Effects of Corruption and Economic Freedom on Total Factor Productivity in Middle- and High-Income Countries

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Received: March 10, 2025 Revised: April 12, 2025 Accepted: May 6, 2025

Available online: May 16, 2025 URL: https://doi.org/10.11114/aef.v12i2.7577

Abstract

This study aims to verify the effects of corruption (CPI), economic freedom (EF), and the interaction between these two variables (CPI×EF) on the growth of Total Factor Productivity (TFP) in middle and high-income countries from 1995 to 2019, using a two-step system GMM method for panel data. The results show that reduced perceived corruption and greater economic freedom are positively associated with TFP growth. However, the interaction term has a negative coefficient associated with TFP, suggesting that in countries with high levels of corruption and low economic freedom, which is often found in middle-income countries, implementing anti-corruption policies along with incentives for economic liberalization is a factor of great relevance to achieve higher productivity gains.

Keywords: corruption, economic freedom, Total Factor Productivity, middle and high-income countries, system GMM

1. Introduction

The influence of corruption on economic growth has been widely investigated both theoretically and empirically, with studies such as those by Mauro (1995, 1998), Mo (2001), De Vaal and Ebben (2011), Campos, Dimova and Saleh (2016), and Gründler and Potrafke (2019) standing out. These studies are based on the premise that corruption has the potential to distort the allocation of resources and increase the costs associated with investment projects, which in turn reduces productive efficiency and limits economic growth. In addition, corruption can undermine a country's competitiveness, discouraging private investment and harming the business environment. From an analytical point of view, a direct connection is established between corruption and productivity (Lambsdorff, 2003).

Corruption is a global phenomenon, with only about 31% of countries ranked by Transparency International having a Corruption Perceptions Index (CPI)[1] above 50. However, its prevalence varies considerably across territories. Specifically, the rankings by this institution highlight that Latin American and African countries consistently rank at the bottom in terms of corruption perception. In general, developing and transition regions are often affected by high levels of corruption, a trend that has persisted over the years. This reality is worrying because, as highlighted by Hall and Jones (1999), factors such as institutions that promote production to the detriment of deviant behavior, trade liberalization policies, and some degree of private property are crucial in explaining the underlying causes of the high productivity observed in certain countries.

In an environment marked by corrupt activities, bidding and contracting procedures for services often lack transparency and impartiality, favoring companies willing to bribe over those that genuinely have the necessary technical expertise. This can result in infrastructure and development projects being awarded to less qualified contractors or suppliers, compromising the quality of the work performed. As noted by Lambsdorff (2003), corruption compromises the quality of investments by allowing essential control mechanisms to ensure contracted quality to be circumvented.

According to Mauro (1995), in the first investigations into the effects of corruption, authors such as Leff (1964) and Huntington (1968) suggest that, under certain circumstances, corruption could be “beneficial” for economic growth, an idea that was initially counterintuitive. This perspective, known as the “grease” hypothesis of corruption, argues that in environments with excessive bureaucracy and serious governance deficiencies, corrupt practices such as bribes and "fast money" could act as grease in the gears, promoting efficiency. However, as Xu (2016) suggested, most of the evidence, as discussed above, supports the "sand in the wheels" hypothesis, which holds that corruption is detrimental to economic growth.

One possible strategy to combat corruption is to increase economic freedom, an approach supported by studies that consistently show a negative association between economic freedom and corruption levels (Goldsmith, 1999; Goel & Nelson, 2005; Lambsdorff, 2006; Carden & Verdon, 2010; Enste & Heldman, 2017). In other words, countries that enjoy greater economic freedom tend to face fewer corruption problems, keeping other factors constant. As noted by Acemoglu and Verdier (2000), the underlying argument is that government intervention creates opportunities for corrupt practices by redistributing resources from one party to another. Thus, the absence of competitive policies and efficient regulations can make an environment more susceptible to corruption. In short, promoting greater economic freedom can generate significant benefits for countries, not only by boosting economic growth but also as an effective means of reducing the incidence of corruption.

In the context of the relationship between corruption, economic freedom, and Total Factor Productivity (TFP), the empirical literature is still limited in studies that simultaneously address the effects of the interaction between corruption and economic freedom on TFP. The available evidence from those that investigate separately indicates, for the most part, a negative relationship between corruption and TFP (Salinas-Jiménez & Salinas-Jiménez, 2007; Salinas-Jiménez & Salinas-Jiménez, 2011; Wu, Li, Nie & Chen, 2017) and a positive relationship between economic freedom and aggregate productivity (Klein & Luu, 2003; Alexandre, Bação & Veiga, 2022).

In light of this scenario, this study aims to analyze the effect of the interaction between corruption and economic freedom on TFP growth using a broad sample of countries. To this end, the two-stage system GMM study method (Arellano & Bover, 1995; Blundell & Bond, 1998) will be used, considering a data panel composed of 57 middle-income countries and 50 high-income countries from 1995 to 2019.

This study contributes to the literature by adopting a different approach from works such as those by Swaleheen and Stansel (2007), Heckelman and Powell (2010), and Malanski and Póvoa (2021), which focus on economic growth. The analysis proposed here allows us to investigate the validity of these empirical findings from the perspective of the aggregate productivity channel, which is considered fundamental to understanding wealth differentials between countries (Hall & Jones, 1999; Caselli, 2005; Jones & Romer, 2010). As a key innovation, the study explores the interaction between corruption and economic freedom, capturing how economic freedom may moderate the effects of corruption on productivity growth. Furthermore, the study presents a methodological advance, albeit marginal, by employing the two-step system GMM. This approach provides greater robustness to the estimates compared to the one-step approach used in two of the studies mentioned above.

By deepening the understanding of the corruption and economic freedom mechanisms that affect aggregate productivity, this study can contribute to the related literature, supporting policymakers and researchers and highlighting the importance of fostering an institutional environment conducive to long-term economic growth and mitigating corruption.

In addition to this introductory section, the text will be organized into four more sections. The second section will address the literature review. Then, the empirical strategy and data sources will be presented. The fourth section will show the results and discussions, and finally, the fifth section will present the concluding remarks.

2. Literature review

2.1 The Effect of Corruption on Productivity

Despite the limitations inherent in the study of the economic implications of corruption, especially concerning the measurement of this variable, heterogeneity between countries, and simultaneity problems, there is a relative consensus on the harmful effects of corrupt practices on economic growth (the "sand" hypothesis). However, as Mauro (1995) notes, the first investigations on the subject pointed to an alternative perspective, known as the corruption's "grease" hypothesis (Leff, 1964; Huntington, 1968). This approach suggests that corruption could act as a "lubricant" for the economy in contexts marked by excessive bureaucracy and severely deficient governance, speeding up bureaucratic processes, improving the quality of certain public services, and reducing administrative delays through bribes.[2]

Empirical studies by authors such as Mauro (1995) and Méon and Sekkat (2005), covering a wide range of countries, refute the "grease" hypothesis, showing that corruption, in general, harms economic growth, in line with the so-called "sand" hypothesis. Subsequently, Méon and Weill (2010) conducted an empirical investigation in 69 developed and developing countries and found evidence supporting the "grease" hypothesis. They argued that the intensity of the positive effect of corruption is strongly conditioned by the quality of governance, suggesting that, in poorly governed countries, corruption can increase efficiency.

According to Hall and Jones (1999), government institutions and policies, which they call “social infrastructure,” are crucial in providing incentives that promote productive behaviors, such as skill improvement, creating new products, and developing innovative production techniques. Acemoglu, Johnson, and Robinson (2005) support this view when they state that good institutions stimulate the accumulation and efficient use of physical and human capital. On the other hand, when weak or ineffective, these structures can encourage harmful practices, such as the pursuit of illicit gains, corruption, and other activities that distort economic incentives, compromising long-term growth and the overall efficiency of the economic system.

Aggregate productivity, as a measure of efficiency, is one of the main channels through which corruption can impact economic growth, either by hindering it or, in particular circumstances, by favoring it. According to Mauro (1997), corruption increases companies' operating costs and is perceived by entrepreneurs as an additional tax that discourages investment. Corruption also harms innovative activities since sectors that depend on government-supplied goods and are in high demand become the main targets of corrupt practices. In the public sector, corrupt practices reduce public goods' supply, diminish aid flows' effectiveness, and promote unproductive and unnecessary government spending. Mo (2001) adds that this results in a poor allocation of resources and talent directed toward activities considered “more profitable” to the detriment of more productive ones, compromising countries' economic efficiency. Lambsdorff (2003) presents similar arguments when empirically analyzing the impact of corruption on capital productivity, reinforcing that corruption is a significant obstacle to economic growth.

Regarding the investigation of the relationship between corruption and Total Factor Productivity (TFP), from an empirical perspective, there is a significant gap in the research investigating this relationship at the country level, especially in developing nations. To date, the available evidence has consistently suggested an inverse association between corruption and TFP. For example, in a study conducted by Salinas-Jiménez and Salinas-Jiménez (2007), which covers 22 OECD countries over the period 1980–2000 and employed a nonparametric frontier approach, corruption is found to impact both efficiency levels and TFP growth negatively. In a subsequent study also conducted by Salinas-Jiménez and Salinas-Jiménez (2011), expanding the sample to include both developed and developing countries and using an additional instrumental variables approach, results were obtained that were quite similar to those of the previous study.[3]

Wu et al. (2017) examine the impact of government expenditure and corruption on TFP using panel data for provinces in China between 2007 and 2014. By applying a dynamic spatial autoregressive model and a panel threshold model, the authors conclude that increased corruption levels could directly reduce regional TFP. Furthermore, a significant finding of this study is the presence of a single corruption threshold in the effect of government expenditure structures on TFP, indicating that once corruption crosses this threshold, increasing government expenditure ratios does not result in improvements in TFP.

2.2 The Moderating Role of Economic Freedom

An effective strategy to mitigate corrupt practices is to restrict the influence of private interests in the public sphere by promoting higher levels of economic freedom. This freedom encompasses several aspects, such as trade liberalization, regulatory efficiency, and strengthening property rights. Elements such as the size of government, the protection of property rights, and the effectiveness of regulations are central components assessed by the leading economic freedom indices. The approach is based on the premise that countries with greater economic freedom tend to face fewer corruption problems. Empirical studies, such as those by Graeff and Mehlkop (2003), Goel and Nelson (2005), Saha, Gounder & Su (2009), and Heckelman and Powell (2010), provide robust support for this hypothesis.

The central argument is that the constitutive elements of economic freedom, such as less government intervention, clear rules, and a streamlined bureaucracy, can reduce the influence of corrupt interests in business and political relations. As Goel and Nelson (2005) highlighted, excessive government intervention and bureaucratic complexity often create opportunities for illicit rent-seeking. In other words, when the government exercises excessive control over the economy and imposes complicated regulations, incentives arise for economic agents to seek advantages through corrupt practices, bypassing regulatory and oversight mechanisms (Acemoglu & Verdier, 2000).

Thus, in the relationship between corruption and TFP[4], economic freedom can play a moderating role. Until this paper was written, no studies were identified that specifically addressed the impact of the interaction between corruption and economic freedom on TFP. Given this research gap, examining studies investigating this interaction's effects on economic growth will be pertinent to situating and comparing the results.

Analyzing a panel of 60 countries from 1995 to 2004, Swaleheen and Stansel (2007) find a negative coefficient for the interaction between corruption and economic freedom. The analysis of partial effects reveals that corruption reduces growth when economic freedom is low, but if economic freedom is high, corruption can favor growth. These results indicate that economic liberalization policies should complement anti-corruption policies, especially in developing countries with high levels of perceived corruption and more significant restrictions on economic freedom.

In contrast, Heckelman and Powell (2010), also analyzing the impact of the interaction between the CPI and economic freedom in 82 countries, observe that the positive effect of corruption tends to be more pronounced in contexts where economic freedom is limited. On the other hand, when economic freedom is improved, the interaction between the two indicators suggests that corruption becomes less advantageous.

Malanski and Póvoa (2021) conduct a similar analysis, exploring the impact of the interaction between economic freedom and corruption on economic growth in Latin America and Asia-Pacific emerging countries. Using the one-step system GMM method from 2000 to 2017, their estimates also present divergent results compared with Swaleheen and Stansel (2007), although they are more specific samples. They observe a negative sign for both CPI and economic freedom, while the interaction between these factors exhibits a positive sign. Based on the analyses of the estimated coefficients and other statistics related to these variables, the authors find evidence indicating that, in Latin America, the "sand" hypothesis is valid for countries with greater economic freedom. In comparison, the "grease" hypothesis is confirmed for countries with less economic freedom. Regarding Asia-Pacific countries, verifying the negative effect of corruption in countries with less economic freedom was only possible.

3. Methodology and Data

3.1 Variables and Data Sources

This study uses the Penn World Table (PWT) as one of its primary databases. For several countries, the PWT does not provide data on TFP, resulting in excluding these countries from the sample. The analysis period was determined by the availability of data on corruption and other institutional measures, which generally started in 1995. The classification of countries into middle- and high-income follows the definition proposed by the World Bank. Thus, we have an unbalanced panel with 107 countries[5] covering 1995 to 2019.

PWT, version 10.0, provides comprehensive information on the GDP of more than 182 countries, covering the period from 1950 to 2019. In calculating the variables, the PWT uses prices collected in several nations by the International Comparison Program (ICP) to calculate Purchasing Power Parity (PPP) exchange rates. These rates enable the conversion of the value of macroeconomic variables from different countries into a common currency: the US dollar (Feenstra, Inklaar & Timmer, 2015). Chart 1 presents a detailed description of the variables and their sources.

Chart 1. Variables and data sources

Variable	Description	Source
TFP	TFP level at current Purchasing Power Parity (PPP) (USA=1).	PWT 10
CPI	Perceived levels of corruption in the public sector, assessed on a scale ranging from 0 (highly corrupt) to 100 (absence of corruption).	Transparency International
EF	Overall score obtained by averaging twelve measures of economic freedom. Range: 0 (least free) to 100 (most free).	Heritage Foundation
TRADE	Trade in goods (% of GDP).	World Development Indicators (WDI)
DFI	Foreign direct investment, net inflows (% of GDP).	WDI
CSH_G	Share of government consumption at current PPPs	PWT 10
PL_C	Household consumption price level, US GDP price level in 2017=1.	PWT 10
POP	Population (in millions).	PWT 10
TFR	Fertility rate, total (births per woman).	WDI
LEAB	Life expectancy at birth, total (years).	WDI
HC	Index of human capital, based on years of schooling and returns to education.	PWT 10
VA	Voice and Accountability measure the ability of citizens to participate in the selection of their government, as well as freedom of expression, association, and access to free media in a country. The score assigned to each country on this indicator is expressed in units of standard normal distribution, with an approximate range between -2.5 and 2.5.	Worldwide Governance Indicators (WGI)[6]
PSAV	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. The estimate gives the country's score on the aggregate indicator in units of standard normal distribution, i.e., ranging approximately between -2.5 and 2.5.	WGI
MIC_D	Income dummy, being 1 if the country is middle-income and 0 otherwise.	-

Source: Prepared by the authors.

The Heritage Foundation compiles economic freedom data across four primary dimensions: rule of law, size of government, regulatory efficiency, and open markets, covering 184 countries. The data has been available since 1995, and both indicators range on a scale of 0 to 100, with a value closer to 100 indicating that the country is more economically free. More specifically, in this study, economic freedom will be represented by the overall score, obtained by averaging twelve measures of economic freedom, with equal weight given to each within the abovementioned categories.

As for Transparency International's CPI, until 2011, it was evaluated on a scale of 0 to 10. However, after that year, the index began to follow the same scale as the Heritage Foundation's indicators. The CPI was adjusted by multiplying it by 10 to ensure compatibility with the economic freedom scale. In addition, this study uses other databases relevant to the analysis of long-term economic growth: World Development Indicators (WDI) and Worldwide Governance Indicators (WGI), both provided by the World Bank.

The construction of the model and the selection of the constituent variables are based, firstly, on studies with objectives similar to those of this work, in addition to the empirical literature on the determinants of TFP.[7] The inclusion of trade openness, often proxied by merchandise trade (exports plus imports) as a percentage of GDP or by trade globalization indices, as seen in Baltabaev (2014) and Tebaldi (2016), is justified by the fact that access to new markets can stimulate competition and innovation, contributing to greater efficiency and higher TFP. In other words, trade openness represents an essential channel for technology transfer, enabling increased access to new technologies from the rest of the world (Coe & Helpman, 1995; Coe, Helpman & Hoffmaister, 2009). In the case of DFI, which is more associated with the idea of financial globalization (Alfaro, Kalemli-Ozcan & Sayek, 2009; Kose, Prasad & Terrones, 2009; Baltabaev, 2014; Li & Tanna, 2019), the same logic of trade openness is followed.

In this literature, the use of macroeconomic measures is also common. Inflation, for example, is often associated with a negative relationship with productivity, as observed in studies by Miller and Upadhyay (2000), Rondán and Cháves (2004), and Loko and Diouf (2009). These studies indicate that higher inflation can harm productive efficiency by creating economic uncertainty and distortions in relative prices. In turn, the impact of government spending on productivity is more ambiguous, with directions and degrees of effect varying significantly across studies. Hansson and Henrekson (1994) point out that the effects depend on the different public spending categories. Loko and Diouf (2009) support this view but highlight that excessively high government spending can hinder productivity growth. They argue that such spending can lead to government inefficiencies when they increase the tax burden and cause distortions due to interventions in free markets.

Previous research highlights the importance of human capital in determining TFP, given its close relationship with the quality of the workforce. Miller and Upadhyay (2000) find evidence that, in low-income countries, the impact of human capital shifts from negative to positive as these countries adopt policies that are more open to international trade. Loko and Diouf (2009) note that the quality of the workforce can directly impact economic growth by improving worker efficiency and indirectly by boosting productivity growth. In addition, human capital in the form of health, represented by life expectancy, is also considered essential.

Finally, additional governance measures are also considered. As discussed earlier, strong institutions and a stable political environment create conditions conducive to productivity gains (Hall & Jones, 1999). Therefore, there is some consensus that effective institutions have a positive impact on TFP and can amplify the effects of other factors, such as Research and Development (R&D), human capital, and DFI (Coe et al., 2009; Bjørnskov & Méon, 2015; Tebaldi, 2016; Li & Tanna, 2019). Broadly speaking, including these controls can reduce the impact of omitted variables that could distort the relationship between corruption, economic freedom, and TFP. For example, countries with a more educated workforce or strong institutions may be better able to deal with corruption and benefit from economic freedom effectively.

Table 1 presents the descriptive statistics of the variables used in the analysis. It can be noted that the institutional measures stand out for their low dispersion. On the other hand, economic freedom exhibits a standard deviation of 10.24, which can be attributed to its nature, involving economic aspects subject to more significant fluctuations, such as trade openness. In addition, it is crucial to consider the heterogeneity of the country base, which may explain the CPI’s standard deviation of 22.30, with values ranging from 6.9 to 100. Notably, the CPI average was 49.26, reinforcing the finding of a high proportion of countries ranked by Transparency International with an index below 50 (higher corruption).

Table 1. Descriptive statistics

Variable	Obs.	Mean	Standard deviation	Min.	Max.
TFP	2675	0.680	0.261	0.116	2.396
CPI	2297	49.260	22.301	6.900	100
EF	2581	63.246	10.240	15.600	90.5
TRADE	2656	69.444	44.757	8.729	419.962
DFI	2654	5.571	19.428	-117.375	449.083
CSH_G	2675	0.179	0.065	0.005	0.640
PL_C	2675	0.546	0.271	0.084	2.538
POP	2675	51.418	174.425	0.266	1433.784
TFR	2675	2.486	1.263	0.792	6.918
LEAB	2675	71.838	8.769	41.957	85.180
HC	2675	2.678	0.605	1.215	4.352
PSAV	2247	0.104	0.881	-2.520	1.759
VA	2247	0.229	0.927	-2.050	1.801

Source: Prepared by the authors.

3.2 Empirical Strategy

To verify the impact of corruption and economic freedom on TFP growth, also considering the dependence of aggregate productivity on its own past achievements, the following dynamic panel model is adopted:

$$GTFP_{it} = \gamma_0 + \gamma_1 GTFP_{it-1} + \gamma_2 CPI_{it} + \gamma_3 EF_{it} + \gamma_4 (CPI_{it} \times EF_{it}) + \lambda' X_{it} + \delta_t + \eta_i + \epsilon_{it}, \quad (1)$$

where the subscripts "i" $(i = 1, \ldots, N)$ and "t" $(t = 1, \ldots, T)$ correspond, respectively, to the countries and the time. $GTFP_{it}$ is the log of TFP, and $GTFP_{it-1}$ represents the lagged dependent variable. CPI_{it} serves as an indicator of corruption. EF_{it} is the measure of economic freedom, $CPI_{it} \times EF_{it}$ captures the interaction effect between economic freedom and corruption; X_{it} is the vector that encompasses the control variables, which include: $TRADE_{\mathrm{it}}$, DFI_{it}, CSH_G_{it}, PL_C_{it}, POP_{it}, TFR_{it}, $LEAB_{it}$, HC_{it}, $PSAV_{it}$, VA_{it}, and MIC_D_i. δ_t represents the time-fixed effects. η_i is the country-specific effect, ϵ_{it} is the error term, and $\eta_i + \epsilon_{it} = \mu_{it}$ can be defined.

Including the lagged dependent variable in the model introduces endogeneity (Greene, 2011), making static panel methods such as Pooled OLS, Fixed Effects, and Random Effects inadequate. An approach based on the Generalized Method of Moments (GMM) is used to overcome this challenge, specifically, the system GMM (Arellano & Bover, 1995; Blundell & Bond, 1998). This technique incorporates additional moment conditions, allowing the variation of GTFP between periods to be independent of the unobserved and invariant individual characteristics over time if a stationarity restriction is imposed on the initial conditions (Bond, Hoeffler & Temple, 2001).

In addition, the system GMM ensures that the lagged variation of GTFP is not correlated with the error term, using the first lagged differences of the variables as instruments for the equations in levels. This process results in forming a specific instrument matrix, which combines equations in differences and levels. By satisfying the orthogonality conditions between the instruments and the errors, the method provides consistent and robust estimates against potential endogeneity problems, offering greater precision in the estimates.

Except for Heckelman and Powell (2010), who used the Weighted Least Squares technique, Swaleheen and Stansel (2007) and Malanski and Póvoa (2021) adopted the GMM system in its one-step version, mainly due to concerns about downward bias in small samples. In this study, we propose applying the GMM system in the two-step approach, which, by constructing a weighting matrix based on the residuals of the initial consistent estimator, offers more efficient estimates. The Windmeijer (2005) correction was adopted to improve the precision of the estimates in finite samples. In addition, some estimates with the one-step version were generated for robustness and comparison purposes.

Swaleheen and Stansel (2007) and Heckelman and Powell (2010) highlighted the possibility of simultaneity problems, such as in the relationship between corruption, investment, and growth rates or between corruption and economic growth, respectively. Based on this same principle, but now considering TFP growth as the dependent variable, the CPI and EF variables are treated as endogenous due to potential simultaneity, using their appropriate lags as instruments.

It is worth noting that system GMM can lead to a problem known as instrument proliferation as time increases (Roodman, 2009a). This can distort the test statistics and impair the consistency of the results. In this context, limiting the number of instruments used is recommended. For example, Cameron and Trivedi (2005) suggest a limit of up to four lags. Alternatively, Roodman (2009b) recommends a technique known as "collapse". In this approach, smaller sets of instruments are added together rather than considered separately, resulting in a smaller instrument matrix. In other words, stacked blocks are created in the instrument matrix. Since no lag is actually eliminated, this technique has the potential advantage of retaining more information (Roodman, 2009a). It is important to note that the above strategies will be employed in this study.

In the specification tests, the Arellano-Bond (1991) serial correlation test stands out, as it verifies the presence of serial correlation in errors. In the AR(1) test, the null hypothesis H_0 assumes the absence of first-order correlation in the errors in the first difference; in this case, a p-value lower than the significance level is expected, indicating the rejection of H_0. In the AR(2) test, H_0 assumes the absence of a second-order correlation, where a p-value higher than the significance level leads to the non-rejection of H_0, indicating that the residuals do not have a second-order correlation, which is the desired result. When both conditions are met, the consistency of the system GMM estimator is guaranteed. In addition, the Hansen (1982) overidentification test[8], or J test, assesses the validity of the instruments, assuming as a null hypothesis that they are exogenous.

4. Results and Discussions

The strategy defined to assess the validity of the hypothesis in this study is based on the estimation of models using the two-stage system GMM method, as widely supported by the literature. The models are enriched with various controls, ensuring both the results' robustness and the instruments' validity and the absence of second-order serial correlation AR(2). Table 2 presents four estimated models. In this first round of analyses, all regressors are linear, except for the dependent variable, which is expressed in logarithm. In all models, fixed time effects are included, and the second lag of the dependent variable is used as an internal instrument. It is worth noting that the system GMM does not require external instruments to address endogeneity. Furthermore, to mitigate the simultaneity problem, it is proposed to include appropriate lags of corruption (CPI) and economic freedom (EF) variables (CPI and EF are considered endogenous) as instruments. Model (I) is the most basic, including only CPI, FE and the interaction between CPI and EF, without additional controls. In Model (II), controls related to technology transfer, macroeconomic variables, and a dummy variable for average income are added. Model (III) expands the previous one by incorporating demographic variables. Finally, Model (IV), the most comprehensive, includes all available controls, including the Political Stability variable.

Table 2. Results of the two-stage system GMM estimations[9]

Explanatory variables	(I)	(II)	(III)	(IV)
Constant	-4.252***	-0.288*	0.511000	0.143000
	(1.394000)	(0.159000)	(0.869000)	(1.271000)
$GTFP_{it-1}$	0.883***	0.794***	0.755***	0.709***
	(0.040300)	(0.057900)	(0.092200)	(0.078900)
CPI	0.00410**	0.00996***	0.0281**	0.0284**
	(0.001890)	(0.003300)	(0.012800)	(0.011500)
EF	0.001990	0.00456**	0.0250*	0.0217**
	(0.001280)	(0.002200)	(0.013000)	(0.009740)
CPI×EF	-4.33e-05*	-8.48e-05**	-0.000372**	-0.000354**
	(0.000022)	(0.000040)	(0.000186)	(0.000154)
MIC_D		-0.0836***	-0.208**	-0.169**
		(0.022800)	(0.099000)	(0.076800)
Macroeconomic controls	No	Yes	Yes	Yes
Demographic controls and HC	No	No	Yes	Yes
Institutional control	No	No	No	Yes
Instruments	50	55	52	52
Observations	2147	2130	1942	1942
No. of countries	104	104	104	104
AR (1) p-value	0.000	0.000	0.000	0.000
AR (2) p-value	0.943	0.348	0.722	0.514
Hansen p-value	0.198	0.592	0.790	0.334

Source: Prepared by the authors.

Note: Dependent variable: GTFP. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively. All estimates consider time-fixed effects, the collapse option, robust standard errors, orthogonalized instruments (orthogonal) regarding the errors, and Windmeijer's (2005) finite sample correction for two-stage standard errors.

The results in Table 2 reveal that the CPI positively influences TFP growth. The estimated coefficients remain positive and statistically significant under different specifications. Thus, increasing CPI (i.e., a country is perceived as less corrupt) positively impacts TFP growth, preliminarily validating the corruption “sand” hypothesis. There is also evidence of the impact of economic freedom on TFP growth. Although this variable was insignificant in the initial model, it is statistically significant in subsequent models, alternating between the 5% and 10% levels with positive coefficients. This suggests that higher economic freedom is associated with increased TFP growth.

However, a negative and statistically significant coefficient of the interaction was obtained, supporting the results of Swaleheen and Stansel (2007) but contrasting with the studies of Heckelman and Powell (2010) and Malanski and Póvoa (2021), both for economic growth. For example, considering the estimated coefficients in model (IV), the following relationship is observed: $\partial GTFP_{it}/\partial CPI_{it} = 0.0284 - 0.000354 \cdot EF_{it}$. This partial effect suggests that when the EF score is approximately 80.23, the CPI does not affect TFP growth. In other words, in countries with an EF index of 80.23, the perception of corruption will not affect GTFP. However, in countries with restrictions on freedom (<80.23), the coefficient of the interaction implies that less perceived corruption could generate productivity gains. On the other hand, for countries with very high levels of economic freedom (> 80.23), less perceived corruption implies a decrease in aggregate productivity growth.

From a certain level of economic freedom, estimated at 80.23, the additional freedom apparently causes the reduction of corruption to cause a negative variation in productive efficiency. This finding initially seems contradictory since, intuitively, one would expect greater economic freedom to always translate into positive benefits. However, the interpretation of this result must be careful and contextualized with the specific sample of this study. It was found that only nine countries in the sample had an EF score above this threshold, including Australia, Canada, Singapore, the United States, Hong Kong, Ireland, New Zealand, the United Kingdom, and Switzerland, countries that are often recognized as global leaders in terms of economic freedom. The results of Swaleheen and Stansel (2007) were also similar, with about 37% of the countries in the sample presenting economic freedom scores above the threshold from which the reduction of corruption would have adverse effects.

When analyzing the partial effect concerning the variation in EF, the equation is: $\partial GTFP_{it}/\partial EF_{it} = 0.0217 - 0.000354 \cdot CPI_{it}$. A CPI of 61.3 is noted to cancel out the impact of EF on GTFP. However, for values below 61.3, the increase in EF leads to an increase in GTFP. In countries with a CPI above 61.3 (less corruption), the increase in economic freedom reduces the growth of TFP. Although it is again paradoxical, setting a threshold of 61.3 for the CPI is more reasonable, given the large number of countries with an index below 50. More precisely, an analysis of descriptive statistics separating income groups indicates that in the middle-income group, only two countries (Botswana and Costa Rica) achieved a CPI higher than 61.3, with an average of 32.72. In contrast, the average EF was 57.27 and a maximum value of 74.7. In contrast, among high-income countries, 34 countries achieved a CPI higher than 61.3, with an average of 66.55 and a maximum value of 100. The average EF in these countries was approximately 70, with a maximum value of 90.5.

Thus, there is considerable scope, especially for middle-income countries, to improve productive efficiency through anti-corruption policies. Furthermore, following the approach of Swaleheen and Stansel (2007), the analysis of the two partial effects indicates that anti-corruption policies, complemented by economic liberalization measures, can be particularly effective in developing countries that simultaneously face high levels of corruption and low scores on economic freedom. This combined strategy can promote a more solid institutional environment and, consequently, increase aggregate productivity.

Based on Osterfeld (1992), Swaleheen and Stansel (2007) argue that, in nations with significant restrictions on economic freedom, an increase in corruption is more likely to reduce production since it tends to be a "restrictive" corruption, which reduces competition and free exchange. Furthermore, it is important to recognize the asymmetric effects of economic freedom on corruption. For example, Graeff and Mehlkop (2003) observe that, in developed countries, a significant government presence is not necessarily associated with higher levels of corruption. These authors even question the validity of this dimension in the economic freedom index. On the other hand, Billger and Goel (2009) show that, in highly corrupt countries, economic freedom can aggravate corruption problems.

Therefore, the negative coefficient of the interaction term ($CPI \times EF$) suggests a complex and non-linear relationship between perceived corruption and economic freedom in determining productivity growth. This result implies that, beyond a certain threshold of economic freedom, further reductions in perceived corruption may not necessarily yield positive effects on productivity – and can, in fact, lead to a decline in TFP growth. One possible explanation lies in the nature of corruption itself and how it interacts with institutional environments. In economies where institutions are already strong, such as in high-income countries with advanced legal and regulatory frameworks (e.g., Switzerland, Singapore, or the United States), the marginal gains from further reducing already-low corruption levels may be limited or even counterproductive if anti-corruption efforts lead to excessive bureaucratic rigidity or a reduction in informal but efficiency-enhancing practices.

Moreover, in such institutional contexts, certain forms of corruption – albeit undesirable – may function as informal mechanisms to circumvent excessive regulation or inefficiencies in the system. Removing them without simultaneous institutional adaptation may disrupt established informal "shortcuts" that previously allowed firms to operate more flexibly. For example, in countries with very high EF scores, further tightening of anti-corruption measures could unintentionally increase transaction costs or hinder entrepreneurial activity. This aligns with findings by Billger and Goel (2009), who point out that economic freedom may, in some circumstances, exacerbate corruption problems in weak institutional settings, but it also suggests that even in strong institutional contexts, the interaction between these variables is far from straightforward. Therefore, policies aimed at reducing corruption must be carefully tailored to the institutional maturity and economic freedom level of each country, rather than assuming a universally positive outcome.

As for the other regressors, negative and statistically significant coefficients are found for the middle-income dummy in the models in which it was included. These results suggest that, on average, middle-income countries have lower TFP growth than high-income countries, even after controlling for other relevant variables. This may indicate relatively lower economic performance regarding productive efficiency within the sample tested. The CSH_G variable also presented negative coefficients, with significance varying between 5% and 10% in models (II) and (IV), results that, as previously discussed, align with the literature on the determinants of TFP.

Four additional models were estimated to assess the robustness of the results. Two of these models use the one-step approach, while the other two follow the two-step approach, with and without Windmeijer's (2005) correction for standard errors. The idea is to verify whether changes to the specifications generate significant differences concerning the estimates presented in Table 3. Model (V) is essentially a replica of Model (IV) but in one step. In the following models, the variables TRADE, CSH_G, PL_C, POP, TFR, LEAB, and HC were transformed to logarithmic form, considering up to the fourth lag of the internal instrument. The variable VA was added as a governance control in models (VII) and (VIII). The specifications and results can be found in Table 3.

Table 3. Robustness analysis of estimation results via system GMM

Explanatory variables	(V)	(VI)	(VII)	(VIII)
	One-step	Two-step	One-step	Two-step
Constant	-0.424000	2.001000	-0.824000	-1.326000
	(0.985000)	(3.022000)	(2.636000)	(2.981000)
$GTFP_{it-1}$	0.749***	0.854***	0.667***	0.694***
	(0.071600)	(0.086600)	(0.140000)	(0.110000)
CPI	0.0179**	0.0145*	0.0295*	0.0326**
	(0.008660)	(0.007380)	(0.016500)	(0.013200)
EF	0.0140*	0.0126**	0.0228**	0.0207***
	(0.008230)	(0.005590)	(0.009750)	(0.006920)
CPI×EF	-0.000228**	-0.000197**	-0.000362**	-0.000326**
	(0.000112)	(0.000091)	(0.000177)	(0.000129)
MIC_D	-0.154**	-0.145**	0.141000	-0.166***
	(0.066000)	(0.067300)	(0.338000)	(0.059200)
Controls in logarithmic form	No	Yes	Yes	Yes
Additional lags	No	No	Yes	Yes
Instruments	52	51	50	52
Observations	1942	1848	1841	1840
No. of countries	104	104	104	104
AR (1) p-value	0.000	0.000	0.000	0.000
AR (2) p-value	0.455	0.972	0.98	0.748
Hansen p-value	0.334	0.456	0.63	0.834

Source: Prepared by the authors.

Note: Dependent variable: GTFP. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively. All estimates consider time-fixed effects, the collapse option, robust standard errors and orthogonalized instruments (orthogonal) regarding the errors.

The variables CPI, EF, and their interaction are noted to maintain their significance and signs in all models, even in the face of changes in specifications and methodological approach. Notably, the income dummy remains significant and has the same sign in almost all specifications. Although the Variable CSH_G, both in level and logarithmic form, has lost significance, the variables DFI and POP, when transformed to logarithmic form, are statistically significant, with positive coefficients. Thus, the results demonstrate robustness to the logarithmic transformations of most regressors, to the increase in the number of lags, and to the change to the one-step approach, thus strengthening the reliability of the conclusions reached in the first round of estimates

5. Final Considerations

This research examines the effects of corruption (CPI), economic freedom (EF), and the interaction between these two variables ($CPI \times EF$) on TFP growth. The study covers middle- and high-income countries from 1995 to 2019, using the two-stage system GMM method for panel data for the estimates.

The results show that, individually, reduced corruption and greater economic freedom are positively associated with TFP growth. However, the negative coefficient of the interaction term reveals that in countries with high levels of corruption and economic freedom, which are common characteristics of middle-income countries, productivity gains are more significant. Furthermore, for countries with very high CPI and EF, the effects on TFP may be adverse. These findings suggest that the interaction between corruption and economic freedom is complex, and its implications vary according to the economic context.

In this context, policy recommendations must be tailored to the institutional and economic realities of each group of countries. For middle-income countries, where high levels of corruption and constraints on economic freedom are more prevalent, it is crucial to adopt comprehensive anti-corruption strategies in parallel with gradual economic liberalization. These reforms should focus not only on removing bureaucratic and regulatory barriers but also on strengthening the institutions responsible for oversight, enforcement, and accountability. The goal is to create an environment where market mechanisms can function more efficiently while limiting opportunities for rent-seeking and corrupt practices.

For high-income countries, on the other hand, where institutional structures tend to be more robust and corruption levels are relatively low, the marginal impact of further increasing economic freedom or reducing perceived corruption may be limited or even counterproductive. In such cases, reforms should prioritize institutional fine-tuning, such as improving transparency, streamlining public services, and ensuring that anti-corruption efforts do not result in excessive rigidity or administrative burden. Additionally, policymakers should be aware of potential trade-offs between strict compliance mechanisms and the flexibility required for innovation and productivity growth.

Ultimately, while both groups benefit from improvements in governance and institutional quality, the sequencing, intensity, and focus of reforms must be adapted to the development stage and institutional maturity of each country. A one-size-fits-all approach may not only be ineffective but could also lead to unintended negative effects on productivity. Therefore, understanding the nuanced relationship between corruption, economic freedom, and TFP growth is essential for designing more effective and context-sensitive economic policies.

Two main limitations are highlighted: endogeneity issues, despite the use of the system GMM method, and the use of the CPI, which may not perfectly reflect the reality of corruption due to its perceptual nature. Future studies could include more direct and objective measures of corruption and consider other sources of endogeneity to improve the robustness of the results. In addition, it is essential to explore institutional differences between countries in greater depth to better understand the mechanisms through which corruption and economic freedom interact and influence countries' productivity.

Acknowledgments

Not applicable.

Authors' contributions

The author Jailson Rodrigues was responsible for conceptualization, data collection, data curation, formal analysis, investigation, methodology, visualization, and writing (original draft). The author Edson Zambon Monte was responsible for conceptualization, formal analysis, methodology, supervision, validation, and writing (review and editing). The author Ricardo Ramalhete Moreira was responsible for conceptualization, formal analysis, methodology, supervision, validation, and writing (review and editing). All authors read and approved the final manuscript.

Funding

This study was financed in part by the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – Finance Code 001 and by the National Council for Scientific and Technological Development (CNPq).

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Redfame Publishing.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding authors. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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Notes

Note 1. Perception of corruption levels in the public sector, measured on a scale from 0 (highly corrupt) to 100 (absence of corruption).

Note 2. For a broader overview of the debate and evidence, see Xu (2016).

Note 3. Even when expanding the possibilities for selecting studies, including those carried out at the industry level (Faruq, Webb & Yi, 2013; Amin & Ulku, 2019; Lu, Zhang & Meng, 2021; Demir, Hu, Liu & Shen, 2022), the inverse relationship between corruption and TFP continues to persist, although the number of works remains small.

Note 4. The studies conducted by Klein and Luu (2003), Krammer (2015), Alexandre et al. (2022), and Henri and Mveng (2024) provide insights into the direct impact of economic freedom on aggregate productivity. Except for the study by Krammer (2015), which identified a negative moderating relationship of economic freedom in transition economies, the others support the hypothesis that fewer restrictions on economic freedom are associated with productivity gains.

Note 5. Angola, Argentina, Armenia, Australia, Austria, Bahrain, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Ivory Coast, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Estonia, Eswatini, Fiji, Finland, France, Gabon, Germany, Greece, Guatemala, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, South Korea, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Latvia, Lesotho, Lithuania, Luxembourg, Macau, Malaysia, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Namibia, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, United Kingdom, USA, Uruguay, Zambia, Zimbabwe.

Note 6. For a methodological discussion of these indicators, see Kaufmann, Kraay & Mastruzzi (2010, 2011).

Note 7. Isaksson (2007) provides an extensive review of the determinants of TFP from micro, sectoral, and macro studies.

Note 8. Roodman (2009a) warns that when the Hansen test returns a perfect p-value of 1.00, this is a classic sign of instrument proliferation, which weakens its ability to test the joint validity of the instruments.

Note 9. Due to space constraints and the lack of statistical significance in most control variables, these variables were omitted from the tables and are discussed throughout the text.