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Is Government Integrity a Lubricant or a Stumbling Block to Economic Growth? Theory and Evidence

Abstract. *This paper attempts to explore the possible nonlinear effect of government integrity on economic growth by combining theoretical discussion with empirical analysis. Specifically, we construct an endogenous economic growth model composed of the private sector and the government sector, and discuss theoretically whether the government integrity is a lubricant or a stumbling block of economic growth under different money supply conditions; and then, based on the data of 140 countries in the world from 2003 to 2019, we verify the theoretical finding by using the dynamic panel threshold regression model. It is found that the impact of government integrity on economic growth is nonlinear; whether the government integrity is a lubricant or a stumbling block to economic growth depends on the money supply. Specifically, when the growth rate of money supply is lower than a certain threshold (30.8%), the improvement of government integrity will significantly promote economic growth. However, if the growth rate of the money supply is too high (higher than 30.8%), the improvement of government integrity may inhibit economic growth. As far as China and other "Belt and Road Initiative" (BRI) countries are concerned, the improvement of government integrity is always beneficial to promoting economic growth.*

Keywords: *government integrity, economic growth, money supply, endogenous economic growth model, dynamic panel threshold regression.*

JEL Classification: C24, E12.

1. Introduction

The government plays an important role in all stages of national economic development, from the planning of infrastructure construction to the decision of public investment, from the formulation of macroeconomic policies to the

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improvement of the economic system, all of which are related to the development of the country and society. Therefore, the government's ruling ability and ruling efficiency are particularly important. Many economists argue that malfunctioning government institutions constitute a severe obstacle to innovation, entrepreneurship, and economic growth. For example, low security of property rights over physical capital and patents may reduce incentives and opportunities to invest and innovate. Cumbersome and dishonest bureaucracies may delay the distribution of permits and licenses, thereby slowing down the process by which technological advances become embodied in new productive or innovative processes. According to the World Bank data, 5% of global GDP is lost due to the malfunctioning government institutions, in particular corruption, and the losses caused by official corruption in some developing countries even exceed 25% of the country's total economy. However, the coexistence of "fast growth and serious corruption" (Jiang & Nie, 2014) in many countries around the world provides evidence that corruption promotes economic growth. Accordingly, this paper further considers that how the government integrity affects the country's economic growth, and whether the government integrity is a lubricant or a stumbling block to economic growth.

Corruption is a common problem all over the world. The impact of corruption on economic growth is not simply confined to a "moralistic view" that unequivocally condemns corruption. Theoretically, there are two conflicting perspectives that relate corruption to economic growth. The first and most traditionally accepted view is that corruption "sands the wheels" of economic development. Corruption may tend to be associated with more fragile institutions and increase transaction costs, weaken market effectiveness, reduce the attractiveness of production activities, and ultimately have a negative impact on economic growth. On the contrary, the second view argues that corruption would "grease the wheels" of economic growth. Corruption may correct government failures and allow individuals and firms to circumvent bureaucratic obstacles, then promote economic growth. Empirically, the relationship between corruption and economic growth is also "pending" and ambiguous, and no unified conclusion has been reached. The inconsistency of the research results provides a new direction for in-depth study of the nonlinear influence of government integrity on economic growth. To this end, this paper attempts to explore the actual nonlinear effect of government integrity on economic growth by combining theoretical discussion with empirical analysis. To be specific, we construct an endogenous economic growth model composed of private sector and government sector, and discuss theoretically whether the government integrity is a lubricant or a stumbling block of economic growth under different money supply conditions; and then, based on the data of 140 countries in the world from 2003 to 2019, we verify the theoretical finding by using the dynamic panel threshold regression model. It is found that the impact of government integrity on economic growth is nonlinear; whether the government integrity is a lubricant or a stumbling block to economic growth depends on the money supply.

The marginal contributions of this paper are mainly the following three aspects. First, in the existing studies, the impact of government integrity on economic growth

is inconclusive, and there is a lack of theoretical framework that can reasonably and comprehensively explain the relationship between government integrity and economic growth. This study constructs an endogenous economic growth model in continuous time, and effectively investigates the actual impact of government integrity on economic growth. Second, most studies attach importance to empirical analysis, and few studies combine theoretical discussion with empirical analysis. This study not only guides practice by theory but also tests theory by practice, thus realising the consistency between theoretical and empirical findings. Third, existing studies are mostly based on the assumption of homogeneity, ignoring the heterogenous impact in different countries. This study pays more attention to the distinctive features of counties, and provides the possibility to investigate the differences in the relationship between government integrity and economic growth caused by the heterogeneity of countries.

The paper is organised as follows. Section 2 describes the literature review. Section 3 discusses the theoretical analysis and empirical hypothesis. Section 4 presents the empirical strategy and describes the data. Section 5 presents our main results and discussion. Section 6 discusses the heterogenous effect of government integrity in different countries. Finally, conclusions are drawn in Section 7.

2. Literature review

Is government integrity a lubricant or a stumbling block to economic growth? Up to now, there is still no consensus. The relationship between government integrity and economic growth is difficult to define from a theoretical or empirical perspective. The specific reasons may be as follows. First, corruption pervades all societies, but its magnitude varies substantially across countries. A relevant determinant of this variability is the quality of the institutions (Acemoglu & Robinson, 2012). This heterogeneity is particularly prominent in empirical studies. Second, there are obvious missing variables in existing studies, such as money supply, political system, and other factors that may affect or distort the relationship between government integrity and economic growth (Paulo et al., 2022). Third, the difference in data and/or estimation methods could lead to different research conclusions (Mao, 2019). According to the research content of this paper, we sort out the relevant literature into three aspects: “government integrity and economic growth”, “measure of government integrity”, and “money supply and economic growth”.

2.1 Government integrity and economic growth

Theoretical predictions about how government integrity influences economic growth are ambiguous. Most scholars discuss the relationship between government integrity and economic growth from the perspective of corruption. For example, the “grease the wheels” hypothesis predicts that corruption increases and the “sand the wheels” hypothesis predicts that corruption decreases economic growth (Acemoglu

& Verdier,1998; Grundler & Potrafke, 2019). Empirical evidence tends to suggest that government integrity increases economic growth. Although the mainstream views regard government integrity as effective for economic development and growth, there is no consensus on this issue. To be specific, there are four different views: (1) harmfulness of government integrity to economic growth; (2) effectiveness of government integrity on economic growth; (3) nonlinear effect of government integrity on economic growth; (4) ineffectiveness of government integrity to economic growth.

Scholars who hold the first view believe that the government integrity hinders economic growth to a certain extent, and the coexistence of high economic growth and high corruption of officials in some countries provides evidence for the harmfulness of government integrity to economic growth. The government formulates various inefficient and complicated regulations to ensure the government integrity, which made it difficult for enterprises to correct or circumvent pre-existing government failures of various types. This issue may reduce the efficiency of resource allocation, and even inhibit economic growth, especially in developing countries (Xie, 2016).

Since the 1990s, a large number of empirical studies have begun to support the view of "effectiveness of government integrity on economic growth". Some scholars believe that government integrity could enhance foreign investors' goodwill towards the host country (Mauro,1995), which not only helps to accelerate the inflow of foreign direct investment, but also helps to enhance the activity of import and export, thus promoting sustainable economic growth. Some scholars point out that government integrity is beneficial in optimizing the allocation of public and financial resources, improving the efficiency of public finance expenditure, thus promoting economic growth (Hessami,2014). Furthermore, some scholars confirm that government integrity can indirectly improve economic growth by optimising the rational allocation and flow mechanism of talents (Hsieh & Klenow, 2009).

Scholars who hold "nonlinear effect view" emphasise that the influence of government integrity on economic growth may be positive or negative. When the incidence of corruption is at a low level, government integrity will inhibit economic growth. However, under the condition of high corruption rate, government integrity is beneficial to economic growth. Aidt et al. (2008) suggest that under the well-established system, government integrity has a positive effect on economic growth; under the low-quality political system, government integrity has no significant impact on economic growth. They confirm that for countries with institutional defects, government integrity is not conducive to economic growth, while for countries with perfect systems, government integrity can promote economic growth. Furthermore, Shabbir (2017) found that the impact of government integrity on economic growth depends on the degree of democracy and political stability of the country. For countries with political instability and low degree of democracy, government integrity will become a resistance to the operation of administrative institutions, which is not conducive to economic growth; for countries with political

stability and high degree of democracy, government integrity may be the lubricant of economic growth.

Besides, there are some scholars who hold the viewpoint "ineffectiveness of government integrity to economic growth". Treisman (2007) suggested that from a world-wide perspective there is no statistically significant correlation between government integrity and economic growth. Jiang (2014) focused on China, and confirm that there is no obvious relationship between government integrity and economic growth.

2.2 Measure of government integrity

Early scholars used the number of corruption cases published by governments or collected by the media to measure government integrity. Due to the various forms of corruption and the concealment of corrupt behaviour, the measurement of government integrity by simply adding up the number of corruptions may lead to higher errors. Therefore, some scholars try to construct a relatively objective index system, for example, the outflows of rents and any related personal receipt of favours by relevant officials, the axiomatic approach (Foster et al.,2012). However, these measure approaches are difficult to be widely used because of their high requirements for the authenticity and reliability of data. Some scholars take the survey of respondents' corruption experience and subjective perception as the index to measure government integrity (Olken,2009). Besides, there are some scholars and organisations providing the measurement and analysis of indices of corruption which can be used to measure the government integrity. Transparency International, an organisation devoted to fighting bribery around the world, has measured the Corruption Perceptions Index (CPI) in different countries. CPI, as the most commonly used index to measure the government integrity, has many advantages, such as credibility, continuity. Apart from this, the World Bank's Control of Corruption Index (CCI), and the World Economic Forum's Irregular Payments and Bribes Index (IPB) are also used to measure the government integrity.

3. Theoretical analysis and empirical hypothesis

3.1 Model Setup

Is government integrity a lubricant or a stumbling block to economic growth? To answer this question, we construct an endogenous economic growth model composed of the private sector and the government sector in continuous time. The representative household is used to describe the private sector, and the utility function is shown below.

$$u(c_t) = \int_0^{\infty} \exp(-\rho t) \log(c_t) d_t \tag{1}$$

where $\rho \in (0, \infty)$ is subjective discount rate, $c_t > 0$ represents the consumption of representative household in period t. This utility function is a special case of the

equielastic utility function, and the intertemporal substitution elasticity is normalised to 1. The advantage of this function lies in its simple form and generality. Drawing lessons from Barro (1990), we consider that the production function of representative household is related to private capital (k_t) and productive public expenditure (g_t).

$$y_t = k_t^{1-\alpha} g_t^{\alpha} \tag{2}$$

Assume that the government integrity will affect household disposable income through tax (y_t^d).

$$y_t^d = (1-\tilde{\tau})\, y_t \tag{3}$$

Specifically, the actual tax rate ($\tilde{\tau}$) on which representative households pay taxes will be lower than the statutory tax rate (τ) because of the possible corruption of government officials (Timmons & Grafias,2015). Referring to the idea of Dimakou (2015), the relationship between the actual tax rate ($\tilde{\tau}$) and the statutory tax rate (τ) is defined by introducing a parameter (ϕ) that can describe the government integrity (Eq.4).

$$\tilde{\tau} = \phi\tau \tag{4}$$

where ϕ is in the range of 0 and 1. The higher the level of government integrity (ϕ), the actual tax rate ($\tilde{\tau}$) is closer to the statutory tax rate (τ). In the extreme situation $\phi = 1$, there is no corruption and all tax revenues accrue to the Treasure. When ϕ a is close to 0, the corruption issue is serious, resulting in the actual tax rate ($\tilde{\tau}$) being far lower than the government statutory tax rate (τ). This leads to the decrease of the actual tax revenue and the increase of the disposable income of representative households ($y_t^d = (1-\phi\tau)\, y_t$). In the extreme situation, $\phi = 0$, the whole revenue base is "eaten up" (Dimakou, 2015).

Representative households need to face the "cash-in-advance" constraints which are related to consumption (c) and investment (z_t). Drawing lessons from Palivos & Yip (1995), we introduce the money supply into the theoretical framework.

$$m_t = c_t + z_t \tag{5}$$

where $m_t = M_t / P_t$ represents the actual money stock. Note that M_t is the nominal money stock issued by the monetary authority, and P_t is the price level. The disposable income is used for consumption, investment, and currency holding. Therefore, the actual budget constraint of representative households can be expressed as follows:

$$\dot{k}_t + \dot{m}_t = y_t^d - c_t - \pi_t m_t \tag{6}$$

where $\dot{k}_t$ and $\dot{m}_t$ respectively represent the capital accumulation and the actual cash flow over time (note that $\dot{x}_t$ is the derivative of variable x with respect to time); $\pi_t m_t$ represents the seigniorage tax[i], π_t is the inflation rate ($\pi_t = \dot{P}_t / P_t$).

Assume that the government has two economic policy instruments to finance productive public expenditure: income tax and seigniorage tax[ii]. The government's budget constraint can be written as follows:

$$g_t = \tilde{\tau} y_t + \omega m_t \tag{7}$$

where $\omega = \dot{M}_t / M_t$ is the rate of seigniorage tax, in other words, the growth rate of money supply.

3.2 Equilibrium

This study constructs a multi-agent game model under government subsidies and digital platform enabling manufacturing enterprise supply chain, and the logical relationship is shown in Figure 1. The equilibrium can be found by maximising the utility function of representative household (Eq.1) under the constraints of Eq.(2), Eq.(4), Eq.(5), and Eq.(6). Assume that the initial capital stock is k_0, the problem of maximising the utility function is transformed into Eq.(8).

$$\mathrm{H}_c = \log(c_t) + \lambda_{1t}\left[(1-\tilde{\tau})k_t^{1-\alpha} g_t^{\alpha} - c_t - \pi_t m_t - z_t\right] + \lambda_{2t} z_t + \chi_t (m_t - c_t - z_t) \tag{8}$$

where $z_t \equiv \dot{k}_t$ represents investment; λ_{1t} and λ_{2t} represent the dual prices related to m_t and k_t; χ_t represents the multiplier of liquidity constraints. The first-order conditions of Eq. (8) are as follows.

$$\frac{\partial \mathrm{H}_c}{\partial c_t} = 0 \Rightarrow \frac{1}{c_t} = \lambda_{1t} + \chi_t = \lambda_{1t}\left(1 + \frac{\chi_t}{\lambda_{1t}}\right) \tag{9}$$

$$\frac{\partial \mathrm{H}_c}{\partial z_t} = 0 \Rightarrow \lambda_{2t} = \lambda_{1t} + \chi_t = \lambda_{1t}\left(1 + \frac{\chi_t}{\lambda_{1t}}\right) \tag{10}$$

$$\frac{\partial \mathrm{H}_c}{\partial m_t} = 0 \Rightarrow \frac{\dot{\lambda}_{1t}}{\lambda_{1t}} = \rho + \pi_t - \frac{\chi_t}{\lambda_{1t}} \tag{11}$$

$$\frac{\partial \mathrm{H}_c}{\partial k_t} = 0 \Rightarrow \frac{\dot{\lambda}_{2t}}{\lambda_{2t}} = \rho - [1-\phi\tau]\frac{\lambda_{1t}}{\lambda_{2t}}(1-\alpha) g_k^{\alpha} \tag{12}$$

where g_k represents the ratio of public expenditure to capital ($g_k \equiv \frac{g_t}{k_t}$).

Based on the above first-order conditions, the following expressions can be found.

$$\frac{\dot{c}_t}{c_t} = r_t - \rho - \frac{\dot{R}_t}{1+R_t} \tag{13}$$

$$\frac{\dot{R}_t}{1+R_t} = r_t - \frac{(1-\alpha)(1-\phi\tau)\, g_k^{\alpha}}{1+R_t} \tag{14}$$

where r_t is the actual interest rate, and R_t is the nominal interest rate ($R_t = r_t + \pi_t$). Eq.(13) corresponds to the Keynes-Ramsey rule[iii], and it describes the consumption growth rate. Eq.(14) depicts the dynamic change of the nominal interest rate. Combined with the government budget constraint depicted in Eq.(7), the expression of g_k can be written as follows.

$$g_k \equiv \frac{g_t}{k_t} = \left(\frac{\phi\tau + \omega}{1+\omega}\right)^{\frac{1}{1-\alpha}} \tag{15}$$

Divide both sides of the equilibrium $y_t = c_t + \dot{k}_t + g_t$ by k_t simultaneously, and the expression of capital growth rate γ_k can be shown as follows.

$$\gamma_k \equiv \frac{\dot{k}_t}{k_t} = g_k^{\alpha} - g_k - c_k \tag{16}$$

On the other hand, based on the expression of actual money stock growth rate ($m_t \equiv \frac{M_t}{P_t}$), we have Eq.(17) after logarithmic linearisation.

$$\frac{\dot{m}_t}{m_t} = \frac{\dot{M}_t}{M_t} - \frac{\dot{P}_t}{P_t} = \omega - \pi_t \tag{17}$$

Combining Eq.(17) with the expression of Fisher Equation ($R_t = r_t + \pi_t$), we get the following equilibrium

$$\gamma_m \equiv \frac{\dot{m}_t}{m_t} = \omega + r_t - R_t \tag{18}$$

The nominal interest rate, the actual interest rate and the inflation rate are constant in steady-state. Consumption, capital, productive public expenditure, and GDP are increasing with constant speed $\gamma^* = \frac{\dot{c}}{c} = \frac{\dot{k}}{k} = \frac{\dot{g}}{g} = \frac{\dot{m}}{m} = \frac{\dot{y}}{y}$. The steady-state growth rate of economy can be deduced according to Eq.(13).

$$\gamma^* = r^* - \rho \tag{19}$$

It is shown that the growth rate γ^* depends on the actual interest rate and the discount rate. The actual interest rate r^* can be derived from Eq.(13) and Eq.(14).

$$r^* = \frac{(1-\alpha)(1-\phi\tau)\, g_k^{\alpha^*}}{1+R^*} \tag{20}$$

The nominal interest rate R^* is deduced from the money market equilibrium.

$$R^* = \omega + \rho \tag{21}$$

By combining Eq.(15), Eq.(19), Eq.(20) and Eq.(21), the equilibrium of economic growth rate in steady-state can be found.

$$\gamma^* = \left[\frac{(1-\alpha)(1-\phi\tau)}{1+\omega+\rho}\right]\left[\frac{\phi\tau+\omega}{1+\omega}\right]^{\frac{\alpha}{1-\alpha}} - \rho \tag{22}$$

3.3 Empirical hypothesis

It is worthwhile to note that the relationship between government integrity and economic growth can be investigated by analysing the following equation.

$$\begin{aligned}\frac{\partial\gamma^*}{\partial\phi} &= \frac{1}{1+\omega+\rho}\cdot\left(\frac{\phi\tau+\omega}{1+\omega}\right)^{\frac{\alpha}{1-\alpha}}\cdot\left[-\tau(1-\alpha)+\frac{\alpha\tau(1-\phi\tau)}{\phi\tau+\omega}\right] \\ &= \frac{1}{1+\omega+\rho}\cdot\left(\frac{\phi\tau+\omega}{1+\omega}\right)^{\frac{\alpha}{1-\alpha}}\cdot\left[\frac{\alpha\tau(1+\omega)}{\phi\tau+\omega}-\tau\right]\end{aligned} \tag{23}$$

According to Eq.(23), it is clear that the value of $\frac{\alpha(1+\omega)}{\phi\tau+\omega}$ determines whether $\frac{\partial\gamma^*}{\partial\phi}$ is positive or negative. When the growth rate of the money supply ω is lower than a certain threshold ($\omega < \hat{\omega} = \frac{\alpha-\phi\tau}{1-\alpha}$), the government integrity will promote economic growth ($\frac{\partial\gamma^*}{\partial\phi} > 0$). The improvement of government integrity can lead to tax appreciation and enhancement of public spending capacity, when the growth rate of money supply is at a low level. Under this situation, the "public expenditure increasing effect" exceeds the "tax burden increasing effect" of the private sector, thus promoting economic growth. On the contrary, when the growth rate of money supply is too high ($\omega > \hat{\omega}$), the government integrity will inhibit economic growth ($\frac{\partial\gamma^*}{\partial\phi} < 0$). Although the government's public expenditure can be increased by improving government integrity, there is the marginal decreasing effect in the

support of enterprises' investment and production in the high-inflation environment. In addition, the combination of high-tax and high-inflation increases the burden on enterprises, and inhibits the private sector's willingness to invest and produce, thus detrimental to economic growth. Overall, the theoretical study gives the following hypothesis to be tested empirically.

Hypothesis: *The government integrity will promote economic growth when the growth rate of money supply is lower than a certain threshold; the government integrity will inhibit economic growth when the growth rate of money supply is higher than a certain threshold.*

4. Methodology and data

We will verify the above hypothesis by using the dynamic panel threshold regression model, based on the data of 140 countries around the world from 2003 to 2019.

4.1 Methodology

The dynamic panel threshold regression model is used to test whether the impact of government integrity on economic growth will show a certain nonlinear trend with the change of money supply growth rate. To be specific,

$$\gamma_{it} = a + \rho \cdot \gamma_{i,t-1} + \theta_1 \cdot \phi_{it} \cdot I\left(\omega_{it} \le \hat{\omega}\right) + \theta_2 \cdot \phi_{it} \cdot I\left(\omega_{it} > \hat{\omega}\right) + \mathbf{x}'_{\mathbf{it}}\mathbf{b} + u_i + \sigma_t + \varepsilon_{it} \quad (24)$$

where the subscript i and t represent respectively the country and time; γ_{it} is the explained variable. γ_{it} is the explained variable, indicating the economic growth of country i in the t year, and $\gamma_{i,t-1}$ indicates the lag of the country's economic growth; ϕ_{it} is the core explanatory variable, indicating the government integrity in country i at t year; ω_{it} represents the growth rate of money supply, which is the threshold variable; $\hat{\omega}$ represents the threshold value; $I(\cdot)$ is an indicator function, and the value of indicator function is 1 if the conditions in brackets are met, otherwise 0; $\mathbf{x}'_{\mathbf{it}}$ represents a set of control variables, including the import and export of the country (im and ex), net inflow of foreign direct investment (fdi), and population (pop); u_i is the individual effect, σ_t is the time effect, and ε_{it} is the random error term.

The estimation process is as follows. First, we sort the values of threshold variable (ω_{it}), and remove some data at the beginning and at the end according to the proportion of 10% to ensure that there are a certain number of observed values in each area. Second, we substitute the remaining data into the Eq.(24) for estimation,

and set the value corresponding to minimising the sum of squared residuals in the regression result as the threshold value of the model. Third, we test the threshold value by Bootstrap sampling method, and determine the significance of the threshold value. Fourth, we repeat the above process, and estimate the second threshold and test the significance[iv].

4.2 Data

We collect the relevant data from 140 countries in the world from 2003 to 2019, including 31 developed countries and 109 developing countries. These data mainly stem from "World Bank Database", "CEIC Database", and "Global Corruption Perceptions Index Database".

The explained variable "economic growth" (γ) is measured by the real GDP growth rate which shows the percentage change in a country's real GDP over time, typically from one year to the next. It can be calculated using the following formula: $\gamma = \left(\frac{\text{final GDP} - \text{initial GDP}}{\text{initial GDP}} \right)$. The core explanatory variable "government integrity" (ϕ) is measured by the global Corruption Perceptions Index (CPI). This index adopts the hundred-point system. Scores range from 0 to 100, with zero indicating low levels of government integrity and 100 indicating high levels. It is worth noting that, in order to alleviate the endogenous problem, we choose the government integrity in the previous year (lag 1) as the core explanatory variable. Central banks often put the monetary control target on M2, which has a high correlation with interest rates. Therefore, M2 is chosen to measure the money supply, and the change of M2 is used to measure the threshold variable "growth rate of money supply" (ω).

In addition, for different countries, the impact of government integrity on economic growth may be differentiated. Thereby, we define two grouping variables: "Belt and Road Initiative country" (br) and "Developed country" (dev). According to the official information of China's Belt and Road Network (https://www.yidaiyilu.gov.cn/xwzx/roll/77298.htm), China had signed 206 cooperation documents with 140 countries and 32 international organisations to jointly build the Belt and Road Initiative. For the countries that signed the cooperation documents with China, we set $br = 1$, otherwise 0. As far as "Developed country" is concerned, 23 European countries such as Britain and Ireland, 2 American countries such as the United States and Canada, 2 Australian countries such as Australia and New Zealand, and 4 Asian countries such as Japan and Singapore are considered as $dev = 1$, otherwise 0. The specific variables and descriptive statistics are summarised in Table 1.

Table 1. Variables and descriptive statistics

Type	Name	Symbol	Mean	Min	Max	Obs	Source
Explained variable	Economic growth	γ	0.085	-0.533	1.926	2380	World bank national

Type	Name	Symbol	Mean	Min	Max	Obs	Source
							accounting data and OECD national accounting data
Explanatory variable	Government integrity	ϕ	44.035	11	97	2380	Global Corruption Perception Index database
Threshold variable	Money supply growth rate	ω	0.117	-0.991	1.874	2380	World Bank and CEIC database
Control variable	Population	*pop*	4.56e+07	82475	1.40e+09	2380	World Bank
	Export[v]	*ex*	1.06e+11	5.00e+06	2.50e+12	2380	World Bank
	Import[vi]	*im*	1.07e+11	4.10e+07	2.60e+12	2380	World Bank
	Net inflow of FDI	*fdi*	1.31e+10	-3.60e+11	7.30e+11	2380	World Bank
Grouping variable	Belt and Road Initiative country	*br*	0.550	0	1	2380	Collected by authors
	Developed country	*dev*	0.221	0	1	2380	Collected by authors

Source: Authors' processing.

5. Main results and discussion

5.1 Threshold effect tests

Before estimation, the existence of thresholds should be investigated in order to clarify the specific form of the threshold regression model. Referring to the practices of Hansen (1999), the existence of threshold is tested, and the F statistics and the p-values are calculated by Bootstrap sampling. The specific results are summarised in Table 2.

Table 2. Threshold effect tests

Model	F statistic	p-value	Bootstrap times	Critical value 1%	5%	10%
Single threshold	100.57	0.000	500	32.712	28.374	26.415
Double threshold	77.80	0.000	500	25.500	21.578	18.825
Triple threshold	49.00	1.000	500	165.704	153.093	145.181
		Single threshold			**Double threshold**	
Threshold value		-0.167			0.308	
95% confidence interval		[-0.242, -0.143]			[0.300, 0.320]	

Source: Authors' processing.

It is shown that under the null hypothesis that there is no threshold, the F statistic is 100.57 and the p-value is 0.000, which means that the null hypothesis can be rejected and there is "single threshold". The "double threshold" and "triple threshold" tests are carried out one after another, and it is confirmed that the p-value of the triple threshold is 1, indicating that there should be two thresholds. The lower part of Table 2 shows that the estimated values of a single threshold and a double threshold are within a 95% confidence interval, which means that the identification of threshold values is effective. In addition, through the statistics of Likelihood-Ratio (LR) in Figure 1, it can be seen that, at a given significance level of 5%, the LR corresponding to the two threshold estimates based on the growth rate of money supply are all less than the critical value of 7.352, and the null hypothesis that "the threshold estimate is equal to the actual value" cannot be rejected. Therefore, the authenticity of the threshold estimated by Bootstrap has been effectively verified.

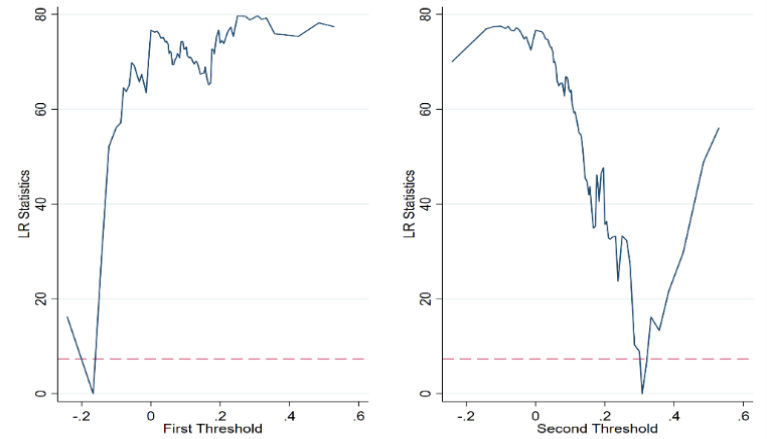

Figure 1. Threshold estimate and confidence interval

Source: Authors' own creation.

5.2 Nonlinear effect of government integrity

According to Table 3, when the growth rate of money supply (ω) does not exceed the first threshold -0.167, the estimated coefficient of ϕ is 0.005, indicating that the improvement of government integrity has a significant positive effect on economic growth (for example, Armenia, Belarus, Kyrgyzstan, Moldova). When the growth rate of money supply is between -0.167 and 0.308, the government integrity still has a significant positive effect on economic growth, but this effect is slightly reduced. Nevertheless, when the growth rate of money supply exceeds 0.308, the influence of government integrity on economic growth turns into a negative effect (for example, Iraq, Northern Macedonia, Montenegro, East Timor). Obviously, the government integrity has a "double threshold" nonlinear effect on economic growth. Only in a situation when the growth rate of money supply is controlled in a moderate range will the improvement of government integrity be conducive to promoting economic growth. In addition, the estimated coefficient of $L.\gamma$ is significant at the statistical level of 1%, and for every 1% increase in the economic growth rate of the lagging period, the economic growth rate of the current period will increase by 0.114%, which indicates that the economic growth has a strong "inertia". This finding strongly supports the necessity of building a panel threshold regression model with dynamic characteristics.

Table 3. Estimated results of double threshold regression model

Explained variable	Coefficient	p-value	95% confidence interval
$\phi(\omega \leq -0.167)$	0.005***	0.000	[0.003, 0.007]
	(4.36)		
$\phi(-0.167 < \omega \leq 0.308)$	0.003***	0.000	[0.002, 0.005]
	(5.20)		
$\phi(\omega > 0.308)$	-0.007***	0.000	[-0.009, -0.005]
	(-9.86)		
$L.\gamma$	0.114***	0.000	[0.074, 0.154]
	(5.57)		
pop	-9.70e-10***	0.004	[-1.64e-09, -3.02e-10]
	(-2.85)		
ex	1.90e-13	0.130	[-5.61e-14, 4.36e-13]
	(1.51)		
im	-2.44e-13*	0.080	[-5.17e-13, 2.95e-14]
	(-1.75)		
fdi	1.56e-13	0.146	[-5.42e-14, 3.66e-13]
	(1.46)		
constant	0.096***	0.000	[0.066, 0.126]
	(6.30)		
Time effect	yes		
Individual effect	yes		
Obs.	2380		

Note: *** and * are significant at 1% and 10% statistical levels respectively; t value in parentheses (); 95% confidence interval in brackets [].

Source: Authors' processing.

5.3 Robustness checks

This subsection will discuss the robustness of the empirical results in two ways: (1) by adding gradually the new control variables, such as *highedu* (proportion of labor force with higher education), *irr* (real internal rate of return), we investigate whether the coefficient and significance of the core explanatory variables have changed; (2) we select sub-samples from the year 2004 to 2019 as research samples to examine whether the results of the empirical study are robust.

We perform robustness test to support the results of Table 3, by supplementing the regressions with some other control variables (Panel B in Table 4) and using the sub-samples (Panel C in Table 4). To be more clear, we put the estimated results of Table 3 in Panel A of Table 4.

Table 4. Robustness test

	Panel A	**Panel B**		**Panel C**
	Full sample 2003-2019	Full sample 2003-2019	Full sample 2003-2019	Sub-sample 2004-2019
Explained variable				
$\phi(\omega \le \hat{\omega}_1)$	0.005***	0.005***	0.005***	0.004***
	(4.36)	(5.82)	(4.89)	(5.18)
$\phi(\hat{\omega}_1 < \omega \le \hat{\omega}_2)$	0.003***	0.004***	0.004***	0.002***
	(5.20)	(4.13)	(3.50)	(3.09)
$\phi(\omega > \hat{\omega}_2)$	-0.007***	-0.002**	-0.002*	-0.001*
	(-9.86)	(-2.26)	(-1.75)	(-1.82)
$L.\gamma$	0.114***	0.040*	0.021*	0.050**
	(5.57)	(2.19)	(1.76)	(2.32)
highedu		-0.009	0.001	
		(-0.91)	(1.20)	
irr			0.008***	
			(8.40)	
constant	0.096***	-0.254***	-0.463***	-0.270***
	(6.30)	(-2.66)	(-4.27)	(-7.86)
Control variable	Yes	yes	yes	yes
Time effect	Yes	yes	yes	yes
Individual effect	Yes	yes	yes	yes
Obs.	2380	2380	2380	2240

Note: ***, ** and * are significant at 1%, 5% and 10% statistical levels respectively; t value in parentheses (); 95% confidence interval in brackets [].

Source: Authors' processing.

Panel B in Table 4 shows the regression results after gradually adding control variables. The coefficient and significance of the main variables are consistent with those of Panel A. Besides, Panel C in Table 4 is the estimated result based on sub-samples from 2004 to 2019. The sign and significance of the coefficients have not changed. The results of the empirical study are robust.

6. Heterogeneity discussion

For different countries, the influence of government integrity on economic growth often has different characteristics. Therefore, we discuss the relationship between government integrity and economic growth in different countries.

6.1 "Belt and Road Initiative" (BRI) countries vs. non-BRI countries

The upper part of Table 5 sorts out the results of the threshold effect tests based on the BRI country group and the non-BRI country group. It is shown that F statistics of single threshold and double threshold based on BRI country group are significant at 1% statistical level, but the F statistic of triple threshold is not significant, which indicates that there is double threshold effect in the dynamic panel threshold regression model. Similarly, in the group of non-BRI countries, there is a double threshold effect. The lower part of Table 4 also shows the estimated values of the threshold variables and their corresponding 95% confidence intervals. The results show that the threshold values in BRI country group are -0.039 and 0.167 respectively, while the threshold values in non-BRI country group are -0.081 and 0.200 respectively. All of these estimated values are within the 95% confidence interval, indicating that the double threshold model should be used for the estimation.

Table 5. Threshold effect tests (BRI countries and non-BRI countries)

Group	Model	F statistic	p-value	Bootstrap times	Critical value 1%	Critical value Model	Critical value F statistic
77 BRI countries	Single threshold	144.94	0.000	500	34.421	29.919	28.057
	Double threshold	57.09	0.000	500	17.112	14.053	8.367
	Triple threshold	15.79	0.560	500	32.215	28.468	23.984
63 non-BRI countries	Single threshold	171.32	0.000	500	31.942	29.263	26.850
	Double threshold	59.42	0.000	500	17.129	10.761	10.002
	Triple threshold	33.94	0.400	500	66.105	53.824	44.439
				Single threshold		**Double threshold**	
77 BRI countries	Threshold value			-0.039		0.167	
	95% confidence interval			[-0.053, -0.033]		[0.160,0.172]	
63 non-BRI countries	Threshold value			-0.081		0.200	
	95% confidence interval			[-0.101, -0.077]		[0.167, 0.208]	

Note: 95% confidence interval in brackets [].
Source: Authors' processing.

Table 6 reports the estimated results based on two groups. As far as BRI countries are concerned, the improvement of government integrity is beneficial to economic growth. When the growth rate of money supply (ω) is higher than -0.039, the promoting effect is obvious; when the growth rate of money supply reaches or exceeds 0.167, the positive role of government integrity in promoting economic growth is further strengthened. Concerning non-BRI countries, when the growth rate of money supply is lower than -0.081, the improvement of government integrity will significantly promote economic growth; when the growth rate of money supply is between -0.081 and 0.200, the promoting effect is no longer obvious; when the growth rate of money supply is higher than 0.200, the improvement of government integrity may slow down the economic growth. In short, no matter whether for BRI or non-BRI countries, there is always a certain nonlinear relationship between government integrity and economic growth due to the change of the growth rate of money supply.

Table 6. Estimated results (BRI countries and non-BRI countries)

Group: 77 BRI countries		**Group: 63 non-BRI countries**	
Variable	**Coefficient**	**Variable**	**Coefficient**
$\phi(\omega \le -0.039)$	0.001	$\phi(\omega \le -0.081)$	0.003***
	(1.28)		(3.55)
$\phi(-0.039 < \omega \le 0.167)$	0.003***	$\phi(-0.081 < \omega \le 0.200)$	0.001
	(3.13)		(1.64)
$\phi(\omega > 0.167)$	0.004***	$\phi(\omega > 0.200)$	-0.001
	(4.78)		(-0.75)
$L.\gamma$	0.058**	$L.\gamma$	0.133***
	(2.14)		(4.74)
pop	-2.46e-09***	*pop*	-1.93e-10
	(-2.96)		(-0.63)
ex	4.28e-13*	*ex*	1.44e-13
	(1.87)		(0.96)
im	-3.77e-13	*im*	-1.58e-13
	(-1.32)		(-1.11)
fdi	3.60e-13	*fdi*	1.10e-13
	(0.76)		(1.26)
constant	-0.017	*constant*	-0.012
	(-0.26)		(-0.25)
Time effect	yes	Time effect	yes
Individual effect	yes	Individual effect	yes
Obs.	1309	Obs.	1071

Note: ***, ** and * are significant at 1%, 5% and 10% statistical levels respectively; t value in parentheses ().

Source: Authors' processing.

6.2 Developed countries vs. developing countries

Table 7 reports the results of the threshold effect test based on the developed country group and the developing country group. The results show that there are double threshold effects in the dynamic panel threshold regression models with developed and developing countries as research samples, and the likelihood ratio (LR) of the threshold variables is less than the critical value at the 5% significance level.

Table 7. Threshold effect tests (developed countries and developing countries)

Group	Model	F statistic	p-value	Bootstrap times	Critical value		
					1%	Group	Model
31 developed countries	Single threshold	79.14	0.000	500	10.683	9.487	7.361
	Double threshold	16.57	0.000	500	9.124	6.840	5.626
	Triple threshold	7.50	0.780	500	18.877	16.884	15.124
109 developing countries	Single threshold	131.10	0.000	500	33.860	31.718	29.751
	Double threshold	63.55	0.000	500	33.319	16.645	13.268
	Triple threshold	27.96	0.780	500	90.000	75.819	60.743
				Single threshold			**Double threshold**
31 developed countries	Threshold value			-0.051			0.129
	95% confidence interval			[-0.059, -0.048]			[0.096, 0.134]
109 developing countries	Threshold value			-0.148			0.167
	95% confidence interval			[-0.233, -0.121]			[0.158, 0.172]

Note: 95% confidence interval in brackets [].
Source: Authors' processing.

Table 8 reports the estimated results based on two groups. According to the threshold estimates, the money supply growth rate can be divided into three intervals: high, middle, and low. There are significant differences in the estimated coefficients of government integrity on economic growth in different intervals, which further confirms that the impact of government integrity on economic growth is nonlinear with the change of money supply growth rate.

Table 8. Estimated results (developed countries and developing countries)

Group: 31 developed countries		Group: 109 developing countries	
Variable	**Coefficient**	**Variable**	**Coefficient**
$\phi(\omega \le -0.051)$	0.02**	$\phi(\omega \le -0.148)$	0.003***
	(2.02)		(3.01)
$\phi(-0.051 < \omega \le 0.129)$	0.001	$\phi(-0.148 < \omega \le 0.167)$	0.005***
	(1.17)		(4.95)
$\phi(\omega > 0.129)$	0.000	$\phi(\omega > 0.167)$	-0.007***
	(0.54)		(9.68)
$L.\gamma$	0.157***	$L.\gamma$	0.083***
	(4.04)		(3.60)
pop	-5.52e-09**	*pop*	-3.41e-10
	(-2.35)		(-0.87)
ex	1.08e-13	*ex*	4.19e-13**
	(0.76)		(2.16)
im	1.64e-14	*im*	-6.06e-13**
	(0.12)		(-2.41)
fdi	5.44e-14	*fdi*	8.82e-13*
	(0.72)		(1.93)
constant	0.072	*constant*	0.032
	(0.106)		(1.48)
Time effect	yes	Time effect	yes
Individual effect	yes	Individual effect	yes
Obs.	527	Obs.	1853

Note: ***, ** and * are significant at 1%, 5% and 10% statistical levels respectively;
t value in parentheses ().
Source: Authors' processing.

Specifically, as far as developed countries are concerned, the promoting effect of government integrity on economic growth will gradually weaken with the increase of money supply growth rate. As far as developing countries are concerned, when the growth rate of money supply is lower than the threshold value of -0.148, the estimated coefficient of ϕ is 0.003, indicating that the improvement of government integrity is beneficial to promoting economic growth. When the growth rate of money supply is at a medium level (between -0.148 and 0.167), the estimated value of the coefficient ϕ increases to 0.005, indicating that the positive effect of government integrity on economic growth has been enhanced. When the growth rate of money supply is higher than 0.167, the estimated coefficient of ϕ is -0.007, indicating that the improvement of government integrity significantly inhibits economic growth in a high-level of money supply growth rate.

On the whole, the level of government integrity in developed countries is generally high, and the promoting effect on economic growth by further improving government integrity is minimal, especially when the growth rate of money supply is at a medium or high level. However, the improvement of government integrity in developing countries may promote or inhibit economic growth. With the increase of

money supply growth rate, the influence of government integrity on economic growth presents an "inverted-U" shape.

7. Conclusions

A number of studies, either theoretical or empirical, in the past investigated the relationship between government integrity and economic growth and drew mixed evidence (Sharma & Mitra, 2019), either noting the adverse effect of government integrity on growth or showing the growth-enhancing effect of government integrity. This paper attempts to explore the actual nonlinear effect of government integrity on economic growth by combining theoretical discussion with empirical analysis. To be specific, we construct an endogenous economic growth model composed of private sector and government sector, and discuss theoretically whether the government integrity is a lubricant or a stumbling block of economic growth under different money supply conditions; and then, based on the data of 140 countries in the world from 2003 to 2019, we verify the theoretical finding by using the dynamic panel threshold regression model. It is found that the impact of government integrity on economic growth is nonlinear; whether the government integrity is a lubricant or a stumbling block to economic growth depends on the money supply. Specifically, when the growth rate of money supply is lower than a certain threshold (30.8%), the improvement of government integrity will significantly promote economic growth. However, if the growth rate of money supply is too high (higher than 30.8%), the improvement of government integrity may inhibit economic growth. As far as China and other BRI countries are concerned, the improvement of government integrity is always beneficial to promoting economic growth. Nevertheless, for non-BRI countries, if and only if the growth rate of money supply is low enough (lower than -8.1%), the improvement of government integrity could enhance economic growth. Besides, the influence of government integrity on economic growth in developing countries shows an "inverted-U" shape.

Based on the findings of this study, the following policy recommendations are made. Governments should actively explore the economic development mode in line with their own national conditions, formulate effective monetary policies, and play a stable role in promoting economic growth by improving government integrity. As the improvement of government integrity in BRI countries is always beneficial to economic growth, BRI countries should continue to carry out the high-pressure anticorruption. Concerning developing countries, governments should prudently implement macrocontrol, guide the reasonable growth of money supply, and strive to control the growth rate of money supply below 16.7%, so as to give full play to the positive role of government integrity in promoting economic growth. As far as developed countries and non-BRI countries are concerned, the governments should reduce the growth rate of money supply as much as possible, to provide an excellent environment for the government integrity to promote economic growth.

There are still some imperfections in this study that can be expanded in the following aspects. First, the integrity measurement method of the government in this study

needs to be improved. In the future, combined with the availability of data, we could build a comprehensive index system that can measure the government integrity in various countries more accurately. Second, the influence mechanism of government integrity on economic growth is not examined in this study. Future research can construct an appropriate theoretical model and conduct proper empirical tests based on a novel setting to investigate how government integrity influences economic growth.

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Notes:

[i] Seigniorage is a hidden tax increase caused by inflation.

[ii] The corruption of officials hinders the government's ability to collect income taxes, which forces the government to restructure public finance through seigniorage tax, thus providing funds for productive public expenditure (Myles & Yousefi, 2015)

[iii] In macroeconomics, the Keynes–Ramsey rule is a necessary condition for the optimality of intertemporal consumption choice. Usually it is a differential equation relating the rate of change of consumption with interest rates, time preference, and (intertemporal) elasticity of substitution.

[iv] Search for the minimum sum of squared residuals of the second threshold ($S_2(\gamma_2)$), and the corresponding second threshold is $\hat{\gamma}_2 = \arg\min S_2(\gamma_2)\cdot$ $F_2 = \frac{S_1(\hat{\gamma}) - S_2(\hat{\gamma}_2)}{\hat{\sigma}^2}$ statistic is used to investigate whether there is a significant difference between the two thresholds.

[v] Export shows the FOB value of goods provided to the rest of the world in current US dollars.

[vi] Import indicates the FOB value of commodities received from other parts of the world in current US dollars.