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Original Article

Can a Reduction in the Contribution Rate of the Basic Old-Age Insurance Scheme Extend the Coverage of the Scheme? A Study Based on a Difference-In-Differences Model Comparing Two Regions

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Abstract:
Reducing the basic old-age contribution rate has become an important measure for reducing enterprises' burdens and maintaining system fairness. This study examines the implementation effects of the current contribution reduction policy and provides empirical evidence for formulating and adjusting subsequent support policies. In this paper, the implementation of the 2019 old-age insurance contribution rate reduction policy is treated as a quasi-natural experiment, and a difference-in-differences approach is used to examine the impact of the reduction in statutory contribution rates on coverage rates. The policy shock of reducing the old-age insurance contribution rate has a significant positive effect of approximately 6.5% on increasing the old-age insurance coverage rate in the experimental group compared with the control group, with a dynamic growth trend. Further heterogeneity analysis across provinces reveals that regions with higher pension burdens do not show a significant upward trend in coverage in the face of falling contribution rates, whereas economically underdeveloped regions show a significant downward trend in coverage. Overall, the policy of reducing old-age insurance contributions is beneficial for increasing old-age insurance coverage rates; however, significant regional disparities exist. In the future, it is necessary to develop differentiated policies tailored to various regions to ensure the fairness and sustainability of the system.

Keywords: Basic Old-age Insurance Scheme; Reduction in Contribution Rate; Coverage Rate; Difference-in-Differences

1. Introduction

Reducing the contribution rate for the old-age insurance of urban workers has become an important measure for reducing the burden on enterprises and increasing the coverage of this insurance. However, the contribution rate for urban employees' old-age insurance in China has remained high for many years. Statistics show that, before the contribution rate reduction in 2019, except for regions with a lighter pension burden, namely, Zhejiang, Jiangsu and some cities in Fujian, where the enterprise statutory contribution rate was between 12% and 15%, most other regions had enterprise statutory contribution rates between 18% and 20% [1]. Thus, the employer contribution rate of China's basic old-age insurance for urban workers is significantly higher than that of developed countries such as the United States (6.2%), Germany (9.345%), France (8.55%) and Japan (9.15%) [1]

[1] Data source: United States Social Security Administration. "Social Security Programs Throughout the World: Asia and the Pacific,2016".

At the same time, the coverage rate of old-age insurance for China's urban workers has been growing slowly. As shown in Table 1, from 2011 to 2018, the coverage rate of China's urban employees' basic old-age insurance increased annually, but the overall increase was relatively slow. During this period, the coverage rate increased by only 9 percentage points, with an average annual growth of 1.1 percentage points, and in some years, the old-age insurance coverage rate did not actually increase annually.

Table 1 Basic old-age insurance coverage rates for urban workers in China for selected years

Year	Number of insured active employees (ten thousand people)	Urban employed population (ten thousand people)	Coverage rate
2011	21565	35914	0.60
2012	22981	37102	0.62
2013	24177	38240	0.63
2014	25531	39310	0.65
2015	26219	40410	0.65
2016	27826	41428	0.67
2017	29268	42462	0.69
2018	30104	43419	0.69
2019	31177	44247	0.70
2020	32859	46271	0.71
2021	34917	46773	0.75
2022	36711	45931	0.80

Source: Data compiled and calculated from the China Statistical Yearbook (2012-2023).

The high statutory contribution rate may be one of the main reasons for the slow growth of old-age insurance coverage. For enterprises, a higher statutory contribution rate increases their contribution burden and operating costs, leading them to evade contributions by underreporting the number of employees and total wages contributed, making it difficult to improve coverage [2]. Additionally, when firms cannot partially shift the contribution burden to low-skilled and less competitive workers by reducing wages, they often lay off these workers, thereby reducing the old-age insurance coverage rate [3-4]. Facing the dual pressure of fiscal decentralization and political promotion, local governments often relax the supervision of enterprises' contributions to keep capital and promote economic growth, which makes it difficult to increase the coverage rate [5]. For individuals, higher contributions affect their intertemporal consumption [6]; on the other hand, they do not meet employees' personal revenue expectations [7]. Given the above considerations, employees themselves are unwilling to participate in this insurance.

To meet the challenge of expanding coverage, since the 18th National Congress of the Communist Party of China, the Party Central Committee and the State Council have placed greater emphasis on the social security system. To actively promote the transition of the old-age insurance system from full institutional coverage to full coverage of the legal population, these government institutions have implemented a series of fee reduction and relief policies for enterprises. For example, in 2019, the Comprehensive Plan for Reducing Social Insurance Contribution Rates was issued, which stipulated that employers' contribution rate for basic old-age insurance for urban employees would be reduced to 16% from 1 May 2019. This measure has significantly reduced the

contribution burden on enterprises and eased payment pressure in regions with heavy pension burdens. However, the following question remains: has the situation of slow growth in old-age insurance coverage improved?

Table 1 shows that before 2019, the growth in the old-age insurance coverage rate of China's urban workers was relatively slow. However, after 2019, the changes in the old-age insurance coverage rate became more significant. The reduction in the statutory old-age insurance contribution rate may have had a positive effect on improving the old-age insurance coverage rate. Thus, is there a direct causal relationship between the decrease in the statutory contribution rate and the increase in the old-age insurance coverage rate? This paper aims to answer this question and provides policy suggestions for improving the coverage rate of old-age insurance during China's transition period.

In this paper, panel data from China's provincial regions for the period 2017-2022 are used to study the impact of old-age insurance contribution rate reductions on coverage rates, with the aim of exploring the implementation effects of old-age insurance contribution rate reductions. Compared with existing research, this paper makes the three following contributions. First, on the basis of a two-region comparative perspective, it calculates the heterogeneous impact of a reduction in the statutory contribution rate on coverage rates in different provinces. Second, it uses data after the implementation of the old-age insurance contribution reduction policy in 2019 to more accurately measure the implementation effects of the policy. Third, by focusing on the impact of the statutory contribution rate reduction, it better identifies the marginal impact on coverage rates, which enhances the credibility of the conclusions.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature, and Section 3 presents the research hypotheses and specifies the econometric model and data. Section 4 examines the impact of the reduction in old-age insurance contributions on coverage rates, Section 5 presents the results and discussion, and Section 6 presents the conclusions and limitations. Finally, policy recommendations are given.

Literature Review

The issue of the coverage rate of old-age insurance has attracted considerable attention from both domestic and international scholars. Existing research has focused on the impact of statutory contribution rates on coverage rates from the perspectives of enterprises, individuals and the government. There is a basic consensus that excessively high statutory contribution rates create disincentives for micro-subject participation, but few empirical studies have examined the effect of reducing old-age contribution rates.

A large body of literature has examined the relationship between statutory old-age insurance contribution rates and enterprise participation rates. Using data from the 2011 China Annual Survey of Industrial Enterprises and employing a Tobit model, Han and Meng (2019) reported that lower contribution rates can incentivize enterprises to participate in the old-age insurance system for urban employees and increase fund income [8]. Li et al. (2020), using enterprise income tax data from 54 Chinese cities between 2007 and 2011 and employing fixed effects models and instrumental variable methods, reported that a 1 percentage point increase in social security contribution rates leads to a 0.785 percentage point increase in the probability that enterprises do not participate in social security. In terms of enterprise type, private enterprises are more likely to avoid participation, whereas foreign-funded and state-owned enterprises' avoidance behavior is not significant. Moreover, in cities where employment contracts are not widespread, corporate avoidance of participation has also become more serious [9]. Taking Shanghai as an example, Feng and Zhang (2012)

used a fixed-effects model to analyze the impact of different social insurance contribution rates on participation behavior and reported that lower contribution rates can increase the level of enterprise participation, with a greater impact on enterprises with lower average human capital levels [10]. Zhao et al. (2016) established an econometric model via social insurance contribution survey data and reported that increasing the statutory contribution rate significantly reduces the probability of enterprise participation but does not affect the probability of employee participation [11]. Chen (2017) established an econometric model using statistical data on the coverage rate of urban employees and reported that a 1 percentage point decrease in the old-age insurance contribution rate for urban employees increases the coverage rate by approximately 1.2 percentage points [12]. Song et al. (2021) used the difference-in-differences (DID) method to study the impact of contribution rate differences between Zhejiang and Jiangsu Provinces on the participation behavior of enterprises. The results revealed that a 6% reduction in the insurance contribution rate increased enterprise social insurance participation by approximately 4.2%. Specifically, the social insurance participation rate of small and medium-sized private enterprises has increased significantly, by approximately 3.2%, and that of manufacturing enterprises has increased significantly, by approximately 8.3% [13].

Many studies have examined the incentive effects of old-age contribution rates on individual participation. Duval (2003) conducted an empirical study and reported that most European countries have high implicit tax rates, which are not conducive to the regular participation of older members of the labor force [14]. Ferreira and Robalino (2011) reported that when high old-age insurance contribution rates are maintained, the participation rate of the highest income quintile of workers in Brazil reaches 70%, whereas that of the lowest income quintile is only 20% [15]. Braham and Marouni (2016) reported that under current old-age insurance contribution rates, low-income workers in large companies in Tunisia have a lower willingness to contribute. Moreover, female workers are more likely to be willing to contribute than male workers are. Additionally, workers in the capital region of Tunisia have a lower willingness to contribute [16]. Using an experimental survey approach to study state-sponsored automatic IRA plans in the United States, Belbase and Sanzenbacher (2017) found that when the contribution rate is 6%, the opt-out rate among workers is approximately 19%. When the contribution rate increases from 6% to 10% annually, the opt-out rate increases significantly to 24% [17]. However, Mexico is an exception. Alonso et al. (2015) reported that Mexico's low contribution rates to the retirement savings system (SAR) actually reduce young people's expectations of participation [18]. Yuan et al. (2009) reported that for some low-income workers, higher statutory old-age insurance contribution rates not only limit their current consumption but also affect their intertemporal consumption, making them less willing to accept enterprise participation arrangements. When faced with higher statutory contribution rates, informal workers' attitudes are largely consistent with those of formal workers [19]. Han (2014) and Wang and Jin (2020) found that high contribution rates lead migrant workers to choose informal employment more often, and the probability of informal employed migrant workers participating in insurance is significantly lower than that of formal employed migrant workers. The contribution rate has a significant crowding out effect on the participation of migrant workers [20-21]. Tian et al. (2021) and Lu (2021) reported that flexible workers not only have to contribute 20% of the old-age insurance contribution themselves but also have to participate in all five basic social security programs in some regions. The heavy

contribution burden causes many of them to switch en masse to the basic old-age insurance of urban and rural residents [22-23].

Additionally, given the high statutory contribution rates, the regulatory intensity of the government is an important factor affecting the coverage of the old-age insurance system. Salditt et al. (2008) suggested that improving employee and enterprise compliance with laws and regulations could expand the coverage of China's old-age insurance system [24]. Holzmann et al. (2009) noted that Japan's Basic Protection Schemes lacks accountability mechanisms, leading to persistently high withdrawal rates [25]. Almeida and Carneiro (2012) suggested that more frequent company audits could improve compliance with social security contributions in Brazil [26]. Furthermore, Jones and Urasawa (2014) suggested that improving compliance with laws and regulations among informal workers and the self-employed can effectively expand the coverage of South Korea's national pension system [27]. Peng and Mei (2014) suggested that strengthening the construction of social security regulatory information systems, standardizing reward and punishment mechanisms, and improving auditing systems can encourage small and microenterprises to actively participate in insurance [28]. Additionally, Duan (2015) proposed similar policy suggestions [29]. From the perspective of old-age insurance collection agencies, tax departments have comprehensive information and strong collection capabilities; collecting old-age insurance premiums through tax departments is also an effective way for the government to strengthen regulatory intensity. Liu (2011) suggested that, compared with social insurance agencies, local tax departments collecting social insurance premium are more conducive to expanding social insurance coverage [30]. Moreover, Liu and Liu (2020) suggested that the collection of social insurance premium by tax departments significantly increases the probability of enterprise participation, with a more pronounced effect on nonstate-owned enterprises, small enterprises, labor-intensive enterprises and enterprises with lower wage levels [31]. However, to attract foreign investment and reduce the burden on enterprises, local governments are likely to relax the regulation of old-age insurance contributions, creating a "race to the bottom" competitive behavior that affects the expansion of system coverage. Xu and Qian (2014) noted that some local governments consider relaxing regulations for large enterprises as a "comparative advantage" policy, resulting in relatively low old-age participation rates for large enterprises [32]. Peng et al. (2018) noted that local governments engage in competitive "race to the bottom" behavior by reducing the intensity of old-age insurance collection to increase enterprises' willingness to invest and reduce their costs, which affects system coverage [33].

Research Hypotheses, Modeling and Data

Research Hypotheses

Reducing the old-age contribution rate is an important measure for reducing regional disparities in contributions and maintaining the fairness of the system. Generally, economically developed regions bear a lighter old-age insurance burden, as their governments can meet the payment needs of pension funds with limited collection efforts. When contribution reduction policies are implemented, economically developed regions often choose to increase collection efforts to maintain a balance between pension fund revenues and expenditures. Increased collection efforts contribute to the expansion of old-age insurance coverage. In this context, reducing the old-age insurance contribution rate can have a positive effect on improving coverage.

Notably, local governments in China have engaged in 'race to the bottom' competitive behavior for many years. For example, Peng

(2009) reported that local governments tend to engage in a "race to the bottom" by reducing social insurance costs in the process of attracting investment [34]. Similarly, Wei and Tian (2023) reported that a "race to the bottom" in fiscal policy distorts the structure of local public expenditure, leading to public service provision deviating from optimal levels [35]. In this context, considering that the reduction in old-age insurance contributions in economically developed regions increases the payment pressure on funds, local governments in these areas are strongly motivated to expand old-age insurance coverage. This expansion increases the size of fund income and reduces the level of additional government expenditure on public services, so competitive advantages in the economic domain are maintained. At this point, the reduction in the old-age insurance contribution rates also has a positive effect on improving coverage.

Compared with economically developed regions, economically underdeveloped regions are more likely to exhibit soft budget constraint behavior in the collection of old-age insurance contributions. Economically underdeveloped regions bear a heavy pension burden; local governments face risks in pension fund payments, and the reduction in statutory contribution rates further widens the payment gap. Local governments do not have any other potential sources of revenue that they can explore, no matter how much they increase their collection efforts. Since the central government will assume fiscal support responsibilities, local governments will "rightly" transfer part of the responsibility for guaranteeing pension funds to the central government. To maintain the economic vitality of their regions, they may even relax their efforts to collect old-age insurance contributions to some extent [36]. In such circumstances, reducing the old-age insurance contribution rates may have no effect on improving coverage or may even have a negative effect.

On the basis of the above analysis, this paper proposes the following testable hypothesis: The reduction in old-age insurance contributions has a significant positive effect on improving coverage rates and shows clear heterogeneity across provinces.

Settings of the Econometric Model

For this paper, we adopted the DID method and treat the implementation of the old-age insurance contribution reduction policy in 2019 as a quasi-natural experiment to examine the impact of the old-age insurance contribution reduction on the coverage rate. Specifically, we considered 2019, when the old-age insurance contribution reduction was introduced, as the policy shock year and used Guangdong and Zhejiang Provinces as the control group to construct the following DID model:

$$fgl_{it} = \alpha_0 + \beta_1 treat_{it} \times time_{it} + \beta_2 control_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

where i indicates province and t indicates time; fgl is the old-age insurance coverage rate; $treat$ is a dummy variable for grouping, where $treat$ equals 1 for the experimental group and where $treat$ equals 0 for the control group; $time$ is a dummy variable for the time of the policy shock, where $time$ equals 1 for after 2019 and where $time$ equals 0 for before 2019; $control$ is a control variable; γ and μ are the time and individual fixed effects, respectively; and ε is the random error term.

Setting Up the Treatment and Control Groups

Since the China Urban Employees' Pension Insurance Scheme was established in 1997, it has consistently maintained a high contribution rate. This high contribution rate increases the operating costs of enterprises and is not conducive to economic growth in various regions. To reduce the burden on enterprises and optimize the

business environment, on 1 April 2019, the State issued the Comprehensive Plan for Reducing the Social Insurance Contribution Rate, which explicitly stipulates that the employer contribution rate for old-age insurance exceeding 16% can be reduced to 16%. However, since Zhejiang and Guangdong Provinces have long had lower insurance contribution rates, they are not affected by this rate reduction. On the basis of the above understanding, Zhejiang and Guangdong Provinces were selected as the control group and Beijing and Shanghai municipalities were chosen as the treatment group for this paper.

Beijing and Shanghai were selected as the treatment group in this paper for three main reasons. First, from 2017 to 2018, the statutory old-age insurance contribution rates in Beijing and Shanghai were stable and consistently maintained at 20%; after the implementation of the contribution reduction policy in 2019, the statutory old-age insurance contribution rates in Beijing and Shanghai remained at 16%, resulting in a more significant change than that in the control group. Second, from 2017 to 2018, the trend of coverage rate changes in Beijing and Shanghai was similar to that in Zhejiang and Guangdong (see Figure 1), indicating that in the absence of policy shocks, the dependent variables of the experimental and control groups basically maintained parallel time trends, which is the key for selecting the treatment group. Third, Beijing and Shanghai, as well as Zhejiang and Guangdong Provinces, are relatively similar in terms of pension benefits, the distribution of innovative talent, and the implementation of national policies, which ensures the comparability of the treatment and control groups.

Data Sources

Panel data of Chinese provincial regions for the period 2017-2022 were used as the research sample for this paper. Among them, data such as the number of employees participating in basic old-age insurance for urban employees, the number of urban employees, the average wage growth rate, the ownership structure, the regional economic development level, and capital intensity were compiled or calculated on the basis of data from the China Statistical Yearbook and the China Labor Statistical Yearbook. For the relevant variables measured in monetary units, we applied logarithmic transformations due to their large numerical values and to reduce the impact of heteroscedasticity. Additionally, before the 2019 old-age insurance contribution reduction, the data on the insurance contribution rates for each province and city from 2017 to 2019 used in this study were based on the data published in the China Pension Development Report (2012-2016) and the official websites of the regional human resources and social security departments. After the old-age insurance contribution rate reduction in 2019, except for Zhejiang and Guangdong Provinces, where the statutory contribution rates remained at 22%, the statutory contribution rates of other provinces were implemented according to the national unified regulation of 24%.

Selection of Variables and Descriptive Analysis

The relevant variables were selected as follows, and their descriptive statistics are presented in Table 2.

1. Statutory contribution rate (npr). The statutory contribution rate refers to the proportion of old-age insurance contributions made by participating employers and individual employees, as defined by relevant national laws and regulations. A higher statutory contribution rate increases the contribution burden on enterprises and individuals and is not conducive to improving pension coverage.

2. Old-age dependency ratio (zd). The old-age dependency ratio is the ratio of the number of retired employees to the number of insured active employees and is used to measure the pressure on pension fund payments. The higher the level of this indicator is, the greater the pressure on the

pension fund to make payments and the greater the incentive for the regions to increase pension coverage.

3. Coverage rate (fgl). The coverage rate of urban workers' old-age insurance is used as the explained variable, expressed as the number of insured active employees/urban working population.

4. Level of economic development ($pgdp$). The level of regional economic development is measured by the regional GDP per capita. On the one hand, the higher the level of regional economic development is, the greater the financial revenue capacity of local governments, which can provide financial support for the establishment and daily management of the old-age insurance system; on the other hand, the improvement in the level of regional economic development helps employees accumulate assets and increases their ability to participate in the old-age insurance system.

5. Average wage growth rate (gz). The average wage growth rate is calculated as the average wage of employees in the current year - the average wage of employees in the previous year, divided by the average wage of employees in the previous year. In accordance with the relevant rules and regulations, old-age insurance contributions are linked to the total compensation of active employees in enterprises. The total payroll of employees determines the company's contribution burden, and the average wage growth rate directly affects the total payroll of employees. As the average wage growth rate increases, the company's contribution burden increases. To reduce costs, companies may evade contributions, which affects coverage.

6. Ownership structure (sy). The ownership structure is expressed by the number of employees in state-owned units/the number of employees in municipal units. Compared with enterprises with other forms of ownership, state-owned enterprises have stronger financial support, more complete participation processes and rules and regulations, strong contribution capabilities and high contribution compliance. They are the main targets for expanding pension coverage and collection, and this study uses the ownership structure as a control variable.

7. Capital intensity ($zbmj$). This indicator is the ratio of fixed asset investment to the number of urban employees. The hiring of labor and pension contributions for workers increases the labor costs of enterprises, especially labor-intensive enterprises, where labor costs account for a larger share of fixed asset investment, thus affecting the participation behavior of enterprises.

Table 2 Descriptive statistics of the main variables

Variable	Sample size	Mean	Standard deviation	Min	Max
Statutory contribution rate (npr)	186	0.237	0.024	0.22	0.29
Coverage rate(fgl)	186	0.845	0.075	0.758	0.984
Old-age dependency ratio(zd)	186	0.307	0.129	0.121	0.477
Capital intensity($zbmj$)	186	11.318	0.357	10.82	12.019
Level of economic development ($pgdp$)	186	11.721	0.295	11.241	12.156
Average wage growth rate(gz)	186	9.797	2.508	5.327	15.067
Ownership structure(sy)	186	0.09	0.029	0.061	0.154

Table 2 shows the descriptive statistics of the main variables for Beijing, Shanghai, Zhejiang and Guangdong Provinces. For the statutory contribution rate, the average statutory contribution rate in each region from 2017 to 2022 was 23.7%, with a minimum of 22% (Guangdong and Zhejiang Provinces, 2017-2022) and a maximum of 29% (Shanghai, 2017-2018). The average coverage rate during the observation period was 0.845, with a minimum of 0.758 (Shanghai, 2018) and a maximum of 0.984 (Beijing, 2022).

Analysis of the Empirical Results

Baseline Regression Analysis

1. Parallel Trend Test

The precondition for the validity of the difference-in-differences method is that the parallel trend assumption is satisfied, i.e., the dependent variables of the experimental group and the control group should have essentially the same time trend before the policy shock. Figure 1 shows that before the 2019 old-age insurance contribution reduction policy was implemented, the old-age insurance coverage rates in the provinces of both the experimental group and the control group grew slowly and exhibited essentially the same trend. However, after this policy was implemented, the coverage rates of the two groups of provinces changed strongly. For the experimental group, the upward trend in coverage rates was more pronounced, while the coverage rates of the control group did not fluctuate significantly, and the overall upward trend was relatively gradual.

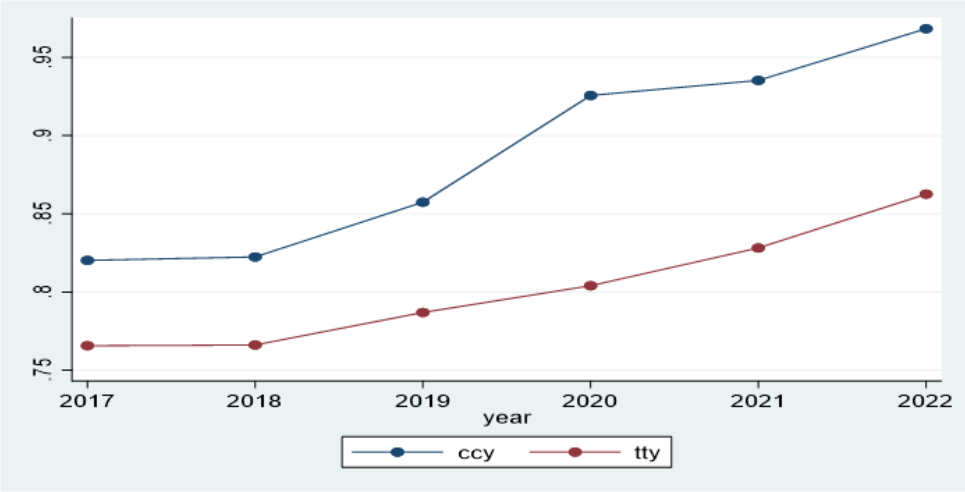

Figure 1. Parallel trends in the coverage rates of provinces and cities in the experimental group (ccy) and the control group (tty)

2. Effect of the reduction in the statutory contribution rate on the coverage ratio

In this paper, we evaluated the impact of the reduction in the statutory contribution rate on old-age insurance coverage by constructing a DID model (see Table 3). Column (1) presents the estimation results without control variables, with an estimated policy effect of 6.4%, which is significant at the 1% level. Column (2) builds on Column (1) by adding control variables, resulting in an estimated policy effect of 6.5%, which is also significant at the 1% level. These results suggest that a 4% reduction in the statutory contribution rate of the Urban Employees' Pension Insurance increases the pension coverage rate by approximately 6.5%.

Additionally, to more clearly identify the dynamic effects of the reduction of the old-age insurance

contribution on the coverage rate, we assigned dummy variables for the first year (2019), second year (2020), third year (2021) and fourth year (2022) after the implementation of the "old-age insurance contribution reduction" policy. These variables cross-multiplied with the treatment group dummy variable and are used as core explanatory variables in the regression analysis (see Columns of Tables 3-4). Except for 2019, the regression results of the core explanatory variables for subsequent years are all significantly positive, and their coefficients gradually increase, indicating that the policy effect of the old-age insurance contribution reduction is becoming more pronounced.

The above results indicate that after the old-age insurance contribution reduction policy was implemented, the old-age insurance coverage rate in the experimental group improved significantly compared with that in the control group. Moreover, dynamically, the effect of old-age insurance contribution reduction on improving the coverage rate shows a time trend of gradual increase.

Table 3 Baseline Regression Results

coverage rate				
	(1)	(2)	(3)	(4)
$Treat \times Time$	0.064***	0.065***		
$Treat \times Year2019$			0.032	0.036
$Treat \times Year2020$			0.100*	0.104*
$Treat \times Year2021$			0.110**	0.112**
$Treat \times Year2022$			0.113***	0.114***
Control		Yes		Yes
Time Effects	Yes	Yes	Yes	Yes
Individual Effects	Yes	Yes	Yes	Yes
Constant Term	Yes	Yes	Yes	Yes
N	24	24	24	24
R^2	0.68	0.70	0.72	0.73

Robustness test

1. Changing the Timing of the Policy Shock

The above analysis reveals that the implementation of the policy to reduce the old-age insurance contribution in 2019 significantly expanded old-age insurance coverage. However, policy shocks at other times may lead to similar results. To further test the robustness of the results, we examined whether the core explanatory variables remain significant when the "old-age insurance contribution reduction policy" is not proposed. If significant, it would indicate that other unobserved policy shocks have promoted the increase in the old-age insurance coverage rate; if not significant, it would suggest that the promotional effect of the old-age insurance contribution reduction policy on the coverage rate is stable and reliable. In this paper, we propose the implementation of the old-age insurance contribution reduction policy by one year and rerun the regression analysis (see Table 4). As shown in Columns (1) and (2) of Table 4, the regression results are not significant, indicating that 2018 did not have a policy shock effect on the old-age insurance coverage rate.

Table 4 Test results for changing the timing of the policy shock

	(1)	(2)
$Treat \times Time$	0.032	0.034

Control		Yes
Time Effects	Yes	Yes
Individual Effects	Yes	Yes
Constant Term	Yes	Yes
N	24	24
R^2	0.68	0.73

2. Excluding Interference from Other Events

In this paper, we focused on the implementation of the 2019 old-age insurance contribution reduction policy. However, during the study period (2017-2022), the COVID-19 pandemic (2019-2023) significantly impacted the normal operation of small and medium-sized enterprises (SMEs) in China, which negatively affected both enterprise and individual old-age insurance participation and contributions. To ensure the healthy and sustainable development of China's pension security system, a series of relief policies for SMEs were introduced during this period, including fiscal and financial policies, investment promotion policies, and tax and premium reduction policies. To ensure the reliability of the results, we conducted robustness tests on the basis of this foundation.

First, we introduced $\text{epidemic} \times Period$ as control variables in the empirical analysis to rule out the effect of a series of policies during the COVID-19 pandemic on the empirical results of this study. Specifically, epidemic is a dummy variable measuring whether each province is affected by a series of policies; if a province is affected by a series of policies, epidemic takes a value of 1; otherwise, it is 0. The policy arrangements during the COVID-19 pandemic involve macrolevel regulation and control at the national level and are effectively implemented by all provinces; thus, epidemic is set to 1 for all provinces. *Period* is a dummy variable indicating when some of the listed policies took place; if the sample observation period is 2019-2022, *Period* takes a value of 1; otherwise, 0. The results in Columns (1)-(2) of Table 5 show that the estimated coefficient of $Treat \times Time$ remains significantly positive at the 1% level, and the test results for dynamic effects are also consistent with the previous findings. This finding indicates that, after controlling for the influence of several policies during the COVID-19 pandemic, the effect of the reduction in old-age insurance contributions on the increase in coverage rates is still present.

Similarly, to exclude the interference of pension funds under the unified administration of the state on the empirical results of this paper, we introduced the variable $\text{national} \times \text{period2022}$ in the empirical analysis. Specifically, national is a dummy variable measuring whether each province is affected by the pension fund policy under the unified administration of the state. If a province is affected by the pension fund policy under the unified administration of the state, national takes a value of 1; otherwise, it takes a value of 0. period2022 is a dummy variable indicating the implementation time of the pension fund under the unified administration of the state. If sample observation occurs in 2022, period2022 takes a value of 1; otherwise, it takes a value of 0. The results in Columns (3)-(4) of Table 5 show that the empirical results of this study remain robust after controlling for the effect of the unified administration of the state of pension funds.

Additionally, since this study is simultaneously affected by the introduction of a series of policies during the COVID-19 pandemic and the unified administration of state-of-pension funds, we introduced the variables $\text{epidemic} \times Period$ and $\text{national} \times \text{period2022}$ to control for the effects of these two types of events and conducts a DID test on this basis. The results of this test are presented

in Columns (5) and (6) of Table 5. The results show that after controlling for the influence of two types of events at the same time, the effect of the reduction in the contributions of old-age insurance on increasing the coverage rate is still present, demonstrating the robustness of the empirical findings in this paper.

Table 5 Estimated results after interference from other events was excluded

Coverage rate						
	(1)	(2)	(3)	(4)	(5)	(6)
$Treat \times Time$	0.101***		0.091***		0.10***	
$Treat \times Year2019$		0.007*		0.03*		0.078*
$Treat \times Year2020$		0.076**		0.085**		0.10**
$Treat \times Year2021$		0.085***		0.073***		0.078**
$Treat \times Year2022$		0.096***		0.089***		0.098***
$epidemic \times Period$	0.027	0.056			-0.054	-0.072
$national \times period2022$			0.016	0.022	0.027	0.039
Control	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant Term	Yes	Yes	Yes	Yes	Yes	Yes
N	24	24	24	24	24	24
R^2	0.56	0.39	0.65	0.53	0.68	0.57

1. Placebo Test

A placebo test is essentially a counterfactual assumption. Following the approach of Li et al. (2016), we first randomly selected two provinces out of 31 and designated them as 'no contribution reduction provinces'. Additionally, we set Beijing and Shanghai as the treatment group, thus constructing a two-level random experiment based on provinces and policy time [37]. When running baseline regressions, as shown in Columns (1)-(2) of Table 3, theoretically, since the "noncontribution-reduction provinces" are randomly selected, the estimated coefficients in the baseline regressions should not be significantly different from zero. To minimize the influence of omitted variables and random factors, we repeated the above process 500 times, and finally, a distribution plot of the estimated $Treat \times Time$ coefficients was generated. On this basis, we assessed whether the increase in the coverage rate of China's urban workers by old-age insurance is influenced by factors other than the contribution reduction policy. As shown in Figure 2, the estimated values of $Treat \times Time$ are concentrated around zero and generally follow a normal distribution. These results suggest that the baseline regression results of this paper are not affected by omitted variables but are caused by the implementation of the policy under study.

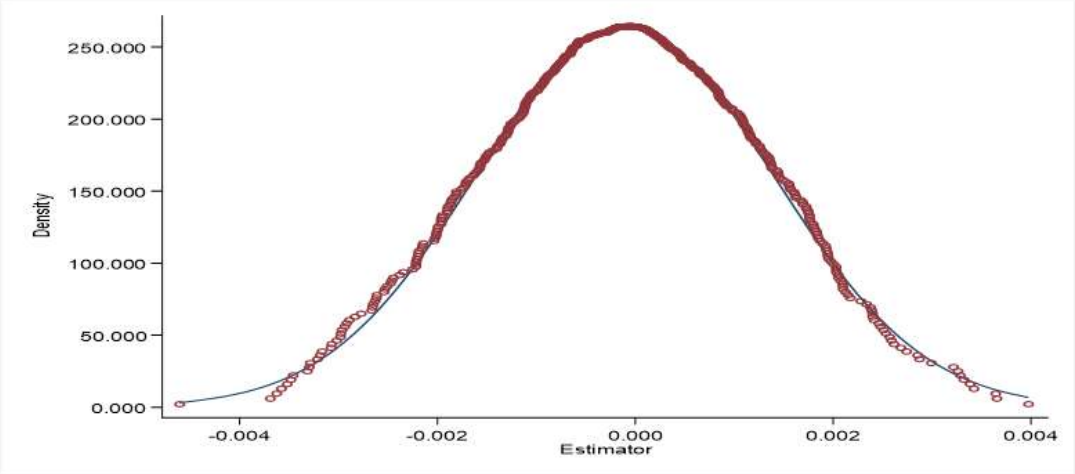

Figure 2 Placebo test

Sample Heterogeneity Analysis

The above analysis suggests that reducing the employer contribution rate of old-age insurance for urban workers can improve the coverage rate of the old-age insurance system to some extent. Notably, different regions in China have different levels of economic development, and there are certain differences in pension burden and regulatory intensity. Against this background, efforts to expand coverage may differ from region to region. Thus, if the empirical result of increased old-age insurance coverage is caused by a reduction in insurance contribution rates, this effect may show heterogeneity across different dimensions. Thus, as presented in this section, we continued to explore the mechanisms through which the reduction in statutory contribution rates affects coverage rates in different regions, with the aim of further refining the relevant research.

First, the heterogeneity test was based on the Old-age dependency ratio. We sorted the research data according to the magnitude of the old-age dependency ratio and selects the two provinces with the highest old-age dependency ratios—Heilongjiang and Jilin—as the treatment group, replacing Beijing and Shanghai (which have lower old-age dependency ratios) to conduct regression analysis. This was done to examine the impact of the old-age insurance contribution reduction policy on the coverage rate under conditions of a high old-age dependency ratio.

The results in Column (1) of Table 6 show that the coefficient of $Treat \times Time$ is small and insignificant, whereas the results in Column (2) of Table 3 show that the coefficient of $Treat \times Time$ is larger and significant at the 1% level. This suggests that, compared with regions with lower Old-age dependency ratio, the policy of reducing the old-age insurance contribution has a limited effect on regions with higher Old-age dependency ratios.

Building upon this, we further introduced the variables $Treat \times Year2019$, $Treat \times Year2020$, $Treat \times Year2021$ and $Treat \times Year2022$ to examine the dynamic effects of the old-age insurance contribution reduction policy on coverage rates. The results in Column (2) of Table 6 show that in regions with relatively high old-age dependency ratios, not only is the effect of the policy weaker, but there is also no time trend of the policy effect gradually becoming more pronounced. In contrast, the results in Column (4) of Table 3 show that in regions with relatively low Old-age dependency ratios, the policy effect is stronger and shows a gradually increasing time trend. These results suggest that, compared with regions with relatively low old-age dependency ratios, the old-age insurance

contribution reduction policy has a relatively smaller effect on improving the coverage rate in regions with relatively high old-age dependency ratios. How can this empirical result be explained?

Generally, in regions with a lower pension burden, the pressure on fund payments is low, and the implementation of a policy of reducing contributions does not affect the balance between fund revenue and expenditure. Thus, there is an intrinsic incentive to participate in the old-age insurance system, whether from the government, companies or individuals. In contrast, regions with a higher pension burden cannot maintain the balance between fund revenue and expenditure on their own. They are easily influenced by the institutional environment of soft budget constraints and lack inherent incentives to extend the coverage of the old-age insurance system. This result implies that a reduction in the statutory contribution rate for old-age insurance has a limited effect on regions with a high old-age dependency ratio. Particular attention should be given to regions with high old-age dependency ratios when formulating and adjusting future pension policies.

Second, we conducted heterogeneity tests based on the level of economic development. We sorted the research data on the basis of the size of the regional GDP per capita and selected Gansu Province and Guizhou Province, which have relatively lower regional GDP per capita, as the treatment group to examine the impact of the old-age insurance contribution reduction policy on the coverage rate in regions with relatively lower levels of economic development.

The results in Column (3) of Table 6 show that the coefficient of $Treat \times Time$ is significantly negative, indicating that the old-age insurance contribution reduction policy significantly reduces the old-age insurance coverage rate in regions with relatively lower levels of economic development. In contrast, the results in Column (2) of Table 3 show that the coefficient of $Treat \times Time$ is significantly positive, suggesting that the old-age insurance contribution reduction policy has a relatively large effect on both economically developed and underdeveloped regions but in completely opposite directions. The results in Column (4) of Table 6 indicate that the contribution reduction policy has a significantly negative effect on the coverage rate in economically underdeveloped regions, specifically characterized by an initial increase followed by a subsequent decrease over time. In contrast, the results in Column (4) of Table 3 show that the contribution reduction policy has a significant positive effect on the coverage rate in economically developed regions, with a gradually increasing trend over time. These empirical results indicate that a reduction in the statutory contribution rate significantly increases the old-age insurance coverage rate in economically developed regions, whereas it has a significantly negative effect on increasing the coverage rate in economically underdeveloped regions.

In fact, economic growth has always been an important indicator for the political promotion of local government officials in China. Thus, local governments are free to perform their pension service functions according to the level of economic development in their regions. Especially in a context where the central government aims to stimulate economic growth by reducing contribution, local governments with different levels of economic development show significant heterogeneity in expanding the old-age coverage rate. In particular, compared with economically developed regions, economically underdeveloped regions have a single economic structure and limited tax revenues; the implementation of old-age insurance contribution reduction policies may instead increase the payment pressure on government funds. Currently, economically underdeveloped regions

may shift the responsibility for pension fund payments to the central government because of short-term economic growth needs. Since the central government is expected to assume the fiscal responsibility for ensuring that funds are available for pay-out, governments in economically underdeveloped regions naturally lack the inherent incentive to increase the old-age insurance coverage rate. This finding has several policy implications. The difficulty in improving the coverage rate of old-age insurance for urban workers in China has long existed, and relying solely on the policy of reducing contributions is insufficient to solve the problem of expanding old-age insurance coverage in economically underdeveloped regions. Thus, practical incentive policies that are in line with the actual economic development of these areas need to be formulated.

Table 6 Differences in the impact of contribution reduction policies on coverage rates in different regions

	Coverage rate			
	Old-age dependency ratio		Economic development	
	(1)	(2)	(3)	(4)
$Treat \times Time$	0.005		-0.149*	
$Treat \times Year2019$		0.033		-0.063
$Treat \times Year2020$		-0.019		-0.201*
$Treat \times Year2021$		0.023		-0.181*
$Treat \times Year2022$		0.012		-0.134*
Control	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Individual Effects	Yes	Yes	Yes	Yes
Constant Term	Yes	Yes	Yes	Yes
N	24	24	24	24
R^2	0.07	0.02	0.52	0.35

Results and Discussion

The reduction in the statutory contribution rate has increased the old-age insurance coverage rate by approximately 6.5% and shows significant heterogeneity across provinces. This finding differs somewhat from related research in recent years, possibly due to differences in research variables, study periods and methodologies used.

Variations in the research variables. Some studies have focused on the statutory contribution rate itself as a variable [12], using the statutory contribution rate of urban employees' old-age insurance as the independent variable and the coverage rate as the dependent variable. Their research revealed that a 1 percentage point decrease in the contribution rate of urban employees' old-age insurance increases the coverage rate by approximately 1.2 percentage points, which is lower than the results of this paper (a 4 percentage point decrease in the old-age insurance contribution rate leads to a 6.5 percentage point increase in the coverage rate). This may be because we considered the reduction in old-age insurance contributions as an independent variable in this study to examine its marginal effect on the old-age insurance coverage rate. Previous studies have shown that using the actual change value of policy variables can provide more accurate estimation results, which is in line with the expectation of economic theory on behavioral responses [38].

Differences in research time. Some studies using data from 2007-2015 have examined the impact of policy measures to reduce contributions to coverage rates [13]. These studies revealed that a 6% reduction in the statutory contribution rate

increased enterprise social security participation by approximately 4.2%, which is lower than the results of this paper (6.5 percentage point increase in coverage). This discrepancy may be related to changes in the Chinese labor market over the past decade. Relevant studies suggest that changes in China's labor market, such as the diversification of employment forms and the migration of rural migrant workers to cities, have had a significant effect on the expansion of the social insurance coverage rate in urban areas [39].

Differences in research methods. In contrast to this paper, in which the DID method was used, other studies have used fixed effects models and instrumental variables methods [10]. These methods result in an increase in participation rates of approximately 9–13%, which is higher than the results of this paper (a 6.5 percentage point increase in coverage). This may be because DID and fixed effects models differ in their approaches to identifying causal relationships and the assumptions on which they rely. Research has suggested that DID is suitable for situations with clear policy interventions and comparable treatment and control groups and is thus better at identifying the causal effects of policies [40].

Conclusions

In this paper, we take the 2019 old-age insurance contribution reduction as a starting point to examine the impact of reduced statutory old-age contribution rates on coverage rates. The main findings of this paper are as follows: (1) A reduction in statutory contribution rates has increased the old-age insurance coverage rate in Beijing and Shanghai by approximately 6.5%, and this improvement shows a clear dynamic growth trend. (2) There is significant heterogeneity in the impact of the statutory contribution rate reduction across provinces. Specifically, Heilongjiang and Jilin Provinces, where the pension burden is high, do not show a significant upward trend in the coverage rate. In contrast, the coverage of the underdeveloped provinces of Gansu and Guizhou shows a significant downward trend. These results suggest that although the current national initiative to reduce the employer contribution rate for the old-age insurance of urban workers has eased the contribution burden on enterprises to some extent, the effect on expanding coverage is not ideal, and the effectiveness of the policy needs to be further improved.

Limitations and future research: Due to sample size limitations in the control group, the experimental group in this study is limited to only two provinces, so it is impossible to examine the impact of the contribution reduction policy on coverage rates in all regions of the country. Additionally, during the implementation of the contribution reduction policy, the COVID-19 pandemic may have affected the effectiveness of the policy. Future research can exclude relevant samples and extend the sample period to reevaluate the impact of the policy.

Policy Recommendations

On the basis of the above conclusions, we make the following policy recommendations in this paper:

First, the institutional environment of soft budget constraints should be changed. Owing to the existence of severe soft budget constraint behavior in economically underdeveloped regions of China, the implementation of the old-age insurance contribution reduction policy has not achieved the expected goals, which is detrimental to the sustainable development of the old-age insurance system. Thus, seizing the opportunity to deepen the reform of the fiscal and tax system to simultaneously change the institutional environment of soft budget constraints is recommended. First, a performance-based fiscal incentive mechanism should be established by linking central fiscal transfers to the effectiveness of local old-age insurance coverage expansion, thereby encouraging local governments to take more responsibility for coverage expansion.

Second, local fiscal autonomy should be increased by providing economically underdeveloped regions with more tax and fiscal control powers to reduce their dependence on central finance. Third, the exit mechanism of fiscal support should be improved by clarifying the temporary and emergency characteristics of central fiscal support to local governments, thereby preventing local governments from developing long-term dependence on central support.

Second, the structure of the system should be optimized to improve the coverage rate of old-age insurance. For a long time, the development of China's old-age insurance structural system has been unbalanced, resulting in serious funding deficits; in particular, the reduction in the old-age insurance contribution rate has further aggravated the financial risk of pensions. Thus, seizing the opportunity presented by placing pensions under the state's unified administration to simultaneously optimize the structure of the system is recommended. First, the situation of the dominance of basic old-age insurance should be changed, and space for the development of other pillars should be created, thereby sharing the main responsibility for pension payments borne by the government. Second, build a noncontributory zero pillar that provides moderate protection for all urban workers, with funding sources coming from the proceeds of state-owned assets and general taxation and with the funding responsibility reasonably shared between the central government and local regions. Third, accelerating the construction of a transfer and linkage mechanism to achieve linkages among enterprise annuity, individual pensions and personal accounts should be prioritized, thereby enhancing the flexibility and attractiveness of the old-age insurance system.

Third, the contribution base should be adjusted to increase enthusiasm for participation. At present, the old-age insurance contribution mechanism for urban workers in China has obvious shortcomings. The average wage level of some low-income workers is far below the minimum contribution base, and the heavy contribution burden has led to many cases of interrupted or abandoned old-age insurance. Thus, this opportunity to advance the unification of the pension system for urban workers to adjust the contribution base at the same time should be taken. First, the minimum contribution base for old-age insurance should be appropriately lowered to reduce the contribution pressure on low-income groups, thereby fundamentally resolving the inherent contradiction between low-income levels and high contribution bases and thereby increasing the participation enthusiasm of low-income groups. Second, we further expand the statistical calibers of the old-age insurance contribution base by including low-income groups in the statistics, thereby making the average wage level of urban workers more representative and lowering the old-age insurance minimum contribution base. Third, the system's return rate for participants with low contribution bases should be increased appropriately. The government should pay more attention to low-income groups in institutional design and increase pension subsidies to encourage more groups to participate.

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