



Smart city pilot policies and enterprise finance mismatch

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Complete List of Authors:	Xu, Xing; Fuyang Normal University, Li, Shengsheng; Fuyang Normal University, Wang, Yuanyuan; Tianjin University of Science and Technology,
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Abstract

The smart city pilot policy (SCPP) is not only an important form of practice for science and technology policies to guide financial innovation, but also an effective measure to enhance enterprises' ability to reduce financial mismatch and optimize financial resource allocation. This study analyzes the impact of SCPP on enterprise financial mismatch (EFM) using difference-in-difference method (DID) with mixed panel data of 246 cities and enterprises in China from 2007 to 2022. It is found that the SCPP significantly reduces EFM in the implemented areas by 0.8% on average. Heterogeneity analysis shows that the policy has a significant policy effect in the eastern region, non-state-owned enterprises and high-tech enterprises, while the policy effect is not significant in the middle and western regions, state-owned enterprises and non-high-tech enterprises. In addition, the SCPP affects EFM by alleviating corporate financing constraints, improving maturity mismatch, and enhancing scientific and technological innovation. The findings provide a scientific basis for optimizing the design and implementation of smart city policies.

Keywords: smart city pilot policy; enterprise finance mismatch; financing constraints; maturity mismatch; technological innovation

1. Introduction

In December 2012, the Ministry of Housing and Urban-Rural Development of China formally issued two documents: the Interim Management Measures for National Smart City Pilots and the National Smart City (District and Town) Pilot Indicator System (for Trial Implementation). These documents marked the launch of the national smart city pilot program. The first batch included a total of 90 national smart city pilots, consisting of 37 prefectural-level cities, 50 districts (counties), and 3 towns. In May 2013, to further promote the national smart city pilot work, the Ministry of Housing and Urban-Rural Development issued the Notice on the 2013 Annual Pilot Declaration of National Smart Cities. This notice initiated the second batch of pilot declaration work. After local cities submitted their applications, provincial housing and urban-rural construction departments conducted preliminary examinations, and experts carried out comprehensive evaluations, 103 cities (districts, counties, and towns) were designated as the 2013 National Smart City Pilots. These included 83 cities and districts, 20 counties and towns, as well as 9 cities and districts that expanded their scope based on the first batch of pilots in 2012. In March 2014, the National New Urbanization Plan (2014-2020) explicitly called for the promotion of smart city construction and announced the list of the third batch of smart city pilots. The plan named 84 cities (districts, counties, and towns), such as Mentougou District in Beijing, as the 2014 annual new pilots of the national smart city initiative. It also designated 13 cities (districts and counties), such as Zhengding County in Shijiazhuang City, Hebei Province, as expanded scope pilots.

The Smart city pilot policy (SCPP), introduced by the Chinese government, is an important strategy aimed at promoting the digital transformation of cities, enhancing urban governance capacity, and fostering high-quality economic development. Since its launch in 2012, the policy has

gradually become a core driving force for urban development by improving information technology infrastructure and promoting the deep integration of digital technology and economic activities. The original purpose of the SCPP is to accelerate the integration of digital technologies with the production and business activities of enterprises by utilizing technologies such as cloud computing, big data, blockchain, artificial intelligence, and the Internet of Things, and to promote the digital transformation of cities (Zhang & Fan, 2023). For this reason, the implementation of the pilot policy has received positive responses from many cities. Pilot regions such as Shanghai, Hangzhou, Nanjing, Yantai and Nantong have successively introduced smart city construction programs to promote local digitalization in terms of industrial planning, technical support and funding.

Enterprise resource mismatch refers to the irrational distribution of resources among enterprises, with some enterprises having an excess of resources and others a shortage, which reduces the efficiency of resource utilization and affects the competitiveness of enterprises and the high-quality development of the economy (Wu et al., 2024). Enterprise financial mismatch (EFM) is a form of corporate resource mismatch. The concept of EFM is derived from financial asset allocation theory (Liu et al., 2022a; Ding et al., 2024). EFM refers to the inefficient allocation of financial resources among different enterprises or industries, resulting in a mismatch between the structure and efficiency of resource allocation (Liu et al., 2022b). It is specifically manifested in the excessive flow of financial resources to low-efficiency enterprises or industries, while the financing needs of high-efficiency enterprises or industries are not met (Li et al., 2021). This mismatch phenomenon not only reduces the utilization efficiency of financial resources, but also negatively affects the innovation ability and business performance of enterprises as well as the high-quality development of the economy. The formation of financial mismatch is closely related to market information asymmetry (Hong et al., 2024). As a result of information asymmetry, financial institutions face adverse selection and moral hazard problems in the credit market, leading to the flow of funds to low-risk but inefficient enterprises, while high-risk but high-potential enterprises have difficulties in financing.

The core objective of the SCPP, as an important strategy for promoting the digital transformation of cities, is to enhance urban governance capacity and high-quality economic development by improving information technology infrastructure and promoting the in-depth integration of digital technology and economic activities (Chen et al., 2025). However, whether the policy implementation process can truly optimize resource allocation, especially in terms of financial resource allocation, still needs to be explored in depth. Enterprise financial mismatch, as a typical manifestation of inefficient resource allocation, directly affects the innovation ability and business performance of enterprises as well as the sustainable development of the economy (Li & Pang, 2023; Zheng et al., 2025; Li et al., 2022). Therefore, studying the impact of smart city pilot policies on corporate financial mismatch not only helps to reveal the economic effects of the policies, but also provides a scientific basis for optimizing policy design and implementation.

SCPP has a significant impact on addressing financial mismatches by improving information transparency and boosting business performance. Smart cities leverage technologies such as big data, cloud computing, and artificial intelligence to improve information acquisition and processing capabilities, thereby addressing the issue of information asymmetry (Guo et al., 2024). Information asymmetry is a major cause of financial mismatches (Yin & Wang, 2024), so SCPP can optimize financial resource allocation by addressing this issue. In addition, SCPP may also mitigate financial mismatches by enhancing the digitization level and operational efficiency of firms and their ability

to raise finance (Du et al., 2024). Studying this issue can help enrich research on the economic effects of SCPP and provide new theoretical perspectives for understanding how digital technology affects the allocation of financial resources.

The implementation of the SCPP provides a quasi-natural experiment for studying the relationship between digital technology and financial resource allocation. The gradual rollout of the policy has resulted in variations across cities in terms of policy implementation timing and intensity. These variations create an ideal setting for comparative analysis of policy effects. By examining the impact of the SCPP on corporate financial resource mismatch, this study can generate empirical evidence to inform policy optimization. For example, if the findings indicate that the policy effectively alleviates financial resource misallocation, governments could expand its adoption by strengthening digital infrastructure and promoting enterprise digitalization. Such measures would optimize financial resource allocation and foster high-quality economic development.

Existing studies on smart city pilot policies have predominantly examined their effects on urban governance (Barns, 2018; Diaz-Sarachaga, 2025), economic growth (Visvizi et al., 2018; Abutabenjeh et al., 2022), and innovation capabilities (Caragliu & Del Bo, 2019; Héraud & Muller, 2022), whereas their implications for financial resource allocation remain underexplored. Particularly, the connection between smart city initiatives and corporate financial mismatch – a critical indicator of allocative inefficiency – has received limited scholarly attention. Investigating this relationship not only advances theoretical understanding of digital governance mechanisms but also yields actionable insights for optimizing policy design. Such research could establish an evidence-based framework for addressing systemic resource misallocation through smart city development.

- The innovations of this paper are as follows:
- (1) Research Perspective: This study begins from the perspective of corporate financial mismatch and explores the mechanisms through which smart city pilot policies affect the efficiency of financial resource allocation. This perspective not only expands the boundaries of smart city policy research but also provides a new theoretical framework for understanding how digital technologies optimize financial resource allocation.
 - (2) Mechanism Analysis: The smart city pilot policy enhances information acquisition and processing capabilities through big data, cloud computing, and other technologies. This reduces information asymmetry between financial institutions and enterprises, thereby alleviating financial mismatch. Additionally, the policy promotes the digital transformation of enterprises, improving their operational efficiency and financing ability, and further optimizing the allocation of financial resources. This mechanism analysis offers a more specific pathway for understanding the economic effects of smart city policies.
 - (3) Research Methodology: The gradual implementation of the smart city pilot policy provides a quasi-natural experimental environment, ensuring that the research findings have strong external validity. While previous studies have largely focused on the impact of internal digital transformation on financial mismatch at the micro level, this paper uses the smart city pilot policy as a quasi-natural experiment to examine its impact on corporate financial mismatch from a macro policy perspective. This approach not only addresses the endogeneity problem but also provides new ideas for

subsequent related studies.

The rest of the paper is organized as follows: Part 2 is the theoretical analysis, Part 3 is data and model setting, Part 4 is results and discussion, Part 5 is impact mechanism analysis, Part 6 is conclusion and policy implications, and Part 7 is limitations and future research.

2. Theoretical analysis

Financial mismatches can complicate corporate financing while increasing costs due to the mismatch between funding conditions and development needs (Zhang et al., 2024). Smart cities are urban forms supported by a new generation of information technology and exist within the environment of next-generation innovation (Innovation 2.0) in a knowledge society. From the perspective of enterprises, they utilize smart city technology tools to enhance their operational effectiveness, reduce operational costs, and improve competitiveness. Against the backdrop of global digital transformation and high-quality economic development, the problem of financial mismatch within enterprises has become a significant obstacle to the efficiency of resource allocation and sustainable economic growth. The smart city pilot policy (SCPP), as a key strategy for advancing urban digital transformation, offers enterprises a novel approach to optimizing financial resource allocation (Wolniak et al., 2024). This is achieved by enhancing information technology infrastructure, increasing information transparency, and fostering the deep integration of digital technologies into the production and operations of enterprises. This paper reveals how SCPPs can reduce the degree of enterprise financial mismatch (EFM) based on the three dimensions of the role of smart city pilot policies in alleviating financing constraints, reducing maturity mismatch, and enhancing technological innovation.

2.1 On alleviating financing constraints

The SCPP has, to some extent, alleviated the problem of enterprise financing constraints through the construction of a multi-level financing support system. The mechanism lies in the combination of government guidance and market-based instruments to create synergies and promote the rational allocation of financial resources. According to the theory of preferential financing (Myers & Majluf, 1984), firms will prioritize the lowest-cost financing method and follow the hierarchical preference of “endogenous financing → debt financing → equity financing” in their financing decisions. In the process of implementing the SCPP: First, the pilot policy alleviates the financing constraints of enterprises and reduces the problem of financial mismatch of enterprises due to difficulties in financing through the establishment of a governmental guiding fund, the provision of scientific and technological loans, the implementation of a risk compensation mechanism and other specific measures (Chen, 2022). Secondly, in the smart city pilot regions, enterprises have been provided with diversified financing channels through innovative financial products, such as intellectual property pledge loans, digital credit loans, and special loans for the transformation of scientific and technological achievements. These new financial products not only lower the financing threshold for enterprises but also optimize their financing structure through differentiated pricing mechanisms (e.g., digital credit scoring) and policy support (e.g., government-subsidized loans). This helps to address the problem of financial resource mismatch caused by an unreasonable financing structure of enterprises. Meanwhile, according to the signaling theory (Akerlof, 1978), venture capital and equity financing can signal the high quality of enterprises to the market, attract more investors, and thereby reduce the cost of financing for enterprises. SCPPs

provide enterprises with diversified financing channels by introducing venture capital institutions and equity financing platforms, and by adopting market-based pricing mechanisms.

2.2 On improving enterprise maturity mismatches

The SCPP effectively addresses the imbalance of corporate debt maturity structure by optimizing financial contract design and improving the financial ecosystem. On the one hand, based on principal-agent theory (Jensen & Meckling, 2019), over-reliance on short-term debt exacerbates managers' short-sighted behavior (Huang et al., 2016). The SCPP reduces firms' over-reliance on short-term debt due to financing constraints by optimizing the design of financial covenants and mitigates the mismatch of financial resources in terms of maturity. Therefore, the SCPP aims to reduce corporate financial mismatches by guiding firms to better manage their financing and protecting them from multiple financing costs. On the other hand, the upper echelons theory emphasizes the influence of managers' expectations on investment and financing decisions (Hambrick & Mason, 1984). A robust financial ecosystem can reduce managers' irrational decision-making and lower the risk of maturity mismatch in corporate investment and financing (Kahl et al., 2015). And smart city pilot policies have created a stable investment environment by minimizing unnecessary government intervention and enhancing the business environment (Song et al., 2022). The optimization of the financial ecosystem improves the expectations of enterprise managers regarding investment activities and enhances their investment confidence. Meanwhile, the improvement of the business environment reduces rent-seeking behavior among enterprises and enhances the allocation efficiency of credit resources.

2.3 On upgrading technological innovation

The theory of financial market functions (Merton, 1995) indicates that the efficiency of capital allocation determines innovation output. The SCPP enhances firms' financing capabilities and market competitiveness by empowering technological innovation, thereby reducing financial resource misallocation caused by insufficient innovation. The SCPP provides enterprises with R&D subsidies (Zhou & Li, 2023; Du et al., 2024) and has established an “R&D subsidy–tax deduction–capital market” linkage and a fund for the transformation of scientific and technological achievements to leverage social R&D investment. These measures have significantly increased the intensity of R&D by enterprises. The rise in innovation output, which enhances the value of corporate technology assets, can help alleviate corporate financial mismatch. The principle behind the SCPP reducing EFM through technological innovation lies in the ability of such innovation to enhance firms' financing capabilities and market competitiveness, thereby optimizing the allocation of financial resources. First, the policy supports corporate R&D investment by establishing mechanisms for R&D subsidies, tax deductions, and capital market linkages, which incentivize firms to increase their R&D intensity. This not only boosts firms' innovation capabilities but also enhances the value of their technology assets, attracting more social capital investment. Second, technological innovation drives corporate digital transformation, improving operational efficiency and transparency, reducing information asymmetry, and enabling financial institutions to more accurately assess corporate risks and optimize credit resource allocation. Finally, the policy also sets up funds for the transformation of scientific and technological achievements to accelerate the commercial application of technological results, further enhancing firms' market competitiveness and profitability, and reducing financial resource misallocation caused by insufficient innovation. Therefore, the SCPP improves corporate innovation capabilities by supporting R&D investment and the transformation of scientific and technological achievements, thus optimizing the allocation of

financial resources.

Based on the above analysis, this paper proposes the following hypotheses:

Hypothesis H₁: The smart city pilot policy (SCPP) will reduce enterprise financial mismatch (EFM).

Hypothesis H₂: The SCPP will reduce EFM by alleviating corporate financing constraints.

Hypothesis H₃: The SCPP will reduce EFM by improving corporate maturity mismatch.

Hypothesis H₄: The SCPP will reduce EFM by enhancing technological innovation.

3. Data and model setting

3.1. Data

(1) Explained variable

The explained variable in this paper is enterprise financial mismatch (*efm*). Following the approach of Wang et al. (2021), financial mismatch is measured by the deviation of a firm's cost of capital from the industry average cost of capital. This method facilitates the study of financial capital allocation efficiency from a firm-level perspective. The specific calculation method for the degree of financial mismatch faced by a firm is as follows:

$$efm_{it} = \left| \frac{I_{ipt} / (L_{ipt} - A_{ipt}) - R_{pt}}{R_{pt}} \right| \quad (1)$$

where efm_{it} denotes the degree of financial mismatch faced by firm i in year t , R_{pt} denotes the average cost of capital in industry p in year t , I denotes interest expenses of firms, L denotes liabilities, and A denotes accounts payable.

(2) Explanatory variable

The core explanatory variable in this paper is a dummy variable (*did*) for the smart city pilot policy (SCPP). If the city where the firm is located is selected as a pilot city for the smart city policy in a given year and in subsequent years, then $did = 1$; otherwise, $did = 0$.

(3) Control variables

Enterprise level: 1) Enterprise Size (*size*): Measured by the logarithm of the total assets at the end of the year (Ding et al., 2024). Large-scale enterprises have more financing channels and stronger risk resistance capabilities, and their capital allocation efficiency is higher. In contrast, small enterprises face difficulties in financing and are more vulnerable to external shocks, resulting in lower capital allocation efficiency and different degrees of financial mismatch (Hoang et al., 2024). 2) Growth rate of main business income (*growth*): Calculated as (main business income of the current year - main business income of the previous year) / main business income of the previous year. Previous literature has shown that enterprises with a high growth rate have a large demand for capital, and if the financing channels are unreasonable, it can easily lead to an imbalance in the allocation of funds. Firms with a low growth rate have high financing costs and low capital utilization efficiency, which exacerbate the mismatch (Almeida et al., 2004). 3) Selling expense ratio (*ser*): Measured using the ratio of selling expenses to operating revenue. A high selling expense ratio will squeeze the funds available for the enterprise's core business, reduce the efficiency of capital utilization, and increase the demand for financing. If the financing channels are unreasonable, it can easily lead to an imbalance in the allocation of funds, thus exacerbating the financial mismatch of the enterprise (Lamont, 1997). 4) Non-debt tax shield (*tax*): Calculated using the ratio of

depreciation of fixed assets, depletion of oil and gas assets, and depreciation of productive biological assets to total assets. Non-debt tax shields substitute for debt and reduce the tax burden (DeAngelo & Masulis, 1980). An increase in non-debt tax shields reduces firms' debt financing needs, which in turn affects the capital structure and weakens the debt tax shield effect. This substitution effect complicates corporate financing decisions and tends to lead to capital allocation imbalances, thus affecting corporate financial mismatches. 5) Return on Assets (ROA): Calculated as the ratio of net profit to total assets (*roa*). ROA is a key indicator for measuring the profitability of firms, and its level directly affects the efficiency of capital utilization and financing demand (Alarussi & Alhaderi, 2018). ROA significantly impacts financial mismatch by influencing corporate profitability, capital allocation efficiency, and financing demand. High ROA firms typically exhibit high capital utilization efficiency and low financial mismatch, whereas low ROA firms tend to have inefficient capital utilization and higher financial mismatch. Therefore, firms should optimize asset allocation and enhance profitability to mitigate the risk of financial mismatch. 6) Company age (*age*): Calculated by subtracting the year of establishment from the current year. Company age has a significant impact on financial mismatch (Yin & Wang, 2024). New companies often face a high degree of financial mismatch due to limited financing channels, an imperfect financial system, and unstable investment decisions. In contrast, mature companies typically exhibit a low degree of financial mismatch, benefiting from abundant financing channels, financial health, and stable investment decisions. 7) Gearing ratio (*lev*): measured using the ratio of a firm's total liabilities to its total assets. Gearing ratio has an important impact on financial mismatch by affecting the financing structure, capital allocation efficiency and financial risk of enterprises. Li et al. (2025) attested that the higher the corporate gearing ratio, the stronger the borrowing capacity, when there is a shortage of cash, it is necessary to obtain sufficient funds through debt financing, thus reducing the rate of financial mismatch.

City level: 8) The level of the economy (*pgdp*): Measured using the logarithm of GDP per capita. The level of urban economic development affects the financial mismatch of enterprises. Developed cities are rich in financial resources, have a favorable financing environment, strong policy support, high corporate innovation ability, and high capital allocation efficiency, resulting in low financial mismatch. Conversely, less developed cities have fewer financial resources, a less favorable financing environment, weaker policy support, lower corporate innovation ability, and lower capital allocation efficiency, resulting in higher financial mismatch. 9) The level of openness (*pfdi*): Measured using the proportion of the region's annual amount of actually utilized foreign capital as a percentage of that year's regional GDP. Open cities are rich in financial resources, have an excellent financing environment, strong innovative capacity, and high resource allocation efficiency, resulting in low financial mismatch. Conversely, closed cities have fewer financial resources, a less favorable financing environment, weaker innovative capacity, and lower resource allocation efficiency, resulting in higher financial mismatch. 10) The level of financial development (*finance*): Measured using the local year-end loan balances of financial institutions as a share of GDP. Cities with developed financial institutions and mature markets can provide enterprises with diversified financing channels, optimize the allocation of funds, and reduce the degree of financial mismatch. 10) The level of human capital (*hum*): Measured by the average number of years of education in the region. Cities with high human capital have high-quality enterprise staff, scientific management, high efficiency of capital utilization, and low mismatch. 11) Population size (*pop*): Expressed as the logarithm of the local year-end household population. Cities with large population

sizes have rich financial resources, superior financing environments, strong innovation abilities, low financial friction, and strong policy support, resulting in low corporate financial mismatch. Conversely, cities with small population sizes have scarce financial resources, high financing costs, weak innovation abilities, high financial friction, and high corporate financial mismatch. 12) Government digital attention (*focus*): Measured by the logarithm of the frequency of words related to digitization in each city's government work report. The government's digital focus in the city where the enterprise is located significantly affects the enterprise's financial mismatch through various mechanisms, such as enhancing information transparency, optimizing financial resource allocation, reducing financing costs, alleviating credit discrimination, improving corporate governance, and providing targeted support (Ding et al., 2024).

The city-level data in this paper comes from the China Urban Statistical Yearbook and the China Economic and Social Development Statistics Database (CESDS), with a data sample covering 246 cities over the period 2007-2022. For firm-level data, the data are from CSMAR (<https://data.csmar.com/>). For city data, cities with a high number of missing values of variables were excluded. For the small number of missing values in the data, moving averages were used to fill in. Also, ST (Special Treatment) or *ST (Star Special Treatment) firms and financial firms were excluded, and firms with more missing values were eliminated. The variables *sga*, *tax*, *roa*, and *lev* were winsorized at the 1% level. Finally, matching the city data with the firm data yields a sample of 4514 firms for the period 2007-2022, of which 2487 firms are affected by the SCPP and 2027 firms are unaffected. The statistical descriptions of the variables are shown in Table 1.

Table 1. Statistical description of variables.

VarName	Obs	Mean	SD	Median	Min	Max
efm	40254	0.701	0.563	0.642	0.011	3.520
did	40254	0.434	0.496	0.000	0.000	1.000
size	40254	22.047	1.407	21.875	14.942	28.615
growth	40254	0.411	0.619	0.240	0.005	4.000
ser	40254	0.072	0.088	0.041	0.000	0.478
tax	40254	0.019	0.014	0.016	0.000	0.076
roa	40254	0.103	0.091	0.085	0.004	0.905
age	40254	17.577	6.259	17.000	0.000	64.000
lev	40254	0.420	0.211	0.410	0.026	1.069
pgdp	40254	10.279	5.351	9.583	0.435	46.775
pfdi	40254	0.028	0.018	0.024	0.000	0.213
finance	40254	2.345	1.126	2.015	0.419	7.203
hum	40254	0.043	0.033	0.036	0.000	0.143
pop	40254	15.669	0.674	15.720	12.108	17.347
focus	40254	13.470	0.388	13.507	0.000	14.523

3.2. Model setting

The difference-in-difference (DID) method is widely utilized within the domain of policy evaluation and causal inference. Its core principle involves contrasting the variations between treatment and control groups prior to and following policy implementation, thereby precisely gauging the policy's influence on the treatment group. In existing literature, numerous studies have

leveraged DID to assess the efficacy of SCPPs (e.g., Guo et al., 2023; Yang et al., 2024; Zhao et al., 2025). To analyze the impact of smart city pilot policies on corporate financial mismatch, this paper sets the following model with reference to Beck et al. (2010):

$$efm_{i,t} = \beta_0 + \beta_1 did_{i,t} + \beta_2 X_{i,t} + \mu_i + \lambda_t + \eta_{ind} + \varepsilon_{i,t} \tag{2}$$

where $efm_{i,t}$ is the explained variable; i is the individual; t is the time; μ_i is the individual fixed effect; λ_t is the time fixed effect; η_{ind} is the industry effect; X is the control variables; $\varepsilon_{i,t}$ is the model error term.

4. Results and discussion

4.1. Analysis of DID results

This paper estimates the impact of smart city pilot policy (SCPP) on enterprise financial mismatches (EFM) by using a fixed effects model, and the estimation results are shown in Table 2. Among them, column (1) is the regression result without adding control variables, and column (2) is the regression result with adding all control variables. As can be seen from the estimation results, the estimated coefficients of *did* are significantly negative at the 1% level, regardless of whether control variables are added or not. This indicates that the SCPP reduces the EFM. Specifically, the estimated coefficient of *did* in column (2) is -0.0080, indicating that the SCPP reduces the financial mismatch of firms by 0.8% on average.

The reason for this may lie in the fact that the SCPP has optimized the financing environment and financial management capacity of enterprises in several ways. On the one hand, smart city construction usually introduces and promotes financial technology, which enables enterprises to access financial information and services more conveniently. This allows them to make reasonable financing arrangements according to their actual needs, thereby reducing financial mismatches due to information asymmetry or other factors. On the other hand, the pilot policy tends to promote the optimization of the business processes and risk assessment systems of financial institutions in the smart city. It also improves the efficiency and precision of financial services and provides enterprises with financial products that are more aligned with their development stages and business conditions. This helps enterprises rationally allocate funds and reduce the risk of financial mismatch. Additionally, the overall economic development and industrial upgrading brought about by smart city construction provide a more stable business environment and more development opportunities for enterprises. These factors enable enterprises to better plan the use of funds and reduce financial mismatches caused by short-term capital pressure or blind expansion. Therefore, hypothesis H1 is verified.

Table 2. Results of DID analysis.

	(1)	(2)
Variable	efm	efm
did	-0.0024*** (-3.40)	-0.0080*** (-3.28)
size		-0.0551***

		(-22.78)
growth		0.0295***
		(6.70)
ser		0.0413
		(1.05)
tax		1.0226***
		(4.42)
roa		-0.0209
		(-0.70)
age		0.0025***
		(4.74)
lev		-0.1125***
		(-7.12)
pgdp		-0.0017**
		(-2.53)
pfdi		-0.3246**
		(-2.00)
finance		0.0088***
		(2.87)
hum		-0.2108**
		(-2.44)
pop		-0.0087*
		(-1.84)
focus		0.0119*
		(1.65)
_cons	0.9644***	2.2019***
	(14.96)	(15.94)
Firm-individual FE	√	√
Year FE	√	√
Industry FE	√	√
N	40254	40254
R ²	0.1054	0.1263
F	14.2083	16.7730

Note: The t-value in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

The following table is the same.

4.2. Parallel trend test

The DID method requires that there be no significant difference between the treatment and control groups before the policy is implemented. If there is a difference between the two, this difference should not change significantly over time in the absence of the policy's impact. Therefore, a parallel trend test is needed when evaluating policies using the DID methodology. For this purpose,

this paper constructs the following model for the parallel trend test:

$$efm_{i,t} = \alpha_0 + \sum_{j=1}^6 \alpha_j before_j + \phi current + \sum_{i=1}^8 \alpha_i after_i + \delta X_{i,t} + \mu_i + \varphi_t + \eta_{ind} + \varepsilon_{i,t} \quad (3)$$

where *before_j*, *current* and *after_i* are dummy variables indicating whether the city entered the SCPP 6 years before to 1 year before, in the current year and 1 year after to 8 years after the observed data, respectively. If the estimated coefficients of *before_j* are mostly insignificant, it indicates that there is no significant difference between the treatment and control groups before the policy was piloted, which suggests that the parallel trend test is passed. The estimation results are shown in Figure 1. The confidence intervals cross the horizontal line of 0 from the first 6 years of the policy to the first 1 year, indicating that none of the estimated coefficients for *before₆* – *before₁* are significant, which suggests that the parallel trend test passes. It is also noted that the estimated coefficients for *current* are also insignificant, indicating that the policy effect did not play out in the year of policy implementation. Subsequently the estimated coefficients of *after₁* – *after₈* are significant and overall gradually become smaller from the latter 1 year to the latter 8 years of the policy implementation, which suggests that the policy has a good policy effect and can effectively reduce the EFM. This is because the construction of smart cities has been progressing gradually, and it takes time for the application of financial technology and the optimization of financial services to play a role, and the effect was not obvious in that year. However, with the passage of time, the policy dividends have been released, the enterprise financing environment has been improved, and the financial mismatch phenomenon has been gradually reduced, indicating that the policy is effective in the long term.

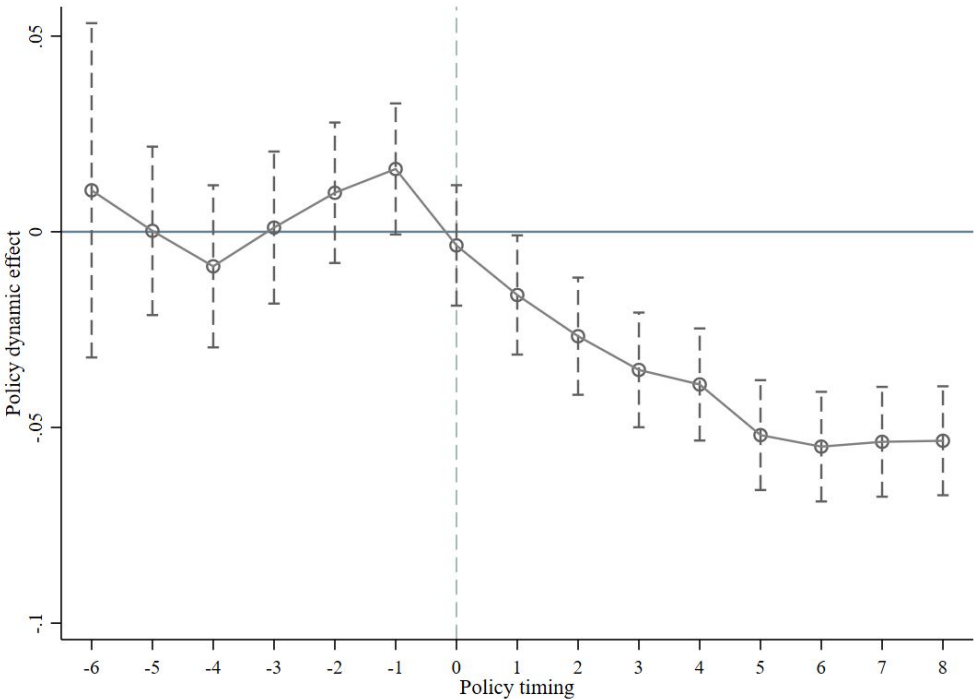


Figure 1. The parallel trend test result.

4.3. Robustness test

(1) PSM-DID

When China implements a smart city pilot policy, it usually does not select pilot cities completely at random. Instead, it selects cities with a higher level of technology and a more developed economy for piloting. This non-random selection may cause selectivity bias. Therefore, this paper adopts the propensity score matching method (PSM) for robustness testing. The PSM calculates a propensity score based on observable influences, matches the control group that did not participate in the pilot with the treatment group based on the propensity score, and excludes unmatched samples (Böckerman & Ilmakunnas, 2009).

After matching, we estimate the matched sample using a fixed-effects model with matching weights added to the regression. The estimation results for PSM-DID are presented in Table 3. Column (1) shows the estimation results after 1:1 matching, column (2) after radius matching, and column (3) after kernel density matching. It can be seen that the estimated coefficients on *did* are all significantly negative at the 5% level after adding control variables, fixed individual effects, time effects, and industry effects. The results show that SCPP still reduces EFM after using the PSM-DID method, and the results are robust.

Table 3. PSM-DID regression results.

	(1)	(2)	(3)
	efm	efm	efm
<i>did</i>	-0.0249** (-2.39)	-0.0178** (-2.48)	-0.0180** (-2.50)
Control variables	√	√	√
Firm-individual FE	√	√	√
Year FE	√	√	√
Industry FE	√	√	√
N	19379	40071	40087
R ²	0.1438	0.1304	0.1304

(2) Robustness test for replacement indicators

Enterprise profitability lower than the industry average may indicate insufficient financing to invest efficiently. Conversely, profitability higher than the industry average may suggest over-financing and idle funds. This deviation indicates that enterprises fail to allocate financial resources rationally and have financial mismatch problems. A smaller deviation suggests that the enterprise's profitability is close to the industry average, indicating that its financing scale and capital use efficiency are more reasonable, financial resources are optimally allocated, and there is no obvious financial mismatch problem. Therefore, this paper adopts the ratio of enterprise profitability to industry average profitability (*lirun*) to measure enterprise financial mismatch. At the same time, the number of listings reflects the efficiency of financial resource allocation across different industries or regions. If the number of listed enterprises in an industry or region is much lower than in other regions, it may imply that enterprises in that region or industry face financing constraints and that financial resources are under-allocated, leading to financial mismatch. Conversely, a higher

number of listings in an industry or region may indicate more efficient financial resource allocation, where firms can obtain financial support more smoothly and the degree of financial mismatch is relatively low. Therefore, this paper uses the number of listed companies (*firmnum*) in each city in the calendar year as a proxy indicator to test whether the policy implementation promotes an increase in the number of listed companies. The estimation results are shown in Table 4.

From the estimation results in Table 4, the estimated coefficient of *did* in column (1) is significantly negative at the 1% level, indicating that the SCPP has reduced the deviation, suggesting that the policy effectively reduces the financial mismatch of firms. In column (2), the estimated coefficient of *did* is significantly positive, indicating that the implementation of the SCPP promotes an increase in the number of firms listed on the stock exchange, suggesting that the policy reduces the degree of financial mismatch. Therefore, the analysis shows that the estimation results are credible.

Table 4. Replacement indicator regression results.

	(1)	(2)
Variable	lirun	firmnum
<i>did</i>	-0.0207*** (-3.20)	0.2113*** (3.42)
Control variables	√	√
Firm-individual FE	√	√
Year FE	√	√
Industry FE	√	√
N	40254	40254
R ²	0.1736	0.8685
F	24.6461	766.3126

(3) Exclusion of other policy effects

Firms' financial mismatches may not only be affected by the SCPP, but other policies may also affect EFMs, thus biasing the estimates in this paper. To address this concern, we search for other similar policies in China from 2007 to 2022 and find that China began implementing the innovative city pilot policy (ICPP) in 2010. Liu et al. (2024) find that the ICPP has a significant role in promoting the digital transformation of enterprises. Therefore, the ICPP affects EFMs in various ways by enhancing their innovation capability and reducing their costs.

To account for this, we add the difference-in-difference term (*did1*), constructed based on the ICPP, to the model and perform regression analysis. The estimation results are shown in Table 5. Column (1) presents the regression results without control variables, while Column (2) presents the results with control variables. The coefficient estimate for *did* remains significantly negative at the 1% level, regardless of whether control variables are included. However, the coefficient estimate for *did1* is also significantly negative at the 5% level, suggesting that the ICPP implemented at a later stage also had some impact on firms' financial mismatches. Nevertheless, the impact of the

SCPP on EFMs does not change significantly after accounting for other pilot policies. This further suggests that the estimation results in this paper are robust.

Table 5. Estimated results of other policy impacts.

	(1)	(2)
Variable	efm	efm
did	-0.0023*** (-3.36)	-0.0084*** (-3.30)
did1	-0.0007** (-2.09)	-0.0018** (-2.23)
Control variables	×	√
Firm-individual FE	√	√
Year FE	√	√
Industry FE	√	√
N	40254	40254
R ²	0.1054	0.1263
F	14.1652	16.7241

(4) Heterogeneity treatment effect test

The two-way fixed-effects estimator in the DID method is complex in terms of heterogeneity of treatment effects, which implies that the same treatment measure may have a significant differential bias in its effect across individuals. To accurately identify and address this issue, we implement a “heterogeneity-robustness” estimator test based on an in-depth analysis of the potential bias of two-way fixed-effects estimators. In this paper, we use the decomposition method of De Chaisemartin and D'Haultfoeuille (2020) for diagnostic validation, and the diagnostic results are shown in Table 6. The results in Table 6 show that the total weights are 1015, with 995 positive weights and 20 negative weights. The negative weights only account for 1.97%, a finding that strongly supports the initial conclusion of this paper—that is, that the current application of the multi-period difference-in-difference model does not suffer from significant bias in its estimators when dealing with heterogeneity of effects. Thus, this paper confirms the robustness of the DID approach in addressing heterogeneity of effects.

Table 6. De Chaisemartin and D' Haultfoeuille (2020) decomposition results.

Total weights	Positive weights	Negative weights	The proportion of positive weights	The proportion of negative weights
1015	995	20	98.03%	1.97%

(5) Placebo test

The above test results indicate that the SCPP has a significant impact on the financial mismatch of enterprises, but this finding still needs to be further validated using the counterfactual method.

To this end, this paper constructs counterfactual difference terms in 246 cities where enterprises are located, randomly selecting a period from 2007 to 2022 as the policy pilot time. We randomly sample 1000 times and plot the estimated coefficients of the difference-in-difference term obtained from each regression into a scatter plot. If most of the empirical p-values obtained from the 1000 random samples are greater than 0.1 and most of the estimates are significantly different from the estimated coefficients of *did* in Table 2, then the counterfactual test is considered passed, and the estimation results of this paper are deemed robust.

The estimation results of the 1000 samples are shown in Figure 2. It can be seen that most of the p-values obtained from the counterfactual test are greater than 0.1 and are not uniformly randomly distributed around -0.0080 (the estimated coefficient of *did* in Table 2). This indicates that the estimation results in this paper are robust.

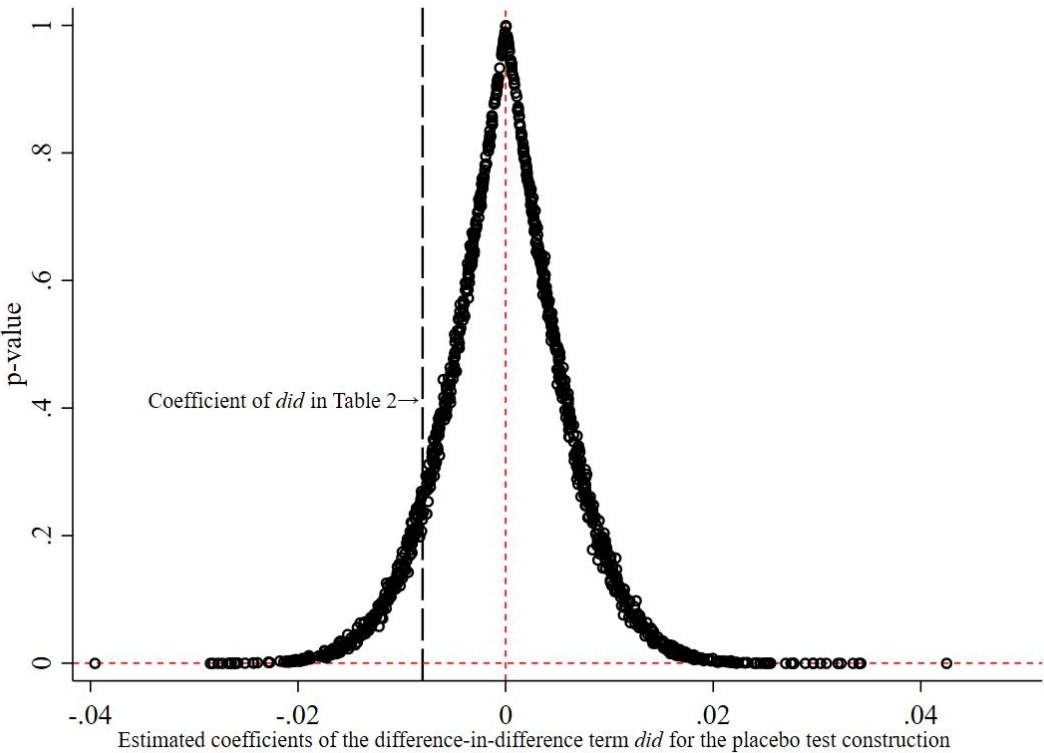


Figure 2. Placebo test.

4.4. Heterogeneity analysis

(1) Regional heterogeneity

We analyzed regional heterogeneity across eastern, middle, and western cities, considering the significant regional differences in China and the potential varying impacts of smart city pilot policies across different regions. Eastern cities primarily include those in the following provinces and municipalities: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Middle cities encompass those in the provinces of Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan. Western cities consist of those in Sichuan, Chongqing, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, and Guangxi. The results of the regional heterogeneity regression are presented in Table 7. The findings indicate that the SCPP exerts a significant effect on firms in the eastern region, substantially

reducing their financial mismatch, whereas the policy's impact in the middle and western regions is not significant.

The SCPP significantly reduces EFMs in eastern cities, likely due to the region's developed economy and well-established information technology infrastructure, which facilitate policy implementation and technological innovation. By optimizing the financing structure, reducing maturity mismatch, and enhancing technological innovation, the policy improves resource allocation efficiency. In contrast, the less significant policy effects in the middle and western regions may stem from their lower levels of economic development and insufficient infrastructure and technological innovation. Additionally, firms in the eastern region may be more adept at leveraging policies to reduce financial mismatches by diversifying financing channels and optimizing debt structures.

Table 7. Heterogeneity analysis regression results.

	(1)	(2)	(3)
Variable	Eastern cities	Middle cities	Western cities
did	-0.0095*** (-3.19)	0.0157 (0.91)	-0.0104 (-0.50)
Control variables	✓	✓	✓
Firm-individual FE	✓	✓	✓
Year FE	✓	✓	✓
Industry FE	✓	✓	✓
N	28262	6979	5013
R ²	0.1163	0.1624	0.1390
F	12.8451	6.7558	4.7287

(2) Heterogeneity in the nature of firms' equity

We examine the impact of the SCPP on the EFM of non-State-Owned Enterprises (non-SOEs) and State-Owned Enterprises (SOEs), considering the distinct characteristics of these enterprise types and their potentially varied responses to the policy. The analysis results are detailed in Table 8, with column (1) displaying the regression outcomes for non-state-owned firms and column (2) showing those for state-owned firms. The findings indicate that the SCPP significantly impacts non-state-owned firms by substantially reducing their financial mismatches, whereas its effect on state-owned firms is not statistically significant.

Non-state-owned enterprises, known for their flexibility and market orientation, can more readily adapt to policy shifts and capitalize on new opportunities for innovation and financing. These firms enhance resource allocation efficiency through strategies such as optimizing financing structures, mitigating maturity mismatches, and bolstering technological innovation. Conversely, the muted policy effects observed in SOEs may stem from their more rigid operational structures and potentially less competitive market positioning. In addition, non-SOEs may be more adept at taking advantage of policies to reduce financial mismatches through diversified financing channels and well-developed debt structures, whereas SOEs are lagging behind in the effects of SCPP due to

their unique financial and operational dynamics.

Table 8. Results of heterogeneity in the nature of firms' shareholdings.

	(1)	(2)
Variable	non-SOEs	SOEs
did	-0.0321*** (-2.99)	0.0012 (0.15)
Control variables	√	√
Firm-individual FE	√	√
Year FE	√	√
Industry FE	√	√
N	14717	25537
R ²	0.1823	0.0911
F	12.1206	9.6148

(3) High-tech enterprise or not

SCPP focus on scientific and technological innovation, aiming to enhance urban management efficiency through information technology and to provide a more conducive development environment for enterprises. This initiative is designed to reduce financial mismatches and foster sustained economic growth. Consequently, SCPP may have varying effects on high-tech versus non-high-tech enterprises. According to the 'Administrative Measures for the Recognition of High-tech Enterprises,' issued by China's Ministry of Science and Technology, Ministry of Finance, and State Administration of Taxation in 2016, enterprises are categorized into high-tech and non-high-tech based on specific criteria. The criteria for classifying high-tech enterprises include the following: for enterprises with annual sales revenue of less than 50 million yuan, the R&D investment to sales revenue ratio should not be less than 5%; for those with revenue between 50 million and 200 million yuan, the ratio should not be less than 4%; and for those with revenue exceeding 200 million yuan, the ratio should not be less than 3%.

The estimation results are shown in Table 9, where column (1) is the estimation result for high-tech enterprises and column (2) is the estimation result for non-high-tech enterprises. From the estimation results, it can be seen that the SCPP significantly reduces the financial mismatch of high-tech enterprises, while it has no significant effect on non-high-tech enterprises. The primary reason for this difference lies in the SCPP ability to significantly mitigate financial mismatches for high-tech firms. By bolstering IT infrastructure and easing digital transformation, these firms can more effectively leverage the policy's benefits, such as technological innovation and enhanced information transparency, to optimize their financing structures. In contrast, non-high-tech firms, with their relatively weaker innovation capabilities, do not fully capitalize on these policy advantages, leading to less significant improvements in financial mismatch.

Table 9. Heterogeneity results of whether firms are high-tech enterprises.

	(1)	(2)
Variable	High-tech	Non-high-tech

did	-0.0343*** (-3.49)	-0.0061 (-0.71)
Control variables	√	√
Firm-individual FE	√	√
Year FE	√	√
Industry FE	√	√
N	17638	22616
R ²	0.1605	0.0950
F	11.6005	9.4448

5. Analysis of impact mechanisms

In this section, we concentrate on analyzing the mechanisms through which smart city pilot policies (SCPP) influence enterprise financial mismatches (EFM). The financial mismatches of firms are contingent not only on the firms themselves but also on the urban governance and policy formulation of China, which subsequently impact the firms located within those cities. The theoretical analysis presented indicates that SCPP can affect corporate financial mismatch by alleviating financing constraints, improving maturity mismatch, and fostering technological innovation. To empirically ascertain these influence mechanisms, this paper investigates the role of SCPP in affecting enterprise financial mismatch from the perspectives of easing financing constraints, rectifying maturity mismatch, and boosting technological innovation. To achieve this, the following model is constructed to test the impact mechanisms:

$$influence_{i,t} = \alpha_0 + \alpha_1 did_{i,t} + \alpha_2 X_{i,t} + \mu_i + \lambda_t + \eta_{ind} + \varepsilon_{i,t} \quad (4)$$

where *influence* is replaced by the financing constraint index (*KZ*), maturity mismatch (*mm*), and technological innovation (*inno*), respectively. The financing constraint index (*KZ*) is calculated with reference to the method of Kaplan & Zingales (1997), and this paper constructs the *KZ* index to measure the degree of financing constraints by taking Chinese listed companies as a sample, and the larger the *KZ* index, the higher the degree of financing constraints faced by listed companies (Chan et al., 2017). Maturity mismatch (*mm*) is measured by the difference between the ratio of short-term liabilities (short-term liabilities/total liabilities) and the ratio of short-term assets (short-term assets/total assets). Technological innovation (*inno*) is measured using the number of invention patents authorized by the enterprise in the year to measure the level of technological innovation of the enterprise.

The outcomes of the impact mechanism test are presented in Table 10. According to the estimation results, the coefficients for the variable *did* in columns (1) and (2) are significantly negative at the 1% significance level, suggesting that the SCPP significantly alleviates the financing constraints and improves maturity mismatch for enterprises. In column (3), the coefficient for *did* is significantly positive at the 1% level, indicating that the SCPP significantly enhances firms' technological innovation. These findings further imply that the SCPP influences EFM by mitigating

financing constraints, rectifying maturity mismatch, and fostering technological advancement. Consequently, hypotheses H₂, H₃, and H₄ are supported by the data.

Table 10. Impact mechanism test regression results.

	(1)	(2)	(3)
	KZ	mm	inno
did	-0.0046*** (-3.28)	-0.6518*** (-15.91)	3.5226*** (3.58)
Control variables	√	√	√
Firm-individual FE	√	√	√
Year FE	√	√	√
Industry FE	√	√	√
N	40254	40254	40253
R ²	0.2603	0.2963	0.0001
F	42.1857	50.2668	1.0155

6. Conclusion and policy implications

This paper empirically analyzes the impact of China's smart city pilot policies (SCPP) on enterprise financial mismatches (EFM) using the difference-in-differences (DID) method based on mixed panel data from 246 Chinese cities and firms spanning 2007 to 2022. The findings indicate that: (1) the SCPP significantly reduce the financial mismatch of firms where it is implemented, with an average reduction of 0.8%; (2) heterogeneity analysis reveals that the policy has a significant pilot effect on enterprises, non-state-owned enterprises, and high-tech enterprises in the eastern region, while the policy effect is not significant in enterprises, state-owned enterprises, and non-high-tech enterprises in the middle and western regions; (3) the SCPP affect the EFM by reducing financing constraints, improving maturity mismatch, and enhancing scientific and technological innovation. Based on the above empirical results, this paper puts forward the following policy recommendations:

(1) Increase Policy Promotion: Further promote the smart city pilot policy nationwide, particularly targeting central and western regions, state-owned enterprises, and non-high-tech firms, to expand the policy's reach and influence and foster balanced regional development.

(2) Strengthen the Financing Support Mechanism: Enhance the policy's implementation rules, focusing on addressing the financing constraints faced by enterprises. By establishing special funds, providing scientific and technological loans, and implementing risk compensation mechanisms, among other measures, offer enterprises a range of diversified financing channels, especially to assist central and western regions and state-owned enterprises in lowering the financing threshold and optimizing their financing structure.

(3) Promote Scientific and Technological Innovation Among Enterprises: Boost support for high-tech enterprises and incentivize them to increase R&D investment and enhance their independent innovation capabilities through R&D subsidies, tax incentives, and funds for the

transformation of scientific and technological achievements. Concurrently, encourage traditional enterprises to transform into high-tech firms to drive the optimal allocation of financial resources with scientific and technological innovation.

(4) Implement Differentiated Policy Guidance: Develop differentiated policy implementation strategies based on the heterogeneous characteristics of regions and enterprises. For the eastern region, continue to deepen the construction of smart cities and promote industrial upgrading and technological progress; for the central and western regions, strengthen support for infrastructure construction and digital transformation to enhance the effectiveness of policy implementation.

7. Limitations and future research

The analysis in this study is based on a specific time period from 2007 to 2022, focusing on 246 Chinese cities, which may not fully capture the long-term impact of the policy. Additionally, the study primarily considered the direct impacts of the Smart City Pilot Policy (SCPP) without extensively exploring potential mediating factors, such as varying administrative efficiencies or changing market dynamics.

Future research could address these limitations by expanding the temporal and spatial scope of the analysis to include a more diverse set of cities and a longer time horizon. Furthermore, future studies could delve deeper into the mechanisms through which SCPP affects Enterprise Financial Mismatch (EFM), including specific channels for easing financing constraints, improving maturity mismatches, and enhancing technological innovation. Concurrently, as the digital environment continues to evolve, future research should also consider emerging technologies and digital platforms that may further influence the integration of digital technologies with urban governance and economic activities. By understanding these dynamics, policymakers can better align SCPP to leverage the potential of digital transformation to optimize financial resource allocation.

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Contribution statement

XXX: Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation.

XXX: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

XXX: Writing–review & editing, Writing–original draft, Software, Methodology, Formal analysis, Data curation.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Data availability

Data will be made available on request.

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Smart city pilot policies and enterprise finance mismatch

Xing Xu^a, Shengsheng Li^{a*}, Yuanyuan Wang^{b*}

^aSchool of Business, Fuyang Normal University, Fuyang 236037, China

^bSchool of Economics and Management, Tianjin University of Science and Technology,
Tianjin 300222, China

*Corresponding authors

Email: suiyingbi198607@163.com (X. Xu), lisheng2@foxmail.com (S. Li),
2019110112@email.cufe.edu.cn (Y. Wang).

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Xu Xing: Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation.

Li Shengsheng: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Wang Yuanyuan: Writing–review & editing, Writing–original draft, Software, Methodology, Formal analysis, Data curation.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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Data availability

Data will be made available on request.