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How FinTech Mitigates Local Government Hidden Debt Risks through Competitive Mechanisms?

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Abstract

The hidden debt of Chinese local governments has been expanding year by year, gradually becoming a "gray rhino" that constrains China's high-quality economic development. This paper explores how financial technology (fintech) effectively mitigates the local government hidden debt risks (LGHDR) by optimizing the triple competitive mechanisms between state-owned enterprises, banks, and local governments. Based on data from 2014 to 2021, this paper uses state-owned enterprises as a unique research subject and introduces an innovative approach to measure the hidden debt risks accumulated by local governments through state-owned enterprises' (SOEs) gray channels, a perspective that has not been deeply explored in existing literature. The empirical results show that fintech significantly optimizes competitive financing mechanisms, thereby effectively mitigating the LGHDR. Mechanism analysis reveals that fintech achieves this through three dimensions: preventing improper competitive behaviors of enterprises, increasing the intensity of bank competition, and limiting violations of government economic competition. Further heterogeneity analysis indicates that the mitigating effect of fintech on LGHDR is more pronounced in regions with weaker fiscal balances, and greater government investment intensity. Based on these findings, this paper not only provides important practical insights for policymakers but also emphasizes the crucial role of competitive financing mechanisms in ensuring sustainable economic governance and financial stability by integrating fintech, competitiveness, and local debt risk management.

Keywords: *financial technology; fintech, competitive financing mechanisms; risks of hidden debt; local governments*

JEL Classification: G23, G3, H63

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1. INTRODUCTION

The report from the 19th National Congress of the Communist Party of China highlighted that one of the three major battles for the Chinese economy is to prevent and resolve significant risks in the financial sector. The Central Financial Work Conference held in October 2023 em-

phasized the need to "establish a long-term mechanism for preventing and resolving local government debt risks, create a government debt management mechanism that aligns with high-quality development, and optimize the debt structure of both central and local governments." Currently, local governments' use of state-owned enterprises (SOEs) or financing platforms for implicit financing and borrowing has become a major issue recognized by the central government and is regarded as a "gray rhino" in China's systemic financial risks. This issue is not confined to China; several other countries and regions around the world are also facing similar challenges regarding local government hidden debt. Specifically, after the European debt crisis in 2010, many Eurozone countries, including Greece, Portugal, and Spain, faced severe fiscal crises due to local government hidden debt (Ardagna & Caselli, 2014). A similar fiscal risk has emerged in some Latin American countries, such as India and Brazil, where local governments have borrowed through non-transparent financial channels, gradually accumulating fiscal risks (Shankar & Trivedi, 2023).

Local government hidden debt refers to debt that is not included in government financial statistics or debt limit management and typically exists in concealed forms. As the National Audit Office of China increasingly tightened audits on local government financing platform debt in 2010, 2013, and 2018, local governments are facing tremendous financing pressure and limited bargaining power. Therefore, local governments have started to rely more on SOEs as a financing channel, gradually replacing financing platforms and becoming the "white gloves" for implicit financing. This phenomenon mirrors the experiences of other countries. For example, in Spain, the lack of transparency in local government debt and the continuous expansion of fiscal deficits once led to a sharp rise in fiscal risks. After the 2008 global financial crisis, the Spanish government strengthened its scrutiny of local government debt and, through reforms, improved debt transparency to reduce the risks associated with hidden debt (Balaguer-Coll et al., 2016). Additionally, local governments in countries like India and Argentina are facing similar hidden debt issues, where local governments have financed through opaque channels and accumulated growing debt burdens, exacerbating their fiscal deterioration (Altavilla & Soares, 2022). The data in Figure 1 shows that between 2014 and 2021, the proportion of local government hidden debt in the total debt of SOEs gradually increased, with 2019 marking a turning point, when the risk of hidden debt significantly intensified. According to the data in Figure 2, the growth rate of urban investment bonds expanded continuously between 2017 and 2018, but since 2019, the growth rate of urban investment bonds has shown a year-on-year decline. These trends reflect

the global nature of the local government debt issue, particularly in the Eurozone and Latin America, where many local governments are under increasing debt pressure and exposing greater fiscal risks (Koehler & König, 2015).

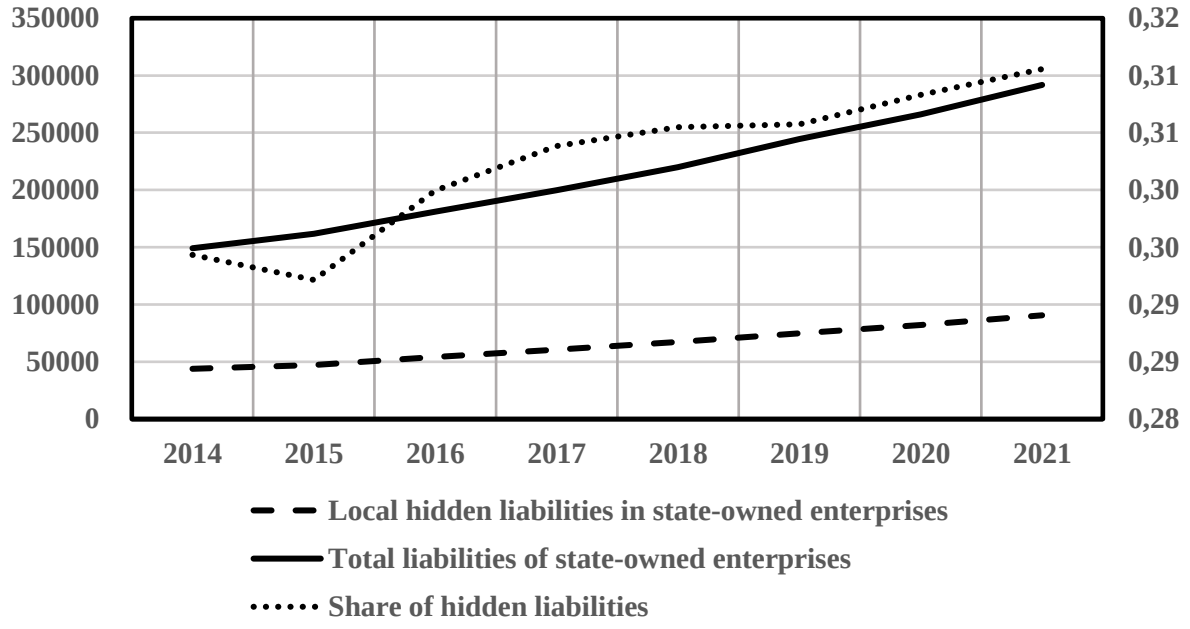

Fig.1-Hidden Debt as a Percentage of Total SOE Debt

[1]Share of hidden liabilities=Local hidden liabilities in SOEs / total liabilities of state-owned enterprise

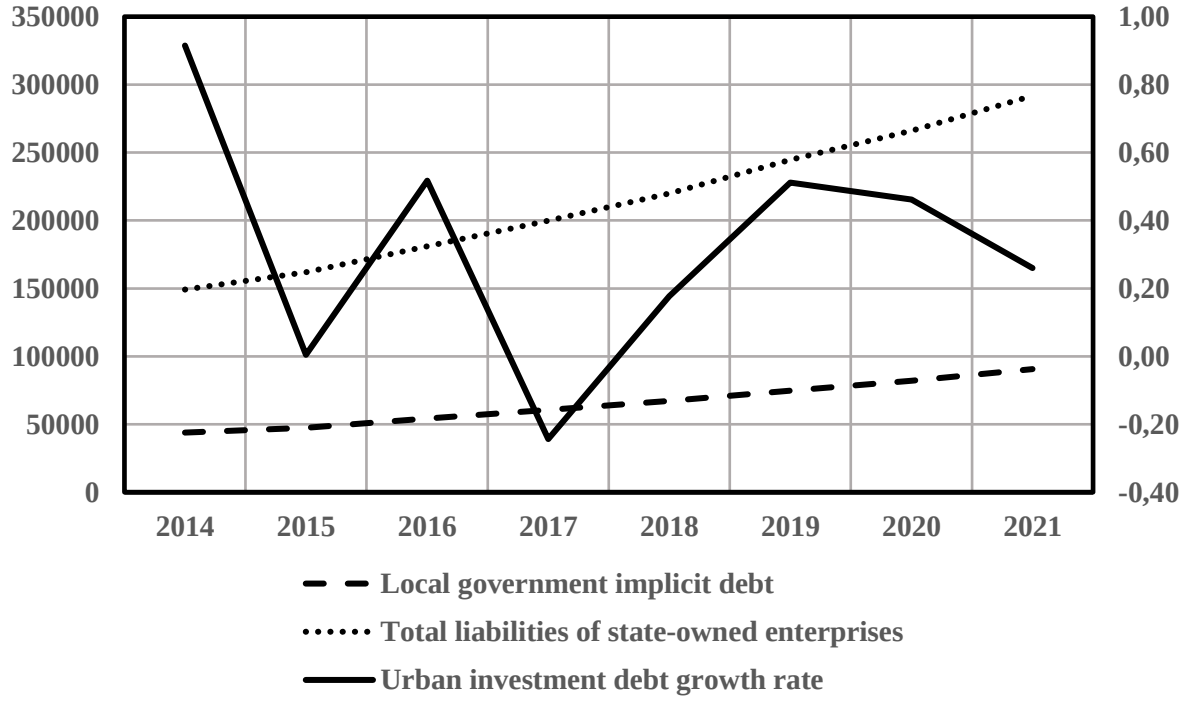

Fig.2- Municipal Bond Growth Rate

In recent years, academic attention to the issue of local government hidden debt has been increasing. Existing research extensively explores the complexities of local government hidden debt, delving into its real-world dilemmas (S. Y. Zhou, 2021), root causes, and measurement methodologies (M. Guo et al., 2020). In particular, the research has focused on analyzing the transmission pathways of hidden debt, especially urban and municipal investment debt, and examining how they exploit financial potential and budgetary soft constraints (Khan et al., 2024; Xu et al., 2020). Furthermore, research has delved into the mechanisms behind local government debt strategies, such as municipal bonds, evaluating their financial potential and bargaining power (Song & Yao, 2021). However, the research objects in the existing literature mainly focus on financing channels like urban investment platforms, with less exploration of the shadow role that state-owned enterprises play in local government implicit debt. Given China's unique national system, SOEs hold a pivotal position in local government financing. Therefore, this paper focuses on this relatively underexplored perspective, filling the gap in existing literature on hidden debt—specifically the issue of illegal debt accumulation through SOEs.

Moreover, while existing literature analyzes the sources, problems, and causes of local government hidden debt, there is still limited research on proposed solutions. Among various approaches, the transformation of urban investment platforms has garnered attention and recognition as one of the solutions to address debt issues (Kuang & Cai, 2014). Related studies suggest that transformed urban investment platforms alleviate some pressure on the debt crisis by optimizing financing structures and increasing investment returns (Liu et al., 2020; Yang & Li, 2021). However, how can the issue of illegal debt accumulation through SOEs be mitigated or resolved? Fortunately, with the continuous development of digital technology, the integration of modern technology and traditional finance—fintech (Y. P. Huang & Huang, 2018; Tang et al., 2020)—is providing innovative solutions to address this issue. Fintech, by leveraging powerful online data platforms, can make the financing behaviors of local governments and SOEs transparent, enabling multi-dimensional joint supervision and optimizing bank financing decisions (M. Wang et al., 2023). By enhancing competitive financing mechanisms, fintech not only increases transparency and compliance in the financing process of SOEs but also provides banks with more efficient and reliable risk assessments, transforming what was once a gray channel for debt through SOEs into a transparent and open path, thereby limiting the illegal debt accumulation of local governments.

The innovations and marginal contributions of this paper are as follows:

- Firstly, innovation in the measurement of variables. Innovatively constructing an index to measure the hidden debt risk of local governments among SOEs in Chinese cities, this paper utilizes basic financial data from SOEs. It constructs and manually calculates an implicit debt index for local governments in each Chinese city, based on city groupings, to assess the implicit debt risk of local governments across the cities.
- Secondly, innovative research mechanism. Analyzing competitive mechanisms from different perspectives of preventing improper corporate competitive behaviors, increasing bank competition intensity, and limiting the government economic competition violations. The study delves into how financial technology (fintech) can alleviate local government hidden debt by optimizing internal and external competitive environments, providing innovative solutions to address the issue of hidden debt in China's local governments.
- Thirdly, innovation in the research object. The continuous expansion of hidden debt risks in local governments presents significant challenges that are difficult to overcome, posing serious financial crises and systemic risks. However, SOEs, as shadow players in hidden debt financing, represent a widely overlooked but increasingly serious blind spot. The role of SOEs in local government hidden debt financing is becoming more prominent, yet it has not received sufficient attention in the existing literature. Therefore, studying SOEs as a key channel for local government hidden debt is of significant theoretical and practical importance.

2. THEORETICAL BACKGROUND

2.1. Reason of local government hidden debt risk

Since the tax-sharing reform of 1994, China has undergone a significant redistribution of financial and administrative powers between the central governments and local governments. This shift resulted in the decentralization of governmental authority downwards and financial authority upwards, leading to growing disparities between local governments' fiscal revenues and expenditures. However, the unique fiscal decentralization system in China grants local governments a measure of revenue autonomy and responsibility for expenditures (Qian & Weingast, 1997; Zhan & Liu, 2020). This arrangement positions local governments as key agents in local economic development, incentivizing them to utilize policy tools to control SOEs in achieving governmental objectives (Deng et al., 2024). Consequently, SOEs have become the primary implementers of local governments' economic directives. At the same time, implicit financial

decentralization encourages banks to act as financing tools, facilitating the acquisition of financial resources for SOEs, thereby enabling the expansion of local governments' implicit debt (H. Gao et al., 2021) (Fig.3).

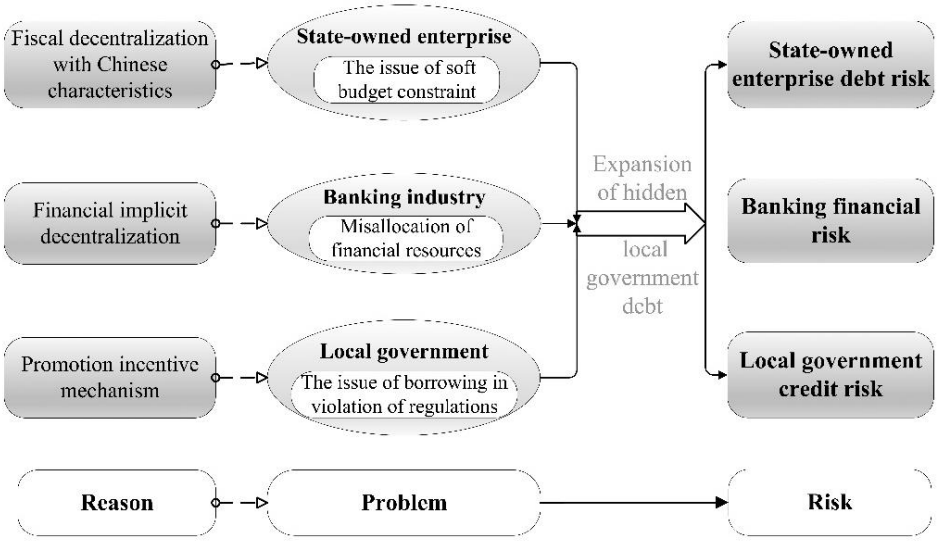

Fig.3 - The reason for local government hidden debt risk

Firstly, characteristic fiscal decentralization in China has led to the issue of budgetary soft constraints within SOEs. Due to local governments' control over SOEs and their implicit credit guarantees, banks underestimate the risks and preferentially finance them, thereby promoting the expansion of SOE debt and leading to a continuous rise in debt risks (Acharya et al., 2014; Borisova et al., 2015). Secondly, the financial implicit decentralization has led to the misallocation of financial resources within banks. Local governments, through de facto control over urban commercial banks and implicit instructions to prioritize financing for SOEs, cause a misallocation of bank resources and a crowding-out effect on private enterprises, thereby increasing the financial risks faced by banks (Brandt & Li, 2003; Giaretta & Chesini, 2021). What is more, the promotion incentive mechanisms has led to the issue of local governments engaging in illegal borrowing. Under the central government's promotion incentive mechanism, local officials use their "administrative authority" to seek "financial power" in order to meet performance requirements for promoting local economic development. This has resulted in a "promotion tournament" among local governments (Blanchard & Shleifer, 2001), leading enterprise decision-making to deviate from profit maximization and increasing the credit risk of local governments (Y. S. Zhang & Wang, 2001).

2.2. Impact of fintech on local government hidden debt risk

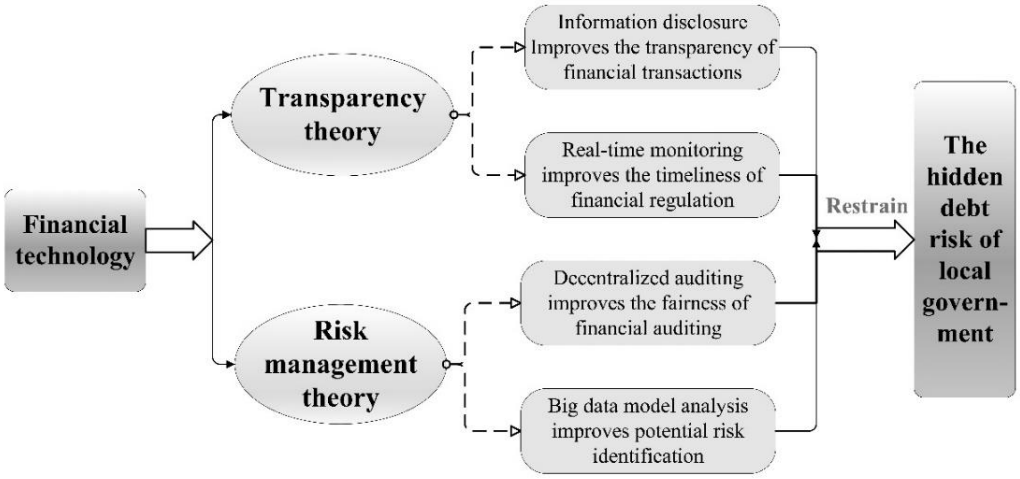

Fig.4 - Impact role of fintech

The introduction of fintech can enhance the efficiency and stability of financial markets. Transparency theory suggests that increased transparency helps regulators and financial institutions more accurately assess the true financial status of SOEs and local governments (Guan et al., 2022; Howell et al., 2020). This enables fintech to play a more effective role in ensuring the authenticity and immutability of financial transactions, thereby reducing the likelihood of local governments engaging in implicit borrowing. Risk management theory posits that fintech can provide more powerful risk management tools. These tools help financial institutions and local governments analyze potential hidden debt risks through big data models, enabling timely identification and appropriate measures to mitigate risk levels (Fig. 4).

From an information disclosure standpoint, fintech significantly enhances the transparency of financial transactions. Each transaction, meticulously recorded on a tamper-proof blockchain, assures the authenticity and traceability of data. This process heightens the transparency of financial activities for SOEs and local governments, thereby facilitating banks and regulators in accessing accurate financial information, including details about local governments' hidden debt (Demertzis et al., 2018; X. Gao, 2023). Consequently, this reduces the likelihood of concealed government borrowing. In terms of real-time monitoring, fintech advances the timeliness of financial regulation. The capability of instant monitoring and reporting by digital technology allows banks and regulators to swiftly identify irregularities, making it challenging for SOEs and local governments to conceal or falsify financial data (Tsai & Kuan-Jung, 2017). This fea-

ture significantly curtails the risk of local governments' hidden debt. For instance, smart contract technology's early warning mechanism promptly alerts relevant entities when specific conditions are met. Regarding decentralized auditing, fintech promotes fairer financial auditing. Blockchain technology's decentralized nature permits multiple parties to participate in the auditing process without depending on a single central institution (L. Guo et al., 2022). This method ensures a more impartial and tamper-resistant auditing process, hindering local governments from unilaterally altering financial information and aiding in the exposure of hidden debts. For example, the coordinated audit of municipal bonds by the audit office and the Ministry of Finance in 2018 allowed less manipulation by local governments, yielding more reliable results (Figures 1-3) (Xu et al., 2020). From a big data analysis perspective, fintech bolsters the identification of latent risks. Its vast data collection and analytical capabilities, through algorithms and models built on historical and real-time data, enable regulators to foresee potential debt defaults (Ozili, 2018). This predictive power can timely spot potential financial crises, empowering SOEs, banks, and local governments to preemptively address hidden debt risks. Based on these insights, this paper proposes Hypothesis 1:

H1: Fintech has mitigated local government hidden debt risks (LGHDR).

2.3. Competitive mechanisms of fintech in mitigating local government hidden debt risk

The restraining effect of fintech on local government implicit debt risk depends on both internal corporate governance and external regulatory environments. This paper explores specific logical pathways from the perspectives of enterprises, banks, and local governments (Fig.5). Firstly, preventing improper competitive behaviors of enterprises. Enhancing the quality of information disclosure helps prevent enterprises from gaining unfair competitive advantages by concealing information or manipulating data. This enables fintech to more accurately identify the debt situation and repayment risks of SOEs, thereby improving the accuracy of banks' financing assessments for these enterprises and avoiding the blind reliance on the "state-owned enterprise trust" filter. As a result, it enhances the precision of debt financing approvals for SOEs. Secondly, increasing competitive intensity of banks. Fintech enhances the intensity of bank competition, prompting banks to proactively undertake top-down institutional reforms. This weakens the institutional loopholes of financial implicit decentralization, improves the misallocation of financial resources within banks, and ensures the rational allocation of debt financing amounts for SOEs. Thirdly, limiting government economic competition violations. Fintech,

through the transparency of networked information technologies, has formed a public joint regulatory system involving multiple functional departments. When combined with the government's strict financial governance measures, it mitigates the speculative mindset of local governments seeking success in the "promotion tournament" through illicit economic competition. This reduces the likelihood of local governments engaging in risky behaviors, such as illegal borrowing. This collaborative mechanism together mitigates the hidden debt risks of local governments.

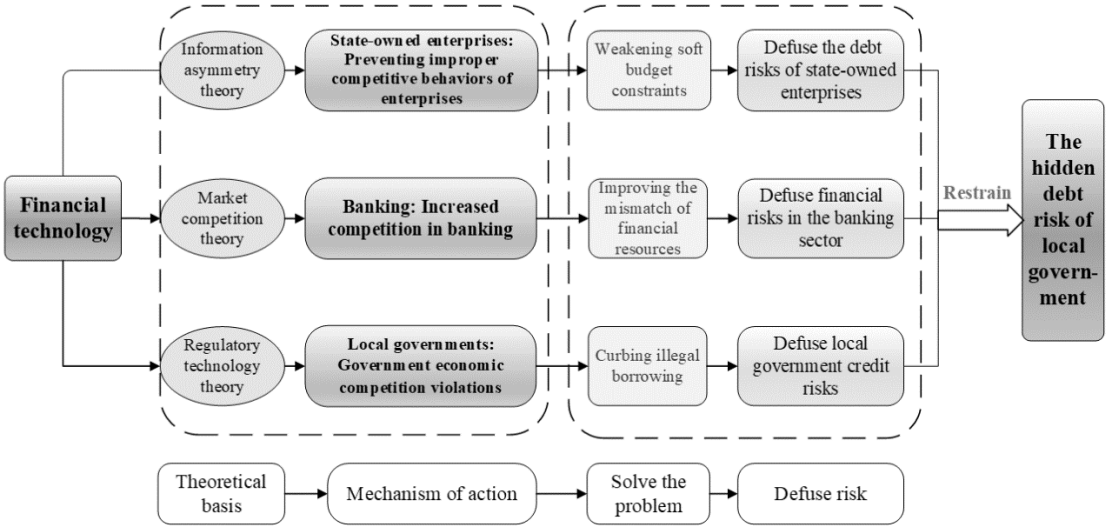

Fig.5 - Mechanism of action analysis

- SOEs: preventing improper competitive behaviors. By enhancing the information transparency of SOEs, fintech has played a role in preventing improper competitive behaviors, reducing the banks' soft budget constraints on these enterprises, and thereby mitigating their debt risks. Information asymmetry theory posits that asymmetries in financial transaction information between interested parties can lead to irrational resource allocation and potential resource allocation failures. Zha and Li (2022), using provincial-level data from China, demonstrate that fintech effectively reduces local government debt risk through enhancing financial transparency. Su and Xu (2023)observe that firms with more transparent information disclosure experience a greater reduction in credit corruption due to fintech. Pérez et al. (2005), analyzing data from European Union countries, find that fintech increases public finance transparency and guards against public sector financial risks. Due to the improvement in the quality of corporate information disclosure, improper competitive behaviors by concealing information have been prevented. This has enhanced the efficacy of fintech, allowing financial institutions to more objectively understand the hidden debt

status and true repayment capacity of SOEs. Consequently, financial institutions can more rationally assess the debt risks of these enterprises, reducing the reliance on "state-owned enterprise faith" as a basis for lending. This has mitigated the soft budget constraints on SOEs, thereby improving the fairness and rationality of bank loan evaluations. Ultimately, this has mitigated the tendency of local governments to incur debt through SOEs and mitigated the debt risks of these enterprises. Thus, the following hypothesis is proposed:

H2: Fintech has mitigated the LGHDR by preventing improper competitive behaviors of enterprises.

- Banks: increasing competitive intensity. Fintech mitigates the problem of financial resource mismatch by intensifying competition within the banking sector, thereby reducing the financial risks faced by banks. Market competition theory asserts that ample competition fosters efficiency and optimizes resource allocation. C. Gao and Wang (2023) have empirically demonstrated that fintech amplifies the competitive intensity among banks, based on a dataset from 2019 cities in China. Vives (2019), using banking data from Spain, highlights that fintech acts as a technological disruptor to traditional banking, necessitating a transformation and upgrade of financial entities' (banks') business models. By intensifying bank competition (Jagtiani & Lemieux, 2018), fintech inflicts pressure on conventional financial institutions, propelling them to become more competitive and initiate comprehensive institutional reforms. These reforms aim to rectify the institutional gaps of implicit financial decentralization and reinforce centralized financial regulation. As a result, banks can impartially evaluate loans to enterprises based on return and risk, addressing the skewed allocation of financial resources towards SOEs. This shift curbs the unchecked debt expansion of SOEs and the emergence of "bad debt" risks, thereby mitigating the financial risks to banks. Consequently, we propose the following hypothesis:

H3: Fintech has mitigated the LGHDR by increasing the intensity of bank competition.

- Local governments: limiting government economic competition violations. Fintech, by enhancing information transparency and networked sharing technologies, ensures that all financing processes involving relevant stakeholders are subject to coordinated supervision by multiple regulatory authorities. This supervisory mechanism strengthens the strict enforcement of debt financing approvals by banks for SOEs. While supervision by a single department may be subject to manipulation by local government officials, public joint supervision by multiple departments effectively limits the exercise of improper political

power (Colliard, 2020; M. Y. Li et al., 2024). Through this multi-layered public supervision, fintech makes it more difficult to conceal local government hidden debt issues, thereby increasing the transparency and fairness of debt financing decisions. At the same time, the strong fiscal governance ability of local governments limits the motivation of local officials to engage in excessive economic competition due to the "promotion tournament" (J. X. Guo & Gong, 2023; He & Quan, 2024). In this process, the combination of fintech's technological advantages and the government's governance capabilities restricts local officials' speculative tendencies to incur debt. The collaborative transparent regulatory approach of fintech, together with the government's strict fiscal governance, weakens the tendency of local officials to seek short-term economic growth through illegal borrowing (B. Zhou et al., 2020). Ultimately, this cooperative mechanism effectively mitigated the hidden debt risks of local governments. Consequently, we propose the following hypothesis:

H4: Fintech has mitigated the LGHDR by limiting violations of government economic competition.

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

3.1. Research objective and data

The hidden debt of China's local governments has been growing every year, gradually becoming a "grey rhino" that hinders China's high-quality economic development. Fintech plays a crucial role in tackling this potential financial crisis and realizing the strategy of building a strong financial nation in the new era. Initially, we gathered financial data from Chinese SOEs listed on the A-share market for the period spanning 2014 to 2021. The original data came from a total of 822 SOEs with financial data for five or more consecutive years. We manually calculated the local government implicit debt within these SOEs, based on the geographical division of cities, representing the local government implicit debt in SOEs within each respective city. Subsequently, we paired this implicit debt data with the digital financial index, utilizing the digital financial index as the independent variable, and the local government implicit debt within SOEs in cities as the dependent variable, thereby constructing the panel dataset. Sample selection was conducted based on the following criteria, resulting in a final dataset covering 1,312 "cities-years": (1) Exclusion of financial enterprises. (2) (Exclusion of ST (special treatment) companies and delisted enterprises during the study period. (3) Exclusion of enterprises that underwent initial public offerings (IPOs) during the sample period (4) A 1% reduction in

the sample data was applied to ensure dataset efficiency. Financial data for the enterprises were sourced from the Wind database and Cathay Pacific database (CSMAR), while the digital financial index was obtained from the Digital Financial Inclusion Index (F. Guo et al., 2020).

3.2. Explained variable

- LGHDR implicit in SOEs (*hdebt*)

This paper refers to the research of M. Guo et al. (2020) and Arslanalp and Liao (2014), and after making amendments to its formula, innovatively measures the local government implicit debt index in SOEs in each city in China manually based on the basic financial data of SOEs and the division of Chinese cities. The index is based on the policy function of China's SOEs and their relationship with local governments, and the local government implicit debt risk in SOEs is measured as a metric from a probabilistic point of view through the following formula. Fig. 6 shows the distribution of the amount of local government hidden debt risk (the explained variable) across Chinese cities. The specific treatment is as follows:

In Eq. 1, the implicit debt pressure of the local government comes from the scale of corporate debt, the probability of default risk, the relevance of corporate default risk, and the probability that the local government will provide bailouts for corporation. The government implicit debt index method synthesizes each of these factors to construct an index of expected government debt pressure $EL_{i,t}$. Among them, the debt level of enterprises ($TAL_{i,t}$) is measured by total liabilities, including long-term liabilities and short-term liabilities. The default probability of specific moments is calculated using the KMV model, and the expected default probability of local SOEs in China are all at a high level around 0.5, and the probability of default risk ($PD_{i,t}$) in this paper is calculated as 0.5. The proportion of loss generated when the enterprise defaults ($LGD_{i,t}$) is set as a fixed value of 50% in the calculation process(M. Guo et al. (2020)). The probability of an enterprise being bailed out ($PSS_{i,t}$) is set to a fixed value of 1 according to the position of SOEs in the national economy.

$$EL_{i,t} = TAL_{i,t} \times PD_{i,t} \times LGD_{i,t} \times PSS_{i,t} \quad (1)$$

Eq. 2 sums the expected government debt pressure created by all SOEs within the same city to create the city's expected government debt pressure EL_t.

$$EL_t = \sum_i EL_{i,t} \quad (2)$$

The concentration of the industry distribution of China's SOEs results in a high degree of interconnectedness between enterprises, and default risks are transmitted to each other between enterprises, creating government unanticipated debt pressure caused by contagious enterprise default risks. Therefore, the government's expected debt pressure formed by all SOEs within the same city is summed up, and then the government's unanticipated debt pressure (UL_t) for the city is found by using Eq. 3.

$$UL_t = 2 \times \text{sqrt}\left[\text{Var}\left(\sum_i^n EL_{i,t}\right)\right] \quad (3)$$

In Eq. 4, the local government implicit debt risk (*hdebt*) in SOEs in each city is the sum of expected and unanticipated government debt pressures created by local SOEs.

$$hdebt_t = EL_t + UL_t \quad (4)$$

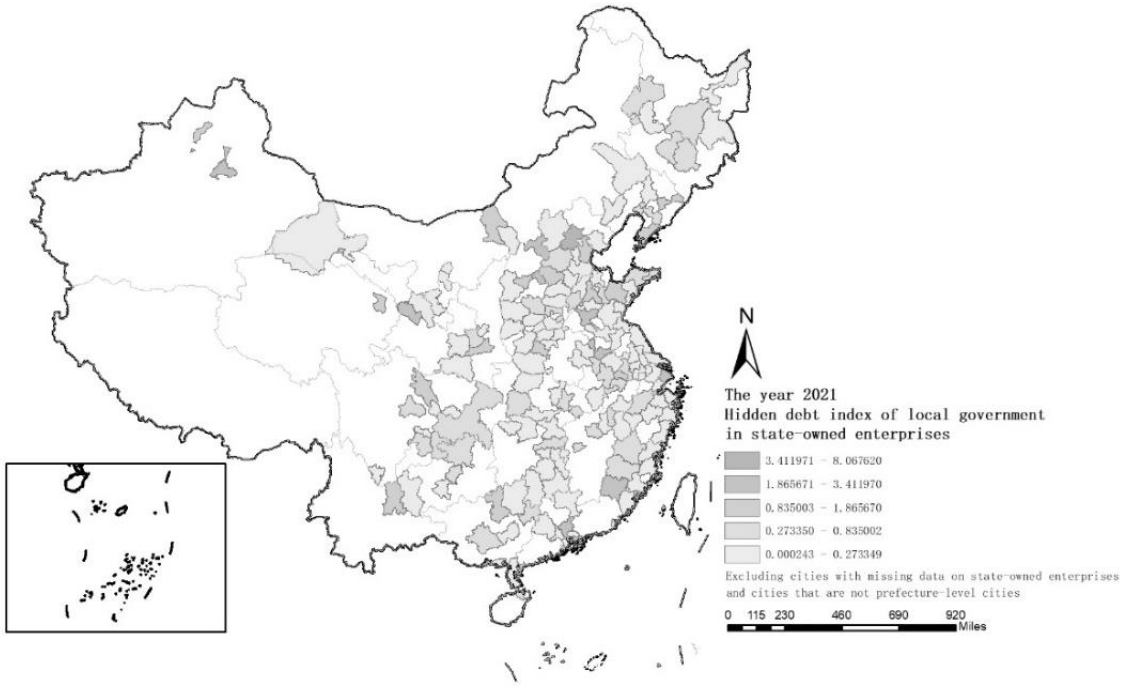

Fig.6 - LGHDR implicit in SOEs

3.3. Core explanatory variable

- Fintech (*fintech*)

Drawing on the studies of F. Guo et al. (2020) and Xie et al. (2018), this paper uses the China digital inclusive finance index, with the data of cities as the measure of the explanatory variable. Specifically, the index system of digital inclusive finance is constructed from three dimensions:

the coverage breadth of digital finance, the use depth of digital finance and the digitalization degree of inclusive finance. The construction of the digital inclusive finance index adopts a hierarchical weighting method: firstly, heterogeneous indicators are dimensionless processed, followed by determining the weights of basic indicators to the criterion layer through the objective weighting method of the coefficient of variation; secondly, the analytic hierarchy process (AHP) is used to combine subjective and objective factors to determine the weights of the criterion layer to the overall goal; thirdly, the comprehensive index is synthesized through weighted aggregation.

3.4. Mechanism variables

- Corporate improper competitive behaviors (kv)

This paper draws on Kim and Verrecchia (2001), using the corporate disclosure quality index as a measure of improper competitive behaviors of enterprises. The index is a measure of the impact of trading volume on returns, which is used to reflect the market's reliance on trading volume information, and a higher index implies a lower quality of corporate disclosure. The model formula is as follows:

$$\mathrm{Ln}\,|P_t - P_{t-1}| = \lambda_0 + \lambda(Vol_t / Vol_0 - 1) + \varepsilon \quad (5)$$

where P_t and Vol_t are the closing price and trading volume (number of shares) of the stock on day t, respectively, and Vol_0 is the average daily trading volume for all trading days in the study period.

- Bank competitive intensity (hhi)

Drawing on Degryse and Ongena (2007) andChong et al. (2013), this paper obtains the Herfindahl index (hhi) by summing the squares of the shares of the number of branches of each bank within a city as a measure of the intensity of bank competition. The Herfindahl index (hhi) takes values between 0 and 1, with the closer to 0 indicating the more competitive the banks are, where $branch_{r\,m}$ represents the number of branches of the r bank in city m, and N_m is the number of all types of banks in city m.

$$hhi = \sum_{r=1}^{N_m} \left(branch_{rm} / \sum_{r=1}^{N_m} branch_{rm} \right)^2 \quad (6)$$

- Government economic competition violations (bce)

Drawing on the research of Cai-Chen et al. (2015), this paper chooses the Budget Compliance Execution Index as a metric for government economic competition violations. This measure is derived from the ratio of local government off-budget expenditures to general public budget expenditures.

3.5. Control variables

In order to avoid the impact of omitted variables and to ensure the precision of the selected control variables, this paper sets up the following groups of control variables from three different levels of consideration: (1) Macro level: GDP growth rate (*gdpg*), urbanization rate (*urban*), import/export trade volume (*vie*), and marketization index (*market*); (2) Governmental level: the degree of fiscal decentralization (*fis*), and the rate of growth of fixed-asset investment (*fig*); and (3) Financial level: financial efficiency (*fe*). The definitions of the variables are shown in Table 1. Descriptive statistics are shown in Table 2.

Tab. 1 – Variable definitions

Sort		Variable	Symbol	Definition
Explained variable		Hidden debt risk of local government	*hdebt*	Based on the basic data of SOEs, the innovative data indicators are manually calculated and sorted by city
Core explanatory variable		Financial technology	*fintech*	Peking University Digital Financial Inclusion Index
Control variable	Macro level	GDP growth rate	*gdpg*	(Current GDP- previous year GDP)/Current GDP
		Urbanization rate	*urban*	Regional urban population/year-end resident population
		Volume of import and export	*vie*	Total import and export trade /GDP
		Marketization index	*market*	General Index of China Marketization. Compiled by (Xiaolu et al., 2019)
	Government level	Fiscal decentralization degree	*fis*	Local government expenditure/National expenditure
		Growth rate of fixed asset investment	*fig*	The growth rate of fixed asset investment
	Financial level	Financial efficiency	*fe*	Financial institutions year-end loan balance/year-end deposit balance
Moderating variables		Corporate improper competitive behaviors	*kv*	Disclosure quality index

	Government economic competition violations	*bce*	Budget compliance execution index = (general public budget expenditure - general public budget revenue) / general public budget expenditure
Intermediate variable	Bank competition intensity	*hhi*	The Herfindahl index
Explanatory variable dimension reduction index	Coverage span	*coverb*	Sub-index of digital financial technology index, covering breadth
	Service depth	*usaged*	Sub-index of digital financial technology index, depth of use
	Digitization level	*digitl*	Sub-index of digital financial technology Index, level of digitization
Heterogeneity index	Fiscal Balance	*expend*	General public budget expenditure
	Investment intensity	*invest*	Regional fiscal expenditure/regional area

3.6. Methodology

In order to investigate the influence of fintech on the LGHDR, the estimation Eq. 7 is constructed:

$$hdebt_{i,t} = \alpha + \beta fintech_{i,t} + \sum \gamma CONTROLS + \sum YEAR + \sum CITY + \varepsilon \quad (7)$$

In the regression model (7), the explanatory variable is local government implicit debt in SOEs, with the local government implicit debt risk index (*hdebt*) constructed in this paper as a measure; the core explanatory variable is fintech, with the fintech index of prefecture-level cities (*fintech*) as a measure; CONTROLS denotes a series of control variables; ε is the randomized disturbance term. This paper carries out the following operations: (1) the sample data are shrunk by 1% up and down; (2) the dummy variable "YEAR – CITY" is controlled, and the measurement is based on the double fixed effects model.

Tab. 2 – Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
hdebt	1312	0.499	0.892	0.000	8.769
fintech	1312	5.405	0.224	4.860	5.802
gdpg	1312	0.089	0.441	-0.900	10.759
urban	1312	0.631	0.136	0.242	1.000
vie	1312	0.184	0.270	0.000	3.640
market	1312	8.827	1.590	3.740	12.390
fis	1312	0.003	0.005	0.000	0.045
fig	1312	6.977	8.187	-56.600	23.400
fe	1312	0.758	0.243	0.085	5.613

kv	1312	0.529	0.158	0.095	1.436
hhi	1312	0.144	0.059	0.052	0.357
bce	1312	0.482	0.212	-0.107	0.885
coverb	1312	5.375	0.239	4.789	5.918
usaged	1312	5.357	0.279	4.264	5.870
digitl	1312	5.552	0.203	4.922	6.365
expend	1312	6.537	9.304	0.221	84.300
invest	1312	8.132	19.164	0.062	230.035
dyn.hdebt	1312	-0.750	4.696	-113.000	1.590

4. RESULTS

4.1. Baseline results

Table 3 shows the benchmark regression test for "fintech – LGHDR". This paper adopts a progressive regression strategy. In M (1), the regression coefficient of fintech is negative and passes the 1% statistical significance test; further, in M (2), the control variables are added, and the regression coefficient of fintech is negative and still passes the 1% statistical significance test. This indicates that fintech has a significant inhibitory effect on local government hidden debt risk. This conclusion verifies the research hypothesis H1.

Tab. 3 – Baseline regression

Explained variable	**code**	*hdebt*	
		M (1)	M (2)
Explanatory variables	*fintech*	-0.839***	-0.697**
		(-2.81)	(-2.29)
Control variables	*gdpg*		-0.013
			(-0.78)
	urban		-0.487*
			(-1.68)
	vie		0.043
			(0.80)
	market		-0.051**
			(-2.44)
	fis		6.940
			(0.58)
	fig		-0.001
			(-0.54)
	fe		0.048
			(1.05)
Constant	*cons*	4.670***	4.615***

		(3.12)	(3.03)
CITY-YEAR Fixed-effects	*CONTROLS*	NO	YES
	CITY	YES	YES
	YEAR	YES	YES
	Adj.R2	-0.117	-0.113
	N	1312	1312

4.2. Robustness and endogeneity tests

- Dynamic measurement model of the explained variable

To further enhance the dynamic interpretability of research findings and the accuracy of the model, this paper has substantially optimized the calculation method of the dependent variable in the benchmark regression. Specifically, when estimating the government's expected debt pressure($EL_{i,t}$),the original indicator data on corporate default risk ($PD_{i,t}$) and default loss rate ($LGD_{i,t}$) adopted Arslanalp and Liao (2014) and M. Guo et al. (2020) were further refined into dynamic indicators, drawing on the studies of J. X. Guo and Gong (2023) and Y. Zhou and Zhang (2023). This adjustment allows the implicit government debt to exhibit dynamic characteristics, thereby verifying the robustness of the core conclusions of this paper. The specific calculation methods of each variable are detailed in Table (4). As shown in the results of M (1) (Table 5), there remains a significant correlation between fintech and local government implicit debt risk at the 10% significance level. This result once again confirms the robustness of the conclusions of this study.

Tab. 4 – Indicator calculation explanation

Indicator	Calculation method
$TAL_{i,t}$	The total liabilities as reported in the balance sheet of a publicly listed company's annual financial statement.
$PD_{i,t}$	$D_{i,t} = CL_{i,t} + 0.5 \times NCL_{1,t}$ (8) $V_{i,t} = D_{i,t} + E_{i,t}$ (9) $\sigma_D = 0.05 + 0.25 \times \sigma_E$ (10) $\sigma_V = \frac{E_{i,t}}{V_{i,t}} \times \sigma_E + \frac{D_{i,t}}{V_{i,t}} \times \sigma_D$ (11) $DD_{i,t} = \frac{\ln\left(\frac{V_{i,t}}{D_{i,t}}\right) + \left(u - \frac{\delta_v}{2}\right)T}{\sqrt{T}\delta_v}$ (12) $PD_{i,t} = (-1) \times DD_{i,t}$ (13)

	This study employs Merton's KMV model to measure the debt default risk of listed companies. Where $V_{i,t}$ denotes the market value of firm assets; $D_{i,t}$ denotes the market value of firm debt, comprising current liabilities($CL_{i,t}$) and non-current liabilities($NCL_{i,t}$); and $E_{i,t}$ denotes the market value of firm equity. u represents the expected asset return rate, assumed to be the stock return rate of the enterprise in the previous year. δ_v denotes the volatility of firm asset value, composed of equity volatility(δ_E) and debt volatility(δ_D). The debt maturity (T) is set to one year. To transform it into a positive indicator, the opposite number of $DD_{i,t}$ is taken, denoted as $PD_{i,t}$; the larger the $PD_{i,t}$ value, the higher the probability of default.
$LGD_{i.t}$	$$\frac{CL_{i,t}+CPLTD_{1,t}}{CA_{i,t}+NCA_{i,t}-IA_{i,t}-NGW_{i,t}} \quad (14)$$ In this study, we define the loss given default ($LGD_{i,t}$) as the ratio of default risk exposure to tangible assets. The default risk exposure, which reflects the firm's debt exposure, consists of current liabilities ($CL_{i,t}$) and current portion of long-term debt ($CPLTD_{i,t}$). Tangible assets are calculated as the total amount of current assets ($CA_{i,t}$) and non-current assets ($NCA_{i,t}$), less intangible assets ($IA_{i,t}$) and net goodwill ($NGW_{i,t}$).
$PSS_{i,t}$	SOEs occupy a prominent position in China, and it is commonly assumed that the probability of their receiving government support is 1.

- Indicator downgrading of explanatory variable

This paper breaks down fintech into three levels: coverage breadth, usage depth, and digitization level (Cai et al., 2024), and conducts baseline regression tests accordingly. The results shown in M (2)-M (4) (Table 5) indicate a significant negative correlation between the breadth of fintech coverage and local government implicit debt risk, passing the 1% statistical significance test. The significance of the relationship between the depth of fintech usage and digitization level with local government implicit debt risk gradually weakens. These results suggest that the widespread adoption of fintech tools by local governments helps reduce the implicit debt risks in SOEs, with the breadth of fintech coverage having the greatest impact. Overall, these findings confirm the robustness of the core conclusions of this paper.

Tab. 5 – Robustness test & endogeneity test

Variables					
	M (1)	M (2)	M (3)	M (4)	M (5)
Dyn.hdebt	-5.246*				

	(-1.83)				
L.hdebt					0.875***
					(338.01)
coverb		-0.776***			
		(-3.36)			
usaged			-0.287*		
			(-1.65)		
digitl				0.057	
				(0.57)	
fintech					0.059***
					(8.17)
cons	28.120**	5.001***	2.540***	0.895	-0.291***
	（-1.97）	(4.30)	(2.96)	(1.58)	(-9.45)
AR (1)					0.005
AR (2)					0.816
Sargan Test					0.185
CONTROLS	YES	YES	YES	YES	YES
CITY	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES
Adj.R2	-0.104	-0.107	-0.115	-0.118	
N	1312	1312	1312	1312	1148

- Endogeneity Test

In this paper, we refer to the studies of Arellano and Bond (1991) and Bond (2002) and apply the generalized systematic according estimation method (SYS-GMM) for the endogeneity test. The p-value of the Sargan statistic estimated by SYS-GMM is not significant (0.1846), and the original hypothesis that the instruments are jointly valid cannot be rejected (M (5), Table 5). Therefore, our selection of instruments and their lag order is appropriate. The accompanying p-value of the residual autocorrelation test AR(1) is significant (0.0048), and the accompanying p-value of AR(2) is insignificant (0.8162), which verifies that the endogeneity test SYS-GMM estimation is better, and suggests that the core conclusion of this paper is robustly established - fintech suppresses local government's implicit debt risk.

4.3. Mechanism analysis

As shown in Table 6, this paper starts from two aspects of enterprise internal governance (moderating effect) and external regulation (intermediary effect), and three perspectives of enterprise

- bank - local government, and selects three types of channels, namely “corporate improper competitive behaviors”, “bank competition intensity”, and “government economic competition violations”, to carry out the following three logical paths of research.

Tab. 6 – Mechanism path analysis

Mechanisms Pathways	Research Perspectives	Intermediate Variables	Measurement Indicators	Modeling Methods
Internal governance	corporations	Corporate improper competitive behaviors	Disclosure quality index （*kv*）	moderated effects
External regulation	banks	Bank competitive intensity	Herfindahl index （*hhi*）	mediation effects
	local governments	Government economic competition violations	Budget compliance execution index（*bce*）	moderated effects

The moderating effects are modeled as follows:

$$hdebt = \rho + \rho_1 fintech + \rho_2 kv + \rho_3 dif \times kv + \sum \rho_j CONTROLS + \varepsilon \quad (15)$$

$$hdebt = \rho + \rho_1 fintech + \rho_2 bce + \rho_3 dif \times bce + \sum \rho_j CONTROLS + \varepsilon \quad (16)$$

Drawing on Wen and Ye (2014), the mediation effect model is constructed as follows:

$$hdebt_{i,t} = \phi + \phi_1 fintech_{i,t} + \sum \phi CONTROLS + \sum YEAR + \sum CITY + \varepsilon \quad (17)$$

$$hhi_{i,t} = \theta + \theta_1 fintech_{i,t} + \sum \phi CONTROLS + \sum YEAR + \sum CITY + \tau \quad (18)$$

$$hdebt_{i,t} = \mu + \mu_1 hhi_{i,t} + \mu_2 fintech_{i,t} + \sum \phi CONTROLS + \sum YEAR + \sum CITY + \xi \quad (19)$$

- Corporate improper competitive behaviors

As shown in Table 7, the combined results of M (1) indicate that fintech mitigates the hidden debt risks of local governments in SOEs by preventing improper competitive behaviors. This

validates the research hypothesis 2 mentioned above. The specific mechanism of transmission is "fintech + enhancing the quality of information disclosure (one way to prevent improper competitive behaviors) → (improving) the accuracy of banks' financing assessments → (mitigating) the hidden debt risk of local governments."

- Bank competition intensity

In Table 7, the results of M (2) to M (4) together show that fintech mitigates the risk of local government implicit debt in SOEs by enhancing the intensity of bank competition. This validates the research hypothesis 3. The specific mechanism of transmission is "fintech → (enhancement of) bank competition → (weakening of) financial resource mismatch → (suppression of) local government hidden debt risk."

- Government economic competition violations

In Table 7, the combined results of M (5) and M (6) show that, under the synergistic effect of the technological advantages of fintech and the governance measures limiting government economic competition violations, the risk of local government hidden debt in SOEs is mitigated. This validates research hypothesis 4. The specific transmission mechanism is: "fintech + (limiting) government economic competition violations → (mitigating) illegal borrowing issues → (mitigating) LGHDR."

Tab. 7 – Mechanism test

Variables	*hdebt*	*hdebt*	*hhi*	*hdebt*	*hdebt*
	M (1)	M (2)	M (3)	M (4)	M (5)
fintech	-0.741**	-0.697**	-0.026***	-0.597*	-0.423
	(-2.43)	(-2.29)	(-5.07)	(-1.94)	(-1.30)
kv	0.096				
	(1.63)				
hhi				3.798**	
				(2.18)	
bce					0.136
					(-0.81)
c_fin_kv	0.424*				
	(1.68)				
c_fin_bce					-0.394**
					(-2.14)
cons	4.809***	4.615***	0.289***	3.520**	28.12**
	(3.16)	(3.03)	(11.16)	(2.20)	(-1.97)
Mechanism Identification	Effective	Effective			Effective
CONTROLS	YES	YES	YES	YES	YES

CITY	YES	YES	YES	YES	YES
YEAR	YES	YES	YES	YES	YES
Adj.R2	-0.110	-0.113	0.595	-0.109	-0.104
N	1312	1312	1312	1312	1312

4.4. Heterogeneity analysis

Furthermore, this paper considers from the point of view that the sample variability may lead to variability in the results, and groups the samples according to the variability in the degree of financial balance of the local government, and the variability in the intensity of the local government's investment, and carries out the following tests of heterogeneity.

- Heterogeneity in the fiscal balance of local governments

Considering the differences in the fiscal balance of local governments, this paper refers to the study by Wei et al. (2023) and uses the ratio of local government fiscal expenditure to fiscal revenue as an indicator of the fiscal balance degree of local governments. The sample is then divided into two groups: low fiscal balance and high fiscal balance. In Table 8, the results show that fintech has a stronger inhibitory effect on local government hidden debt in regions with lower fiscal balance and higher fiscal deficit, while showing no significant impact in regions with higher fiscal balance and lower fiscal deficit. From the perspective of local government financial management, in regions with lower fiscal balance, governments may rely more on debt financing to fill the fiscal gap, thus making fintech's inhibitory effect on hidden debt more significant. In contrast, in regions with higher fiscal balance, the government may focus more on fiscal management, leading to less implicit debt, which makes fintech's inhibitory effect less obvious.

Tab. 8 – Heterogeneity analysis: fiscal balance of different local governments

Variables	*hdebt*	
	M(1)	M(2)
fintech	-0.291	-0.924**
	(-0.57)	(-2.03)
cons	3.854	5.204**
	(1.50)	(2.35)
CONTROLS	YES	YES
CITY	YES	YES
YEAR	YES	YES
Adj.R2	-0.142	-0.171
N	656	656

- Heterogeneity in local government investment intensity

Considering the differences in the investment intensity of local governments, which may have a heterogeneous impact on the core conclusions of this paper, this paper refers to the study of Li et al. (2022), which measures the investment intensity of local governments using the ratio of fixed asset investment to covered area, and divides the samples into three groups: low, medium, and high investment intensity. In Table 9, the results show that the suppression effect of fintech on local government implicit debt risk is significant in cities with high and low investment intensity, but not in cities with medium investment intensity. This paper argues that cities with high investment intensity face more complex fiscal management challenges, making efficient data processing and risk assessment tools, such as fintech, particularly important. Cities with low investment intensity can directly benefit from fintech due to their smaller fiscal size. In contrast, cities with medium investment intensity may not have sufficiently complex fiscal management to fully realize the advantages of fintech, resulting in a less significant impact.

Tab. 9 – Heterogeneity analysis: investment intensity of different local governments

Variables	*hdebt*		
	M(1)	M(2)	M(3)
fintech	-1.113*	0.633	-1.438**
	(-1.78)	(1.12)	(-2.36)
cons	6.842**	-1.716	10.340***
	(2.23)	(-0.60)	(3.37)
CONTROLS	YES	YES	YES
CITY	YES	YES	YES
YEAR	YES	YES	YES
Adj.R2	-0.197	-0.249	0.004
N	438	437	437

5. DISCUSSION

5.1. Discussion on the debt alleviation effect of FinTech

Based on the empirical analysis in Chapter 4, we find that fintech has a significant positive impact on mitigating the hidden debt risks of local governments embedded in SOEs. This finding is consistent with the research of Q. Wang and Liang (2023) and Kluza et al. (2024), which shows that, in recent years, the hidden debt risks of local governments have been expanding to

micro-level entities. Kluza et al. (2024) point out that off-budget debt in Polish local governments has been growing, and this trend is cyclically linked to the debt issues of subordinate enterprises within local governments. Similarly, Rius-Ulldemolins and Gisbert (2019) find that local Spanish governments' debt and corruption issues have expanded through urban projects implemented by SOEs. However, although most studies confirm that the industrial transformation and debt-for-equity swaps of urban investment companies are effective debt resolution methods (Hong et al., 2021; Jiang & Waley, 2020; Oi et al., 2025; P. Zhang et al., 2025), this approach is not applicable to all types of enterprises, especially those outside urban investment platforms. Our study shows that fintech, through methods such as blockchain for joint transparent management, big data for real-time monitoring, and smart contracts for early risk warning, can effectively reduce the hidden debt risks of local governments embedded in SOEs. Therefore, fintech is seen as a novel and promising tool for mitigating the hidden debt risks of SOEs.

5.2. Discussion on competitive financing mechanisms

Firstly, reducing improper competitive behaviors of enterprises. By enhancing the quality of information disclosure and leveraging the transparency advantages of FinTech, improper competitive behaviors of enterprises are effectively reduced. However, improper competitive channels in enterprises vary depending on the policy and regulatory tolerance in different regions (J. Huang et al., 2025; M. Wang et al., 2023), such as political rent-seeking, regulatory competition, and non-market transactions. These factors may reduce the effectiveness of the enterprise competition mechanism discussed in this paper. Regional regulatory differences in Australia, South Africa, the United States, and the European Union lead enterprises to engage in improper competitive behaviors, such as registering or listing in areas with more lenient policies (Franco & Haefliger, 2025; Wood et al., 2024). This indicates that regional policy environment differences may influence the manner in which enterprises engage in improper competitive behaviors.

Secondly, increasing the competitive intensity of banks. Fintech enhances the intensity of bank competition, prompting banks to actively seek institutional reforms and reduce the misallocation of financial resources. Girotti and Salvadè (2022), in their study using a sample of banks in France, demonstrate that increasing the intensity of bank competition helps reduce issues such as managerial self-dealing and other forms of disorder. This confirms the universal effectiveness of the bank competition mechanism in financial management, consistent with the conclusions of this paper.

Thirdly, limiting government economic competition violations. Fintech, through the transparency of information technology combined with the government's strict financial governance measures, forms an effective joint regulatory system involving multiple departments, thereby increasing the exposure risk of local officials seeking promotion through illicit economic competition. However, the effectiveness of fintech may vary in different policy environments and digital infrastructure contexts, limiting the benefits in some regions. For instance, in areas with weak digital infrastructure, fintech may not exert its maximum impact in enhancing regulatory efficiency and information transparency (Ferilli et al., 2024), a finding that has been similarly confirmed in both China and Europe (R. R. Li et al., 2024).

5.3. Discussion on the heterogeneity of local government fiscal governance

Firstly, fintech is particularly pronounced in regions with lower fiscal balance and higher fiscal deficits. In these areas, due to limited fiscal control capabilities and the need for stricter financial regulation, fintech significantly reduces the risk of hidden debt by enhancing information transparency and strengthening the regulatory framework. In contrast, regions with higher fiscal balance and lower deficits show no significant change, suggesting that fintech may have less impact in areas with good fiscal health governance, as these regions already have stronger fiscal management capabilities. This aligns with research on the U.S. government and fintech, which indicates that the debt control advantages of fintech are regionally dependent on local governments' fiscal management capabilities (Chen et al., 2019; Kakhkharov et al., 2024).

Secondly, fintech has a significant effect in reducing local government hidden debt risk in areas with high investment intensity. In cities with high investment intensity, fintech plays a crucial role in managing debt risks, especially in the context of infrastructure expansion and public project construction. This conclusion is consistent with findings from studies such as Ren and Wang (2024) and ,S. Y. Wang and Ma (2024). This suggests that the larger the scale of public resource operation, the greater the advantage of using objective technological tools for regulation, helping to overcome the inherent shortcomings and uncontrollability of individual decision-making.

6. CONCLUSION

The research findings confirm that fintech can alleviate the hidden debt risks of local governments in SOEs. Mechanism analysis indicates that fintech mitigates these risks through three competitive mechanisms: preventing improper competitive behaviors of enterprises, increasing

the intensity of bank competition, and limiting government economic competition violations. Furthermore, the impact of fintech on the hidden debt risks of local governments in SOEs shows heterogeneity in terms of local government fiscal balance and investment intensity.

Thesefindings provide real, reliable and proven policy suggestions for enterprises, banks and government sectors:

- Strengthening local government debt transparency and joint regulatory mechanisms**.** Fintech can enhance fiscal transparency by establishing a comprehensive information disclosure and sharing system, effectively reducing the risk of local government hidden debt. The government should leverage these tools to create a multi-departmental joint regulatory platform, ensuring real-time supervision of financing processes. A digital fiscal management system should be established to connect local governments, SOEs, and banks, enabling real-time monitoring and analysis of fiscal revenues, expenditures, and debt. This system can promptly identify potential risks and prevent debt crises. Additionally, regular disclosure of fiscal information through official websites and public platforms will improve transparency, allowing the public and regulatory agencies to better monitor government and state-owned enterprise fiscal activities, reducing the occurrence of hidden debts.
- Establishing an effective risk management mechanism and internal audit innovation. FinTech can provide powerful risk warning systems to proactively address LGHDR. It is recommended to use these technologies to establish an interconnected early warning mechanism for local government debt risks, involving fiscal and financial regulatory bodies. Additionally, the internal audit model should be innovated to enable timely actions by the government and banks. Developing risk assessment models using big data and artificial intelligence can analyze economic and financial indicators in real-time, predicting potential debt risks, while considering regional differences. Furthermore, combining blockchain technology to create a decentralized audit network will allow multiple departments to collaborate, ensuring impartial, transparent, and de-politicized audits, preventing local governments from manipulating fiscal data and reducing hidden debt manipulation.
- Enhancing competitive evaluation mechanisms and improving accountability systems. To ensure accountability and transparency in fiscal management, it is recommended to establish a long-term performance tracking mechanism using fintech, integrating fiscal health and debt management indicators into local officials' performance evaluations. This should prioritize long-term fiscal stability over short-term economic performance, achieved by

dynamically quantifying fiscal behavior through digital financial tools and monitoring. Performance evaluations should be updated regularly to reflect changes in the economic environment and policy goals, focusing on long-term debt management. Additionally, implementing moderate fiscal decentralization allows local governments to approve financial institutions while strengthening horizontal and vertical accountability mechanisms, with both central and local governments jointly overseeing fiscal management to ensure financial market health.

Although this study has made significant progress in exploring how fintech mitigates the hidden debt risks of local governments in SOEs through competitive mechanisms, there are still some limitations. Firstly, inadequate consideration of mechanism variables. Although this paper analyzes the issue from the perspective of three competitive mechanisms, it still does not comprehensively cover the interactive impacts of governance structures, fiscal policies, and other factors. Future research could introduce more relevant mechanism variables to further refine the analysis of the impacts on local government debt management from multiple perspectives. Secondly, restricted applicability of the sample region**.** The research sample in this paper is primarily focused on China, and given the differences in economic, political, and financial systems across countries, the findings may not be fully applicable to other countries or regions with different contexts. Future studies could expand to countries with different economic and political backgrounds for cross-country comparative research to enhance the generalizability of the conclusions. Thirdly, limited scope of heterogeneity grouping**.** Although this paper analyzes heterogeneity factors such as local government fiscal balance and investment intensity, several other local economic characteristics, such as economic structure and industry distribution, have not been sufficiently considered. Future research could further refine these factors to improve the research model.

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