba et al., 2022).

This study is among the first to focus on the waste management behaviours of tourists in Slovakia. While much research has been conducted on local populations and their waste habits, few studies have explored how tourists' behaviours in tourism settings contribute to waste generation. Hence, the present research is expected to provide valuable insights into the challenges and opportunities for sustainable tourism in the region.

1. Related Work and Literature

Tourism consumers' attitudes towards waste are crucial to their socially responsible behaviour. These attitudes consider their relationship with the environment and influence the decisions they make when travelling. One of the main points of view is the responsibility for generating one's waste. Nowadays, many consumers are interested in environmentally responsible behaviour, and are willing to take responsibility for their waste (Liobikienė and Juknys, 2016; Thøgersen, 2006). Another important aspect is the support of sustainable initiatives, where consumers show a positive attitude towards destinations and businesses which implement sustainable waste policies. Education and awareness also play a key role in forming attitudes, where education contributes to greater sensitivity to the environmental problems associated with waste (Padilla and Trujillo, 2020). Use of reusable packaging is another manifestation of positive attitudes, where consumers prefer recyclable materials that contribute to waste reduction. Some consumers are also actively involved in volunteer activities aimed at cleaning and caring for the environment in tourist places (Šuškevičė and Kruopienė, 2021; Coelho et al., 2020).

As part of travel planning, consumers can also evaluate the waste policies of destinations. Destinations with clear and effective waste policies may be given preference in their decision-making. Research on consumer attitudes towards waste in tourism can offer insight into how these attitudes influence their behaviour and contribute to social responsibility (Ezeah et al., 2015). The waste behaviour of tourism consumers is an essential part of environmentally responsible behaviour. Consumers directly influence the structure and volume of waste, especially in its creation and separation phases. By their behaviour, they condition favourable ecological procedures in the waste management of tourism entities and destinations. With their expectations, attitudes, and values, they can influence the approaches of tourism service producers in waste policy (Coelho et al., 2020; Ezeah et al., 2015).

If tourists behave pro-environmentally, they limit and prevent environmental destruction in tourist destinations (Ulusoy, 2016; Xiong, 2023). Pro-environmental behaviour with factors based on tourists' world outlook is key to sustainable waste management. Waste sorting is beneficial for waste management, it contributes to waste disposal, and supports sustainable development. In connection with this issue, the following sub-chapter examines waste and its connection with tourism in more detail.

Responsible consumption and sustainable tourism share a strong connection, serving as vital components for the industry's long-term growth while preserving the environment. By embracing responsible consumption practices within tourism, we establish a foundation for sustainable development, which is crucial for mitigating adverse impacts on nature. As such, it is essential to incorporate responsible consumption into the waste management strategies of businesses and tourism destinations, thus ensuring that they align with sustainability goals and contribute to minimising negative consequences on the environment. Several authors deal with the issue of responsible consumption and pro-environmental behaviour (Han, 2021; Patwary, 2023; Wang et al., 2023; Stern, 2002; Soper, 2008; Bartošová and Musová, 2022; Hall, 2010; Sharpley, 2006; Goodwin and Font, 2011; Cavalheiro et al., 2020).

Responsible tourist behaviour can be motivated by the theory of planned behaviour and the theory of consumption values. The theory of planned behaviour deals with anticipated patterns of behaviour that are influenced by attitudes, subjective norms, and perceived control over behaviour. Therefore, tourists may exhibit environmentally responsible behaviour based on their attitudes towards nature conservation and ecological concerns and due to expected reactions from society and friends. On the other hand, the *Consumer Value Theory* focuses on the values that influence consumer decisions and preferences. Tourists can display responsible tourism behaviour based on their value orientations, such as environmental protection, social responsibility, and sustainability. These values can lead to a preference for environmentally sustainable destinations, services, and products. Together, these theories offer insight into the factors influencing tourists' responsible behaviour and help them gain better understanding of their decision-making processes and preferences towards sustainable tourism (Hsu and Huang, 2012; Ulker-Demirel and Ciftci, 2020; Phau et al., 2014; Gallarza and Gil Saura, 2020; Wang and Ritchie, 2012).

2. Methodology and Research Design

This study employed a questionnaire to gather data from 324 tourists visiting Slovakia. The questionnaire was designed to measure their attitudes toward waste generation and behaviours related to sustainable tourism practices. Statistical analysis was used to test the relationship between these variables.

A questionnaire was constructed in *Google Docs*. This questionnaire aimed to gather insights from tourists visiting Slovakia. Following its creation, we electronically disseminated the questionnaire through various platforms, including *MS Teams*, email, and various social networks.

Through these channels, we successfully reached out to 324 respondents. Their participation and input provided valuable data for our study, enabling us to analyse and understand various aspects of tourism in Slovakia from the visitors' perspective.

The substantial response rate reflects the tourists' interest and engagement in contributing to our research efforts. This diverse pool of respondents enhances the comprehensiveness of our findings, enriching our understanding of tourists' experiences and preferences in Slovakia. The research was conducted from December 2023 to January 2024.

The questionnaire was designed to capture consumers' attitudes toward waste generation within tourism. It aimed to explore the participants' behaviours and beliefs regarding responsible consumption and environmentally sustainable practices.

Selected attitudes present responsible consumption, leading to the minimisation of waste in the context of daily life and, at the same time, applicable in tourism:

- A1: I am willing to prefer products with renewable or recyclable packaging.
- A2: I am considering buying products with minimal packaging or no packaging.
- A3: I am willing to buy 'second-hand' or use shared products instead of buying new ones.
- A4: I am willing to follow ecological and sustainable certificates when choosing products.
- A5: I prefer to carry my own packaging instead of the individual packaging of products sold directly in the store.
- A6: I minimise waste by extending the life of the products I buy.
- A7: I prefer to produce some products that thereby contribute to minimising waste.
- A8: I am considering growing my food or buying from local farmers to minimise packaging and transport emissions.
- A9: I monitor the waste my shopping produces and try to minimise delivery packaging.
- A10: I am willing to look for accommodation that actively practices waste recycling.
- A11: I am willing to prefer restaurants and catering facilities that use recyclable containers and dishes.
- A12: I am willing to adapt my food and drink consumption to my actual consumption and thereby contribute to minimising waste.
- A13: Minimising single-use plastic products such as straws or food packaging is essential.
- A14: I am willing to take my reusable water bottle or coffee cup while travelling.
- A15: I am interested in information about sustainable transport options while travelling.
- A16: I am willing to use public transport to contribute to reducing the use of cars and thereby reduce emissions in the air.
- A17: I am willing to buy souvenirs or products from local producers supporting sustainable practices.
- A18: I am willing to volunteer for local programs to clean up the environment during my vacations and trips.
- A19: I am willing to inform the neighbourhood about sustainable practices in my destination.
- A20: I am willing to partially use digital technology, thereby supporting the minimisation of waste generation.

The research question "*How do consumers' attitudes towards waste generation in tourism correlate with their behaviours?*" **was formulated after studying the relevant literature and research papers.**

Upon verifying the research question, we have formulated the following hypotheses:

H1₀: There is no statistically significant correlation between tourists' attitudes towards waste generation and their waste management behaviours in tourism within Slovakia.

H1: There is a statistically significant correlation between tourists' attitudes towards waste generation and their waste management behaviours in tourism within Slovakia.

The respondents were given an opportunity to express their agreement /disagreement in the form of answers 'yes/no' and, at the same time, agree/disagree with the given attitude through a 5-point Likert scale, while the values are as follows: '1' – completely disagree, '2' – disagree, '3' – neutral, '4' – agree, '5' – completely agree. We used several statistical methods to analyse the data.

Before performing the factor analysis, the *Kaiser-Meyer-Olkin Test* and the *Bartlett's Test of Sphericity* were performed. The Kaiser-Meyer-Olkin Test was used to assess the suitability of the data for factor analysis. The KMO statistic is a measure of how suited the data is for factor analysis. The test checks the proportion of variance among variables that might be common variance. Higher KMO values (for example, above 0.4) indicate the suitability of the data for factor analysis. Bartlett's Test of Sphericity was used to test whether the correlation matrix is significantly different from an identity matrix. If the p-value is less than a specified significance level (0.05), we reject the null hypothesis, thereby indicating that the correlation matrix is not identical.

Factor Analysis using the Principal Components Method (PCA):

- **Significance:** This method is used to identify patterns in many variables and reduce them to a smaller number of independent variables known as principal components.
- **Calculation:** PCA identifies principal components by calculating a correlation matrix and then applying a linear transformation to the data. It then selects the principal components with the highest eigenvalues that represent the explained variance of the data.

Following the factor analysis, Spearman's correlation was used to explore direct relationships between the variables, such as the connection between tourists' willingness to engage in waste reduction behaviours and their environmental attitudes. Its values range from '-1' (perfect negative correlation) to '1' (perfect positive correlation), with '0' indicating no monotonic relationship between the variables.

These methods provided us with the necessary information about the data's fit and the structure of the patterns in our research, allowing us to understand and interpret the results more accurately.

Factor analysis captures correlations between the variables in the data, although it does not do so while directly using correlation coefficients such as Pearson's or Spearman's

coefficients. Instead, it identifies patterns or factors in the input data and determines how well those factors explain the variability in the data.

Correlations between variables are essential to factor analysis because this method seeks to identify hidden factors that lead to the patterns observed in the data. Strong correlations between variables indicate that these variables are likely part of the same factor. These relationships between the variables are then considered in factor analysis to estimate the interrelationships between the factors and the original variables.

Conversely, PCA focuses on reducing the dimensionality of data by transforming the original variables into a new set of variables called the principal components. These components are orthogonal, which means that they are uncorrelated and are ordered based on the amount of variance they explain. Although PCA does not directly measure correlations between variables, the initial correlations among variables influence the selection and composition of the principal components. Strong correlations between variables lead to more significant variability, which is better captured by principal components, and which results in a closer relationship between the original variables and certain principal components.

In summary, while factor analysis and PCA do not directly rely on correlation coefficients, they are indirectly influenced by the correlations between variables. Understanding these relationships is crucial for accurately interpreting the outcomes of factor analysis and PCA.

3. Results

Two tests were conducted to ensure the suitability of the research variables before performing a factor analysis. To simplify the presentation, attitudes within the model were denoted as A1 to A20.

The Kaiser-Meyer-Olkin (KMO) adequacy Test was employed to assess the data appropriateness for factor analysis. The obtained results affirmed that all variables tapped into the same latent construct, and none were deemed unsuitable for subsequent analysis. Bartlett’s test of sphericity was applied to gauge the uniformity of the correlation matrix among the chosen variables. The findings of this test revealed significant correlations among variables, signalling the potential for factor analysis to unveil concealed relationships or factors within the dataset.

These initial tests provided robust validation of data suitability, setting a strong foundation for the ensuing factor analysis. They ensured a reliable exploration of latent constructs and interrelationships among the model’s simplified attitudes (A1 to A20).

Table 1. Results (source: author’s own research)

KMO test		0.858
Bartlett’s Test of Sphericity	Chi-Square	2624.762
	df	190
	Sig.	0

By utilising the Kaiser criterion, three factors were selected to explain 85.8% of the variability observed in the original manifest variables. Factor loadings exceeding 0.40 were considered significant, aiding in identifying the most influential items for each factor. A correlation analysis was conducted to examine the relationships between these factors, with significant correlations highlighted in blue in Table 2. A moderately strong positive correlation emerged between attitudes, thus indicating interconnectedness among consumer perceptions.

The most notable correlation was found between attitudes A10 and A11, revealing a propensity for consumers who actively seek accommodations practising waste separation to favour restaurants and catering establishments employing recyclable containers and dishes.

The highest correlation was identified in the following attitudes:

A5 and A2: The correlation between preferring to carry one's packaging instead of individual packaging from the store (A5) and considering buying products with minimal packaging or no packaging (A2) suggests that individuals who prefer reusable packaging are also likely to choose products with minimal packaging, which indicates a commitment to waste reduction.

A11 and A10: The correlation between being inclined to prefer restaurants and catering facilities that use recyclable containers and dishes (A11) and being inclined to look for accommodations that actively practice waste recycling (A10) suggests a connection between preferences for sustainable dining options and eco-conscious accommodation choices. This correlation indicates a comprehensive commitment to sustainability in travelling dining and lodging experiences.

A14 and A13: The correlation between being inclined to take a reusable water bottle or coffee cup while travelling (A14) and minimising single-use plastic products such as straws or food packaging (A13) implies a connection between preferences for reusable containers during travel and efforts to reduce single-use plastics. This correlation suggests a consistent commitment to waste reduction and environmental conservation while travelling.

A15 and A16: The correlation between taking interest in sustainable transport options while travelling (A15) and the willingness to use public transport to reduce emissions (A16) suggests a connection between interests in sustainable transportation and preferences.

A18 and A19: The correlation between being eager to volunteer for local programs to clean up the environment during vacations and trips (A18) and being inclined to inform the neighbourhood about sustainable practices in the destination (A19) implies a connection between engagement in environmental volunteering and advocacy for sustainable practices. This correlation suggests that individuals who engage in environmental volunteering are also likely to advocate for sustainability within their communities.

Other correlations are shown in Table 2. Overall, these findings unveil underlying structures in consumer attitudes towards waste management practices, offering insights into the interplay between different aspects of environmental behaviour and consumer preferences.

Table 2. Correlation (source: author's own research)

Corr.	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20
A1	1.00	0.48	0.06	0.38	0.38	0.37	-0.05	0.23	0.24	0.21	0.29	0.35	0.17	0.32	0.46	0.38	0.10	0.19	0.21	0.24
A2	0.48	1.00	0.28	0.44	0.51	0.28	0.25	0.28	0.39	0.25	0.27	0.39	0.32	0.39	0.38	0.39	0.24	0.29	0.23	0.31
A3	0.06	0.28	1.00	0.26	0.26	0.24	0.28	0.15	0.21	0.11	0.26	0.11	0.23	0.21	0.21	0.36	0.18	0.21	0.20	0.10
A4	0.38	0.44	0.26	1.00	0.39	0.36	0.27	0.27	0.44	0.45	0.47	0.38	0.23	0.29	0.42	0.34	0.34	0.44	0.35	0.40
A5	0.38	0.51	0.26	0.39	1.00	0.36	0.17	0.16	0.31	0.27	0.22	0.23	0.23	0.35	0.31	0.36	0.14	0.26	0.39	0.31
A6	0.37	0.28	0.24	0.36	0.36	1.00	0.24	0.36	0.34	0.38	0.33	0.38	0.26	0.31	0.32	0.36	0.23	0.31	0.26	0.27
A7	-0.05	0.25	0.28	0.27	0.17	0.24	1.00	0.36	0.45	0.34	0.18	0.06	-0.03	-0.11	0.10	0.08	0.34	0.23	0.29	0.10
A8	0.23	0.28	0.15	0.27	0.16	0.36	0.36	1.00	0.44	0.40	0.30	0.38	0.27	0.26	0.29	0.19	0.37	0.33	0.19	0.15
A9	0.24	0.39	0.21	0.44	0.31	0.34	0.45	0.44	1.00	0.45	0.36	0.28	0.28	0.20	0.30	0.29	0.33	0.44	0.45	0.47
A10	0.21	0.25	0.11	0.45	0.27	0.38	0.34	0.40	0.45	1.00	0.61	0.31	0.21	0.15	0.30	0.19	0.36	0.40	0.47	0.35
A11	0.29	0.27	0.26	0.47	0.22	0.33	0.18	0.30	0.36	0.61	1.00	0.37	0.30	0.19	0.34	0.32	0.35	0.40	0.37	0.32
A12	0.35	0.39	0.11	0.38	0.23	0.38	0.06	0.38	0.28	0.31	0.37	1.00	0.34	0.47	0.42	0.39	0.24	0.22	0.11	0.26
A13	0.17	0.32	0.23	0.23	0.23	0.26	-0.03	0.27	0.28	0.21	0.30	0.34	1.00	0.56	0.40	0.40	0.40	0.21	0.25	0.28
A14	0.32	0.39	0.21	0.29	0.35	0.31	-0.11	0.26	0.20	0.15	0.19	0.47	0.56	1.00	0.44	0.48	0.32	0.21	0.12	0.22
A15	0.46	0.38	0.21	0.42	0.31	0.32	0.10	0.29	0.30	0.30	0.34	0.42	0.40	0.44	1.00	0.59	0.33	0.33	0.37	0.33
A16	0.38	0.39	0.36	0.34	0.36	0.36	0.08	0.19	0.29	0.19	0.32	0.39	0.40	0.48	0.59	1.00	0.29	0.34	0.38	0.30
A17	0.10	0.24	0.18	0.34	0.14	0.23	0.34	0.37	0.33	0.36	0.35	0.24	0.40	0.32	0.33	0.29	1.00	0.44	0.36	0.24
A18	0.19	0.29	0.21	0.44	0.26	0.31	0.23	0.33	0.44	0.40	0.40	0.22	0.21	0.21	0.33	0.34	0.44	1.00	0.62	0.40
A19	0.21	0.23	0.20	0.35	0.39	0.26	0.29	0.19	0.45	0.47	0.37	0.11	0.25	0.12	0.37	0.38	0.36	0.62	1.00	0.47
A20	0.24	0.31	0.10	0.40	0.31	0.27	0.10	0.15	0.47	0.35	0.32	0.26	0.28	0.22	0.33	0.30	0.24	0.40	0.47	1.00
Significant level (1-tailed), p-value < 0.05																				
A1		0.00	0.14	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
A2	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A3	0.14	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
A4	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A5	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
A6	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A7	0.17	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.15	0.32	0.02	0.03	0.08	0.00	0.00	0.00	0.04
A8	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A10	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A12	0.00	0.00	0.03	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
A13	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
A14	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.02	0.00
A15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
A16	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
A17	0.04	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00
A18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
A19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00		0.00
A20	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

When using the principal component analysis (PCA) method, we focused on eigenvalues which indicate the total explained variance for each principal component. The findings are shown in Table 3:

- Component 1: eigenvalue of 6.84, explaining 34.22% of the total variance.
- Component 2: eigenvalue of 1.95, explaining 9.76% of the total variance.
- Component 3: eigenvalue of 1.27, representing 5.86% of the total variance.

Table 3. Total variance explained (source: author's own research)

Comp.	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
A1	6.843	34.216	34.216	6.843	34.216	34.216
A2	1.952	9.760	43.976	1.952	9.760	43.976
A3	1.269	6.346	50.323	1.269	6.346	50.323
A4	1.204	6.020	56.343	1.204	6.020	56.343
A5	1.170	5.852	62.195	1.170	5.852	62.195
A6	0.898	4.488	66.683			
A7	0.776	3.879	70.562			
A8	0.738	3.689	74.251			
A9	0.676	3.379	77.630			
A10	0.608	3.041	80.671			
A11	0.578	2.892	83.563			
A12	0.538	2.692	86.255			
A13	0.461	2.305	88.560			
A14	0.423	2.117	90.676			
A15	0.387	1.935	92.612			
A16	0.355	1.775	94.387			
A17	0.342	1.712	96.099			
A18	0.309	1.545	97.644			
A19	0.264	1.322	98.966			
A20	0.207	1.034	100.000			

We extracted the same number of components as the items; the values in the 'Extracted sums of squared loadings' column match those in the 'Initial eigenvalues' column. Our primary objective in this research was to reduce variables while retaining as much meaningful variance as possible.

These results demonstrate how each principal component explains the variance within the dataset. By identifying and prioritising components with higher eigenvalues, we effectively capture and summarise the most significant patterns and relationships which are present in the data. This reduction of variables facilitates a more manageable and insightful analysis, aligning with our research objectives.

Five components were identified based on the criterion (these components should have eigenvalues greater than 1). The values are shown in Figure 1.

Based on the obtained results, we can interpret the following findings. Generally, the first component achieves the highest total variance, while the final component achieves the lowest value. However, all three components reach values higher than the eigenvalue.

Five components reach a value higher than 1. The break occurs in component 6, where the variance reaches a value lower than 1.

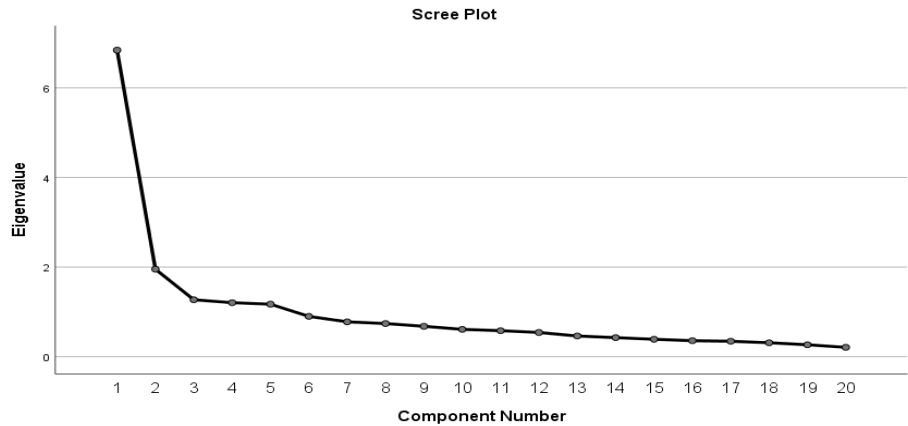


Figure 1. Scree Plot (source: author’s own research)

Table 4. Component matrix (source: author’s own research)

A1	A2	A3	A4	A5
0.525	-0.380	-0.349	0.221	-0.307
0.629	-0.215	-0.218	0.338	0.109
0.396	0.011	0.039	0.183	0.683
0.691	0.079	-0.178	0.085	-0.106
0.565	-0.145	-0.446	0.195	0.195
0.595	-0.032	0.018	0.269	-0.092
0.366	0.617	0.113	0.427	0.273
0.539	0.174	0.448	0.327	-0.179
0.658	0.337	-0.033	0.097	-0.017
0.625	0.394	0.061	-0.019	-0.334
0.630	0.173	0.083	-0.111	-0.244
0.579	-0.324	0.243	0.167	-0.325
0.543	-0.340	0.383	-0.284	0.160
0.551	-0.574	0.255	-0.084	0.093
0.669	-0.290	0.002	-0.125	-0.006
0.645	-0.343	-0.049	-0.144	0.266
0.564	0.199	0.441	-0.219	0.120
0.633	0.312	-0.074	-0.316	0.043
0.615	0.354	-0.280	-0.403	0.125
0.569	0.099	-0.302	-0.340	-0.138

A component matrix related to principal component analysis (PCA) presents each row of the matrix representing one of the original variables, while the columns represent individual principal components. Values in individual cells indicate weights, respectively. The contributions of the original variables refer to the individual principal components. For example, a value of 0.525 in the first row and first column means that the first variable positively contributes to the first principal component. Likewise, a value of -0.38 in the first row and second column means that the first variable negatively contributes to the second principal component. The results are shown in Table 4.

4. Discussion

The findings of the study highlight significant correlations between consumer attitudes and behaviours regarding waste management in tourism, particularly concerning the reduction of waste. Spearman's correlation analysis revealed moderate to strong positive relationships among the key attitudes. For example, the correlation between the respondents' willingness to use reusable packaging and their preference for products with minimal or no packaging (A5 and A2) underscores a consistent commitment to waste reduction. This suggests that those who prioritise sustainable packaging choices also tend to align their broader consumption habits with environmental concerns, thereby reinforcing their dedication to reducing waste. The use of PCA further simplified the complex interrelations by reducing the dataset into principal components, thus making it easier to identify the core patterns in consumer behaviour. The first component, which captured the highest variance, reflects the overarching trend of sustainable practices among consumers. The eigenvalues associated with the principal components highlight that a significant portion of the variance in waste management attitudes can be attributed to a few key factors, such as the willingness to choose environmentally responsible accommodations (A10) and dining options (A11), as these were strongly correlated in both the correlation analysis and the PCA results.

We rejected the null hypothesis based on our results.

In our result, a correlation analysis revealed a moderately strong positive correlation among consumer attitudes.

The identified correlations emphasise the interconnectedness of various attitudes towards sustainability in the context of consumer behaviour and travel preferences.

Firstly, the correlation between preferring reusable packaging (A5) and considering products with minimal or no packaging (A2) underscores interest of individuals in waste reduction. This suggests that those inclined towards using reusable packaging are also likely to opt for products that align with their environmental values, which indicates a cohesive approach to minimising waste.

Similarly, the correlation between the willingness to patronise restaurants and catering facilities employing recyclable containers (A11) and actively seeking accommodations that practice waste recycling (A10) highlights a holistic interest in sustainability in travel-related dining and lodging experiences. This correlation implies that individuals prioritising

eco-friendly dining options are also inclined to select accommodation providers with similar environmental practices, thus reinforcing their dedication to sustainable living.

Furthermore, the correlation between carrying reusable containers while travelling (A14) and minimising single-use plastics (A13) suggests a conscientious effort to reduce waste and preserve the environment during travel. This linkage implies that individuals who embrace reusable alternatives for beverages and food containers are also likely to actively reduce their reliance on single-use plastics, thereby promoting environmentally friendly habits while on the go.

Moreover, the correlation between taking interest in sustainable transportation options while traveling (A15) and willingness to utilise public transport to mitigate emissions (A16) underscores a connection between environmental consciousness and transportation preferences. This suggests that individuals interested in sustainable travel are more inclined to adopt eco-friendly modes of transportation, thus contributing to their efforts aimed at reducing carbon footprints during travel.

Lastly, the correlation between volunteering for local environmental cleanup programs during vacations (A18) and advocating for sustainable practices within communities (A19) suggests a synergistic relationship between environmental engagement and advocacy. This implies that individuals actively involved in ecological volunteering are also likely to champion sustainability initiatives within their communities, thus fostering a culture of environmental stewardship beyond individual actions.

Overall, these correlations highlight the multifaceted nature of sustainability attitudes and behaviours, emphasising the importance of integrated approaches towards fostering environmentally responsible lifestyles at home and during travel.

Additionally, we conducted principal component analysis (PCA) focused on eigenvalues. It indicated the total explained variance for each principal component. The first component explained the highest total variance, with the subsequent components explaining decreasing amounts of variance. Five components (A1–A5) had eigenvalues greater than 1, while the break occurred before the sixth component (A6), where the variance fell below 1.

The component matrix related to PCA illustrated the contributions of original variables to individual principal components. Each row represented one of the original variables, with the columns representing individual principal components. Positive and negative values in the matrix indicated the direction and strength of each variable's contribution to the components. These findings offer insights into the underlying structures of consumer attitudes towards waste management practices and the interplay between environmental behaviour and consumer preferences.

Our results are similar to above-cited studies. Our findings emphasise the importance of individuals' relationships with the environment, and how these influence their travel decisions. The following similarities have been observed:

- Interest in environmentally responsible behaviour. Our findings highlight the growing interest among consumers in environmentally responsible behaviour, such as waste reduction and recycling, reflecting a positive attitude towards sustainability (Liobikienė and Juknys, 2016; Thøgersen, 2006).

- Support for sustainable initiatives. Our findings highlight how consumers are positive about implementing sustainable waste policies, indicating a preference for environmentally friendly practices (Padilla and Trujillo, 2020).
- Importance of education and awareness. Our findings recognise the role of education and awareness in shaping consumer attitudes towards waste management and sustainable behaviour, suggesting that greater sensitivity to environmental issues contributes to positive attitudes (Šuškevičė and Kruopienė, 2021; Coelho et al., 2020).
- Behaviour influencing waste management. Our findings emphasise how consumer behaviour directly influences waste management practices in tourism entities and destinations, highlighting the importance of individual actions in promoting environmentally responsible behaviour (Coelho et al., 2020; Ezeah et al., 2015).
- The connection between pro-environmental behaviour and waste management. Our findings highlight that pro-environmental behaviour, such as waste sorting and minimising single-use plastics, is essential for sustainable waste management and environmental preservation (Ulusoy, 2016; Xiong, 2023).

To sum up, our findings underscore the significance of consumer attitudes and behaviours in promoting sustainability and waste reduction in the context of travel, reflecting a shared understanding of the importance of responsible consumption practices and environmental stewardship.

The research has identified certain limitations. The principles of sample surveys are essential for research, as conducting a study on the entire primary population would be impractical due to the extensive physical, time, and financial resources required. We can apply survey results to the entire base population by using the induction method and ensure that specific criteria are met, such as the sample's representativeness and matching the base set's parameters. In the course of conducting the survey, we identified several limitations. Firstly, lengthy, or time-consuming questionnaires can exhaust the respondents and affect their ability to provide accurate answers. Secondly, there is a limitation in relying on the respondents' memory, as their ability to recall events or experiences accurately may be limited. Additionally, the fear of the researcher's failure to maintain anonymity may lead to dishonest answers or refusal to participate in the survey. Finally, unexpected external events such as political, economic, or social changes can affect the research environment and consequently impact the results.

To justify the representativeness of the sample, we calculated the minimum sample size required for a population of tourists in Slovakia. Given a significance level of 95% and a margin of error of 5%, a sample size of 384 respondents is representative, assuming a normal distribution. Although the ideal representative sample for Slovakia's population (over 5 million people) should be approximately 384 respondents, a sample size of 324 is still considered sufficiently representative. The margin of error for a sample size of 324 respondents for a population of 5 million, at a 95% confidence level, is approximately 5.44%. This means that the results from this sample are expected to reflect the population's

responses with an error margin of $\pm 5.44\%$. The difference of around 0.44% is relatively small, and its impact on the accuracy of the findings is minimal. Discussions within the research team indicated that such a difference in the sample size rarely leads to significant changes in the conclusions or interpretations of the research. With a confidence interval of a 5% margin of error, the sample size of 324 is close enough to the ideal value, thereby ensuring the relevance and reliability of the obtained results. Based on these considerations, we conclude that the sample size of 324 is appropriate for this study and provides credible data for analysing consumer behaviour in Slovakia.

Although similar findings were obtained, the importance of further research must be emphasised. Consumer attitudes and behaviours towards sustainability and waste management are continuously changing. As societal awareness of environmental issues is growing and new trends are emerging, updated studies are needed to capture these changes accurately.

Consumer sustainability and waste management behaviours can vary significantly across regions and cultures. Conducting additional studies allows researchers to explore these differences comprehensively and tailor interventions or policies accordingly. With technological advancements and the emergence of new trends, such as the rise of eco-friendly products or sustainable tourism practices, there is a need to investigate their impact on consumer behaviour. A new study can provide insights into how these trends influence consumer attitudes and decision-making processes.

The understanding of consumer attitudes towards sustainability and waste management significantly impacts businesses, governments, and other stakeholders. Additional research can help policymakers devise more effective strategies to promote sustainable practices and address environmental challenges. While there is existing research on consumer attitudes towards sustainability and waste management in the context of travel, there may still be gaps and/or unanswered questions that warrant further investigation. A new study can contribute to filling these gaps and advancing knowledge in the field.

Conclusions

This study addresses the scientific problem of understanding the interconnectedness of various attitudes towards sustainability in the context of consumer behaviour and travel preferences. By identifying correlations between different sustainability attitudes, the study contributes to a deeper understanding of how these attitudes influence consumer choices and behaviours during travel.

Our results underscore that consumers are interested in environmentally responsible behaviour and are willing to take responsibility for their waste. For example, consumers are inclined to use reusable packaging and prefer recyclable materials that contribute to waste reduction. Some consumers are interested in energetically participating in volunteer activities aimed at cleaning and caring for the environment in tourist places. As part of travel planning, consumers can also evaluate the waste policies of destinations. Destinations with a clear and effective waste policy may be preferred in their decision-making.

The results provide valuable insights by advancing our understanding of sustainable tourism and consumer behaviour. Entrepreneurs can benefit from these findings by understanding the consumer preferences better and making informed decisions so that to align their businesses with sustainability goals. Moreover, society can benefit from the promotion of environmentally friendly behaviours and the preservation of natural resources in tourism destinations.

However, it is essential to emphasise that, due to a limited number of currently available studies in this area, continuing research in sustainable tourism and consumer behaviour is vital. The identified correlations highlight the interconnectedness of attitudes towards sustainability and travel preferences, emphasising the need for further investigation. Additional research can validate and extend these findings across different contexts, while uncovering nuanced relationships. Moreover, further research can identify effective interventions for promoting sustainable tourism behaviour and monitor changes over time in consumer attitudes. Collaboration and knowledge exchange within academia, industry, and policymaking are essential for advancing sustainable tourism practices.

Disclosure Statement

The authors do not have any competing financial, professional, or personal interests in relation to any other parties within the scope of this research.

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Financial Development, Economic Growth and Income Inequality in Central Eastern European Transition Economies: Evidence from the Toda-Yamamoto Panel Causality Test

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Abstract. This study rigorously examines the causality between banking development, economic growth, and income inequality using annual panel data for 13 Central Eastern European transition economies from 2000 to 2020. The Granger non-causality test of heterogeneous panels based on the Toda and Yamamoto approach is employed for the empirical analysis. The main findings establish a trivariate causal relationship between financial development, economic growth, and inequality. In particular, the banking development measured by private credit provided by the financial sector and liquid liabilities Granger causes economic growth, and economic growth Granger causes income inequality. Based on the results, policy implications in European transition economies should focus primarily on expansion and banking system reforms so that to improve financial services, leading to enhanced economic growth. The boosted economic activity could ameliorate income inequality and improve social welfare.

Keywords: economic growth, financial development, inequality, trivariate panel causality, CEE countries.

Introduction

The relationship between financial development, economic growth, and income inequality is complex and multifaceted, as evidenced by various studies. The findings indicate that financial development can spur economic growth but may also exacerbate income inequality (Aghion et al., 2021). Financial development contributes to economic growth through capital accumulation and efficiency of economic activity (Levine, 2005). Income inequality can benefit or harm economic growth through various channels, such as savings, the political economy channel that includes fiscal policy, and market imperfections (Mdingi and Ho, 2021). A sound financial system is essential to boosting economic growth by providing financial opportunities for all the segments of society to participate in economic

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activities. Unequal access to credit can impede the investment opportunities and upward mobility of low segments of the population, thus contributing to the widening income inequality gap (Kim et al., 2021).

Many studies have explored financial development, economic growth nexus, and income inequality growth nexus separately. The causal relationships between financial development and economic growth have been extensively analyzed by employing different econometric methods, and they remain controversial among academics and policymakers. Likewise, empirical studies investigating the causality between inequality and economic growth produce mixed results, and a few studies have examined the direction of causality between financial development and income inequality. Most studies focus on a causal relationship in a bivariate framework without considering the consequence of the third variable in the examined nexus. However, less attention has been devoted to the trivariate causality relationships for financial development, income inequality, and economic growth, and this area has yet to be vastly investigated. Hence, this study attempts to simultaneously confirm the direction of causality between financial development, economic growth, and income inequality. The central hypothesis of this study is whether financial development causes economic growth, and if economic growth causes income inequality.

The Central and Eastern European transition economies include countries that are in the process of transformation from planned economies to market-oriented economies. This transformation, characterized by significant changes such as privatization of State-owned enterprises and reforms in economic policies, often leads to rapid economic growth but also to rising income inequalities (Brzezinski, 2018). The financial system in the Central European transition economies was relatively underdeveloped and dealt with challenges in the effective allocation of funds due to the weak regulatory frameworks and the lack of credit access for specific segments of society. The restrictions to capital access can hinder entrepreneurship and investment, affect economic activity, and exasperate income inequality. Furthermore, rent-seeking behavior can widen the inequality gap since the banking sector can allocate lending funds to large corporations and upper-income segments while denying access to the more vulnerable income segments (Manta et al., 2023).

This paper adds to the existing literature by investigating the causality between financial development, economic growth, and income inequality in a trivariate setting while using a novel Granger causality test. This test constitutes an extension of the bivariate non-causality test for heterogeneous panels developed by Dumitrescu and Hurlin (2012), which is based on the Toda and Yamamoto (1995) approach.

The main objective of this study is to determine the direction of causality between financial development, economic growth, and income inequality by using annual panel data for 13 Central Eastern European transition economies from 2000 to 2020. This study offers several contributions to the literature about the causality links between financial development, economic growth, and income inequality. First, by using the trivariate panel, the causality test provides a sufficient understanding of the relationship between financial development, economic growth, and income inequality that will have empirical and policy significance. Secondly, to the best of our knowledge, this is the first comprehensive study

that focuses solely on the Central Eastern European transition economies, thereby providing a unique perspective on the region's economic development. The findings of this study are valuable and have the potential to inform policymakers to design the appropriate strategies for Central Eastern European transition economies about the development of the financial sector that can stimulate economic growth and mitigate income inequalities. Furthermore, the findings could provide insights and offer practical guidance for policymakers and researchers in similar financial development, growth, and inequality issues.

The remainder of this study is structured as follows: Section 2 presents the literature review; Section 3 provides the materials and describes the empirical methodology; Section 4 presents and discusses the results; and Section 5 summarizes the main conclusions of this research work.

2. Literature Review

Financial development, economic growth, and income inequality have been mainly investigated in a bivariate nexus. The relationship between financial development and economic growth has been extensively studied, revealing a complex interplay and the causality direction, which can be summarized in four hypotheses. The supply-leading hypothesis means that the development of the financial system leads to economic growth (Schumpeter, 1912; Christopoulos and Tsionas, 2004). The development of the financial sector leads to the growth of the real economy through diversification of risk, physical capital accumulation, financial resource mobilization, increased productivity, and improved technology. In contrast, the demand-following hypothesis suggests that economic growth causes financial development since better living standards increase demand for financial services (Robinson, 1952). The feedback causality hypothesis supports two-way causality between financial development and economic growth. A well-developed financial sector can stimulate economic growth through technological innovations, which lead to an increased demand for financial services. This financial system expansion can cause higher economic growth (Levine, 2005). Finally, the neutrality hypothesis implies the absence of causality between financial growth and economic growth, and the role of the financial sector in economic growth is overvalued (Lucas, 1988). Several empirical studies have explored the direction of causality between financial development and economic growth.

Caporale et al. (2015) delved into the relationship between financial development and economic growth in ten new European Union members during 1994–2007, uncovering that, despite underdeveloped stock markets and banking sectors, financial development still led to economic growth. Matei (2020) examined the relationship between financial development and economic growth for 11 Emerging European Countries during the period of 1995–2016 by using dynamic panel models and found that financial development has a linear and positive effect on growth in the short-run, thus proving the supply-leading hypothesis. Song et al. (2021) explored the causality between financial development, economic growth, and corruption by using panel error correction models from 2002 to 2016 for 142 countries in the long run, approving unidirectional causality from economic

growth to financial development in developing countries. They established that there is no such causality in developed countries. Mtar and Belazreg (2020) examined the three-way relationship between innovation, financial development, and economic growth by using the panel VAR models for 27 OECD countries over the period of 2001–2016 and showed a unidirectional causality from economic growth to financial development. Ekanayake and Thaver (2021) examined the relationship between financial development and economic growth in 138 developing countries categorized into six geographical regions during the period of 1980–2018 and found a bidirectional causality in Europe and Central Asia, South Asia, and the total sample, a one-way causality from growth to financial development in the East Asia, the Pacific region, Latin America, and the Caribbean region, and no causality between financial development and economic growth in the Middle East and North Africa, and Sub-Saharan Africa. Abbas et al. (2022) investigated the relationships between financial development and economic growth by using data for middle-income countries and employing the Granger causality test based on *Vector Error Correction* (VEC) for the period of 1995–2018 and showed two-way Granger causality between financial development and economic growth. Nguyen et al. (2022) used panel data on 22 emerging markets over the period of 1980–2020, by employing the Dumitrescu and Hurlin (2012) panel Granger causality test, and found a bidirectional causality between financial development and economic growth.

The relationship between income inequality and economic growth is complex and multifaceted, with evidence suggesting that while economic growth can lead to increased income inequality, high levels of inequality can also hinder growth by limiting access to the essential services and human capital development. Kuznets (1955), in his seminal work, studied the links between growth and inequality and noted that income inequality increases at the early stage of economic growth, decelerates during industrial development, and is reduced during the maturity of the economic sector. This hypothesis has been a cornerstone for many subsequent studies that have focused on the reverse direction of causality from inequality to growth. Several authors have empirically investigated the reverse causality between inequality and economic growth. Vo et al. (2019) found bidirectional causality between economic growth and income inequality by using two samples, an unbalanced panel data of 158 countries and a sample including middle-income countries, during the period of 1960–2014 while employing the Granger causality test by Dumitrescu and Hurlin (2012). Koh et al. (2019) investigated the causality between income inequality, growth, and financial depth in China for the period of 1980–2013 by using a vector error-correction model and found a bidirectional causality between financial depth and economic growth while also establishing unidirectional causality from inequality to economic growth. Obiero and Topuz (2023) explored the direction of causality between income inequality, growth, and debt in a bivariate setting for 11 selected countries in the Sub-Saharan African region by using a panel bootstrap causality approach for the period of 1980–2018 and concluded on a one-way causal relationship from inequality to growth in Botswana, Lesotho, Nigeria, and South Africa, while also noting that the relations can differ due to the characteristics of each country.

In contrast, Wolde et al. (2022) examined the long-run relationship between income inequality and economic growth in Ethiopia over the period of 1980–2017 by using Granger causality tests and found a unidirectional causality from economic growth to income inequality. Aremo and Abiodun (2020) examined the causality between fiscal policy, economic growth, and income inequality for twenty-six Sub-Saharan African countries classified as low, lower-middle, and upper-middle-income countries over the period of 1995–2016 and found no causality in low-income countries and lower-middle-income countries; meanwhile, they established unidirectional causality from economic growth to income inequality in upper-middle-income countries. Bentzen and Tung (2020) investigated the causality between income and inequality during the period of 2006–2018 for 61 provinces in Vietnam, by applying the Granger causality test based on out-of-sample forecast errors; they concluded by finding an absence of causality. Soava et al. (2019) analyzed the relationships between income inequality, economic growth, and risk of poverty by using panel data from 28 European Union countries during the period of 2005–2016. They confirmed the Kuznets hypothesis and found a positive link between inequality and growth for emerging EU countries but a negative relationship for highly developed European Union countries. The results also showed no causal relationships between inequality and economic growth.

The relationship between financial development and income inequality is a rich and diverse topic in the literature. Some studies argue that financial development enhances income inequality by facilitating more effective resource allocation to underprivileged populations, thereby boosting human and physical capital investments (Aghion and Bolton, 1997). Whereas, Jauch and Watzka (2016) discovered a positive impact of financial development on income inequality in 138 developing and developed countries from 1960 to 2008, by employing static and dynamic panel data techniques. However, other studies propose that increased financial development can reduce income inequality, as seen in the works of Banerjee and Newman (1993) and Galor and Zeira (1993). In this regard, Weychert (2020), by using data from 59 countries over the period of 2004–2014, demonstrated that financial access reduces income inequality. Furthermore, Manta et al. (2023) found a negative correlation between financial development and income inequality during the period of 2004–2019 in Central and Eastern European Countries. The third strand of the literature suggests that financial development has an inverted U-shaped non-linear relationship with income inequality (Greenwood and Jovanovic, 1990). Nguyen et al. (2019) confirmed an inverted U-curve relationship between financial development and income inequality for 21 emerging countries from 1961 to 2017. Chakroun (2020) found an inverted U-shaped relationship between the banking sector development and inequality, but established that there is no evidence of an inverted U-shaped relationship between the stock market development and inequality. Okafor et al. (2023) investigated the impact of each financial development dimension on income inequality and found that financial access, stability, and efficiency harm income inequality, while an increase in financial depth worsens income inequality in 48 African countries for the period of 1996–2018.

Research on the direction of causality between financial development and income inequality is notably scarce, thereby underscoring the novelty and importance of this study. Most existing studies suggest a one-way causality from financial development to income inequality. For instance, Gimet and Lagoarde-Segot (2011) found that financial development triggered income inequality in 49 countries from 1994 to 2002, with the banking sector having a more significant impact on inequality. Cetin et al. (2021) explored the relationship between technological innovation and income inequality in Turkey within the context of the financial Kuznets curve hypothesis from 1987 to 2018. Their findings revealed a bidirectional causality between financial development and income inequality, with economic growth leading to income inequality. Juuti (2021) investigated the role of financial development in the inequality-growth nexus for a total sample of 69 countries, including 35 OECD member countries, from 1980 to 2017. They found a positive relationship between inequality and growth in more developed financial markets, but there was no such relationship in the less developed financial markets or in the OECD countries. Younsi et al. (2022) studied the reduction of income inequality through financial development with economic growth for 11 Asian and 4 North African countries during the period of 1996–2019. Their findings revealed an inverted U-shaped relationship between economic growth and income inequality, as well as financial development and income inequality. The results of the Granger causality tests showed a one-way causality from financial development to income inequality and a one-way causality from income inequality to economic growth. Verma and Giri (2024) found a unidirectional causality from financial inclusion and depth to income inequality in 22 Asian economies during the period of 2005–2020.

Based on the above outlined context, the literature indicates that while some studies find no significant causal relationship, others reveal unidirectional or bidirectional causality depending on the region and economic conditions. This diversity of findings underscores the pressing necessity for further research. Most empirical studies have focused on a causal relationship in a bivariate framework without considering the outcome of the third variable in the examined nexus. To the best of our knowledge, the most advanced research in this segment is Sotiropoulou et al. (2023), which found a trivariate causality running from economic growth to financial development, and economic growth leads to income inequality for 23 European Union countries from 1987 to 2017. This research gap underscores the novelty and uniqueness of this study, which aims to determine the direction of causality between financial development, economic growth, and income inequality in a trivariate framework by using data for Central Eastern European Union countries.

The central hypothesis of this study is the following:

H1: Financial development Granger causes economic growth, and economic growth Granger causes income inequality.

3. Empirical Analysis

3.1. Data and Variables

This study uses annual panel data of 13 Central Eastern European transition economies, namely, Albania, Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, North Macedonia, Poland, Romania, the Slovak Republic, and Slovenia, covering the period of 2000–2020. Financial development indicators focus on banking deepening since the reform of the financial sector in transition economies started from the banking sector, and the stock markets are undeveloped. Therefore, financial development is expressed by private credit by deposit money banks and other financial institutions to GDP (%) and liquid liabilities to GDP (%). The GDP per capita (based on constant 2015 US\$) measures economic growth, and the Gini index, as the estimate of disposable income after tax and after transfers, measures income inequality. The data on financial development, economic growth, and income inequality indicators were collected by the *Global Financial Development Database*, the *World Development Indicators* of the World Bank, and the *Standardized World Income Inequality Database* derived by Solt (2019), respectively.

3.2. Methodology

This study investigates the direction of causality between financial development, economic growth, and income inequality in a trivariate setting. Three approaches have been mainly employed to examine the direction of causality in the panel data. The first approach uses the *generalized method of moment* (GMM) estimator (Holtz-Eakin et al., 1988) to estimate a panel VAR model. The GMM approach could not be appropriate when T is large due to the immense number of instruments, which often renders a highly inaccurate inference (Bun and Sarafidis, 2015). Furthermore, the GMM estimators ignore the cross-sectional dependence and can produce inconsistent and misleading parameters unless the slope coefficients are, in fact, homogeneous (Pesaran et al., 1999). The second approach, proposed by Kónya (2006), is based on the SUR estimation which allows taking into account cross-sectional dependence across the members of the panel. However, the direction of causality is tested separately based on the Wald tests for each country and does not require a joint hypothesis for all the members of the panel. Although the method of Kónya (2006) does not involve any pretesting for stationary and cointegration except for cross-sectional dependence and slope heterogeneity, this technique can be expanded to a trivariate setting, but the SUR equations include the third variable as an auxiliary variable. The third approach, developed by Dumitrescu and Hurlin (2012), suggests a Granger non-causality test in heterogeneous panel data between two stationary variables, allowing all coefficients to differ across cross-sections.

In a trivariate setting, this study employs a panel causality test to determine the causality direction between financial development, economic growth, and income inequality. Andriansyah and Messinis (2019) developed an extension of the bivariate Granger non-causality test of heterogeneous panels proposed by Dumitrescu and Hurlin (2012).

The traditional panel Granger causality test is invalid when the variables are non-stationary, or when they are integrated in a different order since the Wald test statistic does not follow the asymptotic chi-square distribution. Andriansyah and Messinis (2019) defeated the stationary assumption based on the procedure of Toda and Yamamoto (1995), adding extra m lags, which are the maximum order of integration of the time series variables, to the k -order VAR model to ascertain the validation of the Wald test statistic that is asymptotically distributed. This method can treat the third variable as an additional explanatory variable since all three variables are endogenous with the maximum order of integration m .

Supposing the trivariate VAR ($K+m$) linear models with general form given as follows:

$$GDP_{i,t} = \alpha_{1i} + \sum_{p=1}^{K+m} \beta_{1i,p} GDP_{i,t-p} + \sum_{p=1}^{K+m} \gamma_{1i,p} FINDEV_{i,t-p} + \sum_{p=1}^{K+m} \delta_{1i,p} GINI_{i,t-p} + \varepsilon_{1i,t} \quad (1)$$

$$GINI_{i,t} = \alpha_{2i} + \sum_{p=1}^{K+m} \beta_{2i,p} GDP_{i,t-p} + \sum_{p=1}^{K+m} \gamma_{2i,p} FINDEV_{i,t-p} + \sum_{p=1}^{K+m} \delta_{2i,p} GINI_{i,t-p} + \varepsilon_{2i,t} \quad (2)$$

$$FINDEV_{i,t} = \alpha_{3i} + \sum_{p=1}^{K+m} \beta_{3i,p} GDP_{i,t-p} + \sum_{p=1}^{K+m} \gamma_{3i,p} FINDEV_{i,t-p} + \sum_{p=1}^{K+m} \delta_{3i,p} GINI_{i,t-p} + \varepsilon_{3i,t} \quad (3)$$

where GDP is the logarithm of GDP per capita, FINDEV represents the logarithm of proxies of financial development, more precisely, *private credit* (PRV) and *liquid liabilities* (LLY), and GINI denotes the logarithm of the *Gini index* for each country i ($i = 1, \dots, N$) at time period t ($t = 1, \dots, T$). In addition, m denotes the additional lags as the maximum order of integration of variables, and K represents the optimal lag length taken from the information criteria. The coefficients α_{1i} , α_{2i} , and α_{3i} are fixed across time, while the coefficients of variables $\beta_{i,p}$, $\gamma_{i,p}$ and $\delta_{i,p}$ may vary between and across the equations. The errors $\varepsilon_{1i,t}$, $\varepsilon_{2i,t}$ and $\varepsilon_{3i,t}$ are independent and normally distributed.

In a trivariate framework, the null hypothesis of the panel causality test assumes that *FINDEV* Granger does not cause *GDP*, while the variable *GINI* is constant.

The modified Wald statistics is given as follows:

$$W_{i,T}^* = \frac{\hat{\theta}_i^{*'} R^{*'} [R^* (Z_i^{*'} Z_i^*)^{-1} R^{*'}]^{-1} R^* \hat{\theta}_i^*}{\hat{\varepsilon}_i^{*'} \hat{\varepsilon}_i^* / (T - 3Tlag - 1)} \quad (4)$$

The panel Wald test statistic is asymptotically distributed; it follows a normal distribution with mean zero, and variance equals to one as $T \rightarrow \infty$:

$$Z_{N,T}^{Hnc*} = \sqrt{\frac{N}{2K}} (W_{N,T}^{Hnc*} - K) \quad (5)$$

For a fixed dimension of T , normal distribution holds, and the standardized and modified panel is written as follows:

$$\tilde{Z}_N^{Hnc*} = \sqrt{\frac{N \times (T - 3Tlag - 5)}{2K \times (T - 2K - 3m - 6)}} \times \left[\frac{(T - 3Tlag - 3)}{(T - 3Tlag - 1)} \times W_{N,T}^{Hnc*} - K \right] \quad (6)$$

The maximum lag length in a standard VAR model can be varied and depends on the information criteria used, i.e., the Akaike information criterion, the Schwarz Bayesian information criterion, and the Hannan and Quinn information criterion.

4. Results

This study aims to determine the causal relationship between financial development, economic growth, and income inequality in Central Eastern European transition economies over the period of 2000–2020. To achieve this, we employ a trivariate panel causality test. The results of the panel causality test are reported in the following steps. First, we check for slope heterogeneity and cross-sectional dependence to select the appropriate panel unit root test; second, we test for the order of integration of the variables; third, we find out the optimum lag structure by using the *Schwarz-Bayesian Information Criterion* (BIC). Lastly, we conduct the Toda-Yamamoto panel causality test to determine the direction of causality between financial development, economic growth, and income inequality in a trivariate framework.

Table 1. Results of slope heterogeneity and cross-sectional dependence tests

	PRV, GDP, GINI		LLY, GDP, GINI	
Cross-sectional dependence tests				
	Statistic	p-value	Statistic	p-value
LM	299.8	0.000***	232	0.000***
LM adj*	40.34	0.000***	27.75	0.000***
LM CD*	12.52	0.000***	10.07	0.000***
Slope heterogeneity tests				
Delta	14.966	0.000***	13.160	0.000***
Delta adj.	16.633	0.000***	14.627	0.000***

Note. *** is the 1% significance level.

Source: author's calculation

Table 1 contains details of the results of slope heterogeneity and cross-sectional dependency tests.

The slope heterogeneity tests proposed by Pesaran and Yamagata (2008) are used. The null hypothesis that slope coefficients are homogenous is rejected at a 1% significance level, implying that the slope coefficients are heterogeneous across cross-sectional units of the panel. This study employs the Breusch and Pagan (1980) LM test, the Pesaran (2004) CD test, and the Pesaran et al. (2008) bias-adjusted LM test to detect cross-sectional dependence. The null hypothesis of cross-sectional independence is rejected for all estimated models since p-values are lower than the 1% significance level. The cross-section

dependence test reveals dynamics between the individuals of the panel, and demonstrates how a shock can transmit and affect from one country to another.

The order of integration of the variables is initially determined by using the CIPS test proposed by Pesaran (2007). The obtained results are given in Table 2. The results demonstrate that private credit and liquid liabilities are stationary at levels or integrated zero-order $I(0)$, as the null hypothesis of a unit root is rejected for the level series at a 1% significance level. The variables GDP and GINI have unit roots at first differences, whereas both variables are stationary at second differences or integrated second-order $I(2)$, as the null hypothesis of a unit root is rejected for the second differences series at a 1% significance level. Accordingly, the maximum order of integration in the VAR system is defined as $dmax=2$.

Table 2. Results of panel unit root test

	Levels		First-differences		Second-differences		Order of integration
	Constant ^a	Constant and trend ^b	Constant ^a	Constant and trend ^b	Constant ^a	Constant and trend ^b	
PRV	-2.534***	-3.443***	-3.734***	-3.772***	-4.844***	-4.887***	$I(0)$
LLY	-3.027***	-2.887**	-5.256***	-5.435***	-5.977***	-6.148***	$I(0)$
GDP	-2.509***	-1.812	-2.711**	-2.750*	-4.108***	-4.120***	$I(2)$
GIN	-1.338	-1.269	-1.789	-1.723	-3.569***	-3.811***	$I(2)$

Notes.

a: critical values are -2.47, -2.26, and -2.14 for significance levels of 1%, 5% and 10%, respectively.

b: critical values are -3.01, -2.78 and -2.67 for significance levels of 1%, 5% and 10%, respectively.

***, ** and * denotes significant levels at 1%, 5%, and 10%, respectively.

Source: author's calculation

Additionally, the maximum lag length specification in a standard VAR model is essential for completing the trivariate panel causality test. Table 3 illustrates the results of the lag length using diverse information criteria. Since the results for the order of the optimal panel lag length vary between 1 or 2, the BIC criterion is typically used in preference to the other criteria because it tends to define more parsimonious requirements. Hence, the optimum lag length (k) chosen by BIC is found to be 1.

Table 3. Panel VAR Lag Order Selection

Model	lags	BIC	AIC	HQIC
PRV, GDP, GINI	1	-134.6507*	-27.9883	-71.33079*
	2	-111.7234	-31.72661*	-64.23348
	3	-80.51218	-27.18098	-48.85222
LLY, GDP, GINI	1	-145.5872*	-38.92482*	-82.26732*
	2	-116.9915	-36.99472	-69.50159
	3	-84.79475	-31.46355	-53.1348

Notes. BIC: Schwarz Bayesian information criterion; AIC: Akaike information criterion; HQIC: Hannan and Quinn information criterion.

Source: author's calculation

Given that the order of integration is 2 and the optimal lag length is 1, VAR (3) model is estimated to establish the direction of causality between financial development, economic growth, and income inequality when employing the Toda-Yamamoto panel non-causality test.

Table 4 shows the results of the panel causality test. The first null hypothesis that “private credit (PRV) does not Granger cause economic growth (GDP), while income inequality (GINI) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “private credit (PRV) does not Granger cause income inequality (GINI), while economic growth (GDP) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “economic growth (GDP) does not Granger cause private credit (PRV), while income inequality (GINI) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “economic growth (GDP) does not Granger cause income inequality (GINI), while private credit (PRV) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “income inequality (GINI) does not Granger cause private credit (PRV), while economic growth (GDP) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “income inequality (GINI) does not Granger cause economic growth (GDP), while private credit (PRV) is constant” fails to be rejected at a 1% significance level since the Z-bar statistic is lower than the bootstrap critical value. Hence, private credit Granger causes both economic growth and income inequality, and economic growth Granger causes income inequality. Furthermore, economic growth Granger causes private credit, and income inequality Granger causes private credit.

The null hypothesis that “liquid liabilities (LLY) do not Granger cause economic growth (GDP), while income inequality (GINI) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “liquid liabilities (LLY) do not Granger cause income inequality (GINI), while economic growth (GDP) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “economic growth (GDP) does not Granger cause liquid liabilities (LLY), while income inequality (GINI) is constant” fails to be rejected at a 1% significance level since the Z-bar statistic is lower than the bootstrap critical value. The null hypothesis that “economic growth (GDP) does not Granger cause income inequality (GINI), while liquid liabilities (LLY) are constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “income inequality (GINI) does not Granger cause liquid liabilities (LLY), while economic growth (GDP) is constant” is rejected at a 1% significance level since the Z-bar statistic is greater than the bootstrap critical value. The null hypothesis that “income inequality (GINI) does

not Granger cause economic growth (GDP), while liquid liabilities (LLY) are constant” fails to be rejected at a 1% significance level since the Z-bar statistic is lower than the bootstrap critical value. In other words, liquid liabilities Granger cause economic growth and income inequality, economic growth Granger causes income inequality, and income inequality Granger causes liquid liabilities.

According to the results of the empirical analysis, a unidirectional causality runs from financial development to economic growth, and a reverse causality is proven between private credit and economic growth. These results are consistent with previous studies by Ekanayake and Thaver (2021), Abbas et al. (2022), and Nguyen et al. (2022), thereby validating the feedback hypothesis between financial development and economic growth, which combines the supply-leading and demand-following hypotheses.

Likewise, the results expose that economic growth leads to income inequality with no evidence of reverse causality. This finding also complements the previous results of Aremo and Abiodun (2020) and Wolde et al. (2022), who found a unidirectional causality from economic growth to inequality. However, the finding opposes the inference of Koh et al. (2019) and Obiero and Topuz (2023), who exhibit a unidirectional causality from inequality to economic growth, and there is no evidence for a bidirectional causality (Vo et al., 2019).

Furthermore, the results validate a bidirectional causality between financial development and income inequality, aligning with the findings of Cetin et al. (2021), who found a bidirectional relationship along with the unidirectional causality from economic growth to income inequality. This finding challenges the previous assertions of Juuti (2021), Younsi et al. (2022), and Verma and Giri (2024), who suggested that financial development leads to income inequality.

The trivariate causality test discloses causal relationships with the direction from financial development to economic growth and from economic growth to income inequality. The results imply that, in Central Eastern European Union countries, a well-developed banking system can facilitate access to financial services by expanding banks, encouraging the overall activity of economic sectors, and administering individuals and businesses to improve economic and social welfare. This finding contradicts Sotiropoulou et al. (2023), who found that other economic factors can lead to economic growth in European Union countries, economic improvements can lead to more financial services, and the development of the financial system can lead to income inequality. The findings from the trivariate causality test emphasize the importance of financial development for stimulating economic growth and ameliorating income inequality. These findings are valuable for policymakers in designing strategies to boost economic growth and address inequality dissimilarities by focusing on developing the banking sector.

Table 4. Trivariate Toda-Yamamoto approach for Granger non-causality test

Causality hypothesis	Asymptotic Wald statistic		Bootstrap critical values		
			1%	5%	10%
PRV $\rightarrow$ GDP GINI	$Z_{N,T}^{Hnc}$	6.7440***	1.5045	1.4778	1.4666
	$\tilde{Z}_N^{Hnc}$	5.0543***	0.7674	0.7455	0.7364
PRV $\rightarrow$ GINI GDP	$Z_{N,T}^{Hnc}$	6.2269***	0.0215	0.0044	-0.0040
	$\tilde{Z}_N^{Hnc}$	4.6312***	-0.4460	-0.4599	-0.4668
GDP $\rightarrow$ PRV GINI	$Z_{N,T}^{Hnc}$	3.7954***	3.2445	3.0368	2.9182
	$\tilde{Z}_N^{Hnc}$	2.6418***	2.1911	2.0211	1.9241
GDP $\rightarrow$ GINI PRV	$Z_{N,T}^{Hnc}$	9.7492***	1.2372	1.1749	1.1485
	$\tilde{Z}_N^{Hnc}$	7.5131***	0.5487	0.4977	0.4761
GINI $\rightarrow$ PRV GDP	$Z_{N,T}^{Hnc}$	5.8086***	4.1421	3.5722	3.3464
	$\tilde{Z}_N^{Hnc}$	4.2890***	2.9255	2.4591	2.2744
GINI $\rightarrow$ GDP PRV	$Z_{N,T}^{Hnc}$	4.5425	9.8068	9.6732	9.5892
	$\tilde{Z}_N^{Hnc}$	3.2530	7.5602	7.4509	7.3822
LLY $\rightarrow$ GDP GINI	$Z_{N,T}^{Hnc}$	4.0328***	-0.2530	-0.2690	-0.2770
	$\tilde{Z}_N^{Hnc}$	2.8360***	-0.6706	-0.6836	0.6901
LLY $\rightarrow$ GINI GDP	$Z_{N,T}^{Hnc}$	3.0357***	-0.9922	-1.0013	-1.0060
	$\tilde{Z}_N^{Hnc}$	2.0202***	-1.2753	-1.2828	1.2866
GDP $\rightarrow$ LLY GINI	$Z_{N,T}^{Hnc}$	0.0668	3.3821	2.9257	2.7231
	$\tilde{Z}_N^{Hnc}$	-0.4089	0.7181	0.8550	0.9468
GDP $\rightarrow$ GINI LLY	$Z_{N,T}^{Hnc}$	5.4689***	5.4052	5.3659	5.3436
	$\tilde{Z}_N^{Hnc}$	4.0110***	3.9589	3.9267	3.9084
GINI $\rightarrow$ LLY GDP	$Z_{N,T}^{Hnc}$	3.7547***	3.3601	3.1186	3.0252
	$\tilde{Z}_N^{Hnc}$	2.6085***	2.2856	2.0880	2.0116
GINI $\rightarrow$ GDP LLY	$Z_{N,T}^{Hnc}$	1.7133	5.3308	5.2309	5.1823
	$\tilde{Z}_N^{Hnc}$	0.9382	3.8980	3.8163	3.7766

Notes.

Symbol ($\rightarrow$) means that the first variable Granger causes the second variable, while symbol (|) means that the third variable holds constant.

Iterations for bootstrapped critical values are 10,000 times.

***, ** and * denote the significance level at 1%, 5%, and 10%, respectively.

Source: author's calculation

5. Conclusions

This study has attempted to analyze the causal relationships between financial development, economic growth, and income inequality for 13 Central Eastern European transition economies from 2000 to 2020 by using a Granger non-causality test of heterogeneous panels in a trivariate setting, adopting the approach of Toda and Yamamoto (1995). The main objective is to evaluate whether financial development Granger causes economic growth empirically, and if economic growth Granger causes income inequality. Two different indicators are used to capture the development of the financial sector.

The results of the study reveal that private credit causes economic growth, liquid liabilities cause economic growth, and economic growth causes income inequality. These relationships exhibit a trivariate causality with the direction from financial development to economic growth and from economic growth to income inequality. This finding highlights the compulsory role of a more extensive and involved banking sector in Central Eastern European transition economies that can lead to economic growth. Thus, financial development can mobilize capital resources and increase the supply of liquid liabilities to boost economic growth. The flourishing of economic activity can create more prospects for all segments of society, reshaping income distribution patterns.

From a policy perspective, it is vital to explore the causal relationship between financial development, real economy, and social cohesion. Bank credit policies could catalyze economic growth and resolve the conceivable inequality concerns. The principal policy recommendation is to improve the banking sector through the rising money supply and development of banking institutions to foster economic growth, eventually alleviating the issue of unequal incomes. Future research should address the trivariate causality relationships between financial development, economic growth, and income inequality in miscellaneous samples covering distinct periods and country groups so that to deliver more accurate empirical results.

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Features of the Relationship between Corruption, Human Capital Components and Economic Growth (Case of EU Candidate Countries)

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Abstract. The changing geopolitical situation in the European region has actualized the issues of further EU enlargement. As a result, the relevance of studying many aspects of the functioning economic systems of candidate countries has increased. In this context, the purpose of this article is to identify the features of the relationship between economic growth, corruption, and human capital components in EU candidate countries. The study uses annual data for nine EU candidate countries from 1996 to 2021. The research methodology includes the following methods: correlation analysis; logarithm procedure; calculation of the Augmented Dickey-Fuller (ADF) test; calculation of the Granger causality test. The study found no causality in the cases of Albania, Bosnia and Herzegovina, North Macedonia, and Ukraine. The analysis showed that there is a causal relationship from Control of Corruption (CC) to GDP only in Moldova in the long term. In Montenegro, Serbia, and Türkiye, there is a causality from GDP and Life Expectancy at Birth (LEB) to CC. There is a direct causality from Education Index (EI) to GDP in Moldova, from LEB to EI in Georgia, and from LEB to GDP in Serbia and Montenegro. The study found differences in both the direction and strength of causality between components of human capital, control of corruption, and economic growth in the EU candidate countries. In some cases, there is no such relationship. All calculations were carried out using Statistica and EViews.

Keywords: economic growth, human capital, corruption, ADF-test, Granger causality, EU candidate countries

1. Introduction

Further enlargement of the European Union raises issues of uneven economic development of candidate countries. Ensuring long-term economic development depends largely on a country's ability to ensure a sustainable rate of economic growth. Various factors can either favour or hinder economic growth. For example, human capital significantly contributes to economic growth potential, while corruption often impedes it. Consequently, scholars are interested in investigating the impact of these factors on economic growth.

Several studies examine the relationship between human capital, corruption, and economic growth. For example, countries in Sub-Saharan Africa (SSA) face challenges

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such as human capital drain, poverty, inequality, and corruption, which ultimately lead to slower economic growth (Usman et al., 2022). Both corruption and human capital affect growth - insignificantly in developed countries and significantly in developing countries. Moreover, the less corruption, the higher the rate of economic growth (Fatmawati, Suman, & Syafitri, 2018). Human capital contributes to economic growth, while corruption leads to slower growth and eventually economic stagnation (Ikazaki, 2014). Ihnatenko et al. (2019) highlight the importance of controlling corruption, alongside managing labour, to regulate economic development in developing countries. In East, West, and South Asia, human capital generally has a positive influence on growth, but corruption can either accelerate or hinder this effect (Mudassar & Rehman, 2019). In ASEAN countries, both human resource development and the level of corruption affect economic growth (Nurjannah et al., 2023).

Corruption is one of the major challenges for candidate countries on the path to EU membership. One of the main conditions for accession to the EU for candidate countries is to reduce the level of corruption. Most scholars support this position. Thus, Chrun (2023) highlights the importance of anti-corruption reforms for candidate countries seeking EU accession. Apergis and Pinar (2023) point out that rising corruption leads to increased party polarization and more support for populist parties in the EU that oppose further enlargement. Further EU enlargement has both opponents, who argue that the lack of rule of law in candidate countries could lead to greater instability in the EU, and supporters, who believe it would enhance the EU's geopolitical status (Outeda, González, & Troitiño, 2020).

Abdulla (2021) notes that eliminating corruption can increase aggregate output by 18-20 percent, as observed in the US from 1980 to 2000, thereby stimulating the formation of human capital stocks. Using panel data from 35 SSA countries for the period 1996-2018, Bazie, Thiombiano, and Maiga (2023) determined that corruption reduces the returns on education, which is not conducive to human capital accumulation.

In the case of Tunisia from 1987 to 2016, human capital amplifies the effect of corruption (Chokri & Anis, 2020). Generally, studies confirm the negative impact of corruption on growth and the positive impact of human capital. However, modern research does not sufficiently address the mutual influence of corruption, human capital, and economic growth across countries with different levels of economic development. In this context, the purpose of this article is to identify the features of the relationship between economic growth, corruption, and components of human capital in EU candidate countries.

The realization of the research objective involves verifying the following hypotheses:

- H1: The strength of the relationship between the level of economic development and the level of corruption differs among EU candidate countries;
- H2: The strength of the relationship between the level of corruption and human capital development indicators is different for EU candidate countries;
- H3: The strength of the relationship between economic development and human capital development indicators varies across EU candidate countries.

The structure of the study is as follows: a theoretical background, which includes an analysis of the relationship between human capital and economic growth and an assessment of the relationship between economic growth and corruption; a section on data and research methods; a section describing the procedures and results of the study; and finally, discussions and conclusions.

2. Literature Review

2.1. *Economic growth and human capital*

Research on the relationship and mutual influence of economic performance and human capital has been conducted since the theory of human capital emerged as a scientific concept. Most studies confirm the positive influence of human capital on economic growth. Pelinescu (2015) emphasizes the important role of human capital in achieving economic growth. Additionally, scholars note that human capital contributes to financial and economic development (Saroj et al., 2023) and increases the well-being of the population (Kucharčíková, 2014).

Some researchers confirm this relationship using large samples. For instance, Ali et al. (2018) analysed data from 132 countries, Bayraktar-Sağlam (2016) studied data from 90 countries for the period 1970-2010, and Matousek and Tzeremes (2021) examined data from 100 countries for the period 1970-2014. They note that the positive effect of human capital on economic growth increases with higher levels of education. Several studies analyse specific groups of countries. Adeleye et al. (2022) support these findings for 19 MENA countries over the period 1980-2020. Eftimoski (2022) and Ogbeifun & Shobande (2022) obtained similar results for OECD countries.

At the same time, there is a negative relationship between education and economic growth in resource-rich countries, as often a highly educated labour force remains untapped in a resource-based economy (1990-2019, Saudi Arabia example) (Almutairi, 2023). Meanwhile, Yu (2015) points out that human capital, in interaction with social capital, can contribute to growth. Furthermore, human capital influences growth in Brazil (de Abreu Pereira Uhr et al., 2020).

Nevertheless, research shows that this relationship varies across countries. Ali et al. (2022) found it to be positive and significant in high-income countries but insignificant in low-income countries. Sultana, Dey, and Tareque (2022) found it to be positive for 93 developing countries, while increasing life expectancy limits economic growth in 48 developed countries. Ali et al. (2021) identified a significant positive relationship between human capital and economic growth for 12 low-income countries from 1980 to 2016. Meanwhile, Qadri and Waheed (2013) revealed that the return on human capital investment is greater in low-income countries. Analyses for 1970-2010 by Akpolat (2014) showed that investment in physical capital and education is more effective in developed countries than in developing ones.

In addition, the relationship between the analysed indicators varies by regions. Consequently, many researchers emphasize the importance of considering regional and country-specific contexts.

There is a great deal of research focusing on the African continent. Human capital leads to economic growth in 9 SSA countries (Kagochi & Durmaz, 2020), in 22 African countries (Boccanfuso et al., 2013), and in 35 SSA countries for the period 1980-2008, with health contributing more than education (Ogundari & Awokuse, 2018). Human capital impacts economic growth in Mauritius (Neeliah & Seetanah, 2016), Kenya in the long run (Alani, 2018), South Africa from 1993 to 2016 (Ngepah et al., 2021), and Ethiopia from 1980 to 2020 (Wegari, Whakeshum & Mulatu, 2023). Human capital along with technology has a significant positive impact on economic growth in Nigeria (Sulaiman et al., 2015). However, this contribution is insignificant for 9 SSA countries during 1980-2014 (Karambakuwa et al., 2020). Mengesha & Singh (2023) highlight the role of higher and secondary education and the impact of education along with life expectancy on growth in Ethiopia. Khalafalla & Suliman (2013) found that the quality of education plays a significant role in ensuring economic growth in Sudan for the period 1982-2009. Enrollment in higher education has a positive and significant impact on growth in the short run in Nigeria from 1984 to 2016, while enrollment in secondary and primary education does not (Raifu et al., 2021).

Scientists are also interested in determining the link between growth and human capital in Asia. Researchers found such a relationship in Indonesia (Affandi et al., 2019; Prasetyo & Kistanti, 2020), India (Khan, Ganai & Bhat, 2022), and in multiple countries including Indonesia, Malaysia, Philippines, Thailand, and Vietnam (Rahman et al., 2022). Similar findings were observed in Saudi Arabia (Mahmood & Alkahtani, 2018; Islam & Alhamad, 2023) and Pakistan in both the long and short term (Luqman & Soytaş, 2023). For certain South Asian countries (data from 1981-2016), human capital also had a significant impact (Qamruzzaman et al., 2021). This relationship was evident in Malaysia (Mohamad Rusli & Hamid, 2014), Singapore in the long run (Maitra, 2016), and in ASEAN countries (Budsayaplakorn & Sompornserm, 2021). However, Wang et al. (2022) found that the economic growth rate lagged behind human capital growth in Shandong Province, China, from 2005 to 2019. Academics conclude that both quantitative and qualitative characteristics of human capital are important. Human capital reduces poverty and promotes growth in East Java Province (Chotib, Suharto & Lucik, 2019). Health expenditure positively impacts Pakistan's economic growth rate in the short run, while education expenditure does so in the long run (Azeem et al., 2013). Overall, spending on education contributes to growth in East and South Asia (Siddiqui & Rehman, 2017).

Scholars also address the issues of growth in America. For example, increasing human capital does not contribute to economic growth in Honduras (Villela & Paredes, 2022), but it has a positive long-term impact in Brazil (Doré & Teixeira, 2023). This influence is greater in counties with a high quality of life (USA, 2000-2007) (Fan, Goetz & Liang, 2016). Increasing educational attainment reduces inequality and accelerates growth in Latin America from 1980 to 2009 (Gaona & Vásquez, 2021). Thus, it can be concluded

that the direction and strength of the relationship between the analysed indicators vary across most countries and regions.

In some countries, the relationship between human capital and growth is unidirectional. The results of the Granger causality test showed that there is unidirectional causality from both health and education expenditure to growth rate in Bangladesh (Islam & Alam, 2022). Budsayaplakorn and Sompornserm (2021), using data from 1990 to 2018 and the Granger causality test, determined that education growth causes GDP growth in 10 ASEAN countries. Chani et al. (2014), using the Granger causality test for Pakistan, determined that inequality in human capital does not lead to inequality in income, whereas inequality in income causes inequality in human capital. Mehrara and Musai (2013), using a sample of 101 developing countries and applying the Granger test, found a strong long-run causal relationship from GDP to human capital with no feedback effect for the period 1970-2010. The results of the study by Sehrawat and Giri (2017) for the period 1984-2013 in Asian countries, using the Granger test, showed that causality runs from growth to human capital.

In other cases, the relationship is bidirectional. Anoruo and Elike (2015), using the dynamic least squares method, confirmed this fact for 29 African countries. Qamruzzaman et al. (2021) reached similar conclusions for South Asian countries for the period 1981-2016, and Boztosun et al. (2016) found this relationship for Türkiye over the period 1961-2011 in the long run. A Granger test of data from 1971 to 2010 showed that this relationship is bidirectional in Mexico and that it is significantly greater than the impact of physical capital (Garza-Rodriguez et al., 2020).

Jihène (2013), using the Granger test, determined that growth and higher education are cointegrated in Japan and Korea over the period 1960-2012, while they are not in Tunisia and Morocco. Using regression data analysis, Duan et al. (2022) found that the link between human capital indicators and growth is non-linear in BRICS countries during the period 2000-2018. Zolkover et al. (2021), using the Granger test and cognitive modelling, determined that the influence of human capital on the Ukrainian economy is ambiguous. On the one hand, human capital contributes to economic development. On the other hand, this positive impact is offset by state policies that increase investment in education and healthcare and by the incompetence of public authorities.

Human capital can significantly or insignificantly affect economic growth. Therefore, researchers do not limit themselves to analysing just human capital; they introduce other factors to identify patterns and features of their impact on growth. The complementarity of foreign direct investment (FDI) and human capital affects growth in North Africa (Mohamed Sghaier, 2022; Özdoğan Özbal, 2021) but does not have a significant impact in SSA for 1999-2017 due to insufficient skilled labour in the region (Anetor, 2020). Foreign financial flows can have both negative and positive impacts on growth. High levels of human capital reduce the negative effects of financial flows on growth (Dinh Su & Phuc Nguyen, 2022). Rajab and Zouheir (2023) found that in 15 least developed African countries, human capital and FDI do not significantly contribute to economic growth. The reason is the lack of education of the workforce to absorb the investment. Using data from

Pakistan for the period 1980-2017, the Granger causality test showed that human capital influences growth through FDI (Habib-Ur-Rahman, Ghazali & Bhatti, 2020).

Therefore, numerous recent studies indicate that human capital and economic growth are interrelated. However, determining the features and manifestations of this relationship requires additional study. While differences in the relationship between countries that vary significantly in economic development, geographical location, cultural context, and political system are understandable, differences in countries with similar socio-economic conditions raise many questions. One such question is: why do some countries see high returns on similar levels of human capital investment in the form of increased labour productivity and GDP growth, while others do not? This suggests that there are factors that either enhance or negate the effect of human capital. The number and degree of impact of these factors vary from country to country.

2.2. Economic growth and corruption

Corruption is a significant factor that complicates the implementation of socio-economic policies and slows development. It is one of the most substantial obstacles to achieving the state's development goals. Corruption hinders the efficient allocation of resources, worsens the business environment, discourages inward investment, and causes brain drain.

Widespread corruption hinders the realization of free competition and a market economy. Businesses that cannot receive preferences find themselves at a disadvantage compared to local favourites. High levels of corruption make doing business more difficult and significantly increase transaction costs. As a result, large companies are forced to either engage in corrupt relations with local elites or move their activities to countries with better institutional conditions. For small and medium-sized firms, high levels of corruption can lead to a significant decline in income and the transfer of some activities to the shadow economy to reduce overall business costs. Hence, corruption directly impacts the economy in most countries and regions, typically negatively. Numerous studies confirm this. Corruption adversely affects economic growth in many countries, including Nigeria (Odi, 2014), Indonesia (Alfada, 2019), Ghana (Forson et al., 2015), India (Bhattacharyya & Jha, 2013), Vietnam (Anh et al., 2016), South Africa (Olamide & Maredza, 2023), and African countries in general (d'Agostino et al., 2016). Ikazaki (2014) notes that if corruption is widespread, growth rates may be negative. Kunieda et al. (2016) also confirm this. The mechanisms by which corruption impacts the economy vary. Gründler and Potrafke (2019), based on an analysis of data from 175 countries for 2012-2018, concluded that corruption negatively affects growth by reducing FDI and increasing inflation.

Scholars note that corruption holds back GDP levels and growth rates in both developed and developing countries. Afonso et al. (2022) found that for 48 countries from 2012 to 2019, higher corruption levels were associated with lower economic activity levels. Using a case study of 13 Asian countries from 2009 to 2018, Das et al. (2020) proved that corruption slows down growth in the region. Although there are some instances where corruption may incentivize innovation, generally, it is an obstacle to long-term growth.

In general, the level of corruption is higher in developing countries, and its impact

on growth is ambiguous. Spyromitros and Panagiotidis (2022) assessed manifestations of corruption in 83 developing countries from 2012 to 2018 and determined that it negatively affects growth. However, scholars argue that corruption does not necessarily hinder growth when other factors favour it. Typically, corruption hinders economic activity, but scholars have come to the equivocal conclusion that, under certain conditions, developing economies can benefit from increased corruption. For example, Nguyen & Luong (2020) found that corruption positively affected growth in Asian developing countries from 2000 to 2015. By applying the Granger causality test to data from the Gulf countries for 2003 to 2016, Belloumi & Alshehr (2021) determined that corruption does not lead to economic growth. While sometimes positive manifestations of corruption are possible, such as bribery helping to eliminate bureaucratic procedures, the overall impact is generally negative.

Despite the individual benefits that corruption provides to certain interest groups – such as preferential business terms, access to government funding, public transfers, subventions and subsidies, tax incentives, concessional loans, direct government support, and tax evasion – all these factors can act as growth stimulators in the short term, as they contribute to income growth. However, this relationship does not account for the lost budget revenues, the negative societal image of the state, and the further deterioration of the country's reputation. These issues negatively affect the inflow of foreign investment and worsen business conditions, ultimately leading to decreased long-term growth.

Corruption affects all spheres of society and ultimately reduces the efficiency of human capital implementation. A study of Vietnamese provinces showed that corruption generally has a negative impact on human capital, despite some local advantages (Thi Hoa, 2020). Furthermore, corruption negatively affects the education system in African universities (Seka, 2013).

This study aims to identify the features of the relationship between key indicators of a country's development: economic growth, corruption levels, and human capital development, focusing on European Union candidate countries.

3. Data and methods

This study uses annual data from 1996 to 2021¹ for nine EU candidate countries. These countries are making important political and economic decisions to align their domestic regulations with EU requirements. The implementation of reforms is a complicated process, often slowed down by corruption and the disinterest of certain groups in the necessary changes.

The research uses the following World Development Indicators (2023) for analysis:

GDP – GDP per capita (current US\$) to assess the level of economic well-being;

CC – Control of Corruption: Estimate, an indicator of the state of corruption in the country (Kaufmann, Kraay & Mastruzzi, 2010);

¹ The period 1996-2021 is the time period for which comparable data are available for all countries. The indicator control of corruption began to be published in 1996, 2021 is the year for which data are available for all analysed countries.

LEB – Life Expectancy at Birth (years);

EI – Education Index, calculated based on *EYS* (Expected Years of Schooling, years) and *MYS* (Mean Years of Schooling, years):

$$EI = \frac{\frac{EYS}{18} + \frac{MYS}{15}}{2}$$

The last two indicators characterize the level of human capital development in society. The research methodology includes the following methods:

- correlation analysis: to determine the relationship between indicators;
- logarithm procedure: to transform time series into logarithmic form;
- calculation of the Augmented Dickey-Fuller test: to check the stationarity of time series;
- determination of the first and second differences of logarithms: for non-stationary time series to bring them to stationary form;
- calculation of the Granger causality test: to determine the direction of causality between indicators.

4. Results

The main problem for EU candidate countries is that corruption and insufficient support for human capital development exacerbate the existing gap in economic development indicators compared to EU member states. To address this issue, it is necessary to determine the direction of these impacts.

In the preliminary stage, we determine whether there is a relationship between the analysed indicators by calculating the correlation between indicators across countries (Table 1).

Table 1. Pearson correlation coefficients between GDP, CC, LEB and EI

Indicator	GDP	CC	LEB
Albania			
CC	0,86		
LEB	0,83	0,85	
EI	0,91	0,84	0,86
Bosnia and Herzegovina			
CC	-0,36		
LEB	0,61	0,06	
EI	0,91	-0,45	0,48
Georgia			
CC	0,94		
LEB	0,90	0,94	
EI	0,82	0,84	0,80

Indicator	GDP	CC	LEB
Moldova			
CC	0,02		
LEB	0,80	-0,35	
EI	0,91	-0,27	0,95
Montenegro			
CC	0,86		
LEB	0,83	0,88	
EI	0,94	0,92	0,92
North Macedonia			
CC	0,74		
LEB	0,85	0,68	
EI	0,96	0,66	0,89
Serbia			
CC	0,77		
LEB	0,81	0,80	
EI	0,91	0,83	0,95
Turkiye			
CC	0,60		
LEB	0,87	0,22	
EI	0,76	-0,00	0,94
Ukraine			
CC	0,46		
LEB	0,62	0,39	
EI	0,76	0,60	0,61

Note: The noted correlations are significant at the level $p < 0.05$

Source: Author's computation with data from World Bank using Statistica

Table 1 shows that in most cases, there is a significant relationship between the indicators. However, this relationship varies from country to country, and the correlation coefficients can be both positive and negative. Therefore, the next stage of the study is to identify the specific features of these relationships. Graphs of the indicators by countries are presented in Figure 1.

Since the original data had different units of measurement, it was necessary to convert the time series into logarithmic form. Logarithmic values make the analysis more meaningful and easier to interpret, as they bring the series within a single range. Additionally, because the Control of Corruption indicator ranges from -2.5 to 2.5, we adjusted it to a positive scale before applying the logarithm by adding 2.5 to each value, resulting in a new scale from 0 to 5. Graphs of the logarithms of the indicators by countries are presented in Figure 2.

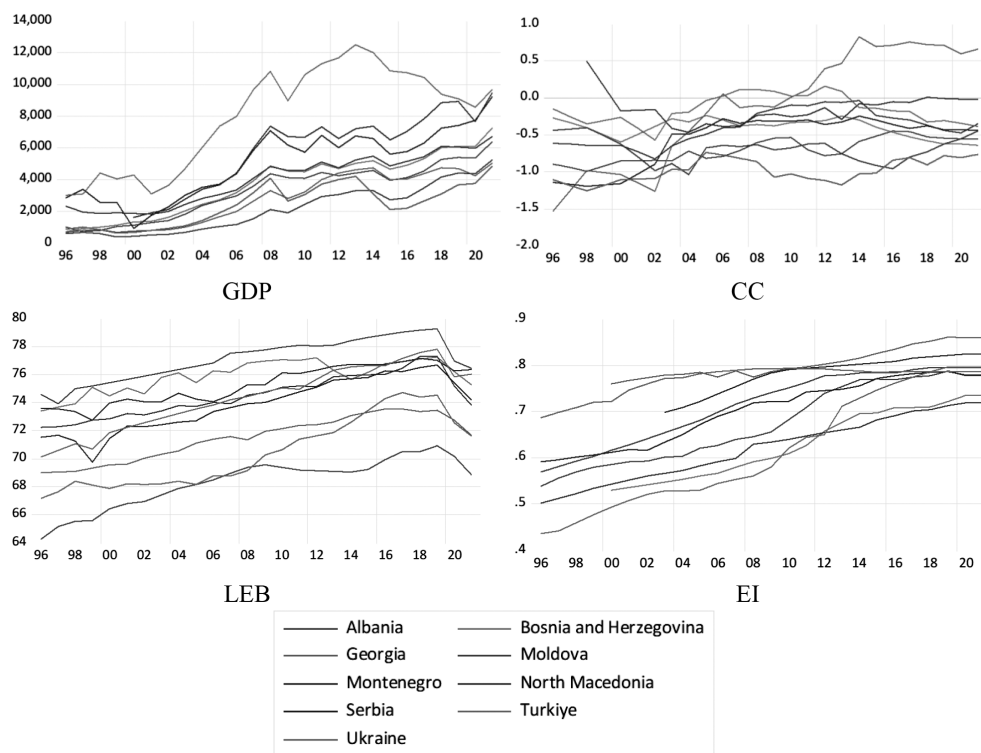


Figure 1. Graphs of indicators by countries

Source: Author's computation with data from World Bank using EViews

Figure 2 shows that the graphs of the logarithms of the analysed indicators exhibit trend areas, indicating the possible non-stationarity of these time series. Additionally, some trends have similar trajectories. Therefore, the next stage of the study is to determine the order of integration of the series, i.e., to check whether these series are stationary. To do this, the paper calculates the Augmented Dickey-Fuller Unit Root Test (ADF-test) for the series $\lg\text{GDP}$, $\lg\text{CC}$, $\lg\text{LEB}$, and $\lg\text{EI}$. The stationarity check procedure is performed separately for each time series.

The p-values for the logarithms of the indicators, their first and second differences by countries are provided in Table 2.

The essence of the Dickey-Fuller test is to compare the calculated test value with McKinnon's τ -statistic. The series is considered stationary if the p-value is less than 5% and McKinnon's τ -statistic is greater than the absolute values of the critical value at the 1%, 5%, and 10% significance levels. As shown in Table 3, most of the time series for all countries are non-stationary, with non-stationary series highlighted in grey. However, some series, such as $\lg\text{CC}$ (Moldova, Montenegro), $\lg\text{GDP}$ (North Macedonia), and $\lg\text{EI}$ (Montenegro, Turkiye, Ukraine), are stationary. Thus, the results of the ADF-test indicate that most logarithmic time series are non-stationary, necessitating the use of logarithmic time series on the scale of first and second differences in the next step of the research.

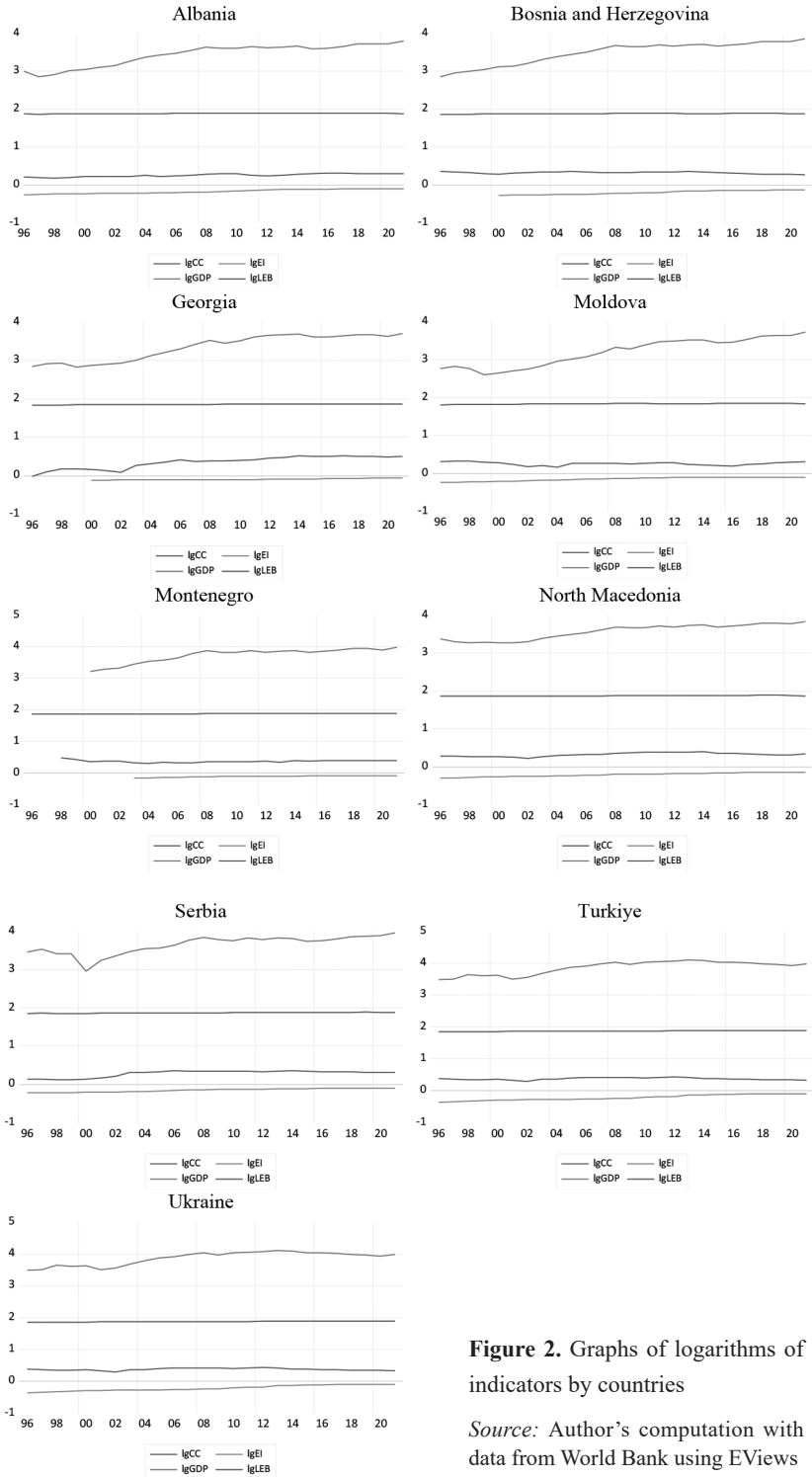


Figure 2. Graphs of logarithms of indicators by countries

Source: Author's computation with data from World Bank using EViews

Table 2. P-values for the analysed indicators

Country	Indicator	p-value for the logarithm of the indicator (lg)	p-value for 1 difference logarithm of the indicator (D1lg)	p-value for 2 difference logarithm of the indicator (D2lg)
Albania	GDP	0.0058	0.0003	0.0001
	CC	0.0427	0.0333	0.0006
	LEB	0.9978	0.0009	0.0000
	EI	0.0801	0.2604	0.0360
Bosnia and Herzegovina	GDP	0.8088	0.0265	0.0001
	CC	0.9139	0.0829	0.0001
	LEB	0.8604	0.0007	0.0020
	EI	0.7403	0.3835	0.0029
Georgia	GDP	0.6929	0.0106	0.0000
	CC	0.1450	0.0017	0.0003
	LEB	0.4323	0.4997	0.0000
	EI	0.9255	0.3225	0.0000
Moldova	GDP	0.6382	0.0481	0.0000
	CC	0.0466	0.0035	0.0000
	LEB	0.9845	0.0056	0.0014
	EI	1.0000	0.2035	0.0002
Montenegro	GDP	0.6797	0.0362	0.0010
	CC	0.0322	0.0043	0.0000
	LEB	0.5619	0.0015	0.0001
	EI	0.0585	0.6695	0.2306
North Macedonia	GDP	0.0187	0.0193	0.0002
	CC	0.9383	0.0656	0.0001
	LEB	0.0992	0.0742	0.0016
	EI	0.9056	0.0032	0.0000
Serbia	GDP	0.3250	0.0008	0.0112
	CC	0.9710	0.0211	0.3149
	LEB	1.0000	0.0340	0.0001
	EI	0.9975	0.0725	0.0000
Turkiye	GDP	0.9169	0.0043	
	CC	0.8792	0.0029	
	LEB	0.9438	0.0007	
	EI	0.0261	0.0366	
Ukraine	GDP	0.8223	0.1060	0.0009
	CC	0.6372	0.0019	0.0000
	LEB	0.4087	0.9562	0.0000
	EI	0.0000	0.8695	0.1361

Source: Author's computation with data from World Bank using EViews

The classical way to transform non-stationary series into stationary ones is by taking successive differences. Using the first differences of the logarithms of the indicators is one de-trending method. The next step is to apply the Dickey-Fuller testing procedure to the transformed series. If the series in the first difference of logarithms is stationary, the analysis can proceed to determine the causality between the analysed indicators. If the series remains non-stationary, it is transformed to the second difference. The Dickey-Fuller Unit Root Test is then calculated for the second difference of logarithms, and the stationarity check procedure is repeated.

The results of the Dickey-Fuller test (Table 3) show that all four indices are stationary in first differences of logarithms for Turkiye only, as McKinnon's τ -statistics are smaller than the critical values at the 1%, 5%, and 10% significance levels. For the other countries, some indicator series are stationary, while others are non-stationary. Including variables in different types of differences for causal analyses is not desirable. Therefore, the next stage is to transform the series into stationary ones for all countries except Turkiye by converting them to the second difference of logarithms.

The results of the Dickey-Fuller test for the second difference of logarithms demonstrate that the null hypothesis of a unit root is rejected ($p < 0.05$) for all four time series in Albania, Bosnia and Herzegovina, Georgia, Moldova, and North Macedonia. Consequently, we can assume stationarity of these time series for all indicators in these countries. In Serbia, three of the four series are stationary, except for the D1lgEI series. However, the null hypothesis cannot be rejected for D2lgEI (Montenegro), D2lgCC (Serbia), and D2lgEI (Ukraine), indicating that these series are non-stationary in the second difference. Therefore, these three time series were excluded from further causality analyses.

The next step is to determine the causality between the analysed indicators. Unlike correlation analysis, causal analysis allows us to determine the dynamics of the interaction, specifically the direction of causal relationships.

The study uses Granger's test to determine the causal relationship between the variables. Since the Granger test is sensitive to the number of lags (m), it is appropriate to perform this test for different values of m . Tests were calculated for lags $m = 2, 3, 4$, and 5 . The choice of the number of lags is also supported by the rule that the number of lags should not exceed the number of observations divided by 4 .

The paper examines the results of causal analysis using F-statistic values and their corresponding p-values to determine causality. The results of the Granger test are used to verify the null hypothesis that "A does not Granger Cause B." The criterion for accepting or rejecting the hypothesis is based on the obtained p-value. To reject the null hypothesis at the 5% significance level, the p-value must be less than 0.05 . If the p-value is less than 0.05 , the null hypothesis is rejected.

Table 3 provides a visual representation, illustrating the direction of causality between the analysed variables.

Table 3. Interpretation of the Granger causality test

Lag Country	m=2		m=3		m=4		m=5	
	F-Statistic	Prob.	F-Statistic	Prob.	F-Statistic	Prob.	F-Statistic	Prob.
Georgia	2 difference							
	no relationship between the indicators		no relationship between the indicators		no relationship between the indicators		11.9161	0.0162
				lgLEB → lgEI				
Moldova	2 difference							
	4.00713	0.0375	no relationship between the indicators		no relationship between the indicators		3.73120	0.0486
	lgEI → lgGDP				lgCC → lgGDP			
				3.74643	0.0481			
			lgEI → lgGDP					
Montenegro	1 difference							
	6.92969	0.0081	5.34963	0.0162	no relationship between the indicators		no relationship between the indicators	
	lgLEB → lgGDP		lgLEB → lgGDP					
		7.66412	0.0034					
	lgLEB → lgCC							
Serbia	1 difference							
	9.95332	0.0012	10.9475	0.0005	6.96868	0.0039	4.33112	0.0276
	lgLEB → lgGDP		lgGDP → lgCC		lgGDP → lgCC		lgGDP → lgCC	
		5.14265	0.0121	10.3903	0.0007	9.54035	0.0021	
		lgLEB → lgGDP		lgLEB → lgCC		lgLEB → lgCC		
	2 difference							
	13.0152	0.0004	4.77461	0.0170	no relationship between the indicators		no relationship between the indicators	
lgLEB → lgGDP		lgLEB → lgGDP						
Turkiye	1 difference							
	4.12331	0.0336	4.91490	0.0142	4.43234	0.0198	3.56791	0.0469
	lgGDP → lgCC		lgGDP → lgCC		lgLEB → lgCC 6.21196 0.0092 lgLEB → lgCC		lgGDP → lgCC	
		7.09653	0.0034					
	lgLEB → lgCC							

Source: Author's computation with data from World Bank using EViews

The analysis showed that there is a long-term causal relationship from CC to GDP only in Moldova. In Montenegro, Serbia, and Turkiye, there is a causal relationship from GDP and LEB to CC. This suggests that high income and education levels lead to less corruption in the long run. Thus, the control of corruption has no direct impact on economic growth and human capital components in the analysed countries. At the same time, there is a direct causal relationship from EI to GDP in Moldova, from LEB to EI in Georgia, and from LEB to GDP in Serbia and Montenegro. Discrepancies in the direction and strength of the relationship between these indicators, as well as the reasons for the absence of such relationships, can be explained by differences in the institutional

systems of society and the socio-economic situations in these countries. The study found no evidence of causality in the relationships between the analysed variables for Albania, Bosnia and Herzegovina, North Macedonia, and Ukraine.

The progress of EU candidate countries is often assessed through official evaluations by the European Commission based on the Copenhagen criteria². Additionally, progress can be determined by comparing the state's position in international rankings, which display the country's advancements in various measurements. Table 4 presents the positions of EU candidate countries in several international rankings, reflecting their political, economic, and institutional progress.

Table 4. Comparison of positions of EU candidate countries in international rankings

Country	Economic Freedom			Freedom in the World			Rule of Law Index			Corruption Perception Index		
	Year		Trend	Year		Trend	Year		Trend	Year		Trend
	Value			Value			Value			Value		
Albania	2005*	2021		2013*	2021		2015*	2021		2012*	2021	
	7,05	7,60	0,55	63	66	3	0,52	0,49	-0,03	33	35	2
Bosnia and Herzegovina	2005	2021		2013	2021		2015	2021		2012	2021	
	6,31	6,66	0,35	62	53	-9	0,57	0,52	-0,05	42	35	-7
Georgia	2005	2021		2013	2021		2015	2021		2012	2021	
	7,41	7,71	0,30	60	60	0	0,65	0,61	-0,04	52	56	4
Moldova	2005	2021		2013	2021		2015	2021		2012	2021	
	6,54	7,18	0,64	65	61	-4	0,48	0,51	0,03	36	36	0
Montenegro	2005	2021		2013	2021		2015	2021		2012	2021	
	6,05	7,59	1,54	72	63	-9	-	-		41	45	4
North Macedonia	2005	2021		2013	2021		2015	2021		2012	2021	
	6,88	7,06	0,18	64	66	2	0,55	0,53	-0,02	43	39	-4
Serbia	2005	2021		2013	2021		2015	2021		2012	2021	
	5,82	6,85	1,03	78	64	-14	0,5	0,49	-0,01	39	38	-1
Türkiye	2005	2021		2013	2021		2015	2021		2012	2021	
	6,39	6,32	-0,07	61	32	-29	0,46	0,42	-0,04	49	38	-11
Ukraine	2005	2021		2013	2021		2015	2021		2012	2021	
	5,41	6,17	0,76	57	60	3	0,48	0,51	0,03	26	32	6

Note:

The maximum progress for the period is highlighted in red in the table, and the minimum in blue;

* - the minimum year for which there are indicator values for all analysed countries.

Source: Author's computation with data from:

- Economic Freedom (scale from 0 (worst value) to 10 (best value). <https://www.fraserinstitute.org/economic-freedom/>
- Freedom in the World (scale from 0 (worst value) to 100 (best value). <https://freedomhouse.org/>;
- WJP Rule of Law Index (scale from 0 (worst value) to 1 (best value). <https://worldjusticeproject.org/rule-of-law-index/>
- Corruption Perception Index (scale from 0 (worst value) to 100 (best value). <https://www.transparency.org/>

² - stability of institutions guaranteeing democracy, the rule of law, human rights and respect for and protection of minorities;

- a functioning market economy and the ability to cope with competitive pressure and market forces within the EU;
- the ability to take on the obligations of membership, including the capacity to effectively implement the rules, standards and policies that make up the body of EU law (the 'acquis'), and adherence to the aims of political, economic and monetary union.

The information in Table 4 shows a decline in all indicators for Türkiye, which is confirmed by the existence of a causality from all indicators to control of corruption. Bosnia and Herzegovina shows no progress in the analysed indicators. Ukraine, despite having low index values compared to the other analysed countries, demonstrates the most significant improvement in these values. In general, the data in Table 4 are consistent with the results of the Granger causality test and demonstrate progressive movement towards achieving the Copenhagen criteria targets for the majority of candidate countries.

5. Discussions

The role of human capital in socio-economic development is well established and is often accepted as an axiom. A more skilled, educated, and healthy workforce ultimately shows higher productivity and, as a result, earns higher wages (Benos & Karagiannis, 2016; Annabi, 2017; Kampelmann et al., 2018; Ezoji et al., 2019; Yu et al., 2022). Increased labour productivity leads to improved economic growth indicators and rates, contributing to the economic well-being of citizens and society as a whole. This logic justifies the need to invest in human capital by improving healthcare and education systems (Romer, 1990). However, in reality, this does not always happen. Often, countries recognize the importance of human capital for growth but do not adequately invest in its development. Additionally, the return on investment in human capital can vary from country to country even with similar levels of funding. Clearly, there are factors that either hinder or facilitate the realization of human capital's potential.

The European Union countries recognize the need to develop human capital. Furthermore, several studies focus on the role of human capital in ensuring economic growth in Europe. Human capital significantly contributes to economic growth in Macedonia (Lazarov & Petreski, 2016), Slovakia (Rafaj & Rehák, 2017), and various EU regions (Laskowska & Dańska-Borsiak, 2016). Barcenilla-Visús & López-Pueyo (2018) highlight the impact of human capital on total factor productivity and, consequently, on economic growth in EU countries. In the context of the formation of Society 5.0, which emphasizes the integration of digital technologies into society, the importance of managing human capital development is increasing (Stryzhak, 2022). This increasing importance cannot be ignored.

There are many factors influencing the relationship between human capital and economic growth, and these factors vary from country to country. Scholars have attempted to explain the reasons for these variations. For instance, Khalfaoui & Derbali (2021) conclude that this relationship depends on the efficiency and productivity of human capital rather than on labour market mechanisms. In Kazakhstan, the low economic effect of investments in healthcare and education indicates inefficiency and a non-innovative economy (Kussaiynov et al., 2020). These findings confirm that numerous factors influence the level of human capital development.

The positive impact of human capital on the economy is evident, especially in developed countries with low levels of corruption. Although developed countries have not

completely eliminated corruption, its negative impact on socioeconomic relations is more significant in developing countries.

While the study did not show a causal relationship for countries such as Albania, Bosnia and Herzegovina, North Macedonia, and Ukraine, at the same time, it is worth noting some patterns that were identified for these countries. In Albania, Bosnia and Herzegovina and North Macedonia there is an average level of life expectancy and gross domestic product production, with an average level of education for Albania and Bosnia and Herzegovina, and low for North Macedonia, and an average level of corruption in society for Bosnia and Herzegovina and North Macedonia and high for Albania compared to other analysed countries. The absence of pronounced causal relationships in this case can be explained by the transformation of the institutional system of society in these countries, since a number of reforms necessary for EU accession are being implemented there.

The situation in Ukraine is fundamentally different: with high levels of both corruption and education, there is a low level of both GDP production and life expectancy. This can be explained by the low quality of state institutions, lack of mechanisms of public control over the use of allocated funds, when public expenditures on education and health care are distributed using corrupt schemes, and most of the funds do not reach the addressees. Also, with a high level of corruption, a formally high level of education is not an indicator of its quality, which ultimately does not lead to high labour productivity and high return on human capital, expressed in the corresponding levels of GDP production.

There is no doubt that EU candidate countries need to implement the successful experiences of developed EU countries in managing human capital and overcoming corruption. Reducing corruption and ensuring sustainable GDP growth rates is possible through the implementation of institutional norms that have proven effective in developed economies. However, harmonizing legislation with EU requirements does not guarantee the effective operation of these norms. It is essential for society to accept them, which is a long process. Nevertheless, the desire to integrate into the common European space provides a strong incentive for many countries to implement reforms more quickly than they were initially adopted by developed countries.

Corruption remains one of the main challenges to the implementation of the European development path for EU candidate countries. It obstructs the realization of human capital and limits competition in the labour market by providing undue benefits based on corrupt ties. For businesses, corruption manifests mainly through unfair advantages granted to corrupt business structures by lobbying for the interests of ruling elites. On one hand, the fight against corruption is the responsibility of the legislative and executive branches of the state; on the other hand, it is the personal responsibility of every citizen. In this context, it is important to establish not only an anti-corruption legislative framework but also to foster a culture of non-acceptance of corruption within society. Increasing transparency, tightening public control over authorities at all levels, and strengthening the mechanisms of fair punishment will help prevent corrupt practices and reduce the motivation to participate in corruption schemes.

The issues surrounding further enlargement of the EU are closely related to the strengthening of China's position in the international arena and the increasing influence of the USA. The admission of new candidate countries to the EU has heightened the significance of many problematic moments related to political, economic, cultural, and religious aspects. As Basheska (2022) found, EU enlargement is primarily a political process. Nevertheless, the rule of law, rather than political interests, should play a decisive role in EU enlargement. Membership in the EU does not guarantee prosperity and economic well-being for candidate countries without the implementation of necessary legal and institutional reforms, including those to control corruption (Mahmutefendic, 2019).

The problem of EU enlargement has not only a geographical but also an economic and political basis. Both the level of GDP in candidate countries and the development of their legal systems are important, especially in terms of compliance with legal norms in society. As Economides, Featherstone, & Hunter (2023) and Dabrowski (2022) remark, issues of further EU enlargement are closely related to integration. Integrating the economies of candidate countries into the EU economic system involves not only economic considerations but also the political will of both the governments and citizens of EU countries.

6. Conclusions

The study found differences in both the direction and strength of the causal relationships between components of human capital, corruption control, and economic growth in EU candidate countries. In some cases, no such relationship exists.

The testing of hypothesis H1, which posits a possible relationship between the level of economic well-being and the level of corruption, showed a statistically significant correlation between these indicators for all countries except Bosnia and Herzegovina and Moldova. Granger causality was found from CC to GDP in Moldova and from GDP to CC in Serbia and Türkiye.

The testing of hypothesis H2, which examines the relationship between the level of corruption and human capital development indicators, showed a statistically significant correlation for all countries except Moldova. The study found a weak correlation between CC and EI in Bosnia and Herzegovina. The calculations also revealed a causal relationship from LEB to CC in Montenegro, Serbia, and Türkiye.

Hypothesis H3, which assumes a relationship between the level of economic well-being and human capital development indicators, was confirmed for all countries without exception using Pearson correlation. The Granger test showed a causal relationship from EI to GDP in Moldova and from LEB to GDP in Serbia and Montenegro.

The absence of a causality between GDP indicators and human capital components, in the author's opinion, does not mean that it does not exist. It is likely that a relationship exists but manifests indirectly through other factors not included in this analysis. For example, Altinok & Arslan M.O. (2020) discovered there is bidirectional causality between real GDP and public expenditures for Albania and Bosnia and Herzegovina and

unidirectional from real GDP to public expenditures for North Macedonia. Xhindi, Kripa & Shestani (2020) found a causal two-way relationship between health expenditure and GDP per capita for Albania. Lazarov & Petreski (2016) figured out that human capital, expressed by gross enrollment in secondary education, contributes to economic growth, expressed by real GDP per capita in Macedonia. In the case of Ukraine Letunovska, Abazov & Chen Y. (2022) determined that an increase in the level of health leads to an increase in the level of competitiveness at the regional level, Zolkover et al. (2021) concluded that HCI has an impact on GDP, but an increase in education and health expenditure does not lead to economic growth.

Additionally, it should be noted that the absence of a direct significant causality from control of corruption to important indicators of socio-economic development in countries with high levels of corruption, such as Albania, Bosnia and Herzegovina, North Macedonia, and Ukraine, suggests a complex interaction. The average CC values for the analysed period were -0.70, -0.41, -0.40, and -0.99, respectively (World Development Indicators, 2023). This suggests that corruption is closely interrelated with other indicators not examined in this paper. This phenomenon requires more careful study, which can be addressed in future research by including additional variables in the analysis.

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