# Vertical Fiscal Imbalances and Firms' Technological Innovation

# Wanqiang Ye

School of Accounting, Anhui University of Finance and Economics, Bengbu 233000, China;

3202300342@aufe.edu.cn

## Abstract

Innovation represents the fundamental driver of comprehensive economic and social advancement. The establishment of a central-local fiscal relationship, characterised by clearly defined responsibilities and balanced resource allocation, is of paramount importance for the enhancement of local science and technology innovation capacity. This study empirically examines data from listed companies in China's A-share market between 2010 and 2019 to investigate the impact of local government vertical fiscal imbalances on firms' technological innovation and the potential courses of action available to them. The findings indicate that local governments' vertical fiscal imbalance exerts a dampening effect on firms' technological innovation. Specifically, the higher the degree of fiscal imbalance, the weaker the firms' technological innovation ability. Further analysis of the mechanisms at work reveals that competition among local governments for economic growth serves to exacerbate the negative impact of fiscal imbalance on technological innovation. Furthermore, the heterogeneity analysis indicates that the inhibitory effect of fiscal imbalance on technological innovation is particularly pronounced among large firms, private firms, firms that do not collaborate with Big 4 accounting firms, high-tech industries, and firms in the digital economy. This study offers a micro-level perspective on how fiscal interactions between different government levels influence firms' decisions, which can inform the optimization of government-firm interactions and the promotion of high-quality regional economic growth.

# Keywords

Vertical fiscal imbalances, technological innovation, intergovernmental fiscal relations.

# 1. Introduction

In response to the evolving demands of the socialist market economy, China embarked on a significant tax reform in 1994. This reform granted the central government the authority to collect the majority of taxes, while local governments were relegated to collecting a limited array of taxes. Despite this diminution in their tax collection capabilities, local governments did not experience a proportional decrease in their public expenditure obligations. This dynamic has become a defining characteristic of China's fiscal system, exemplifying the phenomenon of vertical fiscal imbalance (VFI).

The tax system reform has significantly altered the macroeconomic control landscape for the central government. However, it has also created a potential predicament for local governments, which may find themselves in a precarious financial situation, unable to meet their expenditure needs with their reduced revenue intake. On a national scale, the level of vertical fiscal imbalance, as measured by the VFI index, has remained between 0.4 and 0.6 from 1998 to 2016. Notably, it has surpassed 0.6 in the period from 2016 to 2019, indicating a heightened level of fiscal imbalance.

Innovation stands as the pivotal engine propelling China's sustained socio-economic advancement. The twentieth National Congress of the Communist Party underscored the

imperative to augment the efficacy of scientific research investment and to revamp the financial mechanisms earmarked for science and technology (S&T). Despite the remarkable economic strides post-reform and opening up, China's relentless ascent in S&T investment and bolstered innovation capabilities have not been devoid of challenges. Critical technological domains still grapple with developmental bottlenecks.

The fiscal decentralization system, which delineates the allocation of resources between central and local authorities, exerts a profound impact on the investment levels in science and technology and the innovation prowess of regional enterprises. To catalyze high-quality economic progress, China is tasked with fortifying its innovation impetus and surmounting existing developmental impediments. The government's pivotal role in furnishing innovation resources is paramount, and intensifying reforms within the fiscal S&T funding distribution mechanism is a strategic imperative to heighten the investment efficiency in scientific research. The phenomenon of "public pooling" resulting from fiscal transfers allows local governments to rely on nationwide financial resources for their fiscal expenditures without having to assume full responsibility for their expenditures. This incomplete expenditure responsibility may lead to a tendency for local governments to overspend. At the same time, the existence of the "public pool" phenomenon may weaken local governments' efforts in tax collection (Chu Devin et al., 2019). The problem of soft budget constraints arising from vertical fiscal imbalances stems from the lack of an effective monitoring mechanism for higher-level governments to adjust lower-level governments' fiscal revenues and expenditures. This leads to the possibility that local governments may engage in excessive borrowing and spending behavior out of selfinterest (Aldasoro and Seiferling, 2014).

Vertical fiscal imbalances may have two effects on firms' innovative activities. First, the phenomenon of "public pooling" stemming from vertical fiscal imbalances may lead local governments to shift their tax burden to other regions. This excessive reliance on fiscal transfers from higher levels of government may lead to deviations in the incentive structure of local governments, which may reduce their incentives to collect taxes and, in turn, reduce their tax burden by increasing fiscal subsidies to firms, which may contribute to capital accumulation and provide financial support for innovation activities. Second, in the "soft budget constraint" environment created by the vertical fiscal imbalance, local governments, under the pressure of economic competition, may be more inclined to invest financial resources in areas that can quickly boost GDP growth, while neglecting investment in innovation, resulting in inadequate investment in innovation.

Therefore, this study aims to analyze in depth the potential impact of the vertical imbalance of local finance on technological innovation of enterprises from the dimensions of "public fund pool" effect and "soft budget constraint" effect, with the purpose of verifying the existence of such an impact and exploring the path of its action and its economic consequences.

# 2. Literature Review

The research topic of this paper is the impact of vertical fiscal imbalance on firms' technological innovation. Research on vertical fiscal imbalance is still in its infancy. The extant literature will be organised in accordance with the relevance of the research content.

In terms of the macro impact of vertical fiscal imbalances, Eyrauda and Lusinyan (2013) explored the relationship between vertical fiscal imbalances and the financing structure of local governments and found that as the level of local vertical fiscal imbalances decreases, local GDP increases significantly. Jia, JX et al. (2014) examined the impact of fiscal decentralization on local expenditure policies, and found that expenditure decentralization increases government spending and leads to a greater weighting of funding allocations toward capital construction and a lesser weighting toward education and administration.Li and Du's (2021) study analyzed the potential impact of the vertical fiscal imbalance faced by local governments in China on their

fiscal sustainability, noting that this imbalance increases the fiscal burden of local governments and poses a challenge to their long-term fiscal health. Chu Deyin's (2018) study reveals how the vertical fiscal imbalance deeply affects local governments' public spending decisions at the institutional level, and points out that the problem of local government bias in the structure of public spending becomes more prominent as the degree of imbalance intensifies. Liu Shuxin's (2022) study also points out that vertical fiscal imbalances exacerbate income inequality between urban and rural residents at the macro level. Li Zhen (2023) found an inverted "U"shaped relationship between vertical fiscal imbalance and local government governance capacity, with the effect on government governance capacity shifting from facilitating to inhibiting as vertical fiscal imbalance increases from a moderate level to an excessive level.

With regard to the microeconomic consequences of vertical fiscal imbalances, the study conducted by Cai Qingfeng (2023) indicates that such imbalances result in the loss of incentive for local governments, which, in turn, has a detrimental impact on business investment. Hu's (2023) study reveals that vertical fiscal imbalance fosters corporate tax avoidance by curbing the vigor of local tax collection and government subsidies. Conversely, fiscal horizontal imbalance curtails corporate tax avoidance by enhancing the incentives for local tax collection and government subsidies.

In regard to the existing literature on the relationship between vertical fiscal imbalances and technological innovation, Yu Jingyuan and Wang Chun (2021) discovered that local vertical fiscal imbalances markedly diminished the level of regional innovation. Liu Liangliang and He Jun (2022) investigated the influence of vertical fiscal imbalance on enterprise technological innovation and discovered that vertical fiscal imbalance markedly impedes the advancement of enterprise technological innovation, resulting in a net loss to enterprise technological innovation. Guo Rui (2023) investigated the influence of vertical fiscal imbalance on regional scientific and technological innovation capacity. The findings indicated that vertical fiscal imbalance markedly impedes regional scientific and technological innovation capacity by distorting the fiscal expenditure bias of local governments.

In regard to the external environment of firms and their technological innovation, Guan and Yam (2015) posit that significant government financial incentives, including special loans and tax credits, have a favorable impact on firms' economic performance in innovation. However, direct special funding not only fails to enhance the economic performance of innovation but can, in some instances, exert a detrimental effect. Guo et al. (2016) demonstrate that firms that are funded by the government generate a greater quantity of technological and commercialized innovation outputs when compared to firms that have no government-funded peer firms and the same firms before they received funding. Furthermore, government-funded firms generate a significantly higher quantity of technological and commercialized innovation outputs. In a 2022 study, Li Xiuyu examined the impact of a social insurance premium reduction policy on micro firms' technological innovation. The findings suggest that the policy is conducive to improving firms' technological innovation. In contrast, Qian Long (2023) establishes a link between the macro-level technological service industry agglomeration and the micro-level technological innovation of manufacturing enterprises. The author's findings indicate that the technological service industry agglomeration has a positive impact on the "extensive margin" and "intensive margin" of technological innovation of manufacturing enterprises.

As evidenced by an examination of the extant literature, the current research on the impact of vertical imbalance in local government finance primarily concentrates on the aggregate level, encompassing a macro-level description and analysis of the economic performance of the entire region. However, there is a paucity of in-depth discussions exploring the influence of this imbalance on the behavior of micro-market actors. This research gap offers a vast scope for investigation and significant research value for this paper. Moreover, no scholars have yet explored the influence of external financial factors on enterprise technological innovation in

the context of local financial vertical imbalance. Accordingly, this paper will adopt an enterprise technological innovation perspective to conduct a comprehensive examination of the economic impact of local government vertical fiscal imbalance at the prefecture-level city level. This approach is designed to enhance the existing research on the impact of local government vertical fiscal imbalance with a more detailed and in-depth reference basis.

# 3. Theoretical Analysis

In the context of a decentralized governance framework with Chinese characteristics, issues such as local governments' misbehavior in spending and debt management, deviations in tax policies, and reliance on land-based finance caused by fiscal hierarchical imbalances have emerged as pivotal factors influencing regional economic growth and firms' strategic decisions. The imbalance between fiscal tiers has the potential to either promote or hinder firms' innovative capabilities. This paper will further examine the impact of fiscal imbalance on the intrinsic mechanism of firms' technological innovation within the context of China's decentralized governance system.

# 3.1. The positive promotional effect of vertical fiscal imbalances on firms' technological innovation

In accordance with the administrative decentralization framework that is characteristic of China, local governments are subjected to dual pressures: financial constraints and the need for career advancement. These pressures may prompt local governments to reconsider their financial and tax support for enterprises. On the one hand, the imbalance between fiscal tiers has created the phenomenon of a "shared pool," whereby local governments are able to spread their tax burden to other regions, which may lead to an over-reliance on financial assistance from This may result in an incentive bias created by the central government, which may reduce the incentives for local governments to collect taxes or provide excessive tax incentives for local business growth (Jia Junxue and Ying Shiwei, 2016). This laxity in tax collection directly reduces the tax burden for firms, thereby facilitating their accumulation of capital for investment in innovative technologies. Conversely, the GDP-based performance evaluation system for officials has historically served as a significant motivating factor for local governments to adopt a proactive and competitive stance in regional economic development. To attract foreign capital and corporate investment, local governments frequently prioritize the fiscal well-being of enterprises through measures such as tax incentives and financial assistance, which in turn enhance their potential for technological innovation. While the long-term consequence of financial transfers from the central government to localities may be the provision of inefficient subsidies to enterprises by local governments, which could result in a decline in enterprise vitality and an increased risk of zombification (Fan Ziying and Wang Qian, 2019), this is not an inevitable outcome. Nevertheless, in the short term, such assistance may function as a "catalytic factor," stimulating positive advancement in technological innovation within enterprises. In light of the aforementioned considerations, this study puts forth a research hypothesis:

H1a: Vertical imbalances in local government finance promote technological innovation in firms, i.e., the higher the level of vertical imbalances in local finance, the higher the level of technological innovation in firms

# 3.2. Negative inhibitory effect of vertical fiscal imbalance on technological innovation of enterprises

In a centralized political system, the Chinese political structure places a significant emphasis on the central government's role in administration, granting it the authority to assess and discipline the performance and behavior of local officials (He, 2015). In light of this incentive

structure, which is oriented towards promotion and economic performance, economic growth emerges as the primary indicator for evaluating the performance of local governments (Zhou Lian, 2007). This performance-based appraisal system may prompt local officials to pursue irrational expansionary policies in financial expenditure, favoring the investment of funds in material projects such as infrastructure that can yield immediate economic returns, while neglecting the allocation of financial resources to long-term investments such as innovation. This can result in a "competitive funding shortage problem " for local governments in the allocation of financial resources (Hong Yuan et al., 2018). In light of the fact that investment in innovation typically yields results over a longer period of time and is accompanied by heightened uncertainty and risk (Holmstrom, 1989), local governments, under the pressure of pursuing short-term economic and financial gains, may lack sufficient enthusiasm and commitment to promoting technological innovation in enterprises. Conversely, they may be more inclined to invest in projects that can rapidly stimulate economic growth and tax revenue, a myopic strategy that may impede firms' technological innovation capabilities. Furthermore, local officials may be inclined to select projects that can yield immediate economic benefits, which could impede the innovation potential of enterprises (Wu Yanbing, 2017). Based on these considerations, this study proposes the following hypothesis:

H1b: Vertical imbalances in local government finance inhibit firms' technological innovation, i.e., the higher the level of vertical imbalances in local finance, the lower the level of firms' technological innovation.

# 3.3. Mechanistic analysis of the impact of vertical fiscal imbalances on technological innovation in enterprises

In the context of vertical fiscal imbalance, local governments frequently encounter challenges in aligning their revenue and expenditure responsibilities, leading to a phenomenon known as the "competitive fiscal gap." To overcome this, local governments seek to increase fiscal revenues and stimulate economic growth, typically by expanding their tax base, which relies on a stronger local economy. The pursuit of economic growth remains a primary performance metric for local officials, who prioritize it to maximize political and economic benefits. This focus can result in an emphasis on investments that rapidly boost GDP, which may come at the expense of enterprise innovation. The central government's promotion criteria, based on economic growth, further incentivize this behavior, potentially leading to underinvestment in innovation and hindering regional technological advancement. In light of the aforementioned considerations, this study puts forth the following research hypotheses:

H2: The phenomenon of local governments engaging in 'growth competition' serves to exacerbate the adverse effects of vertical fiscal imbalances on firms' technological innovation.

Local government officials, driven by the pursuit of personal political and economic interests, have become more proactive in promoting regional economic growth and competing for resources. With the national innovation-driven development strategy, their focus has shifted from economic growth to improving innovation capacity. This shift, together with the central government's emphasis on technological innovation and the Party Central Committee's focus on people's well-being and sustainable growth, has led to increased investment in S&T innovation and a competitive landscape centred on innovation. These factors encourage local governments to support enterprises' innovation activities, thereby improving technological innovation capabilities. In light of the aforementioned considerations, this study puts forth the following research hypotheses:

H3: The involvement of local governments in 'innovation competitions' serves to mitigate the adverse effects of vertical fiscal imbalances on firms' technological innovation.

# 4. Data sources and research design

#### 4.1. Data sources

The present study focuses on a sample of listed companies in China's A-share market, selected for analysis between 2010 and 2019. The objective is to assess the impact of vertical fiscal imbalances at the local level on corporate innovation capacity. The data collection process entails the gathering of fiscal and economic indicators at the local and municipal levels. These data are primarily sourced from the China Urban Statistical Yearbook, the China Financial Yearbook, and the China Land and Resources Statistical Yearbook. In contrast, the corporate data are primarily obtained from the Cathay Pacific database and the Wind Financial database. In the initial stages of the sample screening process, this study excluded listed companies in the financial industry. Subsequently, companies that had been subject to special treatment (ST), were in a state of special treatment (ST), were in a state of protracted treatment (PT), or had been delisted during the specified time period were also excluded. Additionally, samples with incomplete key financial data were removed. Following the screening process, a total of 10,176 firm-year observations were obtained for analysis in this study. Moreover, the prefecture-level city to which a firm belongs is identified by its registered address, which enables the effective matching of prefecture-level and firm-level data. To ensure the robustness of the data analysis, this study also implements a 1% reduction of outliers for all continuous variables, thereby eliminating the potential effect of extreme values.

#### 4.2. Research design

In order to investigate the impact of vertical imbalance of local government finance at the municipal levels on the basic innovation of enterprises, this paper employs the following model for empirical analysis. The specific model is as follows:

 $RDA_{i,j,t} = \beta_0 + \beta_1 VFI_{i,j,t} + \beta_2 Control_{i,j,t} + Industry + Year + \epsilon$ (1) In this study, the RDAi, j,t is defined as the ratio of a firm's R&D investment to its total assets in a given year, city, and time period. This approach is consistent with the methodology employed by Shiyuan Liu et al. (2020).

In this study, the primary independent variable is a measure of the degree of vertical fiscal imbalance in the city where the firm is headquartered. At present, the two measurement methods proposed by Eyraud and Lusinyan (2013) are widely recognized as authoritative within the academic community. The first method defines fiscal imbalance through the gap between the ratio of the local government's own revenues and expenditures. The second method is more complex, taking into account the degree of decentralization of revenues and expenditures, as well as the gap between revenues and expenditures of the local finances. This method better reflects China's unique fiscal decentralization practices. The second approach is comprehensive and has been adopted and applied by several domestic scholars in their studies, including those by Chu Deyin (2019), Du Tongwei et al. (2019), and Chu Deyin and Chi Shuxian (2020). This paper therefore uses the second method.

This study utilizes GDP growth rate (denoted as lComp1) and the share of science and technology (S&T) expenditures in the fiscal budget (labeled lComp2) as time-lagged indicators to evaluate local governments' "growth-oriented competition" and "innovation-oriented competition," respectively. These measures are employed to analyze the impact of local officials' efforts and investment in S&T on regional economic development and innovation performance, while addressing potential endogeneity issues.

The control variables selected in this paper include firm-level control variables, industry-level control variables and macro-level control variables. Among them, the firm-level control variables include: firm book leverage ratio(LEV) : total liabilities/total assets of the enterprise; age of the enterprise(lnESTAGE) : (government subsidies received by the firm + 1) taken as

logarithm; firm size(lnSIZE) : logarithmic total assets of the firm; tax burden(TAX) Tax burden: Taxes payable by the enterprise/operating income; Government subsidies(lnGRANT) Government subsidies: (government subsidies received by the enterprise + 1) take the logarithm; enterprise growth(GROWTH) : (current year's operating income - previous year's operating income) / previous year's operating income; enterprise profitability(ROA) : operating profit / total assets; current ratio(CURRENT) Current assets/current liabilities. The industry-level control variable is the degree of competition in the industry, i.e., the Herfindahl-Hirschman index(HHI\_D). The macro-level control variable is the impact of monetary policy (M2): the cross-multiplier term of the logarithmized year-on-year growth rate of provincial financial institutions' deposit balances and the national money and quasi-money supply.

# 5. Results of empirical analysis

## 5.1. Descriptive statistics

Table 1 presents the initial statistical characterization of the key variables. The data indicate that the mean expenditure on research and development (R&D) by firms is 1.64 percent of their total assets. With regard to the measure of financial vertical imbalance, the mean value is 0.4033, indicating that there is some degree of imbalance in the allocation of financial resources in the sample examined. The maximum observed value of this indicator is 0.9460, while the minimum value is 0.0233, indicating a significant degree of variation in the prevalence of fiscal vertical imbalance across different regions.

variant	Ν	Mean	Min	p25	p50	p75	Max.	SD
RDA	10,176	0.0164	0.0000	0.0013	0.0133	0.0248	0.0819	0.0169
VFI	10,176	0.4033	0.0233	0.2064	0.3341	0.5672	0.9460	0.2431
LEV	10,176	0.4705	0.0499	0.3090	0.4796	0.6323	0.9173	0.2111
InESTAGE	10,176	2.8588	1.9459	2.6391	2.8904	3.0910	3.5264	0.3138
lnSIZE	10,176	22.3556	19.7663	21.3400	22.2133	23.2043	26.0536	1.3739
TAX	10,176	0.0246	-0.0582	0.0053	0.0137	0.0294	0.2737	0.0430
lnGRANT	10,176	15.0785	0.0000	14.6768	15.9732	17.1020	20.3156	4.1750
GROWTH	10,176	0.1616	-0.5224	-0.0154	0.1131	0.2730	1.7048	0.3282
ROA	10,176	0.0377	-0.2169	0.0130	0.0367	0.0667	0.2029	0.0586

Table 1 Descriptive statistics of variables

# 5.2. Main regression

Table 2 presents the results of the underlying regression analysis. The preliminary results presented in column (1) of the table exclude control variables and do not account for industry and time fixed effects. Subsequently, columns (2) through (4) introduce control variables, year fixed effects, and industry fixed effects in order to enhance the precision of the model. In particular, the analytical results in column (4) indicate that fiscal vertical imbalances have a statistically significant negative impact on firms' technological innovation at the 1% level of significance. In particular, for each unit increase in the level of fiscal vertical imbalance, firms' share of R&D investment is observed to decrease by an average of 0.67%. This finding indicates that Hypothesis H1a is not supported, while Hypothesis H1b is confirmed. Specifically, the results suggest that fiscal vertical imbalance at the local government level does inhibit firms' technological innovation activities. In other words, an increase in the degree of fiscal vertical imbalance is associated with a reduction in the level of technological innovation activity among firms.

		0 0 0	J = =	
	(1)	(2)	(3)	(4)
	RDA	RDA	RDA	RDA
VFI	-0.0087***	-0.0094***	-0.0035***	-0.0059***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Constant	0.0200***	0.1003***	0.0666***	0.0390***
	(0.0003)	(0.0037)	(0.0041)	(0.0039)
Control variable	No	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Industry fixed effects	No	No	No	Yes
Ν	10,176	10,176	10,176	10,176
R-squared	0.0158	0.1737	0.2020	0.3610

Table 2 underlying regression analysis

Note: \*\*\*, \*\*, and \* denote 1%, 5%, and 10% significance levels, respectively, and standard errors adjusted for firm-year level clustering are in parentheses. The following tables are identical.

#### 5.3. Endogeneity test

It is possible that endogeneity issues may arise in the benchmark regression model. This paper's core explanatory variable is the fiscal vertical imbalance, with enterprise technological innovation serving as the explanatory variable. This variable can be classified as both a macro factor and a micro factor. While the macro factor possesses a certain degree of exogeneity with respect to the micro factor, technological innovation within enterprises may lead to an increase in enterprise value. Consequently, enterprises have greater financial resources available to pay taxes, which results in an uptick in local government fiscal revenue. This, in turn, exerts a downward pressure on the fiscal vertical imbalance. This indicates the potential for reverse causality.

#### **5.3.1.** Instrumental variables approach

In order to address the potential endogeneity of the full sample data, we employed the instrumental variable approach in this study. In accordance with the established practice in academic research, we utilize the preceding period values of the core explanatory variables as instrumental variables in the model and employ the two-stage least squares (2SLS) method for estimation. As demonstrated in Table 3, the coefficients of the one-period lagged vertical fiscal imbalance indicator (IVFI) are markedly positive at the 1% level of significance in columns (1) and (2), indicating a positive correlation between the prior period's vertical fiscal imbalance and the current period. Furthermore, the instrumental variable is validated as its corresponding F-statistic surpasses the critical value of 16.38, thereby rejecting the hypothesis that the instrumental variable is invalid. The coefficient of the Vertical Fiscal Imbalance Indicator (VFI) is significantly negative at the 1% level of significance, which is consistent with the estimation results of the base model. This suggests that the estimation results of this study are robust after the instrumental variable approach to endogeneity has been adopted.

#### 5.3.2. Add control variables as well as cross-multiplication terms

To address potential endogeneity issues, including those stemming from omitted variables and sample selection bias, this study delves more deeply into the technological innovation activities of firms. Technological innovation is not only closely related to the intrinsic characteristics of firms, but also to macroeconomic factors, including regional economic growth (measured by the logarithmic form of gross domestic product) and industrial structure (expressed as the ratio of secondary industry output to gross domestic product). Moreover, industry trends and time effects exert an influence on technological innovation. In this study, we introduce indicators for regional economic growth and industrial structure, as well as interaction terms for industry

and year fixed effects, with the aim of controlling for the potential impact of these macroeconomic and time-related factors. As demonstrated in columns (3) and (4) of Table 3, the estimates presented in this study demonstrate robust results even after the incorporation of additional control variables.

### 5.3.3. Propensity score matching method (PSM)

To mitigate the influence of inherent firm-level differences on the study's findings, propensity score matching (PSM) was employed for a comprehensive analysis. The sample was divided into a treatment group with a higher degree of fiscal vertical imbalance and a control group with a lower degree based on the median of the key independent variables. In the matching process, control variables are employed as covariates. Furthermore, this study incorporates industry and time fixed effects to ensure the accuracy of the matching process. The treatment and control group firms were matched in a 1:2 ratio using the put-back nearest neighbor matching method. The matched sample data were employed in regression analyses, wherein the grouped dummy variables were utilized as independent variables. As evidenced by the PSM regression analysis results presented in column (5) of Table 3, the inhibitory effect of fiscal vertical imbalance on firms' technological innovation remains statistically significant.

	(1)	(2)	(3)	(4)	(5) PSM
	VFI	RDA	RDA	RDA	RDA
VFI		-0.0060***	-0.0061***	-0.0061***	-0.0057***
		(0.0008)	(0.0007)	(0.0007)	(0.0008)
lVFI	0.9688***				
	(0.0032)				
Constant			0.0371***	0.0447***	0.0396***
			(0.0040)	(0.0043)	(0.0048)
Control variable	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	No	Yes
Industry fixed effect	Yes	Yes	Yes	No	Yes
Area-level control variables	No	No	Yes	Yes	No
Industry and year fixed effects	No	No	No	Yes	No
Cragg-Donald Wald F	10000				
statistic	10000				
Ν	7,353	7,353	10,176	10,176	7,184
R-squared		0.1104	0.3619	0.3684	0.3557

Table 3 Test results for endogeneity issues

## 5.4. Robustness tests

## 5.4.1. Replacement of core independent variables.

In calculating the level of fiscal vertical imbalance, we employed the first method proposed by Eyraud and Lusinyan (2013). This method is predicated on the assumption that the level of fiscal vertical imbalance of local governments can be quantified by subtracting the ratio of local governments' own revenues to expenditures from the value of the unit. The specific expression for this calculation is defined as follows: the vertical fiscal imbalance index (VFI\_N) is equal to 1 minus the ratio of local government own revenues to local government own expenditures. The newly proposed indicator, VFI\_N, is designed to supersede the previous model's fiscal vertical imbalance variable, VFI, with the objective of more accurately capturing the extent of fiscal imbalances. The regression results are presented in column (1) of Table 4. It can be

observed that the results remain statistically significant after replacing the vertical fiscal imbalance measure.

This study employs the research methodology of Liu Shuxin and Yang Senping (2021) and Hu Xiaodong (2023), whereby the key explanatory variables of the model are updated by calculating the average of the prior and current periods of fiscal vertical imbalance and rerunning the regression analysis. This approach not only preserves the core features of fiscal vertical imbalances, but also helps to reduce the potential reverse causality issue between fiscal vertical imbalances and firms' technological innovation. As evidenced by the regression analysis presented in column (2) of Table 4, the coefficient of the average vertical fiscal imbalance indicator (AVFI) is statistically significant at the 1% level.

#### 5.4.2. Replacement of dependent variables

It is a widely accepted practice to utilize the firm's total number of patent applications for the year (APP\_TOTAL) as a measure of technological innovation. In comparison to the initial explanatory variable, research and development expenditure as a proportion of total assets (RDA), the overall number of patent applications can provide a more comprehensive representation of the breadth and depth of an enterprise's technological innovation. This approach allows for a more comprehensive reflection of the enterprise's technological innovation capabilities and achievements, a more accurate representation of the enterprise's development trajectory, and the provision of more robust support for strategic decision-making. The regression results are presented in column (3) of Table 4. It can be observed that there is a significant negative correlation between financial vertical imbalance and the total number of enterprise patent applications.

#### 5.4.3. Elimination of municipalities directly under the central government and subprovincial cities

It can be posited that cities with higher administrative levels may have broader autonomy in economic management and social governance, which may in turn lead them to exhibit different patterns of fiscal interactions than prefecture-level cities in general. This is particularly the case for sub-provincial cities and municipalities, which are afforded greater flexibility in fiscal resource allocation and policy implementation than other prefecture-level cities. To eliminate the potential influence of these variables on the findings, this study deliberately excludes the samples of these high-level cities from the regression analysis. As demonstrated in column (4) of Table 4, even after the exclusion of samples from municipalities and sub-provincial cities, vertical fiscal imbalance continues to exert a significant inhibitory effect on firms' technological innovation activities, thereby substantiating the research hypothesis that vertical fiscal imbalance has a detrimental impact on technological innovation.

	(1)	(2)	(3)	(4)				
	RDA	RDA	APP_TOTAL	RDA				
VFI_N	-0.0064***							
	(0.0008)							
AVFI		-0.0059***						
		(0.0008)						
VFI			-0.3719***	-0.0029***				
			(0.0687)	(0.0008)				
Constant	0.0355***	0.0354***	-11.7619***	0.0378***				
	(0.0038)	(0.0046)	(0.4040)	(0.0054)				
Control variable	Yes	Yes	Yes	Yes				
Year fixed effects	Yes	Yes	Yes	Yes				
Industry fixed effect	Yes	Yes	Yes	Yes				

Table 4 Robustness test

		I		
Ν	10,176	7,353	10,176	4,806
<b>R-squared</b>	0.3604	0.3652	0.4634	0.2795

## 6. Mechanism testing and heterogeneity analysis

### 6.1. Mechanism testing

This study aims to examine the impact of fiscal vertical imbalance on the technological innovation capacity of enterprises, with a particular focus on the role of growth-oriented and innovation-oriented competition at the local government level. It also seeks to evaluate the soundness of related research hypotheses. In the established interaction model, multicollinearity among variables is eliminated and the explanatory power of the model is enhanced by standardizing the fiscal vertical imbalance and related competition factors and constructing the interaction term on this basis for empirical analysis. As illustrated in Table 5, the empirical results indicate the existence of significant regression equations, wherein the interaction between fiscal vertical imbalance and "competition for growth" exerts a notable negative influence on enterprise technological innovation. This finding substantiates the research hypothesis H2. In particular, the coefficient associated with the interaction term between fiscal vertical imbalance and "competition for growth" is H2. In particular, the negative coefficient of the interaction term between fiscal vertical imbalance and "competition for growth" indicates that local governments with constrained fiscal resources are more inclined to invest their resources in areas that can facilitate economic growth in the near term rather than long-term technological innovation. This behavior may be attributed to the fact that local government officials are pursuing economic performance and personal promotion goals during their tenure, which leads them to favor short-term economic construction projects in resource allocation, thus unintentionally weakening support for technological innovation in enterprises. Such policy preferences may diminish the role of the government in fostering regional innovation and intensify the adverse impact of fiscal vertical imbalances on firms' technological innovation.

As illustrated in the second column of Table 5, the coefficients of the fiscal vertical imbalance and its interaction term with the "competition for innovation" factor are -0.0016 and 0.1367, respectively. However, these coefficients do not reach the level of significance in the statistical test. This result indicates that the anticipated moderating effect of "competition for innovation" on the relationship between fiscal vertical imbalance and technological innovation in enterprises is not supported, thereby refuting the research hypothesis H3.

	(1)	(2)
	RDA	RDA
VFI	-0.0053***	-0.0016
	(0.0008)	(0.0012)
VFI×lComp1	-0.0562***	
	(0.0121)	
lComp1	0.0446***	
	(0.0049)	
VFI×lComp2		0.1367***
		(0.0416)
lComp2		0.0613***
		(0.0132)
Constant	0.0249***	0.0350***
	(0.0047)	(0.0046)
control variable	Yes	Yes

Table 5 Mechanism test results

Year fixed effects	Yes	Yes
Industry fixed effect	Yes	Yes
Ν	7,369	7,369
R-squared	0.3718	0.3685

### 6.2. Heterogeneity analysis

#### 6.2.1. Heterogeneity in firm size

This study examines the varying impact of fiscal vertical imbalances on technological innovation across firm sizes. The logarithm of total employees is used to define firm size, while median industry values are employed to differentiate between large and small firms. The regression analysis, presented in Table 6, columns (1) and (2), indicates that fiscal imbalances significantly inhibit technological innovation capabilities in both firm sizes, with a more pronounced negative effect observed in large firms. To investigate this heterogeneity, the study employs Fisher's Permutation Test (FPT) using the Bdiff command, considering differences to be statistically significant if the p-values fall below the 10% threshold. The results of the test confirm the presence of significant p-values, thereby substantiating the hypothesis that firm size significantly moderates the relationship between fiscal imbalances and technological innovation capabilities.

#### 6.2.2. Heterogeneity in the nature of property rights

A potential consequence of the local fiscal vertical imbalance is the misallocation of resources, which may in turn affect the level of governmental financial support for innovation. State-owned enterprises (SOE) typically possess greater financial reserves, thereby enhancing their resilience to government funding cuts. This study employs a two-group classification system, comprising state-owned enterprises (SOE) and non-state-owned enterprises (Non-SOE), and performs separate regression analyses to test the hypothesis. The differential effects of fiscal vertical imbalance on technological innovation for both types are illustrated in Table 6, columns (3) and (4). The analysis demonstrates a notable decline in innovation for both SOE and Non-SOE in the context of heightened fiscal imbalance. Nevertheless, the impact on Non-SOE is more pronounced, as evidenced by the larger absolute coefficient value for Non-SOE. Further tests corroborate the statistical significance of the coefficient differences, with p-values < 10%, thereby substantiating the hypothesis that fiscal imbalance exerts a more pronounced inhibitory effect on innovation in Non-SOE.

	(1)	(2)	(3)	(4)	(5)	(6)
	Large	Small	SOE	Non-SOE	Big Four	non-Big
	Scale	Scale				Four
VFI	-	-	-	-	-0.0015	-
	0.0074***	0.0048***	0.0044***	0.0076***		0.0058***
	(0.0009)	(0.0010)	(0.0014)	(0.0011)	(0.0037)	(0.0007)
Constant	0.0591***	0.0681***	0.0511***	0.0292***	0.0694***	0.0369***
	(0.0059)	(0.0061)	(0.0081)	(0.0075)	(0.0200)	(0.0042)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed	Yes	Yes	Yes	Yes	Yes	Yes
effect						
N	5,289	4,887	3,324	6,852	649	9,257
<b>R-squared</b>	0.3770	0.3836	0.3378	0.3052	0.4060	0.3618
Empirical p-value	0.0	23	0.0	36	0.0	00

#### Table 6 Results of heterogeneity analysis

## 6.2.3. Heterogeneity of whether or not it is a Big 4 accounting firm

Firms that have established collaborative relationships with one of the Big 4 international accounting firms typically demonstrate a robust capitalization and high overall competitiveness, which serves to insulate them to a certain extent from the negative consequences of local fiscal imbalances. The regression analysis of heterogeneity based on whether firms have partnered with Big 4 accounting firms, as presented in columns (5) and (6) of Table 6, reveals significant differences. The findings indicate that firms that do not collaborate with Big 4 accounting firms exhibit a statistically significant decline in technological innovation, reaching a 1% level of significance, when vertical imbalances in local finance increase. In contrast, firms that have formed alliances with Big 4 accounting firms do not demonstrate statistically significant alterations in their actual leverage of technological innovation in the context of fiscal vertical imbalances. This finding lends further support to the hypothesis proposed in this study, namely that firms that do not partner with Big 4 accounting firms may experience more severe constraints in their technological innovation activities in the context of vertical imbalance in local financial resource allocation.

#### 6.2.4. Heterogeneity of technological attributes of the industry in which it operates.

The impact of fiscal vertical imbalances on firms' innovative capacity varies across industries with different technological characteristics. In columns (1) and (2) of Table 7, this study presents the results of the heterogeneity regression analysis, demonstrating the impact of fiscal vertical imbalances on innovative capacity in high-tech and non-high-tech industries. The analysis demonstrates that an increase in the degree of fiscal vertical imbalance in the region where the firms are located has a significant negative impact on their technological innovation, both for firms in high-tech and non-high-tech industries. In particular, this negative impact is more pronounced for firms in high-tech industries, indicating that high-tech industries are more severely constrained in their capacity for innovation in the context of unequal financial resource allocation.

# 6.2.5. Heterogeneity of digital economy attributes of the industry in which they operate.

In columns (3) and (4) of Table 7, this study presents the results of the heterogeneity regression analysis of firms according to whether they are located in digital economy industries or not. The analysis demonstrates that when firms are situated within the digital economy industry, an increase in the fiscal vertical imbalance of the region in which they are located exerts a considerable negative influence on the firms' technological innovation capabilities. Conversely, for those firms that are not located within the digital economy industry, an increase in the fiscal vertical imbalance does not exert a significant impact on their technological innovation. This finding lends support to the hypothesis of this study that firms in the digital economy industry are more susceptible to the uneven distribution of local financial resources in terms of technological innovation, and thus face a greater risk of innovation inhibition. Furthermore, the p-values of the differences in the coefficients of fiscal vertical imbalance across industry groups are below 10% by significance test, indicating that such differences are statistically significant. These results serve to further confirm the hypotheses of this study.

	(1)	(2)	(3)	(4)			
	High Tech	Non-High Tech	Digital Economy	Non-Digital			
				Economy			
VFI	-0.0083***	-0.0019**	-0.0088***	-0.0006			
	(0.0011)	(0.0007)	(0.0010)	(0.0008)			
Constant	0.0446***	0.0199***	0.0331***	0.0340***			
	(0.0068)	(0.0044)	(0.0058)	(0.0049)			

### Table 7 Results of heterogeneity analysis

Control variable	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes
N	4,865	5,311	5,732	4,444
R-squared	0.1838	0.3249	0.3069	0.3459
Empirical p-value	0.000		0.00	00

# 7. Conclusion

The deepening of reforms to the financial system has a significant impact on stimulating the technological innovation of enterprises. This paper presents a comprehensive analysis of the direct and indirect mechanisms through which fiscal vertical imbalance affects the technological innovation activities of enterprises. Based on this analysis, research hypotheses are put forth. The data of China's listed enterprises from 2010 to 2019 were subjected to a comprehensive analysis to investigate the impact of fiscal vertical imbalance on enterprise technological innovation and its underlying mechanism. The findings revealed that fiscal vertical imbalance exerts an inhibitory influence on enterprise technological innovation, thereby underscoring the constraining effect of the imbalance of China's current fiscal system at the vertical level on the enhancement of enterprise technological innovation. Secondly, the "competition for growth" factor serves to reinforce the negative relationship between fiscal vertical imbalance and technological innovation. This suggests that as the phenomenon of "competition for growth" among local governments intensifies, the inhibitory effect of fiscal vertical imbalance on technological innovation will become more pronounced. This suggests that as the phenomenon of "competition for growth" between local governments intensifies, the inhibitory effect of vertical fiscal imbalance on technological innovation of enterprises will become more pronounced. Finally, the results of the heterogeneity analysis demonstrate that the inhibitory effect of vertical fiscal imbalance is more pronounced in large-scale enterprises, non-state-owned enterprises, enterprises that do not employ Big Four accounting firms, enterprises in high-tech industries, and enterprises in digital economy industries. The research presented in this paper elucidates the micro-mechanisms through which the fiscal relationship between governments at all levels influences the decision-making processes of enterprises within their respective jurisdictions. It also seeks to rationalize the relationship between governments and enterprises, and to facilitate the high-quality development of the regional economy.

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