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## Article

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Article

# Taxes, R&D Expenditures, and Open Innovation: Analyzing OECD Countries

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**Abstract:** This paper aims to measure the effect of tax contributions in promoting innovation while highlighting the role of corporate taxes in governance quality in nations within and outside the Organization for Economic Co-operation and Development (OECD). The study applied the generalized method of moments (GMM) framework and found that good governance invariably increases the Innovation Index. Moreover, research and development expenditures revealed a positive association with the Innovation Index. However, corporate taxes and taxes paid by the business sector harm the Innovation Index. Following the investigation, we recommended that policymakers should plan well to balance the costs of innovation and tax incentives, to avoid stimulating unproductive innovations or affecting operating budgets.

**Keywords:** research and development expenditure; innovation; taxes; OECD countries; corporate tax



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## 1. Introduction

In the past few years, innovation has become pivotal in the growth of economies. Economic agents' interest in it plays a significant part in economic growth, especially in a developed country whose economy depends on innovation and technology [1]. Recent research focuses on the contribution of corporate taxes to innovation. Following [1], our study seeks the root of innovation at the micro-level. It can be concluded that taxation is an essential instrument for promoting regional innovation activities; primarily, private enterprise tax is a useful tool that contributes to the development and promotion of innovation [2]. Many scholars have concluded that for a country to grow its economy and become competitive, innovation is essential for development, and is highly pivotal for economic growth [3,4].

Some scholars have opined that lowering taxes may increase inequality and distort a government's budget [5], consequently disrupting the operating budget. Hence, it is essential to know the elements that determine the innovation capability of an organization. Scholars have emphasized its significance in recent decades [6]. For a long time, the literature on institutional economics has continually emphasized how enterprise technology's development and innovation are positively influenced by institutions [7]. This study analyzes the connection between system quality, taxation, and innovation. Predominantly, more studies have focused on the contribution of taxation in promoting innovation and its impact on system quality [8]. However, other tools that also help to encourage innovation deserve more attention. This study differs from other studies that take capital tax as a short-cut and treat enterprises as single entities [9,10]. However, our study is one of the very few attempts to utilize the system—generalized method of moments (GMM) method to examine and analyze how innovation is affected by corporate taxes and corruption.

Policymakers apply different public support tools to enable businesses to invest their additional taxpayer donations in R&D activities [1,11]. The public sector plays a significant

role as an R&D performer. It is a significant advocate of R&D in the business sector. For this reason, direct spending from R&D incentives and indirect funding through R&D incentives are widely used by governments. Companies in different countries recognize that more development areas are available, allowing us to use a mix of incentives, tax incentives, etc., as the main drivers that enable them to spend more on R&D [12].

However, firms' taxes have proven to be quite beneficial for innovation in both categories of countries as they fund R&D, which is essential in promoting innovation. Among the most prominent barriers to the promotion of innovation is the governance quality of all kinds; therefore, our study will explore and analyze the impact of both taxes and governance quality on the promotion of innovation in the OECD countries, which include Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. Our study clarifies several aspects of tax contributions in promoting innovation and governance quality in these countries.

Furthermore, we seek to determine and understand the extent to which corporate taxes and governance quality affect innovation in these countries. Previous studies mostly rely on an analysis of the effects of governance quality on innovation in OECD countries. We hope to bridge the gap that previous studies did not cover, using the variable Innovation Index, to promote the innovation process. On the other hand, this study focuses on business taxes, mainly due to institutions' nature that contribute to innovation. Previous studies have left out the use of the variable returns from taxes in general. The analysis results are inaccurate and unclear since it combines various economic activities to drive taxes together. The current study used the Rule of Law Index, which measures the effectiveness of monitoring government spending and tax aid provided to innovation. Clarifying the study's aims raised a few questions. Do taxes and governance quality have different impacts on OECD countries and their innovation promotion? Does governance quality affect the promotion of innovation in each of the countries? Furthermore, what is the extent of its influence on each of them?

Our study offers critical contributions to the decomposition of taxes and accounting for governance quality on innovation promotion. These findings will be essential for building an analysis that compares what determines innovation promotion in OECD countries. The study used data from 36 OECD countries from 2000 to 2018. Given the methodology, descriptive analysis was used to determine the variables' statistical nature, and the GMM methodology was applied to correct the endogeneity issue and the defaults in fixed and random effects.

## 2. Literature Review

Numerous previous authors have analyzed the connection of taxes with corruption and innovation. For example, Rodriguez-Pose and Cataldo [11] tested the relationship between government systems' quality in Europe and innovation performance. Several studies have used the ordinary least squares (OLS) method to analyze the linkage between system quality, taxation, and innovation [12]. Since innovation requires creativity, it requires a high-quality legal system. After using the fixed-effect set OLS method to test the relationship between innovation and taxation, it was found that taxation matters and indeed affects innovation. Another study found that the increase in personal and corporate revenue taxes affects innovation both at the micro-and macro-economic levels [13]. Moreover, Huang and Li [14] tested how institutional quality influenced innovation in developing nations [15]. They concluded that, after using the fixed-effect set OLS method to test the relationship between innovation and taxation, taxation matters and does affect innovation.

Furthermore, Baslandze and Stantcheva [16] concluded that higher personal and corporate income taxes affect innovation at both the micro and macro-economic levels. The causal relationship between enterprises and innovation in developing countries has

also been studied. The effect of different corporate patent applications reflects the positive role of corporate tax cuts. When testing the institutional relationship quality has with innovation in developing nations, a more comprehensive description was found in Li and Jia [17]. The econometric results showed that innovation is needed to strengthen the institutional structure of economic development. This result is contrary to Liesegang and Runkle [18], who studied the connection that taxation has with innovation and institutional quality more closely, revealing the shortcomings.

Moreover, previous studies [19–21] on reducing the contribution of taxes in promoting innovation revealed that tax incentives are an essential factor; however, these studies ignored other types of taxes necessary to enhance innovation, such as taxes generated by the business sector and enterprises' profit tax. Moreover, earlier studies have shortcomings. They are limited to a narrow area comprising only OECD countries concerning tax contribution analysis in promoting innovation and not including non-OECD countries. This process may only reveal the scale of lost tax contributions in OECD countries, whereas comparing both regions would provide better results.

Empirical evidence has indicated that the private sector plays an essential role in innovation processes. It does not capture all the positive externalities created by this activity; the private sector would produce substantially less innovation than economic efficiencies. As a result, government policy plays a critical role in fostering innovation, including contributing inputs to the innovation process and improving innovators' incentives.

Hence, governments should promote pro-competition policies, a more efficient intellectual property rights regime, direct investment in R&D, and tax policies aimed at internalizing the society-wide benefits from R&D.

In [22], the authors showed that direct government financing is responsible for most basic research. At the same time, businesses also play an essential role in basic research and a dominant role in more applied research. Creating those incentives means having a tax system that is less distortionary, with more equal rates on different types of activities. In other words, when business activity generates spillovers that impact other firms, [22] concluded that tax policy should help to align the social and private incentives for these activities. Consequently, tax policy contributes to correcting distortions by appropriately subsidizing or penalizing activities. Some scholars assume that tax policy is the best support for innovation processes. Otherwise, ascending the after-tax labour income of entrepreneurs is required to accelerate technological research [23]. Recent empirical analyses consider that the optimal level of R&D investment can produce a significant rate of economic growth [23–27].

However, earlier studies did not examine OECD countries. Other studies examined and compared tax contributions (paid by businesses and commercial sectors), and corruption and institutional levels concerning innovation promotion that affect the countries. The following points were analyzed to fill the gaps left by previous research studies: Determine which type of tax has a strong impact and contributes to promoting innovation in these countries, and how much tax is required to encourage innovation and assess the level of corruption perception in fostering innovation in OECD countries [22,28].

Controllers are justifiably worried that citizens will utilize charge motivation arrangements in an unforeseen manner. Additionally, few new organizations are key drivers of development, and evidence suggests that they are generally lazy toward burden motivations. Second, development can help improve the expense framework. To fix an issue, one should initially distinguish it; advancement allows observation of where the charge law is accomplishing its objectives and missing the mark. The sharing economy experience recommends a few qualities: the duty framework's meaning of pay and shortcomings, and the partitioning line between self-employed entities and workers [3]. Scholars agree that for productivity to be increased and economic growth to be achieved, both individuals and firms have to be innovative [29].

Policymakers are aware of how the corporate tax system can enhance and encourage firms' innovation, and they directly influence firms through R&D tax credits. An analysis

of the period from 1988 to 2006 revealed that the decrease in taxes increased the quantity of innovation output significantly, while an increase had the opposite effect [3]. The fixed-effect model was applied in this study, utilizing information collected from 1996 to 2013, and taking into account prospective endogeneity biases. The results proved that corruption negatively affected innovation but influenced it positively beyond the threshold level [30]. In [31], the authors stated that audit quality directly impacts the association between firm value and tax aggressiveness. Hence, this factor becomes the essential tool to motivate the firms to plan novel tax strategies to increase shareholder value.

Our study seeks to reveal how tax policies can promote innovation and how governance quality can affect innovation. We estimated the fixed and random effects when implemented. Along with the system-GMM, our study examined the relationship of other taxes with innovation; for example, taxes paid by the business sector. Simultaneously, our study is concerned with innovation and analyzing governance quality in the future and how it can affect the process and promotion of innovation. Most of the other studies we found focused on using the number of innovations as an indicator that expresses innovation's size.

### 3. Materials and Methods

#### 3.1. Descriptions and Sources

The study sample comprises data collected from 36 OECD countries: Poland, Portugal, Sweden, Luxembourg, Belgium, Slovenia, South Korea, Finland, the United States, the United Kingdom, Hungary, Iceland, Latvia, Italy, Japan, Denmark, Mexico, Switzerland, Germany, Greece, Slovakia Republic, the Netherlands, New Zealand, Australia, Norway, Canada, Chile, Czech Republic, Austria, Turkey, France, Israel, Colombia, Chile, Lithuania, and Spain. Our study uses the Innovation Index, corporate tax rate, the number of taxes paid by businesses, and governance collected from the Global Economy database (2020), and the government research and development expenditures collected from the World Bank Database (2020). Table 1 exhibit the detailed description of the study variables.

**Table 1.** Description of variables and Sources.

Variables	Measuring	Symbols	Unit Adopted	Source
Innovation	Innovation Index	LogIn	Points	The Global Economy (2020)
Government Expenditure	Research and Development Expenditure	LogRDE	Government spending as percent of GDP	World Bank (2020)
Taxes	Corporate Tax Rate	LogCT	Tax rate, percent of commercial profits	The Global Economy (2020)
Taxes	Number of Taxes Paid by Businesses	LogTP	Number of Taxes	The Global Economy (2020)
Governance	Rule of Law Index	LogRL	Points	The Global Economy (2020)

#### 3.2. Data Analysis Methods

This study utilizes descriptive statistics to explain every variable's characteristics in the model and correlation test to examine whether the repressors have perfect or linearly exact representations of one another to avoid multicollinearity. Information from 36 countries was utilized to measure how taxes and institutional quality influence innovation, using the GMM estimator technique of Arellano, Bond [32] and Blundell [33]. Thus, applying OLS or fixed-effects (FE) estimators may render the evaluations one-sided and conflicting. This study attains the conditions for the application of system-GMM as the number of years



(time dimension = T) are relatively less than the cross-sections (number of countries = N) ( $T < N$ ). This study applies the GMM approach to minimize errors and increase efficiency.

Additionally, this technique's suitability is justified by its appropriateness when the time ( $T = 18$ ) is less than the number of cross-sectional units ( $N = 36$ ). This technique minimizes discrepancies in measurement, simultaneity, reverse causality, endogeneity, unobserved individual heterogeneity, and heteroscedasticity. [30,34,35] came up with the system-GMM technique by developing the first difference estimator suggested by Arellano and Bover [36]. System-GMM is more efficient than other estimating methods, so it has been used in this study [32,37]. In cases where heteroscedasticity issues exist, a two-step system-GMM estimator was utilized [34]. The null hypothesis should be rejected, and instruments are tested using the Hausman tests [34]. This method eliminates the potential endogeneity problem inherent in the panel data models, showing that an extra-gentle fixed limitation on the underlying conditions' process permits the utilization of slacked contrasts as instruments for conditions at levels, and slacked degrees as tools for conditions in contrasts [38]. Sargan measurement and Hansen statistic tests were utilized to examine the legitimacy of a tool in the GMM framework, where one- and two-step GMM estimators were used. This process was used because the two-step estimator is increasingly productive, yet the revealed two-step standard errors may, in general, be remarkably one-sided [39]. The investigation additionally accounted for this inclination by utilizing limited examples connected to the two-step covariance framework determined by Kwabena-Twerefou, Danso-Mensah, and Bokpin [40]. Two-step is more proficient than one-step, particularly for the GMM framework utilized in this study.

### 3.3. Model Specification

To check our main hypotheses, we have used the following equation:

$$\text{LogIn}_{it} = \beta_0 + \beta_1 \text{LogRDE}_{it} + \beta_2 \text{LogRL}_{it} + \beta_3 \text{LogCT}_{it} + \beta_4 \text{LogTP}_{it} + \varepsilon_{it} \quad (1)$$

where  $\text{LogIn}_{it}$  is the log Innovation Index,  $\text{LogRL}$  is corruption perceptions,  $\text{logCT}$  indicates the log corporate tax rate,  $\text{LogTP}$  indicates the log of the number of taxes paid by businesses, and  $\text{LogRDE}_{it}$  indicates the research and development expenditure. Assessing the quality and taxation of institutions, the Rule of Law Index ( $\text{LogRL}$ ), the influence of R&D expenditure on GDP (R&D), taxes paid by companies, and the amount of tax paid by enterprises in these countries, we can use static panel technology to approximate the formula:

$$\text{LogIn}_{it} = \theta_i + Y_{it} + \beta_0 + \beta_1 \text{LogRDE}_{it} + \beta_2 \text{LogRL}_{it} + \beta_3 \text{LogCT}_{it} + \beta_4 \text{LogTP}_{it} + \varepsilon_{it} \quad (2)$$

$\theta_i$  and  $\lambda_t$  represent the country and time-specific effect, respectively, implying that  $\theta_i$  and  $\lambda_t$  determine which panel model will be selected. Considering that the time effect does not exist, and the country effect presents random error terms, the GLS estimate was used. The kinetic equation is:

$$\text{LogIn}_{it} = \alpha_{i,t} + \theta_1 \text{LogIn}_{it} Y_{it} + \beta_0 + \theta_2 \text{LogRDE}_{it} + \theta_3 \text{LogRL}_{it} + \theta_4 \text{LogCT}_{it} + \theta_5 \text{LogTP}_{it} + \varepsilon_{it} \quad (3)$$

where  $\alpha_{i,t}$  indicates the country-specific effects and  $\varepsilon_{it}$  displays the error, both of which are assumed to be distributed independently.

### 3.4. Data Analysis and Specification

Table 2 below shows the descriptive statistics for the variables incorporated. Table 2 provides informative and descriptive statistics of the indicators and determinants of innovations for the selected 36 OECD countries. The mean, maximum, and minimum values were analyzed.

**Table 2.** Descriptive Statistics.

	<i>LogIn</i>	<i>LogRL</i>	<i>LogCT</i>	<i>LogTP</i>	<i>LogRDE</i>
Mean	3.9261	0.1101	3.6666	2.3160	0.5006
Median	3.9646	0.3646	3.7062	2.1972	0.5247
Maximum	4.2239	0.7419	4.2669	3.4657	1.5151
Minimum	3.5293	−4.6051	1.5040	1.3862	−1.0498
Std. Dev.	0.1549	0.7575	0.3355	0.4167	0.5501

Table 2 shows that the minimum and maximum values of the Innovation Index were 3.5293 and 4.2239, respectively; while the median is (3.9646). For the Rule of Law Index, the minimum and maximum values were 4.6051 and 0.7419, respectively, and the mean value was 0.1101. Research and development expenditure had minimum and maximum values of −1.0498 and 1.5151, respectively, with an average value of 0.524728. Furthermore, the corporate tax rate indicated minimum and maximum values of 1.5040 and 4.2669, respectively, with a mean value of 3.6666. However, the minimum and the maximum number of taxes paid by businesses were 1.3862 and 3.4657, with a mean value of 2.3160.

Based on the above variables, it was found that the standard deviation of taxes paid in the Rule of Law Index, research and development expenditure, corporate tax, number of taxes paid by businesses, and Innovation Index was extensive, meaning there is variance in the Innovation Index for different countries. A comprehensive comparison of various variables shows that the former is better than the latter. More than 50% of national innovations are below average, as illustrated by the distributed Innovation Index.

Table 3 shows the inter-connected matrix between the determinants of innovations with a log scale. The study found a low correlation among the regressors except for corporate tax and taxes paid by businesses, with coefficients of −0.1593 and −0.0305, respectively. Even though the indicators present a high correlation to innovation, this does not cause any multicollinearity problem among the model's regressors.

**Table 3.** Correlation Matrix.

	<i>LogIn</i>	<i>LogRL</i>	<i>Log RDE</i>	<i>LogCT</i>	<i>LogTP</i>
<i>LogIn</i>	1.0000				
<i>LogRL</i>	0.7376	1.0000			
<i>LogRDE</i>	0.7257	0.4659	1.0000		
<i>LogCT</i>	−0.1593	−0.0417	0.1324	1.0000	
<i>LgoTP</i>	−0.0305	−0.0820	0.0821	−0.1111	1.0000

Using the hypotheses of Levin-Lin-Chu, Im et al., ADF-Fischer Chi-square, and Phillips-Perron [41], Table 4 presents the findings of the unit root test. The test's null hypothesis suggests a unit root or stationarity for the variables used in this study; consequently, we can apply a long-run analysis. According to the literature, we need to consider two hypotheses in the alternative [42–44], i.e., *H0*: a unit root test, and *H1*: the stationary variables. The test found that all variables used in this analysis (Innovation Index, rules and low index, corporate tax, tax paid by the business, and research and development expenditure) are stationary.

Table 4. The unit root test.

Levin, Lin and Chu t *					
At Level			At first Difference		
	Statistic	Prob.		Statistic	Prob.
<i>LogIn</i>	−5.6531 ***	(0.0000)	$\Delta$ LogIn	−15.8990 ***	(0.0000)
<i>LogRL</i>	−3.1488 ***	(0.0008)	$\Delta$ LogRL	−1.72575 **	(0.0422)
<i>LogTP</i>	−1.6324 **	(0.0513)	$\Delta$ LogTP	−0.95526 *	(0.0697)
<i>LogCT</i>	−95.337 ***	(0.0000)	$\Delta$ LogCT	−227.028 ***	(0.0000)
<i>LogRDE</i>	−9.1304 ***	(0.0000)	$\Delta$ LogRDE	−18.2259 ***	(0.0000)
Im, Pesaran And Shin W-Stat					
At Level			At first Difference		
	Statistic	Prob.		Statistic	Prob.
<i>LogIn</i>	−1.04127	(0.1489)	$\Delta$ LogIn	−4.61309	(0.0000)
<i>LogRL</i>	1.94442	(0.9741)	$\Delta$ LogRL	1.47487	(0.0299)
<i>LogTP</i>	−59971.1 ***	(0.0000)	$\Delta$ LogTP	−29065.9	(0.0000)
<i>LogCT</i>	$−1.8 \times 10^{14}$ ***	(0.0000)	$\Delta$ LogCT	−46.6347	(0.0000)
<i>LogRDE</i>	−2.53716 ***	(0.0056)	$\Delta$ LogRDE	−4.55159	(0.0000)
Augment Dickey-Fuller					
At Level			At first Difference		
	Statistic	Prob.		Statistic	Prob.
<i>LogIn</i>	87.3449 **	(0.0405)	$\Delta$ LogIn	134.542 ***	(0.0000)
<i>LogRL</i>	52.9124	(0.8373)	$\Delta$ LogRL	52.7310 *	(0.0417)
<i>LogTP</i>	10.1459	(0.9270)	$\Delta$ LogTP	15.6750 ***	(0.0152)
<i>LogCT</i>	156.536 ***	(0.0000)	$\Delta$ LogCT	190.201 ***	(0.0000)
<i>LogRDE</i>	105.012 ***	(0.0016)	$\Delta$ LogRDE	134.626 ***	(0.0000)

Note: *p*-value in parentheses. \*\*\*  $p < 0.01$ . \*\*  $p < 0.05$ . \*  $p < 0.10$ .

#### 4. Results

We used a step-by-step procedure to demonstrate how GMM offers robust estimates compared to OLS, fixed-effect, and random-effect estimates. We began with an OLS analysis to identify endogeneity issues by utilizing the Durbin–Wu–Hausman test, followed by fixed-effect and random-effect estimates modeled with FMOLS and DOLS. The procedure demonstrated that fixed-effect estimates failed to capture dynamic endogeneity. The GMM model incorporated lagged-values of the dependent variable (Innovation Index). The endogeneity concerns were addressed, and the valid estimates were produced by using a rigorous GMM process.

Initially, an OLS study was carried out to analyze the direct effects of the independent variables, such as the Rule of Law Index, R&D investments, corporate taxes, and amount of taxes paid by companies, on the dependent variable (Innovation Index). The findings are listed under Model 1 in Table 5. However, the OLS model suggested that R&D spending and the law index positively impacted innovation processes. This result is consistent with recent research [45,46] that recorded a positive association between R&D expenditure investment and the innovation component that resident and non-resident patents obtain. In Model 1, most rules and low indexes and inventions positively affected growth and innovation efficiency.



Table 5. The estimation results.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	OLS	Random Effects	Fixed Effects	FMOLS	DOLS	GMM
<i>LogIn</i>						0.8540 ***
<i>LogRL</i>	0.0965 ***	0.04159 ***	−0.0464 ***	0.2866 ***	0.1375 ***	0.0138 ***
<i>LogRDE</i>	0.1518 ***	0.1158 ***	0.0062834	0.029168	0.130642 ***	0.0197 ***
<i>LogCT</i>	−0.1005 ***	−0.0501 ***	0.0179516	−0.803093 **	−0.059249 **	−0.0077 ***
<i>LogTP</i>	−0.0223 *	−0.0132	−0.027002 *	−0.414572 ***	−0.0008	−0.0065 ***
<i>_cons</i>	4.2597 ***	4.0824 ***	3.9249 ***	4.1860 ***	4.0630 **	15.0497 ***
<i>year</i>						−0.0071 ***
<i>sigma_u</i>				0.0652	0.1876	
<i>sigma_e</i>				0.0342	0.0342	
<i>Rho</i>					0.9677	
<i>AR(1)</i>						0.000
<i>AR(2)</i>						0.066
R-squared	0.7754	0.6824	0.7169	0.7730	0.7334	0.61712
Adjusted R-Squared	0.7021	0.6172	0.6451	0.7682	0.6152	0.5978
S.E. of Regression	0.0104	0.0784	0.0874	0.07477	0.0672	0.0148
Long-Run Variance	0.0687	0.0321	0.0158	0.0145	0.0127	0.0548

Note: *p*-value in parentheses. \*\*\* *p* < 0.01. \*\* *p* < 0.05. \* *p* < 0.1.

On the other hand, the test results show a negative association between corporate taxes and the amount of tax paid by the company sector in Model 2 (Table 5). A fixed random-effects estimation technique theoretically monitored under the presumption of strict exogeneity for unnoticeable heterogeneity was used. In Model 2 (Table 5), a methodology for estimating fixed effects was utilized.

The random impact test showed a positive interaction between laws, low R&D expenditures, and innovation. However, the fixed-effect test showed that one positive relationship between regulation and innovation resulted in a negative outcome between corporate taxation, company taxes, and the Innovation Index. When using the fully modified least squares (FMOLS) of the panel and the dynamic least squares (DOLS) of the panel, the econometric results were close to the coefficients determined by FMOLS, showing the predicted signs formulated by the hypotheses and the literature review. As described in the methodology, the elasticity-considering coefficients can, therefore, be read. The indicator, R&D expenses, and Rule of Law Index had a positive impact on the creativity index, and the variable was statistically significant at 1%, with coefficient values of 0.2866 and 0.0291 in FMOLS, and 0.1375 and 0.1306 in DOLS.

The empirical studies found a positive effect between the Rule of Law Index and R&D expenditures. In promoting an anti-corruption movement, countries must use enough force, accompanied by a reliable attitude, to facilitate the effect of promoting innovation; contrarily, when corruption is too severe, the effect is not so noticeable. In this panel fixed-effect model, the coefficient of *LogRL* revealed that a 1% increase in R&D expenditures would increase the Innovation Index by 0.2866 in FMOLS and by 0.1375 in DOLS.

Therefore, a positive coefficient of corruption indicates that countries with higher institutional quality can increase innovation, other items being equal to the coefficient 0.2866 in the FAMILS and 0.1375 in DOLS. The analytical research found a positive impact of the Rule of Law Index on R&D expenses. Herman and Xiang [47], who discussed the effect of government R&D grants on company innovation in New Zealand, noted some diverse impacts of R&D on specific innovation metrics. However, the test indicated that the lower the taxes, the greater the amount of innovation. Countries use this as an incentive policy to improve innovation, as the current study has shown. In Model 2 (Table 4), a

method of estimating fixed effects that can theoretically control, under the presumption of strict exogeneity, for unnoticeable heterogeneity was used. The random-effect test showed a positive relationship between rules and low R&D expenditures.

The econometric results are similar to the fully modified least-squares of the panel (FMOLS) and the dynamic least-squares of the panel (DOLS), the coefficients estimated by FMOLS and DOLS, and present the expected signs formulated by the hypotheses and the review of the literature. The variables for the Rule of Law Index and R&D expenditures (0.2866 and 0.1375) had a positive effect on the Innovation Index, and the variable was statistically significant at a 1% level in the FMOLS model, and 0.0291 and 0.1306 in the DOLS model. The empirical studies of Chambers and Munemo [48] were broadly consistent with those of Upreti [49] and Dechezlepr, Eini, Martin, Nguyen, and van Reenen [50], who found a significant contribution from the control of corruption on innovative performance. Although most prior literature argues for a positive relationship between R&D expenditure input and innovation, Halkos and Paizanos [51] found that such a linkage is not always present [52]. In this panel fixed-effect model, researchers' coefficient shows that a 1% increase in R&D researchers would increase the Innovation Index by 0.2866 in FMOLS and by 0.1375 in DOLS. This process implies that researchers contribute to a more considerable impact on trademark applications versus patent applications in the sample countries. Such different influences from R&D on those innovation indicators were also noted by Halkos and Paizanos [51], who discussed the influence of government R&D grants on firm innovation in New Zealand.

The test findings validated previous studies' effects, such as Rule of Law Index (*LogRL*), R&D expenses; the coefficient was statistically meaningful at a level of 1% and had a positive coefficient (0.0138 and 0.0197). The research outcomes, accompanied by reviewing these outcomes, were mostly consistent with Atanassov and Liu [53]. They found a study outcome while most previous literature argues for a positive association between R&D spending and innovation [11]. Such a correlation is not always observed. However, the study indicated a negative relationship between corporate taxes and taxes paid by the business sector and innovation.

## 5. Discussion: Tax, R&D Expenditures, and Open Innovation

Given that substantial government factors have recently influenced public innovation policy as an economic strategy, there needs to be a better framework to investigate the appropriate linkages between corruption and innovation performance. Our study also aimed to identify determinants that contribute to promoting innovation in OECD countries. A political-corruption framework for innovation must inspect the current situation non-linearly to devise policy-induced implications. Thus, our study fills the literature gap by providing a robust policy framework that identifies government quality and corruption as determinants of innovation policies in 36 OECD countries for 2000–2018. We used fixed-effect, random-effect, FMOLS, DOLS, and GMM methods, thus considering the endogenous problem among variables according to our empirical results from the model estimator. We found that a country that possesses good governance will contribute to higher innovation performance.

Additionally, this study explored the nature of the relationship between governance and R&D expenditures. The study results showed a positive relationship with the promotion of innovation in the study sample. While the empirical analysis results demonstrated that the strength of law enforcement and good governance contributes to the advancement of innovation, the positive relationship among research, development, and innovation expenditures contributes directly to the innovation process.

Regarding policy implications, the empirical results indicated that improving institutional policies' quality is attractive to innovation where the quality of governance is relatively low in developing nations. So, if OECD governments wish to promote innovation, they should insist on improving governance and put forward anti-corruption reform programs to promote the innovation.

The cooperating countries must work to create a type of tax specifically for companies with an innovative nature that allows them to contribute to the state's treasury and parallel to the innovative activity's nature by developing a long-term strategy of a promotional nature for innovation. Moreover, tax exemption is one of the financial techniques used to promote technological advancement. A new tax system that is compatible with technology enterprises with unique characteristics needs to be designed to develop the governance of expenditure, particularly R&D expenditure, as a necessary input for technology. From an industry perspective, we agree that creativity is the root of sustainable growth for the industry. Enterprises must also be cautious in the face of rapidly shifting political circumstances, such as institutional quality, and the honesty and self-discipline of officials. For this reason, relatively less corruption among officials is followed by a sound and favorable political environment, which helps enhance a government's ability to promote the implementation of innovation-related and environmental policies, thus further boosting technological performance improvements.

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