A Study of the Impact of Fiscal Vertical Imbalances on Manufacturing Upgrading

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Abstract. Manufacturing is central to the development of China's real economy, while fiscal policy serves as a key tool for macroeconomic regulation by central and local governments. Adjustments in fiscal revenues and expenditures play a critical role in driving the transformation and upgrading of the manufacturing sector. Using panel data from 30 Chinese provinces (including municipalities and autonomous regions) from 2003 to 2020, this study employs a two-way fixed-effects model to examine the impact of fiscal vertical imbalance on manufacturing upgrading. The findings reveal that fiscal vertical imbalance significantly hinders manufacturing upgrading through two mechanisms: suppressing fiscal expenditure bias, which negatively affects upgrading, and intensifying local government tax competition, which has a positive but insufficient countervailing effect. Overall, the net impact is negative. These results highlight the necessity of rebalancing financial and administrative powers between central and local governments to promote the transformation of the manufacturing sector and achieve high-quality economic development in China.

Keywords: Fiscal vertical imbalances; manufacturing upgrading; fiscal spending bias; tax competition

1 Introduction

Manufacturing is the backbone of a nation's economy, underpinning national strength and prosperity. In the early 21st century, driven by two decades of rapid economic growth, China's manufacturing industry leveraged low-cost, abundant labor to achieve a prominent global position. In 2020, China's manufacturing added value accounted for 28.5% of the global total—a 6.2 percentage-point increase since 2012—earning the "Made in China" label international recognition. However, challenges such as rising labor costs due to an aging population, premature deindustrialization, and a lack of core technologies persist. Industrial upgrading has therefore become a critical objective. To address these challenges, government intervention is often required to mitigate information asymmetry in economic development. Fiscal policies, as part of the government's "visible hand," plays a vital role in guiding the manufacturing sector's evolution.

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The 1994 tax-sharing system reform established the foundation of China's fiscal decentralization system, significantly enhancing fiscal capacity, restructuring central-local government relations, and incentivizing local governments to prioritize economic development. By granting the central government greater fiscal authority, the reform enabled effective macroeconomic regulation and contributed to substantial economic growth.

Despite the benefits of fiscal decentralization, local governments under this system face significant vertical fiscal imbalance (VFI) due to the misalignment of revenue allocation and expenditure responsibilities. The central government's delegation of substantial administrative powers and discretionary authority during the hierarchical contracting process granted local officials control over critical economic and administrative resources essential for enterprise operations, potentially constraining business development (Gu & Shen, 2012) [1]. However, the reallocation of fiscal revenue often outpaced the delegation of expenditure responsibilities, resulting in a persistent trend of "centralizing revenue while decentralizing expenditure," thereby exacerbating VFI between central and local governments.

Such fiscal imbalances can lead to "distorted" behaviors among local governments, including shortsighted decision-making. In their efforts to expand tax bases, local governments may prioritize short-term gains over sustainable economic development, often favoring the attraction of low-quality enterprises.

An expanding body of literature explores vertical fiscal imbalances, primarily examining their effects on fiscal expenditures and innovation-related activities. However, limited attention has been given to their impact on specific industries. This study seeks to bridge this gap by analyzing the role and mechanisms of vertical fiscal imbalances within China's fiscal system in driving the upgrading of the manufacturing sector.

The significance of this research lies in two key dimensions:

A. Theoretical Contribution: This study offers a novel perspective on the relationship between the fiscal system and manufacturing upgrading. While existing research primarily focuses on the macroeconomic effects of vertical fiscal imbalances, this analysis examines their industry-specific implications, enriching the discourse on fiscal policy and industrial development.

B. Practical Implications: The findings provide actionable insights for the central government in designing fiscal and industrial policies. By enhancing the synergy between a well-functioning market and proactive government intervention, this research supports fiscal reform, guides local government behavior, promotes industrial transformation and upgrading, and drives high-quality economic development.

2 Literature Review

2.1 Research on Manufacturing Upgrading

With the ongoing advancements in science and technology and the expansion of the global economy, the concept of manufacturing upgrading has emerged as a natural progression. Humphrey et al. (2002) [2] suggest that integration into global value chains encourages developing countries to pursue industrial upgrading driven by

market demand pressures. This process involves four pathways: process upgrading, product upgrading, functional upgrading, and chain upgrading. Similarly, Liu et al. (2017) [3] conceptualize industrial upgrading from two dimensions: the coordinated development and structural enhancement across industries and intra-industry upgrading within the framework of global value chains.

Existing research identifies several critical factors influencing manufacturing upgrading. Innovation investment is widely recognized as the most significant driver (Lin et al., 2019) [4], while human capital has been confirmed to play a crucial role in advancing industrial upgrading (Zhou, 2018) [5]. Bigsten et al. (2004) [6], through an analysis of African manufacturing firms, found that exports substantially improve production efficiency. Mittal and Sangwan (2014) [7], employing the fuzzy TOPSIS algorithm, highlighted factors such as "future legislation," "public pressure," "peer pressure," and "incentives" as key determinants for achieving green manufacturing. Additionally, enhancing social welfare and public services has been shown to be pivotal in promoting the sustainable development of manufacturing (Liu et al., 2024) [8].

In summary, although extensive research exists on manufacturing upgrading, studies addressing the negative factors that impede this process remain notably scarce.

2.2 Research on Vertical Fiscal Imbalances

In recent years, vertical fiscal imbalances (VFI) have garnered significant scholarly attention, with research largely concentrating on their impacts on public fiscal expenditures, technological innovation, and economic development.

2.2.1 Impact of VFI on Public Fiscal Expenditures

Many researchers contend that vertical fiscal imbalances (VFI) shape the structure of public expenditures, often distorting priorities and reducing the allocation of resources to public services that enhance livelihoods. Fiscal transfers can partially alleviate this distortion (Hu et al., 2023) [9]. Within a decentralized fiscal system, the central government frequently faces challenges in supervising local governments effectively, with bureaucratic corruption exacerbating inadequate service provision and undermining social equity (Bardhan & Mookherjee, 2006) [10]. Eyraud and Lusinyan (2013) [11] propose that reducing VFI can bolster local government revenues, while Li and Du (2021) [12] suggest that VFI may negatively affect the sustainability of local public finances. Furthermore, fiscal imbalances between central and local governments influence interregional disparities in healthcare expenditures (Ferrario & Zanardi, 2011) [13].

2.2.2 Impact of VFI on Technological Innovation

Vertical fiscal imbalances (VFI) adversely impact regional innovation capabilities by distorting fiscal expenditure priorities, though effective intergovernmental competition may mitigate these effects (Guan & Fu, 2023; Guo & Hu, 2023) [14-15]. Additionally, research by Reinikka and Svensson (2004) [16] and Galiani et al. (2008) [17]

indicates that higher VFI levels are associated with declines in education quality, hindering human capital development and constraining innovation capacity.

2.2.3 Impact of VFI on the Macro Economy

Research indicates that elevated levels of VFI hinder economic growth (Mitra & Chymis, 2022) [18] and undermine macroeconomic stability (Esu, 2023) [19]. Zhang and Ma (2022) [20] identify VFI as a mediating factor, revealing a threshold effect wherein fiscal decentralization's influence on high-quality economic development fluctuates with varying VFI levels. Boadway (2004) [21] underscores the significance of the vertical fiscal gap (VFG) in federal systems, highlighting its critical role in promoting fiscal equity and achieving broader policy objectives.

In summary, while extensive research has examined the external effects of fiscal imbalances, the relationship between vertical fiscal imbalances (VFI) and manufacturing upgrading remains underexplored. In particular, the mechanisms through which VFI influences manufacturing upgrading are not well understood. Does VFI negatively impact the advancement of the manufacturing sector?

This paper investigates this question through an empirical analysis of provincial panel data spanning 2003 to 2020. The study aims to uncover the mechanisms through which VFI affects manufacturing upgrading, providing a deeper understanding of this critical relationship.

The potential marginal contributions of this paper are highlighted in three key aspects:

A. Research Perspective: This study explores the impact of vertical fiscal imbalances (VFI) on economic development through an industrial lens, providing a fresh perspective on the transformation and upgrading of the manufacturing sector. It also contributes to the field of industrial economics within the framework of fiscal decentralization systems.

B. Research Content: The paper constructs and measures an independent indicator for manufacturing upgrading, elucidating the pathways through which VFI influences this process. It further examines the role of local government behaviors, such as fiscal expenditure bias and tax competition, in shaping these effects. This comprehensive analysis identifies critical fiscal system factors impacting manufacturing upgrading.

C. Research Methodology: Employing a two-way fixed-effects model and a two-step empirical strategy, the study rigorously tests the mechanisms linking VFI to manufacturing upgrading. Robustness checks and instrumental variable methods address potential endogeneity issues, enhancing the reliability and validity of the findings.

3 Theoretical Analysis

3.1 Mechanism Analysis of the Impact of Vertical Fiscal Imbalances on Manufacturing Upgrading

Since the implementation of the tax-sharing system in 1994, China’s fiscal decentralization framework has progressively matured. Local governments have gained rela-

tively autonomous fiscal interests and assumed significant expenditure responsibilities. However, an intensifying trend of "centralizing fiscal authority while decentralizing administrative responsibilities" has led to growing fiscal imbalances between the central and local governments, commonly referred to as vertical fiscal imbalances.

The central government delegates a portion of fiscal authority to local governments, creating a "central-local" principal-agent relationship. To mitigate information asymmetry, the central government introduced GDP growth rates as a key performance benchmark (Li & Zhou, 2005) [22], prompting local governments to generate substantial fiscal revenues to meet these targets. As the mismatch between local revenues and expenditures deepens, fiscal pressures on local governments intensify. Consequently, local governments increasingly prioritize revenue sources such as business taxes and non-tax incomes, including land development and infrastructure investments. This shift in focus diminishes their motivation to pursue industrialization and support the development of industrial enterprises (Sun & Zhou, 2013) [23].

Additionally, the "flypaper effect" of central-to-local transfer payments exacerbates local fiscal instability (Fisher, 1982) [24], complicating efforts to secure adequate funding for public services such as education, science, and technology. Under the influence of VFI, local governments tend to prioritize land development and infrastructure investments as a means to boost fiscal revenues, often at the expense of supporting the real economy and technological innovation. This misallocation of resources hampers the transformation and upgrading of the manufacturing sector.

Hypothesis 1: **Vertical fiscal imbalances have an inhibitory effect on manufacturing upgrading.**

3.2 Pathways of the Impact of Vertical Fiscal Imbalances on Manufacturing Upgrading

Numerous studies highlight that VFI directly alters the structure of public expenditures. Chu and Shao (2018) [25] suggest that VFI reduces the provision of livelihood-oriented public services. Within a promotion-driven evaluation framework, local governments tend to prioritize economic growth while undervaluing investments in science and technology. This short-term focus (Yang and Qiu, 2018) [26] drives local governments to channel resources toward infrastructure projects that yield immediate economic benefits, at the expense of longer-term investments in science, technology, and education. Consequently, this resource allocation strategy effectively "crowds out" expenditures on innovation and non-productive public goods (Borge et al., 2014) [27].

Technological innovation and human capital are widely recognized as pivotal drivers of manufacturing upgrading. However, VFI often constrains fiscal allocations for education and science and technology (Jia et al., 2014) [28], thereby impeding the advancement of the manufacturing sector.

Hypothesis 2: **Vertical fiscal imbalances affect manufacturing upgrading through shifts in public expenditure priorities.**

From a revenue perspective, the fiscal system closely links local governments' tax revenues to their financial sustainability, with VFI playing a critical role in shaping

the intensity of tax competition. As VFI deepens, the disparity between local fiscal revenues and expenditures grows, exacerbating fiscal pressures on local governments.

Driven by performance evaluation mechanisms for local officials, governments may resort to inter-regional tax competition to stimulate economic growth and expand tax bases. This often entails providing tax incentives and reducing tax rates to attract high-quality manufacturing enterprises, which, in turn, lowers local governments' overall tax effort levels (Chu & Fei, 2021) [29].

Lower tax rates benefit manufacturing enterprises by reducing operational costs and boosting profits. This financial relief incentivizes companies to increase investments in research and development, drive product innovation, and improve product quality, all of which collectively promote the upgrading of the manufacturing sector.

Hypothesis 3: **Vertical fiscal imbalances influence manufacturing upgrading through tax competition.**

Figure 1 illustrates the impact mechanism of fiscal vertical imbalance on manufacturing upgrading.

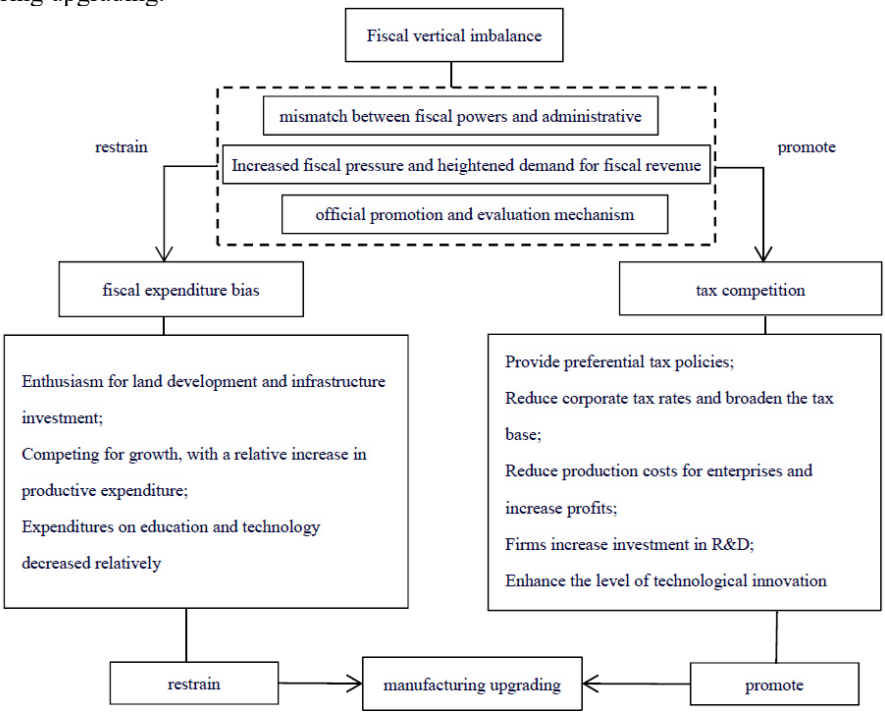

Fig. 1. Mechanism of fiscal vertical imbalance's impact on manufacturing upgrading

4 Model Specification, Variable Selection, and Data Sources

4.1 Model Specification

To empirically analyze the relationship between vertical fiscal imbalance and the level of manufacturing upgrading, the following basic regression model is constructed:

$$MU_{it} = \alpha_0 + \beta_1 VFI_{it} + \beta_2 X_{it} + \gamma_i + \eta_t + \varepsilon_{it} \quad (1)$$

In Model (1), i represents the province, t represents the year, MU_{it} represents the level of manufacturing upgrading, VFI_{it} represents vertical fiscal imbalance, X_{it} represents control variables, γ_i and η_t represent individual and time fixed effects, and ε_{it} represents the random error term.

4.2 Variable Selection

4.2.1 Dependent Variable

The dependent variable in this study is manufacturing upgrading (MU), which refers to advancements in production technologies, innovations in manufacturing processes, and related industry improvements. These enhancements are evidenced by increased production efficiency, higher value-added products, and an enhanced competitive advantage in the market.

To comprehensively measure the level of manufacturing upgrading, this study draws on established methodologies in the literature and constructs a composite index for manufacturing upgrading. The entropy weight method is employed to calculate the trends in China's manufacturing upgrading index, ensuring an objective assessment of indicator weights. The detailed sub-indicators included in the composite index are presented in Table 1.

Table 1. Indicators for Measuring the Manufacturing Upgrading Index

	Indicator	Calculation Method
Manufacturing Upgrading	Labor Productivity	Value added of industry/employment number
	Total Factor Productivity	Manufacturing TFP measured by DEA-Malmquist method
	Position in the Value Chain	Total profits and taxes
	Return on Total Assets	Total profits/total assets
	Output Growth Rate	Growth rate of industrial value added

4.2.2 Independent Variable

This study focuses on examining the impact of vertical fiscal imbalance (VFI) on manufacturing upgrading, positioning VFI as the primary independent variable. Drawing on the measurement methodology proposed by Eyraud and Lusinyan (2013)

[11], VFI is quantified to capture the misalignment in revenue and expenditure distributions between central and local governments. The precise formula and computational details are presented in Table 2.

Table 2. Formulas for Calculating Indicators of Vertical Fiscal Imbalance

Indicator	Formula
Vertical Fiscal Imbalance (VFI)	$VFI = 1 - \left(\frac{FRD}{FED}\right) \times (1 - LFG)$
Fiscal Revenue Decentralization(FRD)	$FRD = \frac{\textit{Per capita local fiscal revenue}}{\textit{Per capita local fiscal revenue} + \textit{Per capita centrall fiscal revenue}}$
Fiscal Expenditure Decentralization(FED)	$FED = \frac{\textit{Per capita local fiscal expenditure}}{\textit{Per capita local fiscal expenditure} + \textit{Per capita centrall fiscal expend}}$
Local Fiscal Gap (LFG)	$LFG = \frac{\textit{Public budget expenditure} - \textit{Public budget revenue}}{\textit{Public budget expenditure}}$

4.2.3 Mediating Variables

The first mediating variable in this study is fiscal expenditure bias (fin), which reflects the allocation priority of local governments toward education and science and technology. It is calculated as the proportion of local government expenditures allocated to these sectors. The formula is as follows:

$$\text{Fiscal Expenditure Bias}\,(fin) = \frac{\text{Education Expenditure} + \text{Science and Technology Expenditure}}{\text{General Public Budget Expenditure}} \quad (2)$$

The second mediating variable is tax competition (tax). Local government tax revenues are predominantly derived from value-added tax (VAT), business tax, and corporate income tax. However, since the business tax was officially phased out in 2016, this study concentrates on examining the effects of local government tax competition in the domains of VAT and corporate income tax.

Tax competition is further categorized into value-added tax competition (tax_add) and corporate income tax competition (tax_inc). The specific formulas for their measurement are as follows:

$$\text{Value - added Tax Competition}\,(tax\_add) = \frac{\text{Local Actual Value - added Tax Rate}}{\text{National Average Value - added Tax Rate}} \quad (3)$$

$$\text{Income Tax Competition}\,(tax\_inc) = \frac{\text{Local Actual Income Tax Rate}}{\text{National Average Income Tax Rate}} \quad (4)$$

A smaller value indicates more intense tax competition.

Furthermore, to account for the potential impact of the "replacing the business tax with a value-added tax (VAT)" reform on VAT revenue, the regression analysis for tax_add is restricted to data from before 2016. This ensures that the results are not confounded by the structural changes introduced by the reform.

4.2.4 Control Variables

Based on existing research, the following control variables are included in this study:

Technological Innovation (innov): Measured by the number of authorized patents per thousand people. Authorized patents are considered more representative of the local technological development level compared to patent applications.

Human Capital (edu): Captured by the proportion of students enrolled in regular higher education institutions relative to the permanent resident population in the region.

Capital Investment (lnassets): Represented by the natural logarithm of the total assets of industrial enterprises above a designated scale, as reported in economic indicators.

Economic Development Level (gdpp): Indicated by the annual GDP growth rate, with GDP deflated using the year 2000 as the base year to account for inflation.

Transportation Infrastructure (traffic): Measured by the transportation mileage per thousand people, reflecting accessibility and connectivity in the region.

Urbanization Level (urban): Defined as the ratio of the urban population to the permanent resident population, indicating the extent of urban development.

These control variables aim to account for external factors that may influence the relationship between vertical fiscal imbalances and manufacturing upgrading, ensuring robust and reliable empirical analysis.

4.3 Data Sources and Statistical Characteristics

This study employs provincial panel data from 30 provinces (municipalities and autonomous regions) in China for the period 2003–2020. Due to challenges in data collection and completeness, regions such as Hong Kong, Macau, Taiwan, and Tibet are excluded. The primary data sources include: *CHINA INDUSTRY YEARBOOK*, *FINANCE YEARBOOK OF CHINA*, National Bureau of Statistics, and other public databases. Descriptive statistics and correlations for each variable are presented in Table 3.

Table 3. Descriptive Statistics of Variables

Variable	Symbol	Mean	Standard Deviation	Minimum	Maximum
Manufacturing Upgrading	*MU*	0.2118	0.0962	0.0474	0.5188
Vertical Fiscal Imbalance	*VFI*	0.6825	0.1934	0.1398	0.9381
Technological Innovation	*innov*	0.7539	1.1385	0.0130	7.4365
Human Capital	*edu*	0.0175	0.0066	0.0039	0.0413
Capital Input	*lnassets*	9.1399	1.2654	5.0661	11.7715
Economic Develop-	*gdpp*	0.0503	0.0641	0.0061	0.3745

ment					
Transportation Access	*traffic*	3.3215	2.2071	0.3799	14.3875
Urbanization Level	*urban*	0.5391	0.1452	0.2264	0.9418

5 Empirical Estimation and Analysis

5.1 Baseline Regression

This study utilizes a fixed-effects model for empirical analysis, as validated by the Hausman test. The baseline regression results are summarized in Table 4. Columns (1) through (7) display the regression outcomes with progressively included control variables. In Column (1), the coefficient is -0.166, and in Column (7), it reaches -0.272. Across all specifications, the coefficient of *VFI* remains statistically significant at the 1% level, demonstrating a robust and substantial negative relationship between VFI and manufacturing upgrading. These findings strongly support Hypothesis 1, confirming that VFI exerts an inhibitory effect on the upgrading of the manufacturing sector.

In Column (7), the coefficients for *innov* and *lnassets* are significantly positive, highlighting that technological innovation and asset investment are positively correlated with manufacturing upgrading. This aligns with existing literature, which emphasizes the role of technology and capital—key production factors—in improving production efficiency and propelling the advancement of the manufacturing sector. Conversely, the coefficient for *urban* is significantly negative, suggesting an inverse relationship between urbanization levels and manufacturing upgrading. This finding may stem from the reshaping of population distribution due to urbanization, where overcrowding in urban areas drives up labor, land, and transportation costs for manufacturing enterprises, thereby hindering their upgrading efforts.

Table 4. Analysis of Baseline Regression Results

	(1) MU	(2) MU	(3) MU	(4) MU	(5) MU	(6) MU	(7) MU
VFI	-0.166***	-0.323***	-0.326***	-0.253***	-0.262***	-0.262***	-0.272***
	(-2.641)	(-5.650)	(-5.624)	(-4.462)	(-4.694)	(-4.700)	(-4.895)
innov		0.033***	0.032***	0.032***	0.031***	0.032***	0.031***
		(10.623)	(9.340)	(9.905)	(9.533)	(9.229)	(9.150)
edu			-0.345	-1.225	-1.395*	-1.398*	-0.546
			(-0.399)	(-1.464)	(-1.697)	(-1.685)	(-0.603)
lnassets				0.050***	0.054***	0.053***	0.059***
				(4.426)	(4.710)	(4.423)	(4.551)
gdpp					19.370	21.527	21.147

					(1.621)	(1.600)	(1.534)
traffic						0.001	0.001
						(0.440)	(0.405)
urban							-0.182**
							(-2.172)
Constant	0.325***	0.407***	0.416***	-0.076	-0.110	-0.106	-0.077
	(7.585)	(10.591)	(9.191)	(-0.644)	(-0.930)	(-0.886)	(-0.628)
N	540	540	540	540	540	540	540
R^2	0.829	0.864	0.864	0.870	0.871	0.871	0.873

Note: ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively. All regressions include control variables, regional and year fixed-effects.The same applies below.

5.2 Mechanism Analysis

This section examines the mediating effects of fiscal expenditure bias and tax competition to elucidate the mechanisms by which vertical fiscal imbalance (VFI) impacts manufacturing upgrading.

5.2.1 The Mediating Effect of Fiscal Expenditure Bias

Fiscal expenditure bias (*fin*) is represented by the proportion of local government spending on education and science and technology. The regression results in Column (2) of Table 5 show that the coefficient for *VFI* is -0.095, significant at the 1% level. This finding suggests that higher levels of VFI are associated with a reduced allocation of local government expenditures to education and science and technology.

Existing research highlights the critical role of advancements in scientific and technological capabilities and human capital in driving manufacturing upgrading (Li and Yao, 2024) [30]. Investments in education and scientific research are fundamental for fostering technological innovation and human capital development. A decline in these expenditures consequently hampers these processes, thereby constraining the advancement and transformation of the manufacturing sector.

In summary, VFI influences manufacturing upgrading by altering fiscal expenditure bias, with reduced spending on education and technology serving as a mediating factor. These findings provide empirical support for Hypothesis 2.

5.2.2 The Mediating Effect of Local Government Tax Competition

Local government tax competition (*tax*) is quantified by the ratio of the actual local tax rate to the national average tax rate. Regression results in Columns (3) and (4) of Table 5 reveal coefficients for *VFI* of -1.004 and -1.389, respectively, both statistically significant at the 1% level. These results indicate that higher levels of VFI are associated with intensified tax competition among local governments, as reflected in reduced tax rates.

Existing research underscores the importance of tax reductions in enhancing corporate vitality over the long term (Ma et al., 2019) [31]. Lower tax rates positively

influence manufacturing upgrading, as rational tax competition by local governments stimulates technological innovation (Jiang and Shi, 2022) [32], thereby fostering the transformation and advancement of the manufacturing sector.

In conclusion, VFI impacts manufacturing upgrading through the mediating mechanism of local government tax competition. These findings confirm the significant role of tax competition in this relationship, thereby supporting Hypothesis 3.

Table 5. Analysis of Mediation Effect Test Results

	(1) MU	(2) fin	(3) tax_add	(4) tax_inc
VFI	-0.272***	-0.095***	-1.004***	-1.389***
	(-4.895)	(-4.912)	(-3.751)	(-6.319)
Constant	-0.077	0.142***	2.842***	2.972***
	(-0.628)	(3.941)	(4.417)	(6.360)
N	540	540	390	540
R^2	0.873	0.866	0.880	0.961

Finally, to ensure the robustness of the mediating effects identified, this study employs the Sobel and Bootstrap methods to test the two channels: fiscal expenditure bias (fin) and tax competition (tax). As shown in Table 6, the results indicate statistically significant mediating effects for fiscal expenditure bias (fin) and corporate income tax competition (tax_inc), with p-values below 0.05. However, the mediating effect of value-added tax competition (tax_add) is not statistically significant, as its p-value exceeds 0.05.

Thus, the Sobel and Bootstrap test results confirm that VFI impacts manufacturing upgrading through the mediating channels of fiscal expenditure bias (*fin*) and corporate income tax competition (*tax_inc*).

Table 6. Mediation Effect Sobel and Bootstrap Test Results

Mediation Variable	Coefficient	Standard Error	z-value	p-value
		Sobel Test		
fin	-0.0207	0.0102	-2.022	0.0432
tax_add	-0.0025	0.0076	-0.3209	0.7483
tax_inc	0.0348	0.0157	2.216	0.0267
		Bootstrap Test		
fin	-0.0207	0.0106	-1.95	0.051
tax_add	-0.0025	0.0069	-0.35	0.723
tax_inc	0.0348	0.0155	2.24	0.025

5.3 Robustness Test

5.3.1 Variable Substitution

To enhance the robustness of the model, this study substitutes the core explanatory and dependent variables and conducts re-estimation. Specifically:

A. Substitution of the Explanatory Variable:

The fiscal self-sufficiency gap rate of local governments (LFG) is utilized as an alternative to vertical fiscal imbalance (VFI). The LFG provides a measure of the disparity between the revenues generated by local governments and their fiscal expenditures, offering a complementary perspective on fiscal imbalances.

The fiscal self-sufficiency gap rate (*LFG*) is calculated as:

$$LFG = \frac{Public\ Budget\ Expenditure - Public\ Budget\ Revenue}{Public\ Budget\ Expenditure} \tag{5}$$

B. Substitution of the Dependent Variable:

Total factor productivity of the manufacturing industry (ind_tfp) is employed as a proxy for manufacturing upgrading (MU). Total factor productivity captures the efficiency of all inputs in the production process and is a well-established metric for assessing advancements in manufacturing performance and competitiveness.

The total factor productivity of the manufacturing industry is measured using the DEA-Malmquist method, where the output indicator is the manufacturing industry's main business income, and the input indicators include total manufacturing assets and the number of employees. By incorporating these indicators, the DEA-Malmquist approach provides a comprehensive measure of the TFP of the manufacturing industry, aligning well with the study's focus on manufacturing upgrading and productivity enhancement.

The robustness check involves applying these substituted variables in the fixed-effects regression framework to verify the consistency of the findings. By doing so, the study seeks to ensure that the observed relationships and mechanisms are not artifacts of the specific measurements initially employed but hold true under alternative definitions of key variables.

The robustness check results, as displayed in Table 7, reinforce the study's primary findings. By substituting the explanatory variable VFI with the fiscal self-sufficiency gap rate of local governments (LFG) and the dependent variable manufacturing upgrading (MU) with the total factor productivity of the manufacturing industry (ind_tfp), the regression outcomes remain consistent. Specifically:

Column (1): The regression coefficient for LFG is significantly negative, indicating that fiscal self-sufficiency imbalances at the local government level have a suppressive effect on total factor productivity in the manufacturing industry.

Column (2): Similar results are observed when additional control variables are included, with the coefficient for LFG maintaining its negative significance.

These findings confirm that the suppressive effect of vertical fiscal imbalance on manufacturing upgrading is robust, irrespective of the variable substitution. This robustness check lends further credibility to the study’s conclusions regarding the detrimental impacts of fiscal imbalances on the manufacturing sector's transformation and productivity growth.

5.3.2 Excluding Certain Samples and Adjusting the Time Frame

To address the potential influence of outlier regions and policy changes, the study performs two additional robustness checks:

C. Exclusion of Beijing, Tianjin, Shanghai, and Chongqing:

These four municipalities possess unique administrative and economic characteristics that could introduce bias. By excluding them, the study ensures that the results are not driven by these outliers. The re-estimation of the model after their exclusion shows that the coefficients of **VFI** remain significantly negative, reaffirming the suppressive effect of vertical fiscal imbalance on manufacturing upgrading.

D. Adjustment of the Time Span (2007–2020):

The fiscal revenue and expenditure classification reform in 2007 altered the categorization rules for local government fiscal income and expenditures, potentially affecting the measurement of fiscal vertical imbalance. To account for this, the study adjusts the sample period to exclude pre-reform years. The re-estimation over the 2007–2020 period continues to yield significantly negative coefficients for VFI, confirming the robustness of the primary findings even under the revised temporal scope.

The results in Table 7, specifically Columns (3) and (4), provide additional confirmation of the robustness of the study's findings. The key observations are as follows:

Column (3): When these four municipalities are excluded, the coefficient for VFI is -0.352 and remains significant at the 1% level. This outcome underscores that the suppressive impact of vertical fiscal imbalance on manufacturing upgrading is not driven by these outlier regions.

Column (4): By limiting the analysis to the period post-2007 fiscal classification reform, the coefficient for VFI is -0.277, also significant at the 1% level. This finding validates that the results are consistent even when accounting for changes in fiscal policies and classification rules.

Both robustness checks—excluding unique municipalities and adjusting the time span—confirm the significant negative relationship between VFI and Manufacturing Upgrading. These results demonstrate that the suppressive effect of VFI persists across different model specifications, further strengthening the reliability of the study's conclusions.

Table 7. Robustness Test Results Analysis

	(1) Replacement of Explanatory Variable MU	(2) Replacement of Explained Variable ind_tfp	(3) After Excluding Samples MU	(4) After Adjusting Time Frame MU
VFI		-4.048***	-0.352***	-0.277***
		(-4.881)	(-5.155)	(-3.663)
LFG	-0.295***			
	(-5.919)			
Constant	-0.147	5.321***	0.072	-0.177
	(-1.363)	(3.229)	(0.488)	(-1.010)
N	540	540	468	420
R^2	0.875	0.753	0.861	0.852

5.3.3 Addressing Endogeneity

To address potential endogeneity arising from the reciprocal relationship between fiscal vertical imbalance (*VFI*) and manufacturing upgrading (*MU*), this study employs instrumental variable (IV) estimation techniques.

Using the lagged explanatory variable (VFI lagged by one period) and per capita central transfer income as instrumental variables provides a robust strategy to address endogeneity. The rationale for this approach ensures the validity of the instrumental variables:

A. Lagged Fiscal Vertical Imbalance:

• **Relevance**: Fiscal vertical imbalance is typically persistent over time, meaning past levels strongly predict current levels.

• **Exogeneity**: The lagged value is predetermined relative to current manufacturing upgrading outcomes, reducing the likelihood of direct reverse causality.

B. Per Capita Central Transfer Income:

• **Relevance**: Central transfers directly influence fiscal vertical imbalance by affecting the fiscal revenue gap between central and local governments.

• **Exogeneity**: While central transfers impact fiscal policy, their direct influence on manufacturing upgrading is limited, operating indirectly through fiscal adjustments.

The second-stage regression results from the IV-2SLS method, as detailed in Table 8, provide robust evidence supporting the study's hypotheses and addressing endogeneity concerns in the model. Here's a breakdown of the key findings and their implications:

A. Instrumental Variable Diagnostics

• **Under-Identification Test (K-P rk LM Statistic)**:

P-values < 0.1: This confirms that the selected instrumental variables (lagged fiscal vertical imbalance and per capita central transfer income) are appropriately identified and relevant, significantly correlated with fiscal vertical imbalance.

• **Weak Instrument Test (Cragg-Donald Wald F Statistic)**:

The strong rejection of the weak instrument hypothesis confirms that the instruments possess sufficient explanatory power, ensuring the reliability of the IV-2SLS estimation.

• **Over-Identification Test (Hansen J Test)**:

P-values > 0.1: This result supports the validity of the instrumental variables, indicating no correlation with the error term and confirming their exogeneity.

B. Regression Findings

The coefficients for the core explanatory variable, VFI (-0.404), and the alternative variable, LFG (-0.393), are both negative and significant at the 1% level. These results reaffirm the suppressive effect of fiscal vertical imbalance on manufacturing upgrading, consistent with the baseline and robustness checks in prior analyses.

C. Implications

The use of instrumental variables eliminates potential biases arising from endogeneity, strengthening the causal interpretation of the relationship between fiscal vertical imbalance and manufacturing upgrading. The significant results for both VFI and LFG demonstrate the robustness of the findings across different measures of fiscal imbalance, further validating the study’s methodological approach.

D. Conclusion

The IV-2SLS analysis reinforces the study's conclusion that fiscal vertical imbalance suppresses manufacturing upgrading. By addressing endogeneity concerns, the results provide a more reliable foundation for understanding the mechanisms through which fiscal policies influence industrial development. These findings not only substantiate the hypotheses but also highlight the importance of addressing fiscal imbalances to promote sustainable manufacturing transformation and upgrading.

Table 8. Second-Stage Regression Results of IV-2SLS

	(1) Baseline Regression	(2) Replacement of Explanatory Variable
	MU	MU
VFI	-0.404***	
	(-4.880)	
LFG		-0.393***
		(-4.786)
K-P rk LM(P-value)	0.000	0.000
C-D Wald F statistic	193.092	182.604
Hansen J(P-value)	0.207	0.2169
N	510	510
R^2	0.804	0.808

5.4 Heterogeneity Analysis

Due to regional disparities in economic development across China, the impact of fiscal vertical imbalance may vary. Following the National Bureau of Statistics' regional classification, this study conducts subgroup regression analysis for the eastern, central, and western regions.

As presented in Table 9, the coefficients for the eastern, central, and western regions are -0.342, -0.263, and -0.372, respectively, significant at the 1%, 5%, and 1% levels. These findings indicate that the adverse impact of fiscal vertical imbalance on manufacturing upgrading is most pronounced in the western region, while the central region experiences the least effect. This variation may stem from the western region's relatively underdeveloped economy, which depends more heavily on central government transfer payments, potentially diminishing the efficiency of fiscal resource allocation.

Table 9. Heterogeneity Analysis Results

	(1) Eastern Region	(2) Central Region	(3) Western Region
	MU	MU	MU
VFI	-0.342***	-0.263**	-0.372***
	(-3.814)	(-2.532)	(-2.963)
Constant	-0.981***	-0.271	0.411**
	(-4.145)	(-1.176)	(2.029)

N	234	108	198
R^2	0.899	0.954	0.875

6 Conclusions and Recommendations

This study empirically investigates the impact of fiscal vertical imbalance (VFI) on manufacturing upgrading, revealing that VFI significantly impedes the sector's advancement. Moreover, the analysis identifies two key mechanisms through which VFI influences manufacturing upgrading: fiscal expenditure bias and local government tax competition.

Specifically, higher levels of VFI decrease the share of local government spending on education and science and technology, hindering advancements in manufacturing productivity and technological innovation. Simultaneously, elevated VFI exacerbates local government tax competition, lowering the tax burden on manufacturing enterprises. Although this may encourage R&D investment and support manufacturing upgrading, the net impact of VFI on manufacturing upgrading remains negative.

Heterogeneity analysis reveals that the negative impact of VFI on manufacturing upgrading is most pronounced in the western regions, compared to the eastern and central regions. This disparity likely stems from the western region's underdeveloped economic conditions and higher reliance on central government transfer payments, which may undermine the efficient allocation of fiscal resources.

To address the challenges posed by fiscal vertical imbalance and enhance fiscal expenditure efficiency, the government may consider the following policy adjustments:

• **Strengthen Oversight and Transparency of Local Government Fiscal Funds:** Improve supervision over local government fiscal expenditures and increase transparency by disclosing the allocation and use of funds for key projects. Enhanced oversight from diverse stakeholders can promote fiscal efficiency and reduce the negative effects of fiscal vertical imbalance.

• **Optimize Performance Evaluation Mechanisms for Officials:** Reform official performance evaluation systems to prioritize quality over quantity. Shift the emphasis from general economic growth metrics to specific advancements in education and science and technology. Develop practical, measurable assessment criteria to better capture these priorities.

• **Increase Investment in Science and Technology:** Expand funding for scientific and technological development, leveraging targeted transfer payments that address the unique needs of different regions. Implement rigorous monitoring mechanisms to ensure resources are utilized effectively and fiscal expenditures yield tangible benefits.

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