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How does smart city building affect bank risk-taking?

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ABSTRACT
The smart city pilot work opened in 2012 has had a profound impact on the intelligence of bank risk management. This paper uses city as well as bank-level panel data from 2010-2023 to build a multi-temporal DID model to analyze the impact of smart city construction on bank risk-taking. The benchmark regression illustrates that smart city construction can significantly reduce bank risk-taking. This conclusion still holds after a series of robustness tests. The mechanism analysis shows that smart city construction effectively suppresses bank risk-taking by improving bank operational efficiency and reducing bank loan concentration. This study can provide an important reference for the government to formulate effective financial policies and economic interventions in the context of smart city construction.

KEYWORDS
Smart cities; Bank risk-taking; Operational efficiency; Loan concentration

1 Introduction

The COVID-19 pandemic severely impacted the global economy, particularly the financial sector. China has controlled the outbreak effectively but still faces economic recovery challenges. It's critical to improve banks' risk-taking ability for their stability and growth. The integration of big data and cloud computing with banking has improved business accuracy and efficiency, affecting risk-taking.

Bank stability is vital for economic recovery and growth, especially post-pandemic when they support business recovery and financial stability. How banks adapt to and mitigate pandemic risks affects the banking sector's health and the economy's stability and growth. Analyzing banks' strategies to manage post-pandemic risks can inform government financial policies. These policies should support banking operations and promote sustainable growth, particularly in smart city construction where banks' stable financing and innovative services are key. Strengthening the banking sector's resilience will support global economic recovery and long-term growth.

2 Literature Review and Research Hypotheses

Digital economy, finance, and fintech are crucial for smart city development. Research indicates that digital economy growth can increase bank risk-taking, but this is mitigated by higher non-interest income and better-educated local officials. Digital finance, leveraging Internet tech, optimizes resource allocation and lessens the need for banks to take risks. Fintech applications increase bank loans and improve credit resource structure, enhancing risk-taking. Advanced fintech tools like big data reduce information asymmetry, lowering adverse selection and moral hazards, and decreasing credit risk.

Smart city construction enhances commercial banks' operational efficiency through deep integration of Internet-based fintech tools, enabling better information integration and access to high-quality customer resources, thus reducing loan concentration. Improved efficiency leads to lower unit income costs, reducing bank risk-taking. Decentralized credit resource allocation, supported by Internet tech, spreads resources to promising enterprises, further reducing loan risk and bank risk-taking.

Based on this, Hypothesis H1: Smart city construction reduces bank risk taking.

3 Study design

Considering that the selection of pilot cities is distributed in 2012, 2013, and 2015, and generally the existing literature treats smart city construction as an exogenous policy shock (Chen, Chi-Ping, and Bian, An-Wen, 2023; Zheng, Wei, 2023), in order to more accurately assess the policy effect, this paper will construct a multi-temporal DID (multiplicative difference method) model to explore the impact of smart city construction on commercial banks' risk-taking. The specific model construction is shown below:

$$lnz_{bct} = \alpha smart_{ct} + + \sum_{\gamma=1}^{\gamma=8} \gamma_i Control_{bct} + \pi_t + \pi_b + \pi_{pt} + \pi_p + \varepsilon_{bct} \quad (1)$$

As shown in equation (1), b represents the bank, c represents the city to which the bank belongs, and t represents the

year. lnz is the explanatory variable of this paper, i.e., bank risk-taking. smart is the core explanatory variable of this paper, i.e., whether or not it is a pilot city for the construction of smart city. The coefficient α before the core explanatory variable is the coefficient that this paper focuses on. It represents how smart city construction affects bank risk taking. When α<0, it means that smart city construction increases bank risk taking, and when α=0, it represents that smart city construction does not have a significant impact on bank risk taking. When α>0, it represents that smart city construction decreases bank risk taking. In order to accurately estimate the impact of smart city construction on bank risk taking, referring to the study of Pan Min et al. (2022), this paper also adds some control variables (*Control*).

4 Empirical findings Analysis

4.1 Benchmark regression

This study employs a stepwise addition of control variables to examine the effect of smart city construction on bank risk-taking. Table 1 shows that in column 1, with the addition of bank risk-taking and a dummy variable for smart city pilot status, the coefficient for smart city construction is positive and significant at the 5% level. This suggests smart city construction likely reduces bank risk-taking. Column 2 adds profitability and non-interest income as bank-level controls, and the positive effect of smart cities on risk-taking remains significant at the 1% level. The inclusion of loan bad debt reserve ratio and financial leverage in column 3, and bank size and capital buffer in column 4, does not alter the findings. Column 5 introduces city-level controls for economic development and foreign investment size, and the positive and significant relationship between smart city construction and reduced bank risk-taking is further supported.

Table 1 Benchmark regression

	(1)	(2)	(3)	(4)	(5)
variant	lnz	lnz	lnz	lnz	lnz
smart (phone, system, bomb etc)	0.294**	0.349***	0.324**	0.336**	0.344***
	(0.123)	(0.124)	(0.137)	(0.133)	(0.133)
roe		50.492***	57.053***	49.938***	49.140***
		(6.788)	(7.526)	(7.661)	(7.682)
lncome		0.007	0.029	0.033	0.042
		(0.039)	(0.042)	(0.044)	(0.045)
llr			-5.144*	-5.050*	-4.943*
			(2.748)	(2.729)	(2.752)
loar			0.796*	0.893*	0.916*
			(0.432)	(0.531)	(0.538)
size				0.309	0.305
				(0.203)	(0.203)
capr				6.219***	6.232***
				(1.796)	(1.792)
lngdp					-0.130
					(0.427)
lnfdi					0.069
					(0.050)
constant term (math.)	4.111***	3.328***	2.709***	-4.961	-3.590
	(0.046)	(0.686)	(0.804)	(4.949)	(8.245)
Bank fixed effects	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
Province fixed effects	Y	Y	Y	Y	Y
Province-Time Fixed Effects	Y	Y	Y	Y	Y
Number of observations	2,641	2,491	2,291	2,291	2,263
R^2	0.498	0.525	0.520	0.526	0.527

Given the possible heteroskedasticity and autocorrelation, the clustering robust standard errors are used in this paper in parentheses in the above tables. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively. Same below.

4.2 Robustness test

4.2.1 Parallel trend hypothesis testing

In 2012, 2013, and 2015, the Ministry of Housing and Construction (MOH&C) chose cities for smart city pilot construction. To analyze the impact of smart city construction on bank risk-taking, this paper uses a multi-temporal DID model. A key requirement for using the DID method is the parallel trend hypothesis test, which is conducted using the

event analysis method as referenced from Zhou Xueren and Zhang Yue (2021). The specific model is set up as follows.

$$riskbct=k=-5k=5\alpha ksmartck+\ \gamma=1\gamma=8\gamma iControlbct+\pi t+\pi b+\pi pt+\pi p+\varepsilon bct \quad (2)$$

The equations show that represents the kth year of city c's inclusion in the smart city pilot construction. For instance, k= -1 indicates 1 year before inclusion, k=0 indicates the year of inclusion, and k=1 indicates 1 year after inclusion. The meanings of other variables align with the baseline model. Regression of the above equation and plotting of the following image show that none of the estimated coefficients before the dummy variables are significant before the pilot strategy implementation, indicating that the experimental and control groups meet the parallel trend hypothesis test.

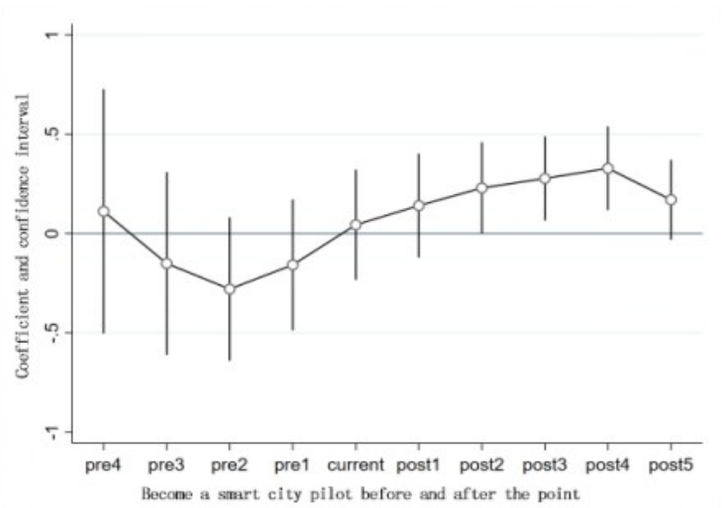

Figure 1 Parallel trend hypothesis test

4.2.2 The "placebo" test

This study employs bank-level and city-level control variables to address potential omitted variable bias in bank risk-taking. Despite these controls, unobservable factors could still skew results. To mitigate this, the paper adopts the methodology of Jiang et al. (2018), selecting smart city pilot cities and their inclusion years randomly. It then creates placebo policy dummy variables and tests them using the placebo method. Results from 500 estimations, with a mean coefficient of -0.004 and a standard deviation of 0.093, suggest the original hypothesis of a zero coefficient is not rejected. The kernel density plot indicates that estimated coefficients cluster around zero, indicating no significant bias from unobserved factors.

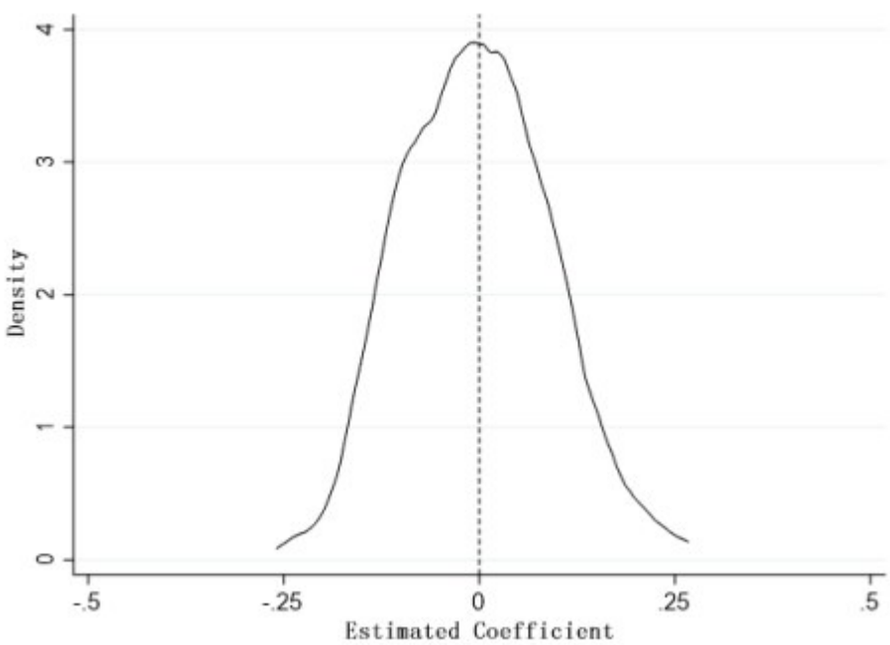

Figure 2 "Placebo" test

4.3 Mechanism testing

The theoretical analysis in this paper shows that smart city construction can make banks' risk-taking lower by improving their operational efficiency and reducing their loan concentration. Here this paper will establish the following model for mechanism testing with reference to Wei Hao and Zhang Pengyu (2020):

$$cir_{bct} = asmart_{ct} + \sum_{\gamma=1}^{\gamma=8}\gamma_i Control_{bct} + \pi_t + \pi_b + \pi_p + \pi_{pt} + \varepsilon_{bct} \quad (3)$$

$$risk_{bct} = \vartheta cir_{bct} + \sum_{\gamma=1}^{\gamma=8}\gamma_i Control_{bct} + \pi_t + \pi_b + \pi_p + \pi_{pt} + \varepsilon_{bct} \quad (4)$$

$$debt_{bct} = asmart_{ct} + \sum_{\gamma=1}^{\gamma=8}\gamma_i Control_{bct} + \pi_t + \pi_b + \pi_p + \pi_{pt} + \varepsilon_{bct} \quad (5)$$

$$risk_{bct} = \delta debt_{bct} + \sum_{\gamma=1}^{\gamma=8}\gamma_i Control_{bct} + \pi_t + \pi_b + \pi_p + \pi_{pt} + \varepsilon_{bct} \quad (6)$$

Equation (3) represents the operational efficiency of banks, with other indicators aligning with the benchmark model. The paper anticipates that smart city construction will notably enhance bank efficiency. Equation (4) examines the impact of bank risk-taking on operational efficiency, using the cost-income ratio as a measure. A positive indicates that higher efficiency leads to more risk-taking, while a negative suggests the opposite. Equation (5) measures bank loan concentration using the debt variable, and the paper expects smart city construction to lower this concentration. Equation (6) shows that increased loan concentration can lead to more risk-taking if is positive, and less if is negative.

Regression analysis of the four equations is presented in Table 2. Column 1 indicates that smart city construction significantly improves operational efficiency compared to non-pilot cities. Column 2 shows that higher operational efficiency correlates with reduced risk-taking. Column 3 demonstrates that smart city construction can decrease loan concentration. Finally, Column 4 reveals that lower loan concentration is associated with decreased risk-taking.

Table 2 Mechanism test

	(1)	(2)	(3)	(4)
variant	cir	lnz	debt	lnz
smart (phone, system, bomb etc)	-0.739**		-0.105**	
	(0.330)		(0.041)	
cir		-0.579***		
		(0.077)		
debt				-3.991***
				(0.249)
roe	-71.859***	7.610	-10.048***	9.089
	(18.325)	(5.762)	(2.489)	(6.017)
lncome	-0.005	0.041	-0.002	0.037
	(0.071)	(0.029)	(0.012)	(0.029)
llr	8.107**	-0.318	1.372**	0.473
	(3.744)	(2.172)	(0.600)	(1.610)
loar	-1.828	-0.149	-0.289	-0.242
	(1.357)	(0.475)	(0.215)	(0.501)
size	-0.823	-0.183	-0.130	-0.225
	(0.578)	(0.209)	(0.090)	(0.218)
capr	5.831	9.632***	1.986**	14.180***
	(6.180)	(3.152)	(0.923)	(2.713)
lngdp	0.659	0.248	0.108	0.296
	(0.490)	(0.258)	(0.083)	(0.206)
lnfdi	-0.133**	-0.007	-0.024**	-0.024
	(0.055)	(0.035)	(0.010)	(0.029)
Bank fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Province fixed effects	Y	Y	Y	Y
Province time fixed effects	Y	Y	Y	Y
Number of observations	2263	2263	2263	2263
R^2	0.549	0.770	0.578	0.843

4.4 Heterogeneity analysis

Table 3 shows that grouping samples by bank type, smart city construction reduces urban commercial banks' risk-taking significantly, yet has no significant impact on rural banks. When grouping by asset size, construction reduces risk for banks with assets under 200 billion, but not for those over 200 billion.

Table 3 Bank Characteristics Heterogeneity

	(1)	(2)	(3)	(4)
	Agricultural and Commercial Bank of China (ABC)	city commercial bank	Assets less than $200 billion	Assets greater than $200 billion
variant	lnz	lnz	lnz	lnz
smart (phone, system, bomb etc)	0.265	0.383**	0.353**	0.297
	(0.180)	(0.177)	(0.138)	(0.700)
roe	50.454***	44.682***	44.580***	62.599
	(10.651)	(12.633)	(8.088)	(44.879)
Income	0.027	-0.009	0.029	-0.016
	(0.062)	(0.071)	(0.053)	(0.274)
llr	-5.719	-5.515	-4.278	-2.508
	(4.098)	(4.362)	(2.928)	(9.636)
loar	0.196	0.751	0.981	-0.075
	(0.825)	(0.767)	(0.632)	(1.836)
size	-0.476	0.452*	0.333	-0.223
	(0.351)	(0.257)	(0.250)	(0.838)
capr	6.595**	5.957***	6.774***	-3.699
	(3.084)	(2.031)	(1.865)	(8.687)
lngdp	-0.264	0.092	-0.408	-0.682
	(0.690)	(0.542)	(0.522)	(2.037)
lnfdi	0.027	0.121*	0.111**	0.494
	(0.089)	(0.065)	(0.052)	(0.374)
Bank fixed effects	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
Province fixed effects	Y	Y	Y	Y
Province-Time Fixed Effects	Y	Y	Y	Y
Number of observations	1,176	952	1,845	323
R^2	0.568	0.528	0.515	0.733

5 Research findings and policy recommendations

5.1 Conclusions of the study

This study employs a multi-temporal DID model to assess the effect of smart city initiatives on bank risk-taking using panel data from 2010-2023. The benchmark regression indicates that smart city projects notably decrease bank risk-taking. This finding is robust to various tests. The mechanism is that smart cities enhance operational efficiency and lower loan concentration, thereby curbing risk-taking. Urban commercial banks see a significant reduction in risk-taking, unlike rural commercial banks. Large banks (>200 billion assets) are unaffected, but smaller banks experience a significant decrease. Smart cities also reduce risk-taking more in less marketized regions and areas with advanced Internet infrastructure.

5.2 Policy recommendations

The government increases the financial budget for information infrastructure construction, expands the coverage of broadband networks, builds high-efficiency and low-energy cloud data centers, rationally plans the geographic layout of big data centers, improves data processing and analysis capabilities, establishes a perfect network security system, builds a multi-level network security protection system, raises the public's awareness of and ability to protect network security, and establishes a network security protection network that involves the whole society. protection network with the participation of the whole society. Through these measures, the information security and stable operation of the smart city will be guaranteed.

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