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Taxation, Corruption and Economic Growth: A Causality Analysis of Developed and Developing Countries

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Abstract

This study aimed to examine the impact of corruption on the relationship between taxation and economic growth. It sought to determine whether corruption acts as a moderating factor that disrupts the positive association between taxation and economic growth rate. To achieve these objectives, the study employed panel data for the year 1985-2016 of developed and developing countries. Additionally, the study employed causal analysis techniques to establish a deeper understanding of the causal relationships between taxation, corruption, and economic growth. This was followed by estimating a co-integration regression using the Dynamic Ordinary Least Squares (DOLS) method. The empirical results of DOLS show that taxation and corruption both are lubricating the wheel of economic growth for developed while for developing countries taxation is stimulating growth, but corruption sands the wheel of growth. Similarly, the indirect effect of taxation through the channel of corruption is also negative for both samples. Likewise, the impact of the square term of taxation is also negative. The VECM Granger causality test shows that bidirectional causality exists between all variables in the long run. During the causality analysis, it was found that in developing nations, there is unidirectional causality from economic growth rate to tax revenues and from corruption to taxation. In developed countries, unidirectional causality was observed from corruption to tax revenues. However, bidirectional feedback exists between economic growth rate and corruption in developing countries, and bidirectional causality exists between taxation, economic growth rate, and corruption in developed countries. The study also suggests policy implications based on these empirical findings to improve the situation of these factors.

Keywords: Taxation Corruption, Growth, Co-Integration

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1. Introduction

The economic growth of a state brings social, economic, and demographic development in the form of better living standards. It increases investment opportunities, inventions, and innovations in the process of production, improves human capital, and decreases unemployment and poverty (Myles, 2009). The important function to maximize welfare is public expenditure and to finance these expenditures, taxes are a vital source of earnings. Tax, a tool of fiscal policy, is a source for the collection of revenues from the public to finance public expenditures and stabilize the economy by keeping stable prices and eliminating negative externalities. The revenue generation capacity is measured through taxes and these taxes play a vital role in regulating the level and steps of economic expansion in countries worldwide (Maharjan, 2012).

Contrary, corruption is generally termed as misuse of the public offices to enlarge private advantages. It is a soundly admitted statement that corruption impedes the smooth working of the economy. Mauro (1995) put prior effort to explore the consequence of corruption on economic growth. He concluded that corruption slows down the phase of growth through decreasing investment. Besides, it reduces the incentive to work, decreases investment (i.e., domestic and foreign), and diverges the distribution of the budget from productive projects to rent-seeking actions (Shleifer and Vishny, 1993). Corruption is a pervasive and unfavorable phenomenon that casts a dark shadow over developed and developing countries collectively. In the context of developing countries, it becomes a curse, creating severe obstacles to their growth trajectory and overall development. It infiltrates various aspects of society and wreaks havoc with the country's tax structure, leading to significant consequences. Tax evasion and other illicit practices driven by corruption not only drain the financial resources of the nation but also erode the trust and integrity of the tax system. (Richupan, 1984).

In recent periods, a growing body of research has been focused on examining the impact of fiscal policy variables on economic growth. However, studies have consistently revealed a significant challenge: the efficiency of fiscal policy, particularly taxation, as a driver of economic growth is limited in both developing and developed countries. Identifying the key factor behind this limitation, this study highlights corruption’s role critically in disrupting the relationship between taxation and economic growth. In addition to investigating the association between corruption and taxation, the study aims to explore how corruption, in combination with other important determinants of economic growth, affects the relationship between taxation and economic growth. By delving into these complexities, the study aims a comprehensive understanding's provision of the intricate dynamics at play in shaping the relationship between taxation, corruption, and economic growth.

This paper is structured as follows for the remaining portions: Section 2 offers a brief literature review; a discussion of theoretical frameworks in Section 3; a description of the research method in Section 4; specification and model estimation in Section 5; and a conclusion of the paper is in Section 6.

2. Literature Review

Literature has been developed over the last decades that explain the linkage between taxation, corruption and economic growth. the existing literature has an extensive debate about the impact of both taxes and corruption on growth separately. Whereas few studies examine the combined effect on growth through tax and corruption. The given literature, which investigated the association between taxation, corruption, and economic growth revealed different results concerning different countries and economic conditions.

Taxation is noted as the instrument of economic growth and concluded that corporate income tax and value-added tax stimulate the wheel of economic growth. Chigbu et al., (2012) established the causality direction among taxation and economic growth and concluded that it is a growth-enhancing tool of fiscal policy. Similarly, Chokri et al., (2018) determined the rate of optimal tax burden by deploying Scully's static and quadratic model. As an example, Atif et al., (2012) studied the association among fiscal and financial factors, growth of investment, and economic growth in Pakistan by applying ordinary least squares (OLS) and Johansen Co-integration tests. The study concluded that the direct effect of taxes on economic growth is not significant but the indirect effect through the channel of investment is statistically significant while this effect is negative. Debates on corruption have fascinated enormous importance particularly, after 1990, with the initial work done by (Shleifer and Vishny, 1993; Mauro, 1995).

Corruption may disturb the economy in many ways, and it is very significant to recognize the mechanisms involved in the process. Several studies have considered a common conclusion that corruption harmfully disturbs the growth rate (Piplica and Covo, 2017). Likewise, some scholars found a nonlinear relationship and argued that in nations that have improved levels of institutional quality, corruption is growth inhibitory while in the states which have comparatively low institutional quality and a medium level of corruption, corruption seems to exert an encouraging significant impact on growth rate (Mallik and Saha, 2016). It seems that corruption is not always a hurdle to the economic growth rate.

Aghion et al., (2016) utilized panel data from developed and developing countries, spanning several years, to analyze the causal relationships among these variables. Their empirical findings highlight the negative impact of corruption on the efficiency of public expenditure utilization and its consequences for economic growth. Moreover, the study explored the bidirectional causality between the rate of economic growth and corruption in developing economies and the bidirectional causality among taxation, economic growth rate, and corruption in developed economies. Furthermore, Fisman and Svensson (2007) revealed a strong and significant negative correlation between rates of bribery and short-term growth among Ugandan firms. Surprisingly, the detrimental impact of bribery on growth is found to be even more pronounced compared to the inhibiting effect of taxation. This suggests that addressing corruption is crucial for fostering business growth and economic development in Uganda.

These studies suggest that there are four important roots through which corruption leads to the inadequate distribution of government revenues. The first one is by lowering the revenues, the government investment in basic infrastructure (i.e., roads, health, and education) will decline. The second root is corruption enlarged the size of tax distortions and becomes more harmful to growth than the tax itself. Thirdly, agents of private companies seek to benefit more from corruption, and tax evasion has become a common practice. Corruption distorts the composition of government spending. It also strengthens the inverse effect of military burden for economic growth and corruption with taxation exerting a negative effect on TFP.

Empirical studies have highlighted the detrimental effects of corruption on the efficiency of public expenditure utilization (Dzhumashev, 2014), underscoring its significant impact on economic growth. Notably, Hodge et al., (2011) conducted pioneering research that revealed how corruption can stimulate economic growth through reducing expenditures across 81 countries. This study shed light on the role of corruption in the relationship between public expenditure and growth. Furthermore, d'Agostino et al., (2016) conducted a comprehensive analysis spanning 106 countries and found a strong association between corruption and growth. Their findings underscore the close connection between corruption and economic growth on a global scale.

Furthermore, a study by Zeeshan et al., (2022) showed the short- and long-term effects of political unrest and the availability of natural resources on GDP. They discovered that whereas political unrest has a negative impact on GDP growth, natural resources have a beneficial impact. It's interesting to note that corruption has been found to boost GDP temporarily but depress it over the long term. The study also emphasized asymmetric findings, showing that while GDP decreases when corruption rises, it increases when corruption falls. These findings were reinforced by causal analysis, which also emphasized the necessity for strategies to combat rent-seeking and patronage behavior in order to foster a clearer atmosphere across the nation.

Based on Ugur (2014), corruption can have negative indirect consequences for economic growth with its effect on public finances and human capital in nations with low incomes and ineffective bureaucratic institutions. This shows that corruption impedes the distribution and use of resources, impeding the advancement of these countries' economies. According to Alfada (2019), corruption can also affect how taxes are collected and how the government spends its money. However, Ali and Solarin (2020) report opposing data, showing that nations with higher degrees of corruption typically devote more resources to military spending. This demonstrates the intricate ways in which corruption affects government expenditure priorities and emphasizes the necessity for all-encompassing policy solutions to lessen its detrimental effects on economic growth.

Beyond its effects on economic growth, corruption has far-reaching effects. It reduces the effectiveness of both the corporate and public sectors through enabling individuals to obtain positions of responsibility without the required training and credentials. This harm the overall functioning of these sectors by creating a compromised worker and a lack of meritocracy. Empirical data reveals a weak or negative relationship between EG and corruption in the OIC (Erum and Hussain, 2019). The possibility for the area to experience robust and long-lasting economic growth is hampered by the presence of rampant corruption (Malanski and Póvoa, 2021). In order to create an atmosphere that encourages accountability, fairness, and efficiency in both the public and commercial sectors and, ultimately, supports long-run economic growth and prosperity, it is essential to address corruption (Ramoni-Perazzi and Romero, 2022).

The impact of corruption on EG is vulnerable to conflicting theoretical projections. The hypothesis "grease the wheels" claims that corruption can help EG (economic growth), although it also contends that corruption slows growth.

However, empirical research typically indicates that corruption has a negative effect on economic growth (Gründler and Potrafke, 2019). Thereby, developing nations may embrace tactics that prioritize EG and temporarily overlook corruption as a strategy to foster financial development. In contrast, industrialized countries may need to investigate alternate channels and techniques to support financial development, noting the possible dangers and obstacles connected with corruption (Song et al., 2021).

Similarly, according to our knowledge based on a review of existing literature, no sole research work found in the existing literature that tries to explore the association between tax revenues, economic growth, and corruption by employing a sample of both developed as well as developing economies. The current study is prior in a sense of comparing the differences in important variables that determine economic growth inside developed and developing economies.

3. Theoretical Framework

Firstly, the study considers the hypothesis "grease the wheels", which suggests that corruption can "grease" the wheels of the economy by facilitating economic transactions and reducing bureaucratic inefficiencies. This hypothesis implies that corruption may have a significant impact on economic growth. But on the other side, the study also examines the hypothesis "sand the wheels", which argues that corruption may "sand" the wheels of the economy by distorting resource allocation, undermining institutions, and discouraging productive activities. According to the hypothesis above, corruption might have a negative impact on EG (Economic Growth).

In order to examine these hypotheses, the study draws on the empirical literature already in existence, which usually supports the notion that corruption has a detrimental/negative impact on EG. The theoretical framework takes note of this empirical data and seeks to examine it deeper into the causal links between corruption, taxation, and EG. Additionally, the theoretical framework considers the role of taxation in this context. Taxation is recognized as a crucial policy instrument for government revenue generation and public expenditure allocation. The study examines how taxation interacts with corruption and its effect on economic growth. It acknowledges that corruption may impact how taxes are collected and how government spending is distributed, further influencing economic growth outcomes. Furthermore, taxation is a way to support the government (Smith, 1776) and capital tax claimed as a part of the factor of production is necessary to finance public spending. Similarly, economists presented there are different theories presented by different economists regarding taxation and optimal taxation rate which led to increased economic growth.

The benefit theory says that the amount of tax should be according to the benefits a person enjoys from government activities (Cooper, 1994). While this theory has been criticized because it is not possible to estimate exactly the number of benefits that everyone is getting from the state. Similarly, in the case of defense spending, it is impossible to exclude non-taxpayers. On the other hand, cost of service theory suggests that individuals should be taxed by an equal amount of the cost that the government is bearing to provide public goods and services. The tax rate has different effects on revenues as arithmetic effects and economic effects. The economic effect identifies a lower tax rate provides an incentive to raise economic activities, output, and employment. While, if the tax rate is too high, the inverse economic effect overweights the direct arithmetic effect hence, the overall public income of a country declines (Islahi, 2015).

The optimum tax theory (Mirrlees, 1971) suggested a tax rate that maximizes the state revenue, minimized the tax distortion, and encourages the fair distribution of income. Furthermore, Wagner (1883) proposed a Socio-Political theory of taxation, which stated that social and political purposes play a major role in the determination of taxes. It is also noticed that the purposes of the tax system should be able to cover and eliminate other issues of society besides providing basic facilities to the citizen.

4. Research Methodology

4.1. Model Specification and Data

The study expanded the neoclassical Cobb-Douglas production function with the inclusion of taxation, corruption, and a set of some other control variables. Through this, we observe the consequence of every variable for the determination of the GDP growth rate. Furthermore, the study follows the Aghion et al., (2016) model to specify our main growth equation. The author considered the growth model as a function of taxation and corruption while taxation with the square term is used to capture non-linear impacts. In this study, the production function with appropriate functional form is written as.

$$Y_t = f(tax_t, tax_t^2, cor_t, tax_t.cor_t, tax_t^2.cor_t, X_t) \quad (1)$$

$$Y_t = tax_t^{\alpha_2}, tax_t^{2^{\alpha_3}}, cor_t^{\alpha_4}, tax_t.cor_t^{\alpha_5}, tax_t^2.cor_t^{\alpha_6}, X_t^{\alpha_k} \quad (2)$$

After taking the natural logarithm and one-year lag of left side of the above equation and by including the country period and fixed effect. Our econometric will be written as.

$$Y_{it} = \alpha_1 + \alpha_2 \ln(tax_{i,t-1}) + \alpha_3 \ln(tax_{i,t-1})^2 + \alpha_4 \ln(cor_{i,t-1}) + \alpha_5 \ln(tax_{i,t-1}).\ln(cor_{i,t-1}) + \alpha_6 \ln(tax_{i,t-1})^2.\ln(cor_{i,t-1}) + \sum \alpha_k X_{k,t-1} + \eta s + \varphi_t + \mu_{it} \quad (3)$$

Where, Y_{it} represents per capita economic growth rate, tax revenues represented by *tax* and corruption is measured through *cor*. The variables, economic growth, tax, and corruption are the primary interest of the study. Similarly, coefficients α_5 and α_6 are linked to the interaction effects of taxation and corruption in the determination of economic growth.

Similarly, the non-linear relationship capture with the square term of tax and this square term highlights the presence of inverted-U shape association among corruption, taxation, and economic growth. Further, ηs and φ_t are country and period fixed effects respectively, μ_t represents error term of the model and it is assumed to be distributed as normal.

Many other demographic and institutional factors are also exerting greater influence on economic growth and this study also add some important variables (such as human capital, trade openness, initial GDP, population growth rate, investment, and government spending) *in the model following some empirical studies*[4]. *Where,* $X_{k,t-1}$ *is the vector* of k^{th} explanatory variables and α_k represents the coefficients of these variables.

The study employs two separate panel datasets, Panel-A and Panel-B, to ensure the robustness and reliability of the research findings. Panel-A consists of annual data from 1984 to 2016 for 29 developed countries, while Panel-B includes annual data for the same time period covering 80 developing countries. This comprehensive approach enables the study to capture the diverse economic and institutional contexts across various countries, providing a more thorough analysis of the relationship among corruption, taxation, and economic growth. By utilizing these distinct datasets, the study enhances the credibility and validity of its conclusions, allowing for a more nuanced understanding of the dynamics at play in different country groups. According to the World Bank's definition, developed and developing countries are categorized in this study based on their per capita income.

4 Levine and Renelt (1992), Attila (2008).

The appendix specially Table 1 (Appendix), which contains the list of chosen countries for each category.

All of the variables were taken from the World Bank Development Indicators (WDI) in order to get the required study data. However, the International Country Risk Guide (ICRG) is employed as a source of data for determining the level of corruption. The study ensures the consistency and dependability of the data used for analysis by relying on these reliable sources.

4.2. Estimation Method

The empirical technique of the study is structured in four distinct sections, each relying upon the one preceding it, in order to thoroughly analyze the relationship concerning corruption, taxation, and EG (Economic Growth). Panel unit root tests are first used to determine whether the variables are stationary. The data utilized in the study must be trustworthy and appropriate for further research, which is why this phase is so important. The study verifies that the variables reflect static behavior across time, which is necessary for proper inference in statistics, by using panel unit root tests.

Co-integration tests are conducted in the second phase to determine whether the variables possess a long-term relationship with one another. The examination of the long-run patterns of the variables is made possible by co-integration tests, which are crucial in taking the relationship of equilibrium within the variables. Popular co-integration tests, including the Pedroni (1999, 2001, 2004), Johansen (1995), and Kao (1999) tests, are used in this work. These tests offer solid insights into whether taxation, corruption, and economic growth have a stable, long-term relationship. The third stage entails calculating long-run vector co-integration using the DOLS (Dynamic Ordinary Least Square) technique. This estimation method has been specifically designed to manage the variables' probable endogeneity and dynamic character. By using DOLS, the study may account for any lag effects along with other dynamic aspects while capturing the link between the variables over the long term.

The Panel Granger causality test is then used to examine the direction of causation within the variables. This test helps to determine whether one variable has a significant effect on another variable, providing insights into the causal relationships among corruption, taxation, and economic growth. By checking the causality among these variables, the study aims to uncover the underlying mechanisms and shed light on the direction of influence. By following this systematic empirical strategy, the study aims to strengthen its argument and comprehensive analysis of the interconnections between corruption, taxation, and economic growth is provided. These rigorous analytical steps enhance the reliability and validity of the study's findings, contributing to a more robust understanding of the relationships among these key factors.

i. Panel Unit Root Test

With the formative effort of Levine and Renelt (1992), the study of the unit-root becomes a vital part of the practical investigations of non-stationary panel data sets. According to Baltagi et al., (2008), non-stationary econometric panels seeks combining of both characteristics: (i) the dealing of non-stationary time series data method (ii) Increased data and power from the cross-section. This study uses the augmented dickey fuller (ADF), and Im, Pesaran, and Shin (2003) panel unit root tests. The Im et.al., (2013) test suggests a flexible and simple unit root method. The econometric form of this panel unit root test is written as.

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{i,t-1} + \sum_{i=1}^{N} \alpha_{ij} \, \Delta y_{it-j} + \epsilon_{it} \quad (4)$$

Here, i=1, 2, 3...N, t=1, 2, 3…T and null hypothesis can be stated as:

$H_0 : \beta_i = 0$ for all i and alternate hypothesis

$H_1 : \beta_i < 0$ for i= 1, 2, 3...N_1 $\beta_i = 0$ for all i, with $0 < N_1 \leq N$.

The null hypothesis describes each time series as non-stationary whereas, the alternate hypothesis tells that some (not all) individual series have a unit root. For robustness check of IPS test empirical results, the study employs Fisher type test. It was presented by Maddala, and Wu (1999):

$$P = -2 \sum_{i=1}^{N} ln p_i \quad (5)$$

In this test, the individual p-values are combined with every panel cross-section for performing the unit root test. Null and alternative hypotheses for the ADF unit root test and IPS unit root test are identical.

ii. Panel Co-integration Test

In further steps, after the confirmation with regard to the unit root existence, it becomes necessary to explore the presence of co-integrating between the variables. For this purpose, like panel unit root tests, the study uses different types of estimation methods. In the first set, the panel co-integration development of Pedroni (1999) is used and the second set used is proposed by Kao (1999) which is Engle and Granger's (1987) residual-based test with two stages. Such tests are constructed from residuals which are taken from the estimation of the following equation,

$$\Delta Y_{it} = \alpha_i + \beta_{it} + \sum_{j=1}^{q} \alpha_{ji} X_{ji,t} + \mu_{it} \tag{6}$$

Where, Y_{it} and $X_{ji,t}$ is supposed to be stationary at first difference. Similarly, the coefficient α_i is an individual intercept for countries and β_{it} represents the countries' trend. Both α_i and β_{it}varies in each cross-section and μ_{it} is the residual term. As discussed earlier, the Pedroni (1999, 2004) test consists of seven statistics. Out of seven, four tests be determined by the within-dimension approach, rest of the three be determined by the between-dimension approach.

Within dimension approach contains panels of the v-statistic panel (Y_v), rho-statistic (Y_r), PP-statistic (Y_{pp}), and ADF-statistic (Y_{ADF}). Contrary to the first approach, in the second approach merely an average of the separately assessed coefficients is taken for every cross-section. Likewise, between dimensions contains a group of rho-statistic $\bar{Y}_r$, PP-statistic $\bar{Y}_{pp}$, and ADF statistic $\bar{Y}_{ADF}$.

Both of the above approaches have the same null hypothesis while the alternate hypothesis is different for both, and these approaches were designed with the purpose of testing the null hypothesis '*nonexistence of cointegration'* that refers to the absence of a long-term relationship;

$H_0: \beta_i = 1$ *for all i*

By using within dimension approach, the alternate hypothesis is.

$H_1: \beta_i = \beta < 1$ *for all i*

By using between-dimension approaches, the alternate hypothesis is.

$H_1: \beta_i < 1$ *for all i*

The study also uses Kao's (1999) test of co-integration for the robustness of the findings. The Kao (1999) test is the expanded form of the Dickey-Fuller (*DF*) and *ADF* tests. The following equation is proposed for the DF test.

$$Y_{it} = \beta_i + \alpha Z_{it} + \varepsilon_{it} \tag{7}$$

Where $Y_{it} = Y_{it-1} + \mu_{it}$ and $X_i = X_{it-1} + \varepsilon_{it}$. Similarly, Y_{it} and X_{it} denotes random walks. With the nonexistence of a long-run relationship for the null hypothesis, the error term is assumed to contain a unit root. Moreover, Dickey-Fuller regression is characterized by intercept variation but the same slope for all cross-sections and fixed-effect model specifications. Following estimated residual equation can be deployed to estimate Dickey-Fuller (DF).

$$\tilde{e}_{it} = \rho\tilde{e}_{it-1} + v_{it} \quad (8)$$

Where, $\tilde{e}_{it} = \tilde{y}_{it-1} - \beta\tilde{z}_{it}$ and $\tilde{y}_{it-1} = \tilde{y}_{it} - \tilde{y}_i$, in the case of ADF, equation (7) becomes.

$$\tilde{e}_{it} = \rho\tilde{e}_{it-1} + \sum_{j=1}^{q} \alpha_{ji}\Delta\tilde{e}_{it-j} + v_{itp} \quad (9)$$

Where $\tilde{e}_{it}$ represents the estimated residuals and ρ describes the lag length for the ADF test. While the null and alternate hypotheses in Kao (1999) test and the Pedroni (1999, 2004) co-integration test are the same.

iii. Panel DOLS Estimation

In the next step, after confirmation of co-integrating among all variables, the panel co-integration model will be estimated. It can measure by using the OLS, DOLS, and FMOLS (Fully Modified Ordinary Least Square) methods. Where the OLS will not produce an unbiased estimator and valid inference also cannot be drawn. This issue will be resolved by employing FMOLS developed by Pedroni (2001). FMOLS will also address the issue regarding serial correlation and simultaneous biasedness, but it produces efficient results with a small sample size (Maeso-Fernandez et.al, 2006).

Additionally, Kao and Chiang (2001) suggested the DOLS method to estimate the coefficients of co-integration. In opposition to FMOLS, DOLS approximation is entirely parametric, has convenient computation, and is better to use with a large sample size. While both FMOLS and DOLS resolve the endogeneity issue, yield reliable and efficient results.

iv. Granger Causality test and VECM

The study uses the two steps Engel and Granger (1987) test for the estimation of the causal connection among the right and left-hand side variables. In the first phase, the long-term affiliation between variables will be estimated, as stated in equation (2). Subsequently, the lagged residuals taken from the above equation (2) will be used as Error Correction Term (ECT_{-1}). The vector error correction models (Appendix B) were estimated for each sample.

5. Results and discussion

i. Panel unit root tests results

The presence of long-run association requires non-stationarity at the level of variables and stationarity at the first difference I (1). So, the results of panel unit root tests of ADF Fisher type and Im, Pesaran, and Shin (2003) for each variable are presented in Table B (Appendix) for developed and developing nations. The null hypothesis of the ADF Fisher type and Im, Pesaran, and Shin (2003) test is stated that variables have unit root and unit root results (Table B) revealing that the null hypothesis is not rejected at a level for all variables. While we can accept the alternate hypothesis and reject the null hypothesis (variables have no unit root at first difference).

ii. Panel co-integration tests results

Pedroni's (1999, 2001, 2004) co-integration test and Kao’s (1999) residual co-integration tests are applied to confirm the long-run association (Table 1). For both tests, the null hypothesis is the nonexistence of co-integration, and the alternate hypothesis is the existence of co-integration.

Table 1 Pedroni Panel Co-integration test results

Developed countries Panel-A											
	Within-Dimension				Within-Dimension (Weighted)				Between-Dimension		
Series	Panel v-stat.	Panel rho-stat.	Panel pp-stat.	Panel ADF stat.	Panel v-stat.	Panel rho-stat.	Panel pp-stat.	Panel ADF stat.	Group rho-stat.	Group pp-stat.	Group ADF-stat.
Growth rate of GDP, ln(Tax t-1), ln(cor t-1) , ln(Tax t-1) . ln(cor t-1)	-2.23 (0.98)	-3.34 (0.00)*	-8.4 (0.00)*	-7.8 (0.00)*	-3.6 (0.99)	-3.46 (0.00)*	-10.46 (0.00)*	-10.04 (0.00)*	-0.78 (0.21)	-13.38 (0.00)*	-9.6 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1). ln(cor t-1), {ln(Tax t-1)}2, {ln(Tax)t-1}2.ln(cor t-1)	-3.46 (0.97)	1.34 (0.00)*	-5.96 (0.00)*	-5.32 (0.00)*	-5.23 (0.99)	1.39 (0.00)*	-8.69 (0.00)*	-7.77 (0.00)*	3.73 (0.04)*	-10.57 (0.00)*	-6.14 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1). ln(cor t-1), ln(Govt) t-1, ln(Tr t-1), ln(Inv t-1)	-1.94 (0.97)	3.27 (0.97)	-7.09 (0.00)*	-6.68 (0.00)*	-4.33 (1.00)	4.42 (0.01)*	-7.11 (0.00)*	-6.4 (0.00)*	5.8 (0.01)*	-12.28 (0.00)*	-6.22 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1).ln(cor t-1), ln(Pop t-1), ln(Secondary t-1), Initial GDP	1.25 (0.10)	0.53 (0.70)	-2.89 (0.00)*	-1.69 (0.04)*	1.62 (0.00)*	1.06 (0.85)	-3.63 (0.00)*	-3.04 (0.00)*	1.84 (0.96)	-8.34 (0.00)*	-3.52 (0.00)*
Developing countries Panel-B											
	Within-Dimension				Within-Dimension (Weighted)				Between-Dimension		
Series	Panel v-stat.	Panel rho-stat.	Panel pp-stat.	Panel ADF stat.	Panel v-stat.	Panel rho-stat.	Panel pp-stat.	Panel ADF stat.	Group rho-stat.	Group pp-stat.	Group ADF-stat.
Growth rate of GDP, ln(Tax t-1), ln(cor t-1) , ln(Tax t-1) . ln(cor t-1)	1.57 (0.05)**	-5.48 (0.00)*	-13.85 (0.00)*	-5.68 (0.00)*	-2.51 (0.94)	-5.53 (0.00)*	-14.57 (0.00)*	-8.06 (0.00)*	-0.94 (0.17)	-21.3 (0.00)*	-6.9 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1). ln(cor t-1), {ln(Tax t-1)}2, {ln(Tax)t-1}2.ln(cor t-1)	-2.96 (0.99)	1.003 (0.84)	-9.86 (0.00)*	-3.85 (0.00)*	-7.45 (1.00)	2.74 (0.95)	-3.23 (0.00)*	1.35 (0.01)*	5.6 (0.12)	-15.38 (0.00)*	-3.88 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1), ln(cor t-1), ln(Govt) t-1, ln(Tr t-1), ln(Inv t-1)	-1.48 (0.93)	2.53 (0.94)	-13.22 (0.00)*	-2.98 (0.001)*	-6.22 (1.00)	2.93 (0.99)	-12.36 (0.00)*	-3.76 (0.001)*	7.48 (1.00)	-21.4 (0.00)*	-3.92 (0.00)*
ln(Tax t-1), ln(cor t-1), ln(Tax t-1).ln(cor t-1), ln(Pop t-1), ln(Secondary t-1), Initial GDP	0.58 (0.27)	0.7 (0.75)	-2.99 (0.00)*	-0.14 (0.44)	0.85 (0.19)	1.003 (0.84)	-4.7 (0.00)*	-1.61 (0.05)**	1.87 (0.96)	-9.41 (0.00)*	-1.85 (0.03)*

Note: * and ** denote the significance levels of 1% and 5% respectively.

The above table reports the consequences of Pedroni's (1999, 2001, 2004) panel co-integration tests of developed states group, and it is based on seven statistics, as discussed earlier. The results show that all tests' statistics confirm the presence of long-term co-integration between economic growth, taxation, and corruption together with other control variables of the model for the developed countries group. Similarly, the following Table 2 represents the results of Kao's (1999) residual co-integration tests, and the results indicate the existence of co-integration for each series of developed and developing countries.

Table 2. Kao Residual Cointegration test results

Series	t-statistic	Prob	Residual Variance	Hac. Variance
Developed countries Panel-A				
Growth rate of GDP, ln(Tax t-1), ln(cor t-1) , ln(Tax t-1) . ln(cor t-1)	-13.68	(0.00)*	0.001	0.00009
ln(Tax t-1), ln(cor t-1), ln(Tax t-1). ln(cor t-1), {ln(Tax t-1)}2, {ln(Tax)t-1}2.ln(cor t-1)	-10.71	(0.00)*	0.0012	0.0007
ln(Tax t-1), ln(cor t-1), ln(Tax t-1), ln(cor t-1), ln(Govt) t-1, ln(Tr t-1), ln(Inv t-1)	-9.97	(0.00)*	0.0009	0.00005
ln(Tax t-1), ln(cor t-1), ln(Tax t-1).ln(cor t-1), ln(Pop t-1), ln(Secondary t-1), Initial GDP	-8.92	(0.00)*	0.001	0.00006
Developing countries Panel-B				
Growth rate of GDP, ln(Tax t-1), ln(cor t-1) , ln(Tax t-1) . ln(cor t-1)	-9.92	(0.00)*	0.002	0.001
ln(Tax t-1), ln(cor t-1), ln(Tax t-1). ln(cor t-1), {ln(Tax t-1)}2, {ln(Tax)t-1}2.ln(cor t-1)	-11.8	(0.00)*	0.002	0.001
ln(Tax t-1), ln(cor t-1), ln(Tax t-1), ln(cor t-1), ln(Govt) t-1, ln(Tr t-1), ln(Inv t-1)	-9.18	(0.00)*	0.002	0.001
ln(Tax t-1), ln(cor t-1), ln(Tax t-1).ln(cor t-1), ln(Pop t-1), ln(Secondary t-1), Initial GDP	-11.61	(0.00)*	0.0001	0.0001

Note: * denotes the significance levels of 1%.

a. Long Run Dynamics

i. Dynamic Ordinary Least Square (DOLS)

Long-run changing aspects among variables are estimated by using the DOLS test and these results are shown in the following Table 3 both for developed and developing countries. The first columns in Table 3 show the estimates calculated from the basic model with regressors, taxation, corruption, and the interaction term of taxation and corruption. The results from the model with a square term of taxation and interaction term of taxation square with corruption are presented in the second column (Table 3) to capture nonlinear effects. Investment, government spending, and trade openness are added in column 3 (Table 3) and population growth, initial GDP, and secondary education (a proxy for human capital) are added in column 4 (Table 3). Furthermore, the sequence of variables in columns 1, 2, and 3 is the same both for developing and developed countries.

ii. Developed Countries

The results of developed countries are reported in panel-A of the table in the following Table 3. In column 1, the tax revenue employs an encouraging and substantial impact on economic growth and these findings are consistent with Aghion et al., (2016). The presented numeric states that growth will rise by 7% as tax revenues increase by 1%, other things being equal. Furthermore, the result shows that if the corruption index increases by 1 unit, the economy expanded by 0.3%. While the corruption coefficient is significant with a small value (0.003), it is clear that tax revenue is the most important determinant instead of corruption for boosting the economic growth of developed economies.

The coefficient of an interactive term (tax revenue and corruption) is negative and significant at a 5% level. So, the negative value of interactive terms shows the negative effect of taxation on economic growth when corruption is prevailing in the country. Surprisingly, the positive direct impact of corruption means that government financing through other sources except taxation has proven to be more effectively utilized when bribery payments are taken.

In column 2 of Table 3, the square term of taxation was added individually as well as interacted with corruption. Again, taxation has positively related to growth while the square term of taxation has a negative coefficient value, and it clarifies that as taxation increases it leads to falling in growth rate which is supported by the inverted-U shape hypothesis. Furthermore, some control variables are also added (column 3 and 4) to check the robustness of the model, and the inclusion of these variables do not erode the association between taxation, corruption, and economic growth.

iii. Developing Countries

The results of DOLS for emerging countries are presented in Table 3, clearly mention header with developing countries panel-B. As predicted in previous literature, the coefficient value of taxation indicates that a 1% rise in tax revenue will stimulate economic growth by 9% while economic growth reduces by 17% as corruption is optimized by one unit. So, in emerging economies, corruption has a positive influence on taxation on economic growth.

Table 3. Dynamic Ordinary Least Square (DOLS) test results

	Dependent Variable: Per Capita GDP Growth Rate							
	Developed countries Panel-A				Developing countries Panel-B			
Variables	Model.1	Model.2	Model.3	Model.4	Model.1	Model.2	Model.3	Model.4
Constant	0.03 0.25	0.001 (0.00)*	0.09 (0.05)***	0.19 (0.02)**	0.09 (0.01)**	0.09 (0.08)***	0.11 (0.00)*	0.14 (0.00)*
$\ln{(tax)}_{t-1}$	0.07 (0.01)**	0.19 (0.00)*	0.04 (0.00)**	0.35 (0.00)*	0.09 (0.00)*	0.20 (0.00)*	0.05 (0.00)*	0.02 (0.02)**
$\ln{(cor)}_{t-1}$	0.003 (0.00)*	0.015 (0.02)**	0.001 (0.00)*	0.003 (0.00)*	-0.17 (0.00)*	-0.30 (0.04)**	-0.15 (0.00)*	-0.18 (0.00)*
$\ln{(tax)}_{t-1}.\ln{(cor)}_{t-1}$	-0.02 (0.03)**	-0.07 (0.03)**	-0.03 (0.00)*	-0.06 (0.03)**	-0.06 (0.00)*	-0.15 (0.00)*	-0.05 (0.00)*	0.08 (0.00)*
$\ln{(tax)}_{t-1}^{2}$		-0.01 (0.04)**				-0.07 (0.00)*		
$\ln{(tax)}_{t-1}^{2}.\ln{(cor)}_{t-1}$		-0.03 (0.04)**				-0.09 (0.04*)*		
$\ln{(pop)}_{t-1}$				-0.21 (0.01)**				0.01 (0.00)*
$\ln{(govt)}_{t-1}$			0.01 (0.00)*				0.03 (0.00)*	
$\ln{(secondary)}_{t-1}$				0.01 (0.00)*				0.07 (0.00)*
$\ln{(tr)}_{t-1}$			0.008 0.56				0.007 (0.00)*	
$\ln{(Inv)}_{t-1}$			0.01 (0.00)*				0.001 (0.00)*	
Initial GDP				-0.002 (0.01)**				-0.53 (0.00)*
Observations	1280	1280	1280	1280	2240	2240	2240	2240
$R-Squared$	0.65	0.80	0.73	0.99	0.53	0.71	0.85	0.99

Note: * and ** denote the significance levels of 1% and 5% respectively.

Furthermore, an interaction term (Taxation and corruption) is significant and negative. It indicates, in the presence of corrupt administration (corruption), a 1% increase in taxation leads to a 6% fall in economic growth. Corruption is reducing tax revenue and in turn, seriously hurting the economic growth of developing countries. Likewise, column 6 (Table 3) shows that a 1% increase in tax revenues will boost 20% economic growth while the rise of one unit in corruption will reduce economic growth by 30%. Similarly, as expected, taxation square negative sign which indicates the inverted U shape link between taxation and economic growth. According to the coefficient value of taxation square, a 1% increase in taxation will reduce the economic growth rate by 7%. While the coefficient value of the interaction term of corruption with taxation square indicates that a 1% increase in taxation reduces 9% economic growth.

iv. Comparative Position of Developed and Developing Countries

After discussing the empirical outcomes, the study will compare the scenario of association among taxation, corruption, and economic growth both for developing and developed countries. These empirical results are presented in the following Table 4.

Table 4. Comparative Position of Developed and Developing Countries

Independent Variables	Developed countries Panel-A	Developing countries Panel-B
tax	0.19 (0.00))**	0.20 (0.00) ***
corruption	0.015 (0.02))***	-0.30 (0.04) **
tax. corruption	-0.07 (0.03) **	-0.15 (0.00) ***
tax^2	-0.01 (0.04) **	-0.07 (0.00) ***
tax^2. corruption	-0.03 (0.04) **	-0.09 (0.04) **
observations	1280	2240

Note: *, **, and *** denote the significance levels of 1%, 5%, and 10% respectively.

In the context of developed countries both, taxation, and corruption, are greasing the wheel of economic growth as they act individually. Similarly, the relationship involving corruption and taxation condenses economic growth as explained earlier (Table 3). Whereas corruption has a deleterious impact on economic growth in the case of developing economies.

Taxation plays an inspiring role in growth, but this role becomes worse when corruption distracts the taxation process both in developed and developing countries. While the indirect effect of taxation is negative, it is worst in developing countries. Similarly, higher taxation is harmful both for developed and developing countries because it promotes bad activities like corruption and damages economic growth. While, with higher taxation, corruption becomes more injurious to growth in developing countries.

b. Short Run Dynamics

The estimated summation of coefficients for short-run variations is documented in the following Table 5. These are based on variations in the assessment of the Vector Error Correction Model (VECM) and F-statistics results concerning short-run variations in the explanatory variables. Furthermore, for developing countries, the long-run coefficient of economic growth has a value of -0.69 with a P-value of 0.00, indicating that, it takes less than 2 years to adjust fully if no additional shock has been taken place in respective explanatory variables. Similarly, the corruption coefficient has a value of -0.06 with a 0.08 probability value which depicts that corruption takes more than 16 years to fully adjust if no additional shock has taken place in respective independent variables. Similarly, the coefficient value of taxation (0.03 with a P-value of 0.00) reveals that taxation required almost 33 years to fully adjust with the condition that no other shock will take place in the economy.

While, for developed countries, results are quite different regarding the speed of correction on the way to long-run stability. In these (developed countries), economic growth has -0.04 as a coefficient with 0.00 p-value, which indicates that GDP changes by 4% in a year with the change of explanatory variables and it will take 25 years for full adjustment. Surprisingly, the coefficient value of corruption (-0.70) shows that it takes only 1.42 years to fully adjust if no additional shock has taken place in respective explanatory variables. While the coefficient of taxation has a value of 0.03 with a 0.04 probability value indicating that it takes 33.3 years to fully adjust given that no other shock will exist in developed economies. Similarly, taxation square, the interaction term of corruption and taxation, and corruption with taxation square react to deviancies from long-run stability with 1.51-year, 5.55-year, 1.85-year, and 3.70-year, respectively.

Based on the above discussion, the scenario is very interesting, the adjustment of economic growth, taxation, population growth, human capital, and initial GDP takes significantly less time in the case of developing countries than the time required for the same adjustment in developed countries. In contrast, for developed countries the speed of adjustment of corruption, the interaction term of taxation square with corruption, the interaction of taxation with corruption, government spending, trade openness, and investment is faster than in developing countries.

Table 5-A. Panel causality test results for Developed Countries Panel-A

Dependent Variables	Source of Causation, Short run (independent variables)												Long run ECT
	Δ growth	$\Delta \text{lncor}_{t-1}$	$\Delta \text{lntax}_{t-1}$	$\Delta \text{lntax}^2_{t-1}$	$\Delta \text{lntax}_{t-1}.\Delta \text{lncor}_{t-1}$	$\Delta \text{lntax}^2_{t-1}.\Delta \text{lncor}_{t-1}$	Δ initial GDP	$\Delta \text{lnpop}_{t-1}$	Δlnhc_{t-1}	Δlntr_{t-1}	$\Delta \text{lngovt}_{t-1}$	$\Delta \text{lninv}_{t-1}$	
Δ growth	-	3.78 (0.21)	13.-1 (0.00)*	12.28 (0.00)*	5.18 (0.07)***	4.40 (0.12)	13.01 (0.00)*	3.42 (0.10)	0.72 (0.69)	1.35 (0.50)	4.80 (0.08)***	1.48 (0.47)	-0.07 (0.00)*
$\Delta \text{lncor}_{t-1}$	6.67 (0.03)**	-	0.40 (0.04)**	4.35 (0.00)*	2.86 (0.23)	0.97 (0.05)***	2.39 (0.35)	3.62 (0.16)	0.88 (0.23)	0.08 (0.95)	0.26 (0.87)	0.29 (0.86)	-0.93 (0.07)***
$\Delta \text{lntax}_{t-1}$	5.29 (0.05)***	4.10 (0.01)**	-	0.03 (0.84)	0.71 (0.07)***	0.83 (0.63)	1.08 (0.58)	0.76 (0.68)	0.94 (0.10)	0.10 (0.94)	0.88 (0.64)	0.99 (0.01)**	-0.34 (0.02)**
$\Delta \text{lntax}^2_{t-1}$	5.45 (0.06)***	4.75 (0.09)***	0.03 (0.85)	-	0.06 (0.96)	1.61 (0.44)	1.18 (0.55)	1.18 (0.55)	0.93 (0.13)	0.93 (0.12)	0.78 (0.67)	0.98 (0.03)**	-0.66 (0.04)**
$\Delta \text{lntax}_{t-1}.\Delta \text{lncor}_{t-1}$	2.19 (0.03)**	1.57 (0.45)	0.001 (0.97)	0.12 (0.66)	-	0.81 (0.66)	1.16 (0.55)	0.82 (0.32)	0.99 (0.01)**	0.26 (0.87)	0.92 (0.14)	0.24 (0.88)	-0.41 (0.01)**
$\Delta \text{lntax}^2_{t-1}.\Delta \text{lncor}_{t-1}$	0.74 (0.08)***	2.02 (0.36)	0.003 (0.95)	0.40 (0.53)	0.10 (0.94)	-	1.52 (0.46)	0.81 (0.40)	4.38 (1.00)	0.88 (0.24)	0.96 (0.06)***	0.34 (0.88)	-0.16 (0.04)**
Δ initial GDP	9.81 (0.00)*	3.56 (0.16)	0.03 (0.84)	0.37 (0.54)	7.57 (0.02)**	0.83 (0.35)	-	4.90 (0.08)***	0.41 (0.80)	0.83 (0.61)	1.90 (0.38)	2.84 (0.24)	-0.01 (0.02)**
$\Delta \text{lnpop}_{t-1}$	6.23 (0.04)**	0.59 (0.74)	0.15 (0.68)	10.56 (0.00)*	0.68 (0.71)	0.69 (0.70)	0.32 (0.85)	-	0.88 (0.64)	1.48 (0.47)	2.45 (0.29)	0.32 (0.85)	-0.002 (0.03)**
Δlnhc_{t-1}	1.78 (0.40)	0.98 (0.02)**	0.88 (0.01)**	2.60 (0.13)	0.68 (0.71)	1.67 (0.43)	0.05 (0.97)	5.30 (0.06)***	-	0.48 (0.32)	1.37 (0.50)	0.06 (0.96)	-0.005 (0.00)*
Δlntr_{t-1}	0.78 (0.02)**	0.66 (0.71)	1.54 (0.21)	0.17 (0.67)	2.36 (0.30)	6.62 (0.02)**	0.87 (0.27)	0.96 (0.07)***	1.24 (0.53)	-	6.54 (0.03)**	3.45 (0.17)	-0.001 (0.06)***
$\Delta \text{lngovt}_{t-1}$	7.16 (0.02)**	0.02 (0.98)	0.17 (0.67)	0.10 (0.24)	1.66 (0.43)	1.79 (0.40)	0.62 (0.95)	0.85 (0.30)	0.81 (0.66)	1.86 (0.39)	-	3.45 (0.14)	-0.010 (0.00)*
$\Delta \text{lninv}_{t-1}$	1.63 (0.44)	1.06 (0.58)	0.25 (0.61)	3.21 (0.07)***	1.58 (0.21)	1.54 (0.46)	3.60 (0.16)	6.26 (0.04)***	2.22 (0.32)*	2.07 (0.35)	7.04 (0.02)**	-	-0.19 (0.00)*

Note: *, **, and *** denote the significance levels of 1%, 5%, and 10% respectively.

Table 5-B. Panel causality test results for Developing Countries Panel-B

Dependent Variables	Source of Causation, Short run (independent variables)												Long run
	Δ growth	$\Delta lncor_{t-1}$	$\Delta lntax_{t-1}$	$\Delta lntax^2_{t-1}$	$\Delta lntax_{t-1}.\Delta lncor_{t-1}$	$\Delta lntax^2_{t-1}.\Delta lncor_{t-1}$	Δ initial GDP	$\Delta lnpop_{t-1}$	$\Delta lnhc_{t-1}$	$\Delta lntr_{t-1}$	$\Delta lngovt_{t-1}$	$\Delta lninv_{t-1}$	ECT
Δ growth	-	3.40 (0.06)***	3.46 (0.06)***	2.57 (0.17)	3.87 (0.04)**	2.40 (0.12)	25.90 (0.00)*	2.57 (0.10)	6.50 (0.01)**	3.93 (0.04)**	0.04 (0.94)	12.65 (0.00)*	-0.18 (0.00)*
$\Delta lncor_{t-1}$	0.14 (0.56)	-	0.14 (0.21)	0.009 (0.53)	0.08 (0.30)	0.08 (0.30)	4.06 (0.04)**	2.97 (0.40)	0.006 (0.04)**	-0.001 (0.93)	0.16 (0.32)	0.69 (0.03)**	-0.06 (0.08)***
$\Delta lntax_{t-1}$	3.58 (0.05)***	0.9 (0.02)**	-	1.91 (0.34)	0.71 (0.07)***	1.43 (0.23)	1.06 (0.58)	0.11 (0.73)	0.46 (0.79)	0.50 (0.77	0.50 (0.77)	10.02 (0.00)*	-0.03 (0.00)*
$\Delta lntax^2_{t-1}$	2.50 (0.01)**	1.76 (0.41)	0.44 (0.50)	-	0.06 (0.96)	1.61 (0.20)	1.53 (0.46)	0.46 (0.00)*	0.74 (0.68)	0.009 (0.99)	0.99 (0.00)*	0.56 (0.00)*	-0.23 (0.00)*
$\Delta lntax_{t-1}.\Delta lncor_{t-1}$	2.35 (0.02)**	1.24 (0.53)	0.05 (0.81)	4.15 (0.12)	-	1.68 (0.19)	1.90 (0.38)	3.25 (0.00)*	0.53 (0.76)	0.33 (0.84)	0.33 (0.84)	14.43 (0.00)*	-0.35 (0.00)*
$\Delta lntax^2_{t-1}.\Delta lncor_{t-1}$	3.63 (0.05)***	1.27 (0.52)	-0.013 (0.13)	2.43 (0.29)	0.108 (0.94)	-	1.94 (0.37)	0.10 (0.74)	1.05 (0.58)	0.12 (0.93)	0.12 (0.93)	0.60 (0.00)*	-0.76 (0.01)**
Δ initial GDP	0.73 (0.39)	2.66 (0.27)	0.20 (0.65)	0.87 (0.64)	3.68 (0.15)	0.94 (0.33)	-	2.72 (0.09)***	1.59 (0.45)	0.35 (0.83)	0.35 (0.89)	0.87 (0.00)*	-0.005 (0.00)*
$\Delta lnpop_{t-1}$	0.85 (0.01)**	0.41 (0.81)	0.65 (0.23)	2.91 (0.23)	7.57 (0.02)**	0.002 (0.95)	1.59 (0.44)	-	1.15 (0.56)	0.27 (0.87)	0.27 (0.87)	2.21 (0.32)	-0.005 (0.04)**
$\Delta lnhc_{t-1}$	0.76 (0.00)*	3.28 (0.19)	0.77 (0.37)	0.17 (0.55)	0.68 (0.71)	0.90 (0.34)	11.12 (0.00)*	1.93 (0.16)	-	1.59 (0.04)**	1.29 (0.45)	5.53 (0.06)***	-0.001 (0.05)***
$\Delta lntr_{t-1}$	0.43 (0.03)**	0.34 (0.01)**	0.61 (0.43)	0.62 (0.73)	0.84 (0.01)**	0.98 (0.32)	1.10 (0.57)	0.23 (0.67)	2.22 (0.32)	-	4.91 (0.02)**	0.40 (0.00)*	-0.002 (0.04)**
$\Delta lngovt_{t-1}$	0.70 (0.40)	0.52 (0.77)	0.13 (0.71)	3.91 (0.14)	1.92 (0.38)	0.62 (0.42)	0.33 (0.00)*	0.91 (0.00)*	1.97 (0.34)	4.91 (0.08)***	-	6.97 (0.00)*	-0.03 (0.00)*
$\Delta lninv_{t-1}$	1.22 (0.40)	2.18 (0.33)	0.14 (0.70)	0.07 (0.96)	2.36 (0.30)	0.93 (0.06)***	0.91 (0.01)**	5.07 (0.07)***	9.59 (0.00)*	20.59 (0.00)*	7.32 (0.02)**	-	-0.19 (0.00)*

Note: *, **, and *** denote the significance levels of 1%, 5%, and 10% respectively.

6. Conclusion and policy implication

During the last decades, research is being directed to analyze the influence of fiscal policy variables in the determination of economic growth. A major issue found by these studies was that fiscal policy variable like taxation is not working well as a growth-enhancing tool in developing countries as well as for developed countries. Hence, this study found the most important reason that interrupts the taxation and economic growth relation is the high level of corruption. Along with corruption -taxation association, we have endeavoured to discover how the connotation between taxation and economic growth is interrupted by the presence of corruption in combination with some sets of other important determinants of economic growth.

This study operated with panel data from 29 developed (Panel-A) and 80 developing (Panel-B) countries, according to the world bank classification, from 1985-2016. The econometric strategy follows four steps, in the first step, the study performs a panel unit root test to judge the variable's stationarity. Then, the next step proceeds the study to check long-run association by employing Pedroni and Kao test with the condition that every variable is I (1) and found that all variables are co-integrated. As in the third step, co-integration regression is estimated using DOLS and the findings indicate that taxation (individually) stimulates the economic growth of both developed and developing countries. While the impact of corruption on the economic growth of developing nations is negative but for developed countries, it is lubricating the wheel of economic growth. Furthermore, the indirect influence of taxation on economic growth through corruption is negative in both sets of economies. So, corruption exerts a hostile impact on public revenue collection. Similarly, the impact of taxation square (both direct and indirect) is also negative, and the negative impact of corruption is stronger than stimulating taxation effect for economic growth in emerging/developing countries.

In the last step, the VECM Granger causality test is applied to analyze the causality direction among variables. Results of the VECM Granger causality test show that all variables react toward long-run stability. However, a short investigation reveals that unidirectional impact exists between economic growth to taxation and bi-directional causality exists among economic growth and corruption in developing countries. In contrast, for developed countries, bidirectional causality exists among corruption, taxation, and economic growth. While unidirectional causality occurs between economic growth and corruption.

The similarities between this study and existing studies lie in their use of panel data and econometric techniques to evaluate the relationships among corruption, taxation, and economic growth. They both acknowledge the importance of examining these factors in both developing and developed countries. Additionally, they recognize the potential negative effect of corruption on economic growth and the role of taxation in revenue generation and economic development.

However, this study varies from earlier studies in numerous aspects. Firstly, it operates with a larger sample size, encompassing 29 developed countries and 80 developing countries, providing a broader representation of global economies. This wider coverage enhances the generalizability of the findings. Secondly, the study utilizes specific econometric techniques to address issues of stationarity and co-integration. It employs panel unit root tests to assess the stationarity of variables and employs the Pedroni and Kao tests to establish the long-run association. These rigorous statistical techniques strengthen the reliability of the results.

Furthermore, the study goes beyond examining the direct effects of corruption, and taxation on economic growth. It explores the indirect influence of taxation through corruption, providing insights into the complex interplay between these variables. This expanded analysis helps to understand the procedures by which corruption influences economic growth and public revenue collection. Moreover, the study highlights the differences in the impact of corruption and taxation between developed and developing countries. As it finds that corruption negatively affects the economic growth in developing nations but acts as a lubricant for economic growth in developed countries. This understanding of the divergent effects contributes to a more comprehensive analysis.

a. Policy Implications

This study suggests that government and policy analysts should focus on solid steps in the form of institutional reforms for taxation division to assure tax collection free from corruption. If, these types of steps are not taken then tax collection will not reach the desired optimal level. Because it is clear from the study that for both types of countries taxation has an encouraging effect on economic growth in the absence of tax evasion. So, public officials should immediately improve and systematize the tax structure, making it easy for taxpayers. The findings clearly state that the unfavourable influence of taxation on economic growth is due to corruption. So, if the government successfully controls corruption, tax collection will be increased which ensures self-sustaining economic growth.

This is so because the high tax collection reduces the reliance on foreign debt, grants, and deficit financing for fueling the development project.

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Appendix

Table A. List of selected countries

A. Developing Countries			
Albania	Ecuador	Malaysia	Sierra Leone
Algeria	Egypt	Mali	Slovakia
Angola	El Salvador	Mexico	South Africa
Bahamas	Ethiopia	Moldova	Sri lanka
Bahrain	Gambia	Mongolia	Suriname
Bangladesh	Ghana	Morocco	Tanzania
Belarus	Guatemala	Namibia	Thailand
Bolivia	Honduras	Nicaragua	Togo
Botswana	India	Nigeria	Turkey
Brazil	Indonesia	Pakistan	Tunisia
Bulgaria	Iran	Papua New Guinea	Uganda
Burkina Faso	Jamaica	Paraguay	Ukraine
China	Jorden	Peru	Vietnam
Columbia	Kazakstan	Philippine	Zambia
Congo, Dem. Rep.	Kenya	Romania	Zimbabwe
Costa Rica	Lebanon	Russian Federation	
Cote d’ Ivoire	Liberia	Senegal	
Dominican Republic	Madagascar	Serbia	
B. Developed Countries			
Argentina	Ethiopia	Korea	Poland
Australia	Finland	Kuwait	Portugal
Austria	France	Latvia	Singapore
Belgium	Germany	Lithuania	Slovenia
Canada	Hungary	Luxemburg	Spain
Chile	Iceland	Malta	Sweden
Cyprus	Ireland	Netherland	Trindad and Tobago
Czech Republic	Israel	New Zealand	United Kingdom
Denmark	Italy	Norway	United States
Estonia	Japan	Oman	Uruguay

Table B. Panel unit root test results

Variables	Developed countries, Panel-A N = 29, T=38				Developing Countries Panel-B N=72, T=32				
	ADF (At level)	**ADF (Δ)**	**IPS (At level)**	**IPS (Δ)**	**ADF (At level)**	**ADF (Δ)**	**IPS (At level)**	**IPS (Δ)**	**Order Of Integration**
GDP Growth	-2.85 (0.11)	13.33 (0.00)*	-1.95 (0.1)	-11.99 (0.00)*	1.7 (0.9)	9.8 (0.00)*	-2.7 (0.3)	-6.07 (0.00)*	I(1)
$\ln(tax)_{t-1}$	-7.92 (0.31)	29.32 (0.00)*	-1.27 (0.10)	-20.88 (0.00)*	1.47 (0.7)	60.01 (0.00)*	-1.71 (0.4)	-24.02 (0.00)*	I(1)
$\ln(cor)_{t-1}$	1.93 (0.61)	8.36 (0.00)*	-2.51 (0.20)	-11.89 (0.00)*	0.72 (0.23)	9.63 (0.00)*	-0.93 (0.17)	-7.10 0.00)*	I(1)
$\ln(tax)_{t-1}.\ln(cor)_{t-1}$	-0.09 (0.53)	38.08 (0.00)*	0.94 (0.82)	-21.8 (0.00)*	1.92 (0.2)	46.22 (0.00)*	0.43 (0.66)	-26.78 (0.00)*	I(1)
$\ln(tax)^2_{t-1}$	0.01 (0.49)	33.11 (0.00)*	0.57 (0.71)	-34.34 (0.00)*	-0.74 (0.77)	13.37 (0.00)*	-3.94 (1.00)	-28.52 (0.00)*	I(1)
$\ln(tax)^2_{t-1}.\ln(cor)_{t-1}$	0.57 (0.28)	33.68 (0.00)*	0.24 (0.59)	-34.17 (0.00)*	1.7 (0.3)	25.19 (0.00)*	-1.17 (0.12)	-21.32 (0.00)*	I(1)
$\ln(pop)_{t-1}$	0.03 (0.48)	2.82 (0.00)**	-1.70 (0.1)	-11.9 (0.00)*	1.06 (0.14)	7.4 (0.00)*	-2.42 (0.07)	-12.25 (0.00)*	I(1)
$\ln(govt)_{t-1}$	0.59 (0.27)	6.6 (0.00)*	-4.28 (0.1)	-37.53 (0.00)*	0.07 (0.46)	2.38 (0.00)*	2.34 (0.81)	-17.6 (0.00)*	I(1)
$\ln(secondary)_{t-1}$	1.22 (0.10)	66.38 (0.00)*	-2.60 (0.4)	-17.2 (0.00)*	1.64 (0.4)	27.12 (0.00)*	2.54 (0.99)	-22.77 (0.00)*	I(1)
$\ln(tr)_{t-1}$	0.24 (0.40)	10.0 (0.00)*	-3.57 (0.2)	-3.2 (0.00)*	0.56 (0.28)	9.86 (0.00)*	1.25 (0.89)	-23.35 (0.00)*	I(1)
$\ln(Inv)_{t-1}$	0.84 (0.2)	7.86 (0.00)*	0.18 (0.42)	-34.8 (0.00)*	0.21 (0.41)	16.58 (0.00)*	2.24 (0.98)	-21.43 (0.00)*	I(1)
Initial GDP	4.11 (1.00)	-20.1 (0.00)*	-0.09 (0.46)	-13.32 (0.00)*	-4.07 (1.00)	16.20 (0.00)*	4.94 (1.00)	-9.09 (0.00)*	I(1)

Note: * and ** denote the significance levels of 1% and 5% respectively and Δ denotes the results at first difference.