Review of Economic Assessment

Homepage: https://www.anserpress.org/journal/rea

The Impact of Innovation Reform on Wealth Inequality: Evidence from Comprehensive Innovation Reform Pilot Zones

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ABSTRACT

This study investigates the effects of innovation reform on wealth inequality by analyzing China's Comprehensive Innovation Reform Pilot Zones (CIRPZs). Employing a difference-in-differences methodology, we assess the impact of CIRPZs on urban wealth distribution among China's prefecture-level cities. Our findings reveal a paradox: although CIRPZs are designed to stimulate economic growth and technological advancement, they inadvertently exacerbate wealth inequality. This outcome is confirmed through a series of rigorous robustness checks. We identify two key mechanisms driving this phenomenon: the virtual wealth effect, whereby technological progress disproportionately benefits tech-savvy individuals and firms, and wage stratification, leading to increased income disparities within innovative sectors. Additionally, we find that the impacts of CIRPZs vary across regions, with significant widening of wealth inequality observed in Beijing-Tianjin-Hebei, the middle reaches of the Yangtze River, and Chengdu-Chongqing, while a moderating effect is noted in the Central Plains. These insights emphasize the nuanced effectiveness of innovation reform policies and their implications for policymakers in developing economies. We advocate for policy frameworks that balance technological advancement with equitable economic outcomes, a crucial step for fostering sustainable and inclusive development.

KEYWORDS

Innovation Reform; Wealth Inequality; Urban Distribution; Economic Growth; Policy Analysis

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ISSN
doi: 10.58567/rea04010001

Received 21 December 2024; Accepted 26 January 2025; Available online 12 March 2025; Version of Record 15 March 2025

1. Introduction

Income inequality is a significant challenge to sustainable economic development worldwide. As nations strive for inclusive prosperity, the gap between the affluent and the impoverished often threatens progress toward equitable growth. Innovation, as a catalyst for economic advancement, presents dual-edged potential: boosting productivity and economic growth while potentially exacerbating disparities if the benefits are not widely distributed.

Recent technological advancements have revolutionized industries and economies, propelling countries to new development heights. However, these transformations highlight stark socio-economic divides, prompting critical examination of how innovation policies can promote rather than hinder equitable growth. Understanding the role of innovation in shaping income distribution is vital for achieving shared prosperity.

China's vision of becoming a global leader in science, technology, and innovation by 2050 makes it a compelling case study. Central to this strategy are innovation-driven policies, including the Comprehensive Innovation Reform Pilot Zones (CIRPZs) in major urban centers like Beijing, Tianjin, Hebei, Shanghai, and Guangdong (Zhao, Shahbaz, & Dong, 2022). These zones are designed to stimulate innovation, boost economic development, and position China at the forefront of the global knowledge economy. However, the implications of these policies extend beyond mere economic metrics; they also raise questions about their impact on income inequality and wealth distribution.

Previous research has documented the positive effects of innovation on economic growth and productivity (Z. Chen, Zhang, & Chen, 2021). Yet, there remains a significant gap in the literature regarding the direct relationship between innovation policies and income inequality. While innovation can drive economic prosperity, its benefits are often unequally distributed, raising concerns that such policies may inadvertently widen income disparities. This concern is particularly pertinent in the context of China's innovation-driven reforms, which could potentially affect different urban regions in varied ways.

China has made notable strides in poverty alleviation, lifting millions out of poverty and improving overall living standards. However, the challenge now lies in consolidating these gains and addressing relative poverty, which reflects disparities in income and wealth rather than just the presence of poverty itself. As China continues its modernization and development trajectory, it becomes increasingly critical to address income inequality in tandem with overall economic progress. An essential aspect of this endeavor is exploring how innovation policies influence income inequality and whether they contribute to or detract from efforts to achieve equitable economic outcomes.

This study seeks to address this gap by investigating the effects of the Comprehensive Innovation Reform Pilot Zones on income inequality in China. By leveraging urban panel data from 2011 to 2019 and employing the Thiel index—a sophisticated measure of income disparity—this research examines how these pilot zones influence the wealth gap through mechanisms such as virtual wealth accumulation and wage stratification. Additionally, the study explores the heterogeneous impacts of these policies across different urban agglomerations, offering a novel perspective on the spatial dimensions of policy effects.

This study makes several significant contributions to the literature: (1) By employing a quasi-natural experiment framework, it addresses endogeneity issues, offering robust estimations of innovation policies' impact on income inequality at multiple economic levels. (2) It delves into the nuanced effects of innovation policies on wealth and wage distributions, enhancing the understanding of how knowledge creation and diffusion can foster equitable economic growth. (3) By examining the differential impacts of innovation policies across various urban regions, this research provides new insights into the spatial variability of policy outcomes, contributing to the discourse on the role of knowledge in addressing complex socio-economic challenges. These contributions highlight the interplay between innovation, knowledge-based economies, and equitable development, resonating with the journal's focus on empirical studies and a comparative approach.

Overall, this study not only addresses a crucial gap in the existing literature but also offers valuable insights for policymakers aiming to harness innovation as a tool for achieving sustainable and inclusive economic development.

2. Literature Review

Since the late 20th century, rapid economic development in many countries has coincided with a widening gap between the rich and the poor, despite efforts to achieve shared prosperity. Despite intensified efforts to promote shared prosperity, the disparity between the rich and the poor has remained a persistent issue (Kakwani, Wang, Xue, & Zhan, 2022). This dual phenomenon of economic growth and wealth inequality has spurred extensive academic research focused on the causes, consequences, and measurement of income inequality, as well as the effectiveness of policies aimed at mitigating it.

Current research on income inequality primarily focuses on measurement methods, situational analysis, and influencing factors. The Gini coefficient remains one of the most widely used indicators of income inequality, with recent studies such as Han, He, Liu, Zhao, and Huang (2023) utilizing it to assess national wealth gaps. The Theil index (B. Zhang, Nozawa, & Managi, 2021) offers a decomposition of inequality into within- and between-group components, making it especially useful for analyzing regional or industrial disparities. Other methods, such as the Kuznets index (Magazzino, Mele, Schneider, & Sarkodie, 2021) and regression models, have also been employed to explore the relationship between economic growth and income inequality.

Scholars generally agree that wealth inequality manifests in several key dimensions: urban versus rural disparities (N. Li, 2023), regional differences (Fremeaux & Leturcq, 2022; Gim & Jang, 2022), and inequalities within industries. The urban-rural gap is often attributed to the dual economic system in many developing countries, which creates unequal access to resources and opportunities. The regional wealth gap, in turn, is further compounded by intra- and inter-industrial inequality, where industrial growth and structural adjustments serve as the primary drivers (Khalifa & El Hag, 2010). In addition to these fundamental economic disparities, scholars have pointed to various structural factors such as human capital (both entrepreneurial and labor), digital finance inclusion, the structural optimization of the banking sector, and biased government policies as key drivers of wealth inequality (Chang, 2002).

In recent years, the relationship between innovation and wealth inequality has gained increasing attention. While innovation has been widely recognized as a key driver of economic growth, its effects on income distribution remain less understood. Innovation may contribute to economic growth in the form of new technologies, business models, and production processes, but its impact on wealth inequality is complex and multifaceted. On the one hand, innovation can create new opportunities, improve productivity, and increase incomes for certain groups, particularly those in high-skilled or tech-driven sectors. On the other hand, innovation can also exacerbate inequality by disproportionately benefiting those who already possess capital, skills, or access to technological advancements (Piketty, 2014).

Existing literature exploring the effects of innovation on wealth inequality remains limited, with much of the focus on the macroeconomic impacts of technological change rather than its distributional effects. For instance, studies have emphasized how technological innovations and market liberalization can contribute to economic disparities by altering labor market dynamics, favoring capital-intensive industries, and widening the income gap between skilled and unskilled workers (Autor, 2014; Brynjolfsson & McAfee, 2014). However, there is a gap in research that specifically analyzes the role of innovation policies—such as Comprehensive Innovation Reform Pilot Zones (CIRPZ)—in shaping wealth distribution. This paper aims to address this gap by investigating how innovation-focused policy reforms affect wealth inequality in the context of pilot zones, particularly in China.

Research on Comprehensive Innovation Reform Pilot Zones (CIRPZ) has predominantly focused on policy formulation, local-level implementation, and impact evaluation. Scholars have analyzed the design of innovation reform policies, emphasizing how local governments tailor policies to their specific economic and social contexts (Forliano, Bullini Orlandi, Zardini, & Rossignoli, 2023). These studies often propose recommendations for improving the formulation of innovation policies to better align with local needs and priorities.

In terms of policy implementation, the evaluation of innovation reforms has been a central theme in recent research. Some studies have employed large-scale data analysis and network data collection methods to assess public opinions on policy effectiveness, as well as to identify trends in policy implementation (Lv, Song, & Lee, 2022). Additionally, scholars have employed quantitative models such as the difference-in-differences approach, spatial econometrics, and the PMC index model to evaluate the impact of these policies on various economic indicators, including innovation outputs and regional economic development (Gao & Yuan, 2021, 2022; T. Liu, Li, Zhang, & Xia, 2022).

While significant strides have been made in evaluating the effectiveness of CIRPZ policies, most existing studies have focused on the macroeconomic impacts of innovation reforms, such as changes in GDP, employment, or overall technological outputs. There is a lack of in-depth analysis of how these policies influence wealth inequality, especially in terms of the distributional effects on different social and economic groups. This paper aims to fill this gap by focusing on the specific effects of CIRPZ policies on wealth inequality, particularly through the lens of consumer behavior, regional disparities, and industry-level changes.

From the review of existing literature, this study identifies several areas for further exploration: (1) While much research has focused on the role of innovation in fostering economic growth, few studies have examined the impact of innovation on income inequality. This paper aims to contribute to the literature by exploring how innovation reform policies, particularly CIRPZ, influence wealth distribution in China. (2) Most research on CIRPZ policies has been qualitative, with a focus on policy design and implementation. There is a need for more quantitative, empirical research that examines the actual effects of these policies on economic outcomes, particularly wealth inequality. (3) Existing literature often analyzes wealth inequality at the macro level but overlooks the specific pathways through which innovation may affect income distribution. This study seeks to provide a deeper understanding of these pathways, with a particular focus on the impact of innovation on different product categories and regional disparities.

3. Theoretical analysis and research hypotheses

In recent years, innovation-related policies have become essential policy guidelines for economic development in various regions. As China is undergoing a high-quality economic transformation, the innovation-driven strategy serves as a pivotal breakthrough for achieving this transformation (Cao, Zhang, & Qian, 2019). Implementing the innovation strategy can stimulate the organic growth of China's economy, boost the vigor of the innovation drive, and contribute to the sustainable innovation of society and the sustainable development of the nation (Gibellato, Ballestra, Fiano, Graziano, & Gregori, 2023). However, the success of these policies is often contingent upon the disparities between regions, industries, and individuals, which can result in uneven outcomes. The degree of government support and industrial integration will also influence the effectiveness of innovation reforms, potentially amplifying regional disparities. In this context, regions with higher resource endowments are likely to benefit more from innovation policies, while those with fewer resources may experience less benefit, leading to a Matthew effect that exacerbates the wealth gap between regions (S. Wang, Xiao, Lu, & Zhang, 2022). Comprehensive Innovation Reform Pilot Zones will lead to local governments implementing tax incentives and policy relaxation. It will attract enterprises and talents to the pilot zones. This differential development could lead to faster economic growth in the pilot zones, while other regions may experience slower growth, deepening the urban wealth divide

(S. Chen, 2022). This situation widens the divide between the wealthy and the impoverished in urban areas. In addition, the Comprehensive Innovation Reform Pilot Zones policy may lead the government to invest significant funds for infrastructure construction and talent introduction (Yan, Mao, & Ho, 2022). These funds are frequently transferred from other regions, resulting in a lack of resources in other regions. Consequently, the uneven distribution of resources across regions could intensify the wealth gap between cities (Irfan, Razzaq, Sharif, & Yang, 2022). Building on the above analysis, this paper proposes the following hypothesis (H1):

H_1: Implementing the Comprehensive Innovation Reform Pilot Zones policy will widen the gap between the rich and the poor in cities.

Implementing the Comprehensive Innovation Reform Pilot Zone policy has promoted the activity of regional financial markets (C. Liu & Xiong, 2022). Innovation inputs require large amounts of capital, but with limited access to capital from the private sector, this funding gap promotes the development of financial markets (Peneder, 2008). Innovation policies facilitate the consolidation of firms and innovation components, thereby reducing business transaction costs and supporting the expansion of financial markets. The expansion of the scale of the financial market will inevitably lead to an increase in the demand for labor in the financial sector and an increase in the financing activity of enterprises, resulting in the formation of a financial market bubble to deflate wealth (Shi, Yu, Li, & Wang, 2022). At this point, the positive effect of innovation output is not enough to offset the negative effect of capital consumption and resource waste. At the same time, there are certain obstacles to transforming innovation output into economic benefits, thus inhibiting economic growth (Hu, Li, Lin, & Wei, 2023). Innovation often leads to new technologies and products and makes old technologies and products to be replaced. For example, when new technologies emerge, the older technologies may become obsolete, thereby diminishing the wealth of individuals who hold outdated products (Lin, et al., 2023). When a new technology or product is introduced and widely used in the market, the original technology and products may be obsolete, making the value of these old technologies and products decline. For example, when a new electronic product technology is introduced, it may make the original electronic products obsolete, making the value of these old electronic products decline, which leads to a deflation of wealth, i.e., a decline in the actual value of the wealth of those who hold these old electronic products (X. Li, Wang, & Xu, 2022). Innovation may increase financial market practitioners. Innovation often leads to new financial products and services, requiring specialized personnel to develop, sell, and manage them (J. Liu, Zhang, Li, Chen, & Teng, 2022). Thus, innovation may increase employment opportunities in financial markets. In addition, innovation may also facilitate the development and innovation of the financial industry, increasing employment opportunities in the financial market. For instance, as Internet finance evolves, the emergence and growth of fintech companies and Internet finance platforms may enhance employment prospects in the financial sector (Patelli, Napolitano, Cimini, & Gabrielli, 2023). Based on this, this paper proposes the hypothesis H_2:

H_2: Implementing the Comprehensive Innovation Reform Pilot Zones policy will widen the gap between the rich and the poor through the virtual wealth effect.

The wage gap has increased due to adopting the Comprehensive Innovation Reform Pilot Zones strategy (Vannutelli, Scicchitano, & Biagetti, 2022). The wage gap is a fundamental driver of wealth inequality, and an increase in income levels is essential for achieving both overall and shared prosperity (Luo, Li, & Sicular, 2020). In developing countries, inequality in the income gap can negatively affect economic development mainly through its impact on finance, social stability, human capital, and economic structure (Castelló-Climent, 2010). Excessive income disparity can lead to significant welfare losses and hinder economic progress (Hausmann, Pietrobelli, & Santos, 2021). Innovation often leads to new technologies and products, making the old ones obsolete. This situation leads to increased demand for new technologies and products and decreased demand for older ones. Individuals with skills and knowledge related to these new technologies tend to earn higher wages due to the increased demand for their expertise (Babkin, Dunn, Hueth, & Segarra, 2022).

The wage gap has increased due to adopting the Comprehensive Innovation Reform Pilot Zones strategy (Vannutelli, et al., 2022). The pay level gap is the most fundamental cause of the wealth gap, and an increase in income levels is necessary to achieve overall and shared prosperity (Luo, et al., 2020). In developing countries, inequality in the income gap can negatively affect economic development mainly through its impact on finance, social stability, human capital, and economic structure (Castelló-Climent, 2010), and excessive income disparity can also cause severe welfare losses (Hausmann, et al., 2021). Innovation often leads to new technologies and products, making the old ones obsolete. This situation leads to increased demand for new technologies and products and decreased demand for older ones. People with knowledge and skills related to new technologies and products may be paid more because their skills and knowledge are more desirable in the marketplace (Babkin, et al., 2022).

H_3: Implementing the Comprehensive Innovation Reform Pilot Zones policy will widen the gap between rich and poor through a wage stratification effect.

4. Research design

4.1. Model construction

This paper treats the Comprehensive Innovation Reform Pilot Zones as a quasi-natural experiment and develops a difference-in-differences (DID) model to investigate whether implementing the Comprehensive Innovation Reform Pilot Zones has resulted in shared prosperity or wealth gap. The constructed difference-in-difference model is as follows.

$$gap_{it}=\alpha_0+\alpha_1 IRP+\sum \alpha_j\, control_{jit} + city_i+year_t + u_{it} \quad (1)$$

Where, gap_{it} denotes the gap between rich and poor, i denotes the city, and t denotes the year, and *IRP* (Innovation Reform Pilot) denotes the Comprehensive Innovation Reform Pilot Zones policy dummy variable, which is one only when the pilot area is implemented in the policy, and 0 in other cases. $control_{jit}$ denotes the set of control variables, and $city_i$ denotes city-fixed effects, and $year_t$ denotes year-fixed effects, and u_{it} denotes the random error term.

4.2. Variable design and data sources

The explanatory variable is the gap between rich and poor, characterized by the Thiel index. Thiel's index is more in line with the reality of China, and most academics use this indicator to study the wealth gap in China (Gravier-Rymaszewska, Tyrowicz, & Kochanowicz, 2010; Tang, Gong, Ma, & Rahut, 2022). The higher the index, the greater the disparity between rich and poor and the existence of a wealth gap. Inversely, the lower the index, the narrower the disparity between the rich and the poor, and the greater the formation of shared prosperity.

The core explanatory variable is the policy dummy variable of the Comprehensive Innovation Reform Pilot Zones, only when the area is a pilot area and the year is in the year after the policy implementation, and 0 in all other cases. Specifically, there are 24 cities in the pilot area, namely, Beijing, Tianjin, Shijiazhuang, Baoding, Langfang, Hefei, Wuhu, Bengbu, Chengdu, Deyang, Mianyang, Wuhan, Xi 'a Shenyang, Guangzhou, Foshan, Zhaoqing, Shenzhen, Dongguan, Huizhou, Zhuhai, Zhongshan, Jiangmen and Shanghai. The policy was implemented in September 2015, and since this paper uses annual data from 2011 to 2019, 2015 and after that are considered as the post-policy implementation period, the rest of the period is the policy non-implementation period.

This paper picks seven control variables based on prior research in order to adjust for other factors affecting the wealth gap and to account for the multicollinearity issue amongst variables, which are: (1) Economic

development level, represented by logarithmic gross urban product (Cordova, Grabka, & Sierminska, 2022); (2) Industrial structure, represented by the proportion of output value of tertiary industry (Langbauer, Diengsleder-Lambauer, & Lieschnegg, 2021); (3) Government intervention, represented by the ratio of urban government expenditure to income (Faber, 2020); (4) Financial development level, characterized by the ratio of deposit and loan balances of financial institutions at the end of the year (Wanke, Hassan, Azad, Rahman, & Akther, 2022); (5) Openness level, characterized by the logarithm of the actual amount of foreign capital used in the year (Capolupo, Ardito, Petruzzelli, & De Massis, 2022); (6) Natural population growth rate, characterized by the natural population growth rate (Shamsuddin, Katsaiti, & El Anshasy, 2022); (7) Human capital, characterized by the logarithm of the number of college students per 10,000 students (Sims, 2022).

The data for the Thiel Index are manually collected from various sources, primarily provincial and prefectural statistical yearbooks. In particular, the urbanization rate is based on the resident population's urbanization rate, rather than the registered population, to more accurately reflect the urbanization process in China. Due to data limitations, the per capita disposable income for rural areas prior to 2013 is replaced by the per capita net income, which is the closest available measure. In addition to data on financial development and openness, which are obtained from the WIND database, all other data are sourced from the China Statistical Yearbook, the China Urban Statistical Yearbook, and statistical bulletins of prefecture-level cities. These sources provide a comprehensive set of economic, demographic, and urbanization data, which are crucial for the analysis of wealth inequality and the effects of policy reforms. For consistency and comparability, all price-related data are deflated using 2010 as the base year. Additionally, to address the potential issue of volatility in certain variables, logarithmic transformations are applied to those variables where necessary. The final descriptive statistics, including the mean, standard deviation, and range of key variables, are provided in Table 1.

Table 1. Descriptive statistics.

Variables	N	Mean	Standard deviation	Min	Max
Thiel Index	1818	0.0803	0.0451	0.0053	0.2794
Comprehensive Innovation Reform Pilot Zones	1818	0.0523	0.2226	0.0000	1.0000
Economic development level	1818	16.6671	0.9377	14.2434	19.7598
Industrial structure	1818	40.8723	9.5376	16.4800	83.5200
Government intervention	1818	2.6920	1.5879	0.9037	11.7990
Financial development level	1818	0.6882	0.2756	0.2237	6.2050
Openness level	1818	10.0888	2.0530	1.0986	14.9413
Natural population growth rate	1818	6.7281	5.1918	-15.2400	37.4000
Human capital	1818	4.7738	0.9972	0.6931	7.1655

5. Empirical results

5.1. Benchmark regression results

The results of the impact of the Comprehensive Innovation Reform Pilot Zones on the Thayer Index are shown in Table 2. Model (1) is the estimation result without adding control variables but controlling for year-fixed effects, model (2) is the estimation result without adding control variables but controlling for both city-fixed effects and year-fixed effects, and model (3) is the estimation result with adding control variables and controlling for both city and year fixed effects. Model (3) has the highest R-square, and its estimation results are the most robust. Model (3) serves as the primary focus for interpretation in this paper. The regression results show that the effect of the Comprehensive Innovation Reform Pilot Zones on the urban wealth gap is positive, and all of them are significant at the 1% level, indicating that the Comprehensive Innovation Reform Pilot Zones significantly widen the urban

wealth gap and creates a wealth gap, which is not conducive to shared prosperity. Accordingly, hypothesis 1 of this paper is verified.

Regarding the control variables, government involvement successfully narrows the urban wealth gap toward shared prosperity, which is one of the government's purposes and functions. The increase in human capital creates a more significant gap between the rich and the poor, thus contributing to the wealth gap, probably because the rapid expansion of human capital leads to "human capital failure," which leads to an unequal exchange of human capital and thus contributes to the wealth gap.

Table 2. Baseline regression results.

	(1) Thiel Index	(2) Thiel Index	(3) Thiel Index
IRP	0.011*** (3.599)	0.012*** (7.864)	0.012*** (7.167)
Control variables	No	No	Yes
Urban fixed effects	No	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	1818	1818	1818
R-square	0.593	0.929	0.931

*Note: t-statistic in parentheses; *** indicates p<0.01, ** indicates p<0.05, * indicates p<0.1.*

5.2. Robustness checks

5.2.1. Parallel trend test

The parallel trend is a vital prerequisite assumption of the difference-in-difference model (Thomas & Chintagunta, 2022). To test this assumption, this study employs an event study approach using a dynamic effects model, where the year of policy implementation (2015) is set as the current year, the pre-policy period is set as pre_, and the post-policy period is set as post_.

Table 3. Dynamic effect regression results.

	Thiel Index
pre_3	0.000
	(0.013)
pre_2	0.005
	(1.081)
pre_1	0.007*
	(1.802)
current	0.012***
	(3.084)
post_1	0.013***
	(3.409)
post_2	0.015***
	(3.790)
post_3	0.016***
	(4.100)
post_4	0.018***
	(4.502)
Control variables	Yes
Urban fixed effects	Yes
Year fixed effects	Yes
N	1818
R^2	0.931

*Note: t-statistic in parentheses; *** indicates p<0.01, ** indicates p<0.05, * indicates p<0.1.*

As shown in Table 3, we used the year prior to the policy implementation (2011, labeled as pre_4) as the benchmark period. The regression results demonstrate that none of the pre-policy estimates are statistically significant. Specifically, the coefficients for pre_3, pre_2, and pre_1 are all close to zero and not statistically significant, indicating that there were no significant differences between the Thiel Index for the control group and the treatment group before the policy was implemented. This result provides strong evidence in favor of the parallel trends assumption: both groups exhibited similar trends in wealth inequality prior to the policy intervention, fulfilling the critical assumption of the DiD methodology.

Additionally, the results reveal that the policy effect grows stronger after the policy implementation. The coefficients for the post-policy periods (from post_1 to post_4) are all statistically significant and increase over time, reflecting a growing impact of the Comprehensive Innovation Reform Pilot Zones (CIRPZ) on reducing the urban wealth gap. This suggests that the policy not only had a discernible effect on the wealth gap, but its influence also intensified in the years following implementation.

5.2.2. Randomness test

The selection of pilot cities may not be completely random when implementing a Comprehensive Innovation Reform Pilot Zones policy. In the process of policy formulation, the location factors of each city, sustainable economic and social development level, and regional radiation drive capability are taken into account as references for whether the city is established as a pilot, so the baseline regression results may have the problem of selection bias (Zeng & Wu, 2022). To solve this problem, this paper adds the interaction terms of time trend (including primary, secondary, and tertiary terms) and city factors (including municipalities directly under the central government, provincial capitals, and special economic zones) to the original model based on the previous practice (Moser & Voena, 2012). Adding the interaction above factors to the original regression model may minimize the estimated bias produced by the non-random selection of treatment groups, and Table 4 displays the regression findings. The table's significant coefficients of the difference-in-difference term indicate that the initial baseline regression results are robust.

Table 4. Randomness test.

	Thiel Index
Comprehensive Innovation Reform Pilot Zones	0.008***
	(4.505)
Control variables	Yes
Urban fixed effects	Yes
Year fixed effects	Yes
N	1818
R-square	0.932

*Note: t-statistic in parentheses; *** indicates p<0.01, ** indicates p<0.05, * indicates p<0.1.*

5.2.3. Placebo test

Although the regression results in this paper have passed the parallel trend test and the non-random selection effect test, other unobservable factors may also affect the results, such as biased estimates of policy effects caused by other policies (Xiao, 2022). Therefore, this paper uses a placebo test to disprove its robustness further. The core idea of this test is to construct spurious policy dummy variables for estimation. If the regression results under the spurious policy dummy variable approach are far from the actual results, the initial estimation results are proven robust. Figure 1 shows the results of the placebo test with 300 Monte Carlo simulations conducted, in which the horizontal dashed line is the critical point with a significance level of 10%, and the vertical dashed line represents the actual value of the baseline estimated coefficient of 0.012. As can be seen, the dummy estimates are distributed

around the value of 0 and form a standard distribution shape. The actual estimate is an outlier in the graph, indicating that the estimation results of this paper are not influenced by unobservable factors influence, which further verifies the robustness of the conclusion.

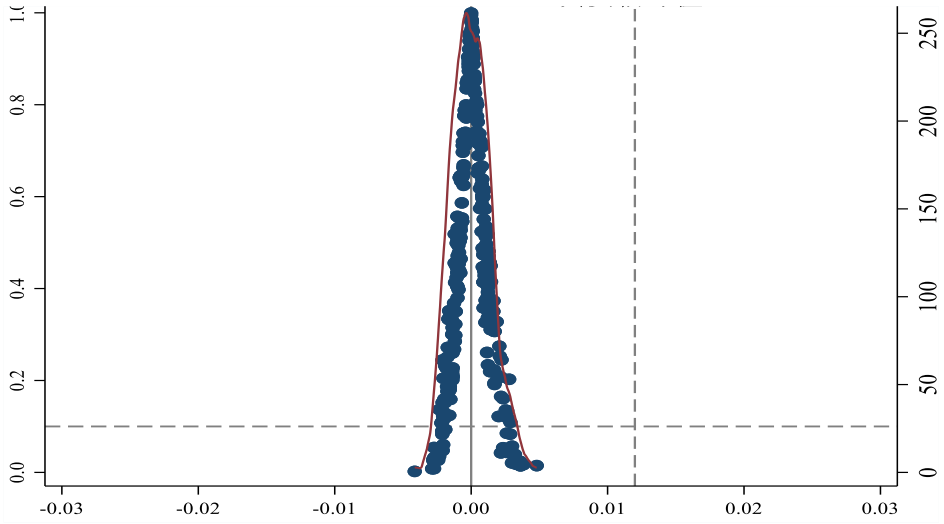

Figure 1. Placebo test.

6. Further analysis: path and heterogeneity analysis

6.1. Path analysis

Why did the Comprehensive Innovation Reform Pilot Zones policy lead to a wealth gap? What are the conduction paths? To answer this topic, this article examines the probable routes of the wealth gap generated by the policy of the Comprehensive Innovation Reform Pilot Zones from two perspectives: virtual wealth and wage stratification. This paper uses the number of employees in the financial industry to measure wealth dilution. The employees' wage gap in different positions is used to measure wage stratification. The reason is that the financial market is highly speculative. When the speculative returns in the financial market increase, many people will be attracted to work in the financial industry. Therefore, the number of employees in the financial industry reflects the degree of speculation in the financial market and the degree of virtual wealth. The wage of employees on the job is divided into several points, and the degree of wage stratification can be measured by studying whether the wage gap of different points is enlarged or narrowed. This paper examines the effect of virtual wealth using a mediated effects model, while the effect of wage differentiation is assessed through quantile regression.

From the estimation results in Table 5, it can be seen that, in terms of the virtual wealth effect, since corporate innovation requires a large amount of financial support, it inevitably leads to an increase in corporate financing activity (Javeed, et al., 2022). The financing fervor catalyzes the development of the financial sector, leading to an increase in labor demand in the financial sector—the superposition of the two leads to the creation of financial market bubbles. Regarding wage differentiation effects, innovation leads to changes in workers' wages, but the effects on wages at different levels do not seem to have attracted much attention from academic circles. Therefore, incorporating quantile regressions into the path analysis framework, this research evaluates the effect of the Comprehensive Innovation Reform Pilot Zones on workers' earnings in different quartiles.

This paper finds that while the Comprehensive Innovation Reform Pilot Zones significantly increase workers' wages, the increase is unbalanced for different tiers of workers at high, medium, and low wages. Specifically, for low-wage workers, the Comprehensive Innovation Reform Pilot Zones increased their wages by 10.7%. In contrast,

for middle- and high-wage workers, the ratios were 21.0% and 24.6%, about twice as much as for low-wage workers. This wage differentiation is a fundamental cause of the wealth gap. In summary, in addition to directly causing the wealth gap, the Comprehensive Innovation Reform Pilot Zones indirectly cause the wealth gap mainly through the effect of virtual wealth and wage differentiation. Accordingly, hypothesis 2 and hypothesis 3 of this paper are verified.

Table 5. Path analysis results.

	Virtual wealth effect		Compensation differentiation effect			
	Number of employees in the financial sector	Thiel Index	Wage Q25	Wage Q50	Wage Q75	Thiel index
IRP	1.992***	0.010***	0.107**	0.210***	0.246***	0.011***
	(4.729)	(5.694)	(2.381)	(5.358)	(7.067)	(7.095)
Number of employees in the financial sector		0.001***				
		(2.931)				
Wage						0.005**
						(2.519)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Urban fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	1818	1818	1818	1818	1818	1818
R-square	0.958	0.931	0.685	0.700	0.730	0.931

*Note: t-statistic in parentheses; *** indicates p<0.01, ** indicates p<0.05, * indicates p<0.1.*

6.2. Heterogeneity analysis

China's geography is large, and the economic growth of various regions varies considerably. In light of this, this study studies the heterogeneity of the policy consequences of the Comprehensive Innovation Reform Pilot Zones from the perspective of urban agglomeration. According to Table 6, the Comprehensive Innovation Reform Pilot Zones have had the most significant impact on expanding the gap between the affluent and poor in the Beijing-Tianjin-Hebei urban cluster, followed by the middle reaches of the Yangtze River and the Chengdu-Chongqing urban cluster. The Comprehensive Innovation Reform Pilot Zones have decreased the wealth gap and fostered "common prosperity" in the Yangtze River Delta and Central Plains urban agglomerations. The possible reasons for this are:

As China's political and human capital center, Beijing's primary industries are concentrated in high-end service and high-tech industries, and it has also reached a high level of urbanization for the Beijing-Tianjin-Hebei city cluster. (Z. Wang, Liang, Sun, & Wang, 2019). In contrast, Hebei's industries are dominated by secondary sectors, including iron and steel, coal, and electricity, and its urbanization rate is below the national average. In addition, there is a big difference in each city's overall coordinated development index, with Beijing in a coordinated state and Tianjin and Hebei in a dysfunctional state, and this difference cannot be eliminated in a short time (Tian, Li, Song, & Yue, 2022). The large gap between Beijing and Hebei makes the "Matthew effect" prominent and widens the gap between rich and poor cities. The Chengdu-Chongqing urban agglomeration primarily builds a spatial layout of "one axis, two belts, two cores and three districts" with Chongqing and Chengdu as the center axes to play the dual-core driving function of the major axes; nevertheless, the central part of the main axes is severely compressed, resulting in economic incoordination (X. Zhang, Jie, Ning, Wang, & Li, 2022). The urban resilience of the middle reaches of the Yangtze River urban agglomeration is on the rise, but at the provincial level, Hubei has the highest urban resilience, followed by Jiangxi and Hunan, and there is a significant disparity between the urban resilience of these cities and other cities. Also, the resilience of other cities will develop more slowly than that of these provincial capitals, resulting in a further widening of the divide between the rich and the poor.

The Yangtze River Delta city cluster is more mature than the Chengdu-Chongqing city cluster at the level of talent gathering, flow, and sharing (Yao, et al., 2023). So, this city cluster has formed a development model of talent-related interaction and win-win cooperation, but the overall innovation level of the Yangtze River Delta is not high. The high-level innovation is mainly concentrated in the Shanghai-Nanjing-Hangzhou-Ningbo development belt. It is local innovation and extra-regional innovation cooperation interaction will weaken the positive impact of innovation, which may lead to the impact of innovation on the rich-poor gap in the Yangtze River Delta are not significant (Ye, Zhu, Li, Yang, & Chen, 2019). One of the characteristics and advantages of the Central Plains urban agglomeration is its divergent high-speed railway pattern, with Zhengzhou as the center. The unique traffic pattern makes the cooperation and interaction between cities more convenient, and the pattern of Zheng-Kai and Zheng-Bian integration has been set. The urban agglomeration of the Central Plains will have more excellent resource circulation, collaboration, and consultation. Consequently, the National Comprehensive Innovation Reform Pilot Zones have reduced the wealth disparity in the central plains city cluster (Y. Wang, Pei, Gu, Liu, & Liu, 2023).

Table 6. Heterogeneity analysis of urban agglomeration.

	(1) Yangtze River Delta	(2) Beijing, Tianjin and Hebei	(3) Centaline	(4) Middle Yangtze River	(5) Chengdu and Chongqing
IRP	-0.006	0.019***	-0.008*	0.009***	0.006**
	(-1.139)	(3.537)	(-1.718)	(2.662)	(2.543)
Control variables	Yes	Yes	Yes	Yes	Yes
Urban fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
N	234	27	207	243	144
R-square	0.899	0.994	0.962	0.878	0.963

*Note: t-statistic in parentheses; *** indicates p<0.01, ** indicates p<0.05, * indicates p<0.1.*

7. Conclusions and discussion

This study underscores the importance of integrating knowledge-based innovation with equitable economic outcomes. It highlights that while innovation can drive economic growth, it must be strategically managed to avoid exacerbating wealth inequalities, offering valuable guidance for policymakers seeking to leverage innovation for sustainable and inclusive development. This study investigates whether the establishment of Comprehensive Innovation Reform Pilot Zones (CIRPZs) has contributed to or hindered shared prosperity in urban China, emphasizing innovation as an endogenous growth driver that is crucial for transforming China's economic development into high-quality, inclusive development. By employing a difference-in-differences (DiD) model with panel data, the study analyzes the impact of these pilot zones on wealth inequality, focusing on whether they have promoted shared prosperity or, instead, deepened wealth disparities. The study further examines the influence of virtual wealth and wage differentiation, as well as the heterogeneous impacts across different urban agglomerations.

The findings reveal that the implementation of comprehensive innovation policies has significantly widened the urban wealth gap, thus counteracting efforts toward shared prosperity. These results are validated through several robustness tests, including parallel trend and non-random selection effect tests. The study identifies two primary mechanisms through which CIRPZs widen the wealth gap: virtual wealth accumulation and wage stratification. Regionally, the CIRPZ policy has the most pronounced impact on the wealth gap in the Beijing-Tianjin-Hebei region, followed by the middle reaches of the Yangtze River and the Chengdu-Chongqing urban

agglomeration, while the Central Plains urban agglomeration experiences a significant narrowing of the wealth gap. These conclusions offer crucial insights for policymakers in developing countries who are striving to balance innovation with wealth disparity.

Based on the study's findings, several policy implications can guide public sector decision-making: First, the CIRPZ policy has contributed to increased wealth disparities due to differing initial economic conditions across regions and the Matthew effect. Therefore, policymakers should craft innovation and reform policies that are suited to the specific needs of different cities. This includes considering variations in infrastructure, industrial characteristics, and the stages of economic development. The effectiveness of innovation-driven policies will depend on local contexts and targeted interventions.

Second, the study shows that the CIRPZs have expanded wealth gaps through wage differentiation and virtual wealth accumulation. When market mechanisms become uncoordinated, the government must step in to regulate these effects and implement measures that mitigate the widening of income inequality, especially in underdeveloped regions. Investing in infrastructure, particularly in less-developed areas, and establishing financial supervision and early warning systems are critical to ensuring that innovation policies promote equitable development rather than exacerbate regional disparities.

Finally, the narrowing of the wealth gap in the Central Plains urban agglomeration can be largely attributed to its unique transportation networks, which enhance inter-city connectivity and collaboration. Other urban agglomerations could benefit from strengthening linkages and interoperability between cities, removing barriers to cooperation and trade, and facilitating the flow of innovation resources from pilot zones to surrounding areas. Such efforts could help narrow regional wealth gaps by promoting synergistic development across urban clusters.

Future research could explore additional mechanisms through which innovation policies impact wealth inequality, especially considering the dynamic interaction between technological advancements and socio-economic factors. Longitudinal studies could capture the long-term effects of innovation policies on wealth distribution and economic development, providing deeper insights into sustainable and inclusive growth. Furthermore, examining the role of global innovation zones and comparing China's CIRPZs with similar initiatives in other developing economies could enhance the understanding of the broader implications of innovation-driven policies on wealth inequality.

Funding Statement

This research received no external funding.

Acknowledgments

Acknowledgments to anonymous referees' comments and editor's effort.

Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

The author was solely responsible for all aspects of the research, including conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, and writing – review & editing.

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