

The effect of population aging on pension enforcement: Do firms bear the burden?*

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Abstract

Population aging is widely assumed to have detrimental effects on economic development, especially through increased social security burden. This paper starts from the observations that the pension contribution evasion of firms was prevalent in China because local governments lower the pension enforcement under the current pension system. We investigate how the local governments at the city level respond to the population aging and the impact of the population aging on the firm pension burden using administrative data over the period 2008-2015. We present three findings: First, population aging increases the pension contribution burden of firms by enhancing pension enforcement. Second, fiscal pressure is the channel through which population aging affects pension enforcement of firms. Lastly, the pension administration system in China could significantly affect the net impact of population aging on the pension burden.

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1 Introduction

As a result of declines in fertility and improvements in health, population aging has been recognized as one of the global demographic “megatrends”. While proportions of older people typically are higher in more developed countries, the most rapid increases in the aging population’s growth are occurring in developing countries. Between 2006 and 2030, the number of older people in developing countries is projected to increase by 140 percent compared to 51 percent in developed countries (Dobriansky et al., 2007). China also has undergone a significant and rapid demographic transformation, which has led to an increasingly top-heavy population pyramid (Liu and Sun, 2016). The population aged over 60 accounts for 16.41% of the total population in 2015 compared to 11.54% in 2000.¹

The economic and social consequences of population aging are considerable, particularly concerning the pension system’s burden. As the world’s most populous country, China’s pension insurance burden should be paid more attention. The Chinese public pension system with four schemes aims to cover various populations and workforce.² These pension schemes were established by the State Council and are regulated by the Ministry of Human Resources and Social Security of China affiliated to the central government. However, local governments are responsible for managing these schemes. This paper mainly focuses on the most important public pension scheme—the urban basic pension insurance provided for employed workers and government sectors.³ The contribution rate of this pension insurance is the highest in the

¹The data that we use for calculations come from the national 1% sample survey conducted by the National Bureau of Statistics (NBS) of China in 2000 and 2015.

²China’s public pension system encompassed four schemes: urban basic pension insurance, public employee pension, urban resident pension, and new rural resident pension.

³The urban basic pension insurance is specifically provided for employees in for-profit firms,

world. Specifically, the statutory contribution rates for employers and employees are 20 percent and 8 percent of the wages, respectively, so the main burden of pensions is borne by the firms in China (Zheng, 2016).⁴

However, the target for local governments is typically related to regional economic growth. Local governments have an incentive to reduce the tax burden and pension contribution to local firms by relaxing the enforcement of collection (Fang and Feng, 2018).⁵ It is not clear in the previous literature whether the local governments would enforce the pension contribution collection on the firms in order to reduce the financial pressure caused by the population aging.⁶

This paper aims to ask several the following questions: First, whether population aging would increase firm pension contributions? Second, why local governments enforce pension contributions on the firms? Third, what kind of pension administration affects the net impact of the population aging in China?

Our econometric results firstly present that the population aging dramatically raises the pension contribution of the firms. The pension contribution rate increases by two percentage points if the population aging rises by ten percentage points.⁷ We also investigate whether the population aging causes the fiscal pressure of local governments.⁸ We find that the budget deficit ratio approximately increases by 0.11 if

including all for-profit public and private firms. This pension scheme is mandatory with defined contribution and benefit assignments. For convenience, pension insurance is referred to as the urban basic pension insurance if we do not specifically point out other different China's pension insurances in this paper.

⁴The contribution rates may vary slightly across regions (Wu, 2013).

⁵In China, local governments can use budget revenue to make up the deficit of pension account, but pension revenue is earmarked and not be used for other types of expenditure.

⁶Some previous studies only have investigated the impact of population aging on the fiscal burden of governments (Ruggeri and Zou, 2007; Lee, 2019). Other papers mainly focus on the tax enforcement of governments (Chen, 2017; Zhao and Zhang, 2020).

⁷All variables are defined in Table A1.

⁸For convenience, local government is referred to as the city government at the prefectural level

the population aging rises by 0.1. In addition, we examine the impact of a salient reform implemented by the central government, known as the “Province-Managing-County” (hereafter PMC) reform, in order to investigate whether fiscal pressure is the channel through which population aging affects pension enforcement. The results indicate larger effects of population aging on the pension contribution of the firms that locate in the cities with higher fiscal pressure. Finally, China’s pension administration can significantly affect the responsibility and capacity of pension collection of local governments, so we respectively explore the influences of the pension collection agencies and the “Provincial Pooling of Pension Insurance” reform on the net impacts of population aging. We find that the local taxation bureaus significantly intensify the impact of population aging on firm pension contribution than social insurance agencies. The “provincial pooling” that reduces the responsibility of pension collection of local governments at the city level would eliminate the contribution burdens of firms caused by population aging.

Our study contributes to the literature in two significant aspects. First, this paper complements the literature by providing explicit evidence on the impact of population on the pension enforcement of governments. Many early studies mainly focus on the lower pension compliance rate and how to manage pension compliance in emerging economies. [Nyland et al. \(2011\)](#) find an incentive for collusion between employers and employees to default on pension contributions in China. Meanwhile, local governments do not have an incentive to enforce the pension contribution of firms ([Fang and Feng, 2018](#)). [Li et al. \(2020\)](#) find that corporate tax rate can be used as a companion policy instrument with social security contribution rate in de-

if we do not specifically point out other different local governments in this paper.

veloping countries. Besides, some studies show that several features of firms could affect compliance behavior, including firm ownership, the skill of employees, risk factors, and the size of firms (Nyland et al., 2011; Gao and Rickne, 2014; Li and Wu, 2018; Han and Meng, 2019). However, few studies examine the circumstances under which the government would enforce the pension contribution and the specific impact of enhancing the pension enforcement. Under the current pension system in China, pension contributions caused by population aging can be transferred to the firms by increasing pension contributions for local governments. This paper explores whether local governments enforce pension contribution collection under the influence of population aging. As the population aging leads to fiscal pressure, local governments need to decide whether to keep lax in pension collection for the target of region growth or enhance the pension enforcement to resolve the fiscal stress.

Second, we provide direct evidence for the influence of pension administration on the impact of population aging. Aging populations pose a challenge to different aspects of government across countries. Therefore, pertinent and prompt policy solutions are necessary to resolve the impact of population aging. Hansen and İmrohoroglu (2018) finds that replacing income taxation with consumption taxation in Japan will stabilize the debt to output ratio. In the example of the US, Novy-Marx and Rauh (2014) show that introducing risk-sharing through variable annuities would have substantial effects on the solvency of state pension systems. In the specific context of China, while some previous studies discuss the linkage of pension administration to pension enforcement, this paper mainly identifies the influences of the different pension collection agencies and “Provincial Pooling of Pension Insurance” on the impact of population aging.

This paper proceeds as follows. In [Section 2](#), we introduce China’s pension system and discuss the primary problems of the pension system. In [Section 3](#), we provide two hypotheses. [Section 4](#) describes the data and main variables. [Section 5](#) discusses the empirical strategies to test these hypotheses. [Section 6](#) presents the main results, potential mechanisms, robustness checks, and effect heterogeneity. [Section 7](#) concludes.

2 Institutional Background

This section provides a brief description of China’s pension system and the current public pension system’s problems after 1997. Besides, we also introduce the current status of population aging and the relationship between population aging and employer pension insurance contributions in China.

2.1 China’s pension system

Prior to the initiation of economic reform in 1978, China’s urban pension system was a pure pay-as-you-go (PAYG) that each SOE was responsible for paying out pension benefits to employees who had reached the statutory retirement age ([Dixon, 1981](#); [Mok, 1983](#)).⁹ This arrangement worked well because the Chinese government was responsible for all firms, and there was no severe aging population and a high degree of labor mobility across regions. The reform of China’s pension system goes hand-in-hand with the reform of SOEs. During the transition of China’s market economy in the early 1980s, as the firms attained more financial independence than

⁹The statutory retirement ages in China are 66 for the male, 55 for the female civil servants, and 50 for the female workers.

before, employers had more responsibility to consider their profits and losses. Due to intensified competition, the SOEs' monopoly power was reduced, so many SOEs faced financial difficulties. Meanwhile, the first batch of workers since the founding of the people's republic of china in 1949 began to reach the full retirement age, which dramatically increased the pension expenditure burden under this pension system. Therefore, the reform of the pension system was imperative.

In 1986, State Council Document No. 77 officially proposed labor contract reform for SOEs and encouraged the limited pooling of pension obligation at the city level. Since 1997 State Council Document No. 26 was issued, the statutory pension arrangement labeled as a partial funding system in the Chinese context was based overwhelmingly on two pillars.¹⁰ The first is social pooling account based on the PAYG principle, with a defined-benefit portion. The second was a defined-contribution portion that relied on mandatory individual accumulative savings ([Feldstein et al., 1999](#)). Employers and employees paid 20% and 8% of gross monthly earnings as the pension contribution. Two pillars of the pension arrangement are more flexible and sufficient to overcome the PAYG arrangement's rigidity or the full funding plan ([Liu and Sun, 2016](#)). However, there are still some challenges in the partial funding system.

2.2 Problems in Current Pension System

The current Chinese pension arrangement has several features: The first is a high mandatory pension contribution rate in China. The pension contribution rate in

¹⁰Based on the new system, benefit formulas for three types of workers have defined: New workers entered the labor force after 1997 will receive a pension income from social pool pension benefit and individual account-related monthly benefit. Middle workers (those who started work before 1997 but had not retired by 1997) got a mixture of the new and old system credit services. Older workers who retired before 1997 are entitled to benefits defined by the old system, will receive an average replacement rate of 80% ([Cai and Cheng, 2014](#)).

China is the highest worldwide, even higher than the contribution rates in the United States, United Kingdom, Netherlands (see in [Table 1](#)). Moreover, the pension contribution rate of employers is 2.5 times that of employees, indicating that firms are mainly responsible for China’s pension contributions. Second, most pension insurance

Table 1: Cross-Country Comparison of Contribution Rates

Country	Employer	Employee	Total
Brazil	7.65	20.00	27.65
Canada	4.95	4.95	9.90
France	6.80	9.90	16.70
Germany	9.95	9.95	19.90
Japan	7.68	7.68	15.35
Korea, Rep.	4.50	4.50	9.00
Netherlands	17.90	5.70	23.60
Sweden	7.00	11.91	18.91
Switzerland	4.90	4.90	9.80
United Kingdom	11.00	12.80	23.80
United States	6.20	6.20	12.40
China	20.00	8.00	28.00

Source: HDNSP Pensions Database of the World Bank

contributions are assigned to the social pooling account with redistribution characteristics. Only a small portion of the contributions are assigned to the accumulative personal accounts, which had never contributed to an individual pension account.

Local governments divert the pension benefits from the personal pension accounts to finance the current retirees' needs, causing the so-called problem of "empty accounts" (Shao and Xu, 2001). Therefore, the accumulation of pension funds exists on paper in the accounts; however, the accounts are usually empty in reality. Third, the collection and distribution of pension insurance premiums are managed by various local governments ("localized management"), resulting in the geographical separation of the pension system and institutional barriers to the interregional transfer of pension insurance benefits for employees.

2.2.1 Pension Participation Incentives

The evasion of social insurance contribution prevails in China.¹¹ According to the "China's Enterprise Social Security White Paper 2016", 74.89% of firms did not pay social security based on the actual wage of employees, of which 36.06% of firms only paid the minimum standards of the social security. Only 25% of firms fully comply with social security contributions in 2015. Besides, the number of employees with social security compliantly paid by firms accounts for 80% of the number of insured employees in 2015, according to "China's Social Security System Development Report 2016". In other words, Firms did not comply with the social security contributions of 20% of insured employees.

There are several reasons for low participation incentives. First, as has already been mentioned, China's statutory contribution rate of pension is one of the highest

¹¹The evasion of social insurance contribution is a common problem worldwide, particularly in developing countries and emerging countries (Cowell et al., 1990; Nitsch and Schwarzer, 1995). Mesa-Lago (1991) finds that about 50% - 60% of firms defaulted social security contributions in some Latino American countries and more than 60% of firms in Brazil. Approximately 20% -30% of social insurance premiums are lost in Central and Eastern European countries (Gillion, 2000).

worldwide. For example, the basic pension insurance contribution rate for urban employees in China is 28% in 2016. Still, mandatory pension contribution rates for an average earner approximately averaged 20% for the OECD countries (OECD, 2017).¹²

Second, there is an incentive for collusion between employers and employees to evade pension contributions (Nyland et al., 2011). The previous literature has been devoted to examining and resolving the evasion of social security contributions. As emphasized earlier, Zhao and Yang (2016) find that the features of current China's pension system lead to the evasion of pension insurance contributions. The high statutory contribution rate and most of the contributions going to the public accounts for redistribution of pension insurance contributions are fundamental reasons for the low pension insurance participation rate.

Third, local governments do not have an incentive to punish the firm defaults on the contribution of pension insurance (Fang and Feng, 2018). Local governments focus more on economic growth and implement local policies to reduce the local firm's tax burden and social security insurance contribution. Gillion (2000) finds that the local governments would lower the supervision of evasion of social security contribution in attempting to gain more resources for themselves through interregional competition. Therefore, less strict supervision of pension contributions from the local government also reduces the effective contribution rate, which is a fundamental reason that the local firm does not share the heavy burden of social security contribution and then achieve rapid development.

¹²Mandatory pension contribution rates for an average earner averaged 18.4% in 2016 for the 22 OECD countries that have specific contributions for pensions only. For another 12 countries, social insurance contributions and mandatory private pension contribution rates averaged 22.9% for employee and employer contributions combined.

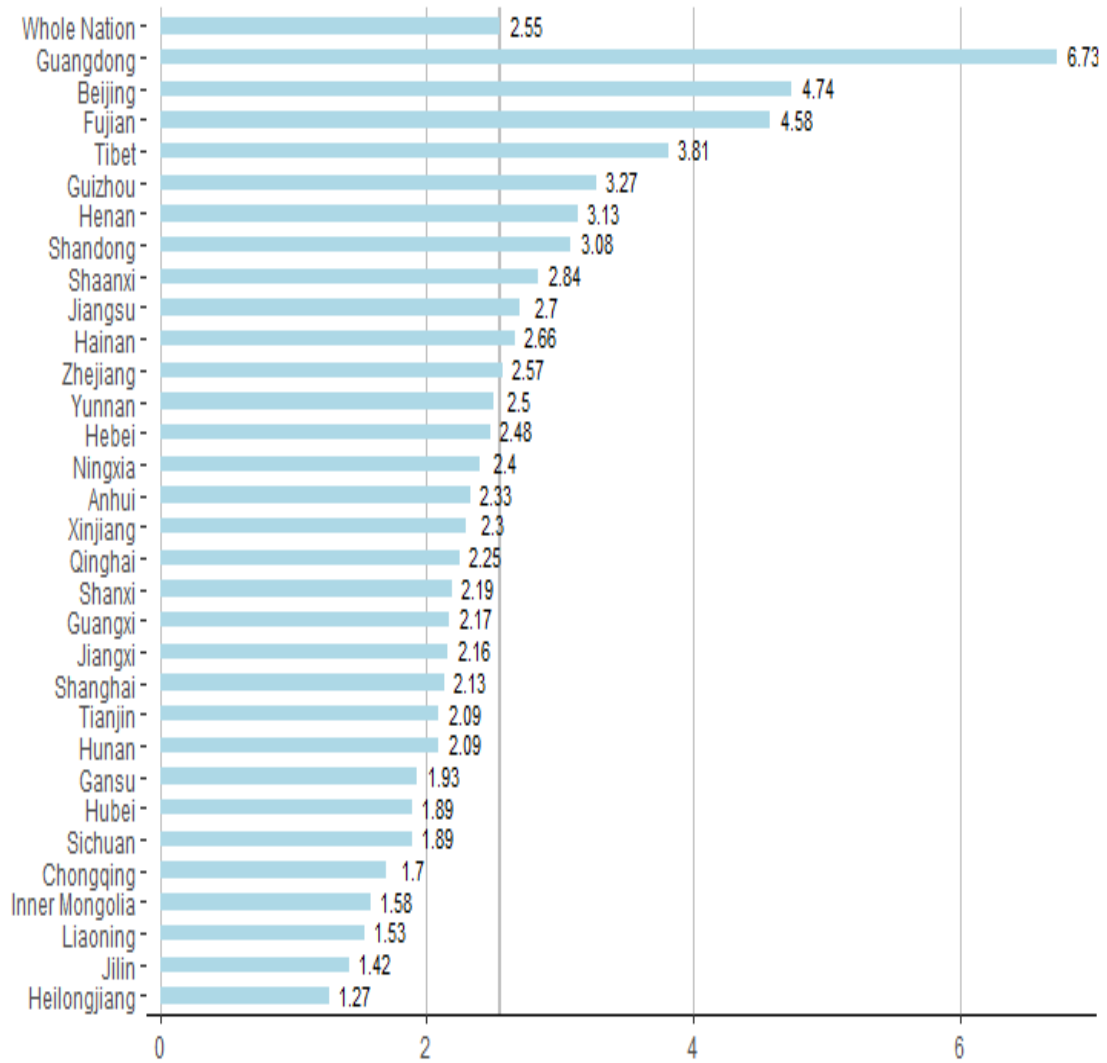
2.2.2 Regional Inequality

The pension systems in China are managed by local governments. Although the central government determines the statutory contributions and benefits of social security insurance, the effective contribution rates of pension are different across regions. The “localized management” of pension insurance eventually leads to serious inequality issues and labor mobility problems across regions (Barr and Diamond, 2010). The workers in east coastal provinces can get a higher wage than those in the inland provinces. When these workers move from a city to another to get a better job, pension contribution of social pooling in the developed provinces increased from the inflow of labor (Fang and Feng, 2018). However, the pension contributions in the less-developed provinces are relatively lower because of the outflow of labor. Moreover, local governments in these provinces still pay for pension insurance for retired workers who worked in other provinces because their pension plans remain tied to their original areas.

Along with the rise in regional disparities, the actual demographic structure across provinces becomes more differentiated. Due to more labor mobility and differentiated economic development across regions, the employees can get much better job opportunities in developed areas, so the proportion of the young is relatively higher in these provinces than in the underdeveloped provinces. For example, in Guangdong province, almost seven employees support one retiree. However, in the provinces where labor greatly outflows, like Northeast China, including Liaoning, Jilin, and Heilong Jiang, averaged fewer than 1.5 employees support one retiree (See in Figure 1).¹³

¹³Besides, regional inequality also is reflected in contributions, benefits, and the accumulated

Figure 1: Regional Disparity in the Support Ratio, 2018



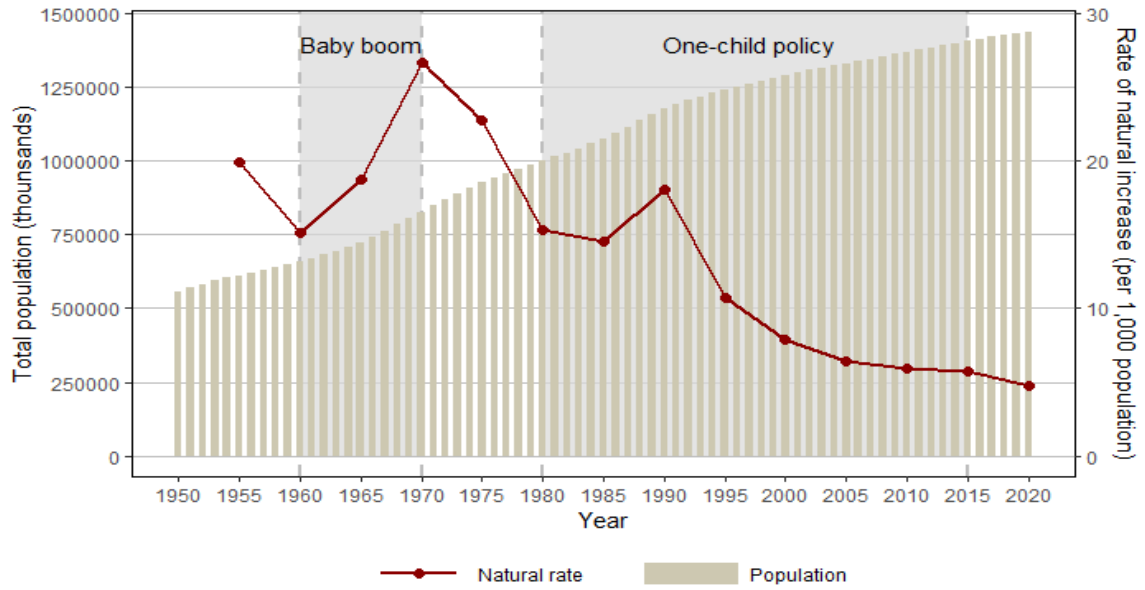
Notes: Support ratio = Number of Contributors / Number of Retirees.

Source: Authors' calculations using data from MOHRSS

3 Theoretical framework and hypothesis

China is the most populous country around the world. In the early 1970s, the Chinese government started to control the birth rate, and in 1980, enforced the one-child policy. Therefore, in the early 1980s, the population growth rate has consistently

Figure 2: China's population and rate of natural increase 1950-2020



Notes: The rate of natural increase a statistic calculated by subtracting the crude death rate from the crude birth rate.

Source: Authors' calculations using data from United Nations ([UN DESA, 2019](#)).

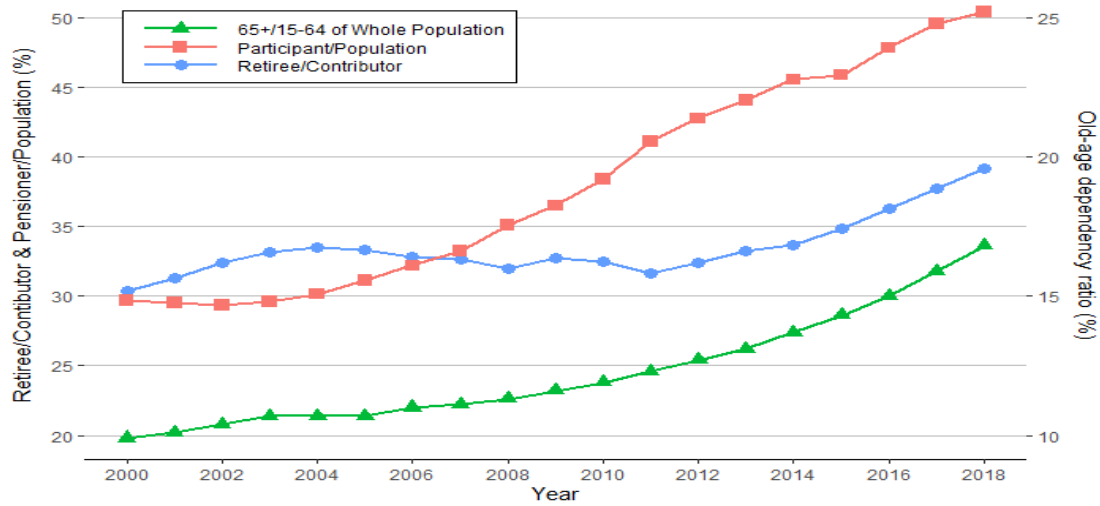
declined. [Figure 2](#) shows changes in both the total population and the rate of natural increase (RNI) in China from 1950 to 2020.¹⁴ In the period of “baby boom”, the rate of natural increase reached more 2.5% relative to 1.5% in 1960. After the one-child policy implemented in 1980, the rate of natural increase dramatically reduced, and

surplus of pension insurance across regions (See [Figures A1 to A3](#) in [Appendix](#)).

¹⁴The rate of natural increase refers to the difference between the crude birth rate and the crude death rate. This measure of the population change excludes the effects of migration ([United Nations Statistical Office, 1991](#)).

eventually reached about 0.5% at the end of 2015. China has experienced a lower birth rate for more than thirty years due to the one-child policy.

Figure 3: Population aging and pension burden of government



Notes: The green line represents the old-age dependency ratio measured by the old-age group (65+) ratio to the group of working age (15-64). The red line represents the participant of pension insurance ratio to the total population. The blue line represents the retiree ratio to the contributor of pension insurance.

Source: Authors' calculations using data from China Statistical Yearbook, various years.

Furthermore, the dependency ratio of urban basic pension insurance system increased from 30% in 2000 to 39% in 2018 (See Figure 3). In other words, the pension system has gone from 3.3 workers supporting one retiree in 2000 to 2.56 workers supporting one retiree in 2018. The old-age dependency ratio has gradually risen over time. In 2018, The proportion of people over 65 increased to 16% of the working-age group (15 - 64 age). Therefore, China's economy has been facing more severe problems of population aging. The fact that the dependency ratio of the urban basic pension insurance is much higher than the population-wide dependency ratio in 2018. The coverage of urban pension insurance has steadily increased in recent decades.

The number of participants as a percentage of the total urban population increased from 30% in 2000 to above 50% in 2018. If local governments still lower the enforcement of pension contribution for the local firms as mentioned before, a higher pension expenditure of social pooling accounts eventually can cause heavy fiscal pressure of the local government.

There are many findings in the literature on the increase in social security contributions due to population aging (Roseveare et al., 1996; Tabellini, 2000; Cutler and Johnson, 2004; Lindert, 2004). However, few studies have rigorously examined how population aging influences the pension contribution burden of the firms, particularly in developing countries. We argue that due to the fiscal pressure from population aging and a lower effective pension contribution rate, the local governments could increase the pension collection enforcement on the firm, which leads to our first hypothesis:

Hypothesis 1 *The rapid population aging of a region will increase the pension contribution burden of local firms.*

The hypothesized effect of population aging may be realized through fiscal stress because the local governments do not have an incentive to punish the defaults on pension insurance contribution. Figure 3 shows a positive relationship between old-age dependency ratio and dependency ratio in the urban basic pension insurance, which implies that fewer workers to support retirees are consistent with a more severe population aging. As emphasized previously, fiscal pressure caused by the population aging eventually enforces the local governments to strengthen supervision over the evasion of pension contribution for the local firms. Therefore, our next hypothesis as follows:

Hypothesis 2 *Population aging affects pension enforcement by increasing the fiscal pressure on local governments.*

4 Data and Variables

4.1 Data

In our empirical analysis, we use prefecture city-level data from 2008 to 2015 on our key explanatory variables, i.e., population aging, and many control variables at the prefectural level, including logarithm of GDP per capita, the share of the secondary sector to GDP, the ratio of fiscal revenue to GDP. The measure of population aging in this paper is based on the current chronological-age structure in China. The Old Age Dependency Ratio (OADR) frequently uses the chronological age of 65 years as the age above which a person is defined as the “old.” However, China’s legal retirement age is 60 years for males and 55 years for females, so the population aging in this paper is measured by the proportion of the population above 60 years old to the total population at the prefectural level. The local government is responsible for the pension of people with hukou rather than that of people living in the city, due to “localized management” of pension insurance. Therefore, the variable “Aging” is calculated by the household registration population (population with hukou) in order to capture the effect of population aging on the pension enforcement of local governments. The data on population aging is obtained from the “China Civil Affairs Statistical Yearbook”.¹⁵ The data of these control variables at the prefectural level

¹⁵ “China Civil Affairs Statistical Yearbook” is compiled based on the annual reports of civil affairs statistics of various provincial regions and is published annually since 1990 by the Civil Affairs Ministry. This yearbook shows the total registered population and the registered population over

are mainly obtained from the “China Statistical Yearbook for Regional Economy” and various issues of “Statistical Yearbook of the province, city, and county.”

Our firm-level data are taken from the National Tax Survey Database (NTSD). The data are jointly collected by the State Administration of Taxation of China and the Ministry of Finance of China (SAT-MOF). The NTSD was initiated in 1985 for tax enforcement purposes. However, the sampling methods and chosen variables were not consistent until 2007. Since 2007, the government significantly increased the sample size and made the variables chosen consistent over the years. Therefore, this paper only uses the data from 2008 to 2015. The NTSD annually contains about 700,000 firms in all industries of the whole economy, including valuable and detailed information about social security payment and financial conditions at the firm level. Approximately 80% of the sampled firms are key firms and mostly involve medium and large firms. Meanwhile, the other 20% are selected from the remaining firms by using a stratified random sampling method.¹⁶ Due to the tax enforcement purpose, the taxation and financial information provided by the firms in the NTSD is very authoritative and reliable. The information provided by the firm in the sample consists of three parts: The first is the basic information of these firms, including taxpayer identification number, name, address, ownership type, industry, and the opening year and month; The second is corporate tax and financial information, covering 17 major taxes, balance sheet, income statement, and cash flow statement; The last is the corporate goods and services information, including the number of domestic sales and export, the average price of the product and the quality of the

60 by region.

¹⁶The SAT-MOF annually uses all actual taxpayers (firms) as the population of the surveyed sample, and based on it, produces a stratified sample of surveyed taxpayers. Stratification occurs by total sales, industry, and types of taxpayer (Liu and Mao, 2019).

product. In 2014, the added value of 454,026 firms in the sample accounted for 16% of China’s GDP. Meanwhile, the overall tax receipts reported by the sampling firms accounted for 75% of the aggregate national tax revenue (Liu and Mao, 2019; Fan and Liu, 2020).

Moreover, compared to other primary firm-level databases in China, such as the Annual Survey of Industrial Firms (ASIF) conducted by the National Bureau of Statistics of China, Chinese Private Enterprise Survey (CPES), and China Stock Market Accounting Research (CSMAR) database, The NTSD is comprehensive and unique on several features as follows: First, the NTSD is much more representative because this database has a large sample size, including many small and tiny firms, and contains all sectors of the whole economy, compared to other datasets. For example, the ASIF only includes manufacturing and mining firms with annual sales of ¥5 million (about US \$650,000) or more. Second, the NTSD provides a wide range of essential information on taxation, financing, and firms’ activities. Lastly, the current major firm databases are mostly pre-2008. We can contribute to how population aging affects the pension burden and investment of the firms using this database from 2008 to 2015 to make up for the period of data sample selected without severe China’s population aging in the previous literature. Table A1 provides detailed definitions of the variables, and summary statistics of key variables are shown in Table 2.

5 Empirical Strategy

To test Hypothesis 1 that population aging may prompt the rise in the pension contribution burden for the firms, we regress the pension contribution burden of

Table 2: Summary Statistics for the key variables

Variable	Obs	Mean	Std.Dev	Max	Min
Pension contribution rate	1,462,179	0.1218	0.1416	0.6714	0.0000
Aging	2,216	0.1402	0.6598	0.3311	0.0049
Size	2,105,468	4.6985	1.7846	9.2546	0.4794
Debt-asset ratio	1,698,785	0.5987	0.4979	3.0215	0.0016
Profit rate	1,379,696	0.0698	0.1347	0.7513	0.0000
Wage	1,501,375	2.0164	1.4168	6.7541	0.0131
Ln(GDP per capita)	2,216	11.2685	0.1537	17.3347	4.1235
Share of secondary industry	2,216	0.4712	0.6348	0.9286	0.1977
Fiscal Revenue/GDP	2,216	0.1131	0.1297	0.5013	0.0021
Budget deficit ratio	2,125	1.3615	1.5732	-0.3701	8.4561

Notes: For definitions of these variables, see [Table A1](#) in the [Appendix](#)

firms on population aging. The equation underlying this specification assumes the following form:

$$Pension_{ijt} = \beta_0 + \beta_1 Aging_{it} + X'_{ijt}\phi_1 + Z'_{it}\phi_2 + \delta_j + \mu_t + \epsilon_{ijt} \quad (1)$$

where i denotes city i , j denotes firm j , and t denotes year t . $Pension_{ijt}$ denotes pension contribution rate for firm j in city i and year t . Our key explanatory variable $Aging_{it}$ is the ratio of the population above 60 years old to the total population in city i and year t .¹⁷ In addition to the impact of population aging, both the characteristics of the firms and the regional differences can also affect the pension burden of local firms, so we introduce two control variable sets at different levels. X_{ijt} denotes control variables at the firm level, including the size of the firm, the ratio of debt to asset, the share of total profit to operating revenue, the average wage level. Z_{it}

¹⁷Here the population refers to the household registration population (the population based on hukou status). All definitions of variables in detail are shown in [Table A1](#).

denotes control variables at the city level, including logarithm of GDP per capita, the ratio of the secondary sector to GDP, the share of public budgetary revenue to GDP.¹⁸ Population aging raises the pressure of pension contribution for local governments, which eventually increases pension burden for local firms by strengthening pension contribution enforcement. Therefore, β_1 as expected should be positive in [Hypothesis 1](#).

In order to reveal that the fiscal pressure is the channel through which population aging affects pension enforcement of firms, we examine the effect of population aging on the budgetary deficit of local governments at the city level. Thus, we can confirm by estimating the following specification:

$$Deficit_{it} = \alpha_0 + \alpha_1 Aging_{it} + X'_{it}\phi + \theta_i + \eta_t + \nu_{it} \quad (2)$$

where $Deficit_{it}$ is budget deficit ratio is measured by the ratio of the budget deficit to budget revenue of local governments in city i and year t . X_{it} denotes control variables at the city level, including the logarithm of GDP per capita, the ratio of the secondary sector to GDP, the share of public budgetary revenue to GDP. The inclusion of prefecture fixed effects θ_i captures any time-invariant characteristics of cities, such as culture and geography. η_t is year fixed effects. [Hypothesis 2](#) shows that the population aging increases the fiscal pressure of local governments, so the expected sign of coefficient α_1 is positive.

¹⁸In the specification, we actually also add the interactive fixed effects between province and year and between industry and year.

6 Empirical Results

6.1 Main results

In this section, we primarily discuss the estimated impact of population aging on the pension contribution burden of the firms. In addition, we investigate whether fiscal pressure is the channel through which population aging affects pension enforcement of the firms. Finally, we examine the impact of the mechanism of the pension administration on firms' pension burden.

[Table 3](#) presents the results of our baseline specification in [Equation \(1\)](#). Under current China's pension system, the pressure of pension contribution caused by population aging can be transferred to the firms by increasing pension contributions for local governments. In general, the Chinese local governments do not punish the defaults of pension contribution to the firm, which leads to a massive evasion of pension contribution and a lower effective contribution rate in China.

We start the estimation by controlling for firm-specific fixed effects and year-specific fixed effects in column (1) of [Table 3](#), where pension contribution rate for the firm is used as the dependent variable.¹⁹ It turns out that population aging is positively and statistically significantly associated with the pension contribution burden of the firms. Column (2) takes a step further to add firm size, debt to asset ratio, profit rate, and average wage level as control variables at the firm level. The coefficient of population aging is persistently positive and statistically significant. Column (3) includes the logarithm of GDP per capita, the share of secondary industry, and the share of public budgetary revenue to GDP as additional control variables at

¹⁹The definitions of all variables are shown in [Table A1](#).

Table 3: The impact on pension burden of the firm: Baseline Results

	Pension contribution rate				
	(1)	(2)	(3)	(4)	(5)
Aging	0.3655*** (0.0804)	0.3526*** (0.0823)	0.2705*** (0.0827)	0.1851*** (0.0500)	0.1873*** (0.0513)
Size		0.0306*** (0.0027)	0.0175*** (0.0012)	0.0166*** (0.0009)	0.0156*** (0.0009)
Debt-asset ratio		0.0037*** (0.0011)	0.0033*** (0.0010)	0.0031*** (0.0008)	0.0027*** (0.0008)
Profit rate		0.0037*** (0.0005)	0.0024*** (0.0003)	0.0022*** (0.0003)	0.0021*** (0.0003)
Wage		-0.0473*** (0.0025)	-0.0274*** (0.0023)	-0.0258*** (0.0018)	-0.0250*** (0.0018)
ln(GDP per capita)			-0.2292*** (0.0228)	-0.2492*** (0.0093)	-0.2517*** (0.0094)
Share of secondary industry			0.0027*** (0.0009)	0.0010** (0.0005)	0.0010** (0.0005)
Fiscal Revenue/GDP			-0.1315*** (0.0172)	-0.1272*** (0.0085)	-0.1255*** (0.0083)
Firm fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
Province-year fixed effect	NO	NO	NO	YES	YES
Industry-year fixed effect	NO	NO	NO	NO	YES
<i>N</i>	1,459,168	1,379,696	1,124,614	1,124,614	1,103,438
R-squared	0.5531	0.5972	0.7489	0.7679	0.7705

Notes: The dependent variables are pension contribution rate measured by the ratio of pension contribution to wage. Column (1) starts the estimation by controlling for firm fixed effects and year fixed effects. Column (2) adds firm size, debt-asset ratio, profit rate, and wage as control variables at the firm level. Column (3) adds additional control variables at the city level, including the logarithm of GDP per capita, the share of the secondary industry to GDP, the ratio of fiscal revenue to the GDP. Column (4) includes province-year interactive fixed effects to the specification. Column (5) includes an additional industry-year interactive fixed effects. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

the city level. Column (4) includes an interactive fixed effect of the province with the time. The interactive fixed effects capture a common shock to the counties within each province over time. Column (5) adds industry-year interactive fixed effects to control for an unobservable shock on each industry over time. Quantitatively,

column (5) indicates that the coefficient of population aging is 0.1873, implying that if the population aging increases by 0.1, the pension contribution rate for firms will approximately increase by two percentage points.

In order to explore whether the fiscal pressure is the channel through which population aging affects pension enforcement in [Hypothesis 2](#), we examine how the population aging affects the budget deficit of local governments in columns (1) and (2) of [Table 4](#). We start the estimation by controlling for city-specific fixed effects and year-specific fixed effects and adding the control variables at the city level in column (1), where the budget deficit ratio is used as the dependent variable. It turns out that the population aging is positively and statistically significantly associated with fiscal pressure of local governments, which is consistent with our previous expectation. Column (2) takes a step further to add province-year interactive fixed effects. The coefficient of population aging is persistently positive and statistically significant at the 1 percent level. Quantitatively, column (2) shows that if the population aging increases by 0.1, the budget deficit ratio of local governments would approximately increase by 11 percentage points.

Furthermore, we further investigate whether the population affects the pension contribution burden of firms by increasing the fiscal pressure of local governments in columns (3)-(6) of [Table 4](#). We add the variable “budget deficit ratio” in the specification in column (3). The result shows that the estimated coefficients of fiscal pressure of local governments are positive and statistically significant at the 1 percent level. It turns that the fiscal pressure of local governments is positively associated with the pension contribution burden of firms. In other words, The greater the fiscal pressure on local government in the city, the heavier the local firms’ pension burden

Table 4: The impact on pension burden: Mechanism of Fiscal Pressure

	Budget deficit ratio		Pension contribution rate			
	(1)	(2)	(3)	(4)	(5)	(6)
Aging	0.8903** (0.4144)	1.0989*** (0.3927)	0.1467*** (0.0469)	0.0378* (0.0199)	0.2003*** (0.0516)	0.1207* (0.0711)
Budget deficit ratio			0.0046** (0.0023)	0.0250*** (0.0083)		
Budget deficit ratio \times Aging				0.1448*** (0.0347)		
PMC _{number}					0.1689*** (0.0323)	0.1168*** (0.0373)
Aging \times PMC _{number}						0.3264** (0.1546)
Controls	YES	YES	YES	YES	YES	YES
City fixed effect	YES	YES	NO	NO	NO	NO
Firm fixed effect	NO	NO	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Province-year fixed effect	NO	YES	YES	YES	YES	YES
Industry-year fixed effect	NO	NO	YES	YES	YES	YES
<i>N</i>	2,119	2,119	1,061,416	1,061,416	1,103,438	1,103,438
R-squared	0.8034	0.8183	0.7852	0.7860	0.7724	0.7726

Notes: The dependent variable is indicated on the top of each column. Additionally, the budget deficit ratio is measured by the ratio of budget deficit to budget revenue for the local governments at the city level. The pension contribution rate is measured by the ratio of pension contribution to the wage at the firm level. Column (1) starts the estimation by controlling for city fixed effects and year fixed effects and including the control variables at the city level, such as the logarithm of GDP per capita, the share of secondary industry to GDP, and the ratio of fiscal revenue to GDP. Column (2) adds province-year interactive fixed effects in the specification. In columns (3)-(6), the PMC_{number} represents the number of counties implementing PMC reform as a ratio to the total number of counties in a city. Column (3) includes the variable “budget deficit ratio”, the control variables at both city and firm levels and firm fixed effects, year fixed effects, province-year interactive fixed effects, and industry-year interactive fixed effects. Column (4) adds the interaction term of the variable “budget deficit ratio” with population aging. Column (5) includes the variable “PMC_{number}”. Column (6) adds the interaction term of the variable “PMC_{number}” with population aging. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

would be. Column (4) adds an interaction term of fiscal pressure with population aging. We find that the estimated coefficients of the interaction term of fiscal pressure with population aging are significantly positive, which indicates that population aging has a more significant effect on the pension contribution burden of firms in the cities with severer fiscal pressure.

As a step further, we study how the fiscal pressure affects firms’ pension burden

in the context of China’s population aging based on the impact of the “Province-Managing-County” (PMC) reform on the local finances of cities. The PMC reform replaced the previous fiscal relationship between county and city governments with a direct fiscal relationship between provincial and county governments (Li et al., 2016).²⁰ In columns (5)-(6), we add PMC_{number} that is defined as the number of counties implementing PMC reform as a ratio to the total number of counties in a city in the specification. The PMC reform eliminated the city government as the intermediate layer between the province and the county. On the one hand, some previous studies find that the reform largely improved administrative efficiency and lessen the fiscal stress of county governments. On the other hand, the reform also reduced the fiscal revenues of the city government (Liu and Alm, 2016). Therefore, the greater the proportion of the number of counties implementing the PMC reform, the more the city government’s fiscal revenues reduced. In column (6) of Table 4, the estimated coefficient of PMC_{number} is positive and statistically significant because the greater proportion of the number of counties implementing PMC reform leads to higher fiscal pressure of the city government. The significantly positive coefficient of the variable “Aging \times PMC_{number} ” shows that the population aging would affect the city governments with higher fiscal pressure to increase the pension enforcement, thus increase the pension contribution burden of local firms.

Finally, we explore the role of the pension administration in how population aging

²⁰In China, each subnational level of government is wholly subordinate to the next higher order of government. For example, the county government is managed by the city government rather than the provincial government before implementing the PMC reform. The reform was first piloted in counties of provinces located in the middle and north part of China, such as Anhui, Henan, Hubei, Liaoning, and Jilin. In 2006, the program was expanded to Jiangsu, Shaanxi, Sichuan, Gansu, and Qinghai in Eastern and Western China. By the end of 2012, 1099 counties from 24 provinces, representing approximately 56% of all counties across the country, had implemented the PMC reform (Huang et al., 2017).

influences the pension contribution of firms. We conjecture that pension administration probably affects pension enforcement due to different pension collection agencies. The State Council of China issued the “Interim Regulation on Collection and Payment of Social Insurance Premiums” on January 22, 1999, which formally confirmed the autonomy of various provincial governments in choosing social security institutions. Thus, the provincial governments can choose the social insurance agency or the local taxation bureau to collect pension insurance benefits. The existing literature about which institutions are more conducive to collect social security contributions for firms is still controversial. Local taxation bureaus could significantly increase pension insurance participation and improve administration and collection of social security contributions. The social insurance agencies could strengthen the enforcement of social security and increase the level of social security contribution for firms. The administration and collection of social security contributions for firms are essential for social insurance agencies, so they have incentives to enforce social security contributions collection. However, due to a lack of information about firms, social insurance agencies have relatively lower supervisory capacity for social security contributions. Besides, local taxation bureaus do not have such similar problems with social insurance agencies. However, the collection and administration of social security insurance benefits is only a “sideline” for the local taxation bureaus. Therefore, local taxation bureaus do not have incentives to increase the pension enforcement for local firms.

Columns (1)-(2) of [Table 5](#) report the corresponding results by adding a dummy variable for the local taxation bureaus (LTB) and its interaction term with population aging. LTB takes the value of 1 if local taxation bureaus collect the firms’ pension

contribution in the city. Otherwise, LTB takes a value of 0. In column (1), we start estimation by controlling for firm-specific effects, year-specific effects, and industry-year interactive fixed effects. The coefficient of the LTB is positive and statistically significant, which indicates that the local taxation bureaus significantly increase the burden of pension contribution on firms relative to social insurance agencies. In other words, these two pension collection agencies have a statistically significant difference in the enforcement of pension collection for firms. In column (2), we add the interaction term of LTB dummy variable with population aging and additional control variables at both the firm and city levels, including firm size, debt-asset ratio, profit rate, wage, the logarithm of GDP per capita, the share of the secondary industry to GDP, and the ratio of fiscal revenue to GDP. The estimated coefficient of interaction term of LTB dummy variable with population aging is positive and statistically significant at the 1 percent level. This indicates that the difference in pension enforcement between local taxation bureau and social insurance agencies would become significantly greater, due to the impact of the population aging.²¹ Quantitatively, the coefficient of LTB dummy variable is 0.2252 in column (2), indicating that the local tax bureau would increase the pension contribution rate of firms by 22.52 percentage points, compared to the social insurance agency collecting the pension of firms. Meanwhile, if the population aging increases 0.1, the difference in pension contribution rate between local tax bureau and social insurance agency to collect the pension is approximate 0.27.²²

Furthermore, raising the pooling level of pension is also an important mechanism

²¹The local governments can require local taxation bureaus to increase punishments on the evasion of pension contributions of firms under fiscal pressure because the local taxation bureau is affiliated to the local government.

²² $0.2252 + 0.4271 * 0.1 \approx 0.27$

Table 5: The impact on pension burden: Mechanism of Administration

	Pension contribution rate			
	(1)	(2)	(3)	(4)
Aging	0.0853** (0.0416)	0.1706 (0.1627)	0.2647*** (0.0564)	0.6254*** (0.0915)
LTB	0.1609*** (0.0175)	0.2252** (0.0869)		
Aging \times LTB		0.4271*** (0.1552)		
Provincial Pooling			-0.0807*** (0.0164)	-0.0221** (0.0116)
Aging \times Provincial Pooling				-0.4350*** (0.0635)
Controls	NO	YES	NO	YES
Firm fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Industry-year fixed effect	YES	YES	YES	YES
N	1,595,684	1,103,438	1,436,699	1,103,438
R-squared	0.4105	0.7756	0.5736	0.7762

Notes: The dependent variable is the pension contribution rate measured by the ratio of pension contribution to wage. Column (1) includes a dummy variable for the local taxation bureaus (LTB) and controls firm fixed effects, year fixed effects, and industry-year interactive fixed effects. LTB takes the value of 1 if local taxation bureaus collect the pension insurance benefits for firms in the city. Otherwise, LTB takes a value of 0. Column (2) adds an interaction term of LTB with population aging and the additional control variables at both the firm and city levels, including firm size, debt-asset ratio, profit rate, wage, the logarithm of GDP per capita, the share of the secondary industry to GDP, and the ratio of fiscal revenue to GDP. Column (3) includes a dummy variable for the “Provincial-level Pooling”. “Provincial Pooling” takes the value of 1 if the provincial government uniformly arranges pension expenditures for this county. Otherwise, “Provincial Pooling” takes a value of 0. Column (4) adds the interactive term of “Provincial Pooling” with population aging and additional control variables at both the firm and city levels. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

to affect firms’ pension burden. In China, the standards of pension collection, the settlement of funds generally are coordinated from the city or the county level to the provincial level. The transfer system of pension insurance is established at the city and the county level. In the case of pension provincial-level pooling, provincial governments can prioritize helping the county or city with a higher pension deficit through the pension transfer system. Thus, raising the pooling level reduces the fiscal

pressure of subordinate local governments by sharing pension expenditure pressure. The columns (3)-(4) of [Table 5](#) present the results concerning how the provincial pooling of pension eliminates the pension contribution burden of firms caused by the population aging.²³ Column (4) presents that the estimated coefficient of the provincial pooling of pension is negative and statistically significant at the 5 percent level, which indicates that the provincial pooling of pension could reduce the burden of pension for local firms relative to in cities without the implementation of provincial pooling. A negative and statistically significant coefficient of its interaction term with population aging implies that the provincial pooling of pension could reduce pension contribution caused by population aging.

6.2 Other Robustness Checks

In order to further test for the robustness of the basic results, we conduct sensitivity analysis along three dimensions. First, population aging probably changes slowly over time, so we use census data every five years to measure the variation in population aging. Besides, the local government needs more time to decide to increase the pension enforcement in response to the fiscal pressure caused by population aging. Therefore, we switch the panel-data model to a cross-sectional regression model using city-level data to investigate how the variation of population aging affects the pension contribution. In [Table 6](#), We calculate a five-year difference in population aging across cities as the explanatory variables of interest, using the census data. Due to the lack of city-level data related to the pension contribution, we obtain the

²³Before the “Provincial pooling” reform, the benefits and expenditure of pension insurance are pooled at the city level. In other words, the prefectural governments are responsible for pension insurance. After the reform, the pension insurance is pooled at the provincial level, so the administration of pension transfers to the superordinate level, which is the provincial government.

Table 6: Robustness Checks: Cross-sectional analysis

	Pension contribution rate			
	2010 city-level (1)	2010 firm-level (2)	2015 city-level (3)	2015 firm-level (4)
$\Delta\text{Aging}_{2010}$	0.2521** (0.1258)	0.1626*** (0.0058)		
$\Delta\text{Aging}_{2015}$			0.2105** (0.1043)	0.1186*** (0.0063)
Control	YES	YES	YES	YES
N	277	259,177	277	137,330
R-squared	0.0461	0.0811	0.0297	0.2098

Notes: Columns (1) and (3) use the city level's pension contribution rate as the dependent variables. Columns (2) and (4) use the pension contribution at the firm level as the dependent variables. In columns (1) and (2), $\Delta\text{Aging}_{2010}$ is measured by the change in the level of population aging between 2005 and 2010. In columns (3) and (4), $\Delta\text{Aging}_{2015}$ is measured by the change in the level of population aging between 2010 and 2015. In columns (1) and (3), control variables at the city level include the logarithm of GDP per capita, the share of the secondary industry to GDP, the ratio of fiscal revenue to the GDP. Columns (2) and (4) add additional control variables at the firm level, including firm size, debt-asset ratio, profit rate, and wage.

pension contribution and wage by aggregating our firm-level data by the city and then calculate the aggregate pension contribution rate as the dependent variables in columns (1) and (3). To compare aggregated pension data with pension data at the firm level, we use the firm level's pension contribution rate in columns (2) and (4). In column (1), we start the estimation by adding the control variables at the city level, including the logarithm of GDP per capita, the share of secondary industry, and the ratio of fiscal revenue to GDP, where the explanatory variable $\Delta\text{Aging}_{2010}$ is measured by the change in the level of population aging between 2005 and 2010. The results show that the impact of the variation of population aging on pension contribution at the city level is significantly positive. The estimated coefficient of the $\Delta\text{Aging}_{2010}$ is statistically significant and positive. It turns out that the variation of population aging is positively and statistically significantly associated with the firm pension contribution, which is consistent with the impact on pension contribution

at the city level in column (1). We use the pension contribution rate at the firm level as the dependent variable in column (2), which indicates that the coefficient of $\Delta\text{Aging}_{2010}$ is consistently positive and statistically significant at the 1 percent level. In columns (3) and (4), we examine the impacts of the variation of population aging between 2010 and 2015 on the pension contribution rate at both city and firm levels, which are persistently positive and statistically significant.

Table 7: Robustness Checks: Aggregate analysis at the city level

	Pension contribution rate		
	(1)	(2)	(3)
Aging	0.0912** (0.0410)	0.1249*** (0.0416)	0.1287*** (0.0466)
Controls	NO	YES	YES
City fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Province-year fixed effect	NO	NO	YES
N	2,326	2,118	2,118
R-squared	0.4676	0.4963	0.5565

Notes: Columns (1) and (3) use the city level's pension contribution rate as the dependent variables. Columns (2) and (4) use the pension contribution at the firm level as the dependent variables. In columns (1) and (2), $\Delta\text{Aging}_{2010}$ is measured by the change in the level of population aging between 2005 and 2010. In columns (3) and (4), $\Delta\text{Aging}_{2015}$ is measured by the change in the level of population aging between 2010 and 2015. In columns (1) and (3), control variables at the city level include the logarithm of GDP per capita, the share of the secondary industry to GDP, the ratio of fiscal revenue to the GDP. Columns (2) and (4) add additional control variables at the firm level, including firm size, debt-asset ratio, profit rate, and wage.

In the second dimension of the robustness check, we examine the impact of population aging on the pension contribution burden using the aggregated data in order to capture the pension enforcement of local governments. We aggregated pension contribution and wage payable at the firm level into the city-level and calculated the city level's aggregate pension contribution rate. As indicated in [Table 7](#), the impact of population aging on the pension contribution is persistently positive and statistically

significant using the aggregated data. Quantitatively, the estimated coefficient of population aging is 0.1287 in column (3), indicating that if population aging increases 0.1, the pension contribution rate will rise by 12.87 percentage points. Meanwhile, We find that the estimated impact of the population aging using aggregate data is less than using the firm-level data shown in [Table 3](#).

6.3 Effect Heterogeneity

In this section, we explore the extent to which the impact of population aging may vary across regions or firms. First, the effect heterogeneity may reflect the impact of the level of pension balance. Whether the pension balance can be maintained affects directly affects the pension enforcement of local governments. In [Table 8](#), we present the heterogeneous effects of population aging on firms' pension contribution across regions. Meanwhile, we find that the effect heterogeneity arises from the difference in pension insurance balance across regions. Columns (1)-(4) of [Table 8](#) indicate that Northeastern and Western areas in China are more responsive to the impact of population aging compared to East China and Central China. Local governments in Northeast and West China would enforce the pension collection, thus raising the pension contribution of local firms. In columns (5) and (6), we investigate the influence of pension insurance balance on the net impact of population aging across regions. The estimated coefficients of both pension insurance balance ratio and its interaction term with population aging are negative and statically significant in column (6).²⁴ This implies that more pension balances could lax the pension enforcement of local

²⁴The pension insurance balance ratio is measured by the accumulated surplus of pension relative to pension expenditure at the provincial level. All definitions of variables in detail are shown in [Table A1](#).

governments, thereby reducing firms' pension burden. Meanwhile, population aging would have less impact on local firms' pension burden for cities with more pension balances.

Table 8: Regional Effect Heterogeneity in the Pension Balance

	Pension contribution rate					
	East (1)	Northeast (2)	Central (3)	West (4)	Full Sample (5)	Full Sample (6)
Aging	-0.0505 (0.0404)	0.1017** (0.0518)	0.0546 (0.0833)	0.3390*** (0.0956)	0.0246** (0.0123)	0.0455*** (0.0212)
Pension insurance balance ratio					-0.1135** (0.0523)	-0.1396** (0.0685)
Pension insurance balance ratio \times Aging						-0.0425*** (0.0115)
Controls	YES	YES	YES	YES	YES	YES
Firm fixed effect	YES	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES	YES
Province-year fixed effect	YES	YES	YES	YES	NO	NO
Industry-year fixed effect	YES	YES	YES	YES	YES	YES
N	511,490	158,217	210,745	216,878	1,102,585	1,102,585
R-squared	0.7544	0.7879	0.7986	0.7707	0.6585	0.6713

Notes: The dependent variable is the pension contribution rate measured by the ratio of pension contribution to the wage. In columns (1)-(4), "East," "Northeast," "Central," and "West" represent East China, Northeast China, Central China, and West China, respectively. In columns (5) and (6), we use the full sample. Column (5) includes the pension insurance balance ratio measured by the accumulated surplus of pension relative to pension expenditure at the provincial level. Column (6) adds an interactive term of population aging with the pension insurance balance ratio. All columns include control variables at the firm level and the city level, firm-specific fixed effects, year-specific fixed effects, and industry-year interactive fixed effects. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

We conjecture that the outflow of the labor force would lead to the higher pressure of local governments on maintaining the pension balance. Due to the "localized management" of the pension in China, the local government is responsible for the pension of the registration household population (population with hukou) even if they do not live and work in the area. Besides, the inflow of labor would increase the pension benefits because the local governments could get the pension benefits

from migrant employees regardless of whether they have a hukou in the area. The more developed areas can provide better job opportunities to attract a large number of migrant workers, so the local governments in these areas obtain more benefits of pension from the migrant workers.

Table 9: Regional Effect Heterogeneity in the Outflow of the Labor Force

	Pension contribution rate		
	2011 (1)	2013 (2)	2015 (3)
Aging	0.2403*** (0.0063)	0.3960*** (0.0098)	0.8808*** (0.0102)
Outflow rate	0.0151*** (0.0003)	0.0158*** (0.0006)	0.0104*** (0.0006)
Outflow rate \times Aging	0.0051** (0.0023)	0.0393*** (0.0045)	0.0838*** (0.0041)
Control	YES	YES	YES
City fixed effect	YES	YES	YES
N	210,810	157,303	139,201
R-squared	0.1588	0.3060	0.3562

Notes: The dependent variable is the pension insurance contribution rate in 2011, 2013, and 2015, respectively. The variable “Outflow rate” is measured by the ratio of the difference between registered population and resident population to the registered population using 2010 census data. The control variables at the city level include the logarithm of GDP per capita, the ratio of the secondary sector to GDP, the share of public budgetary revenue to GDP. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

Table 9 summarizes the main results concerning the influence of outflow of the labor force on the net impacts of population aging. We add the outflow rate of the labor force and its interaction term with population aging in the specification. While our dataset does not provide information on the outflow of the labor force, we calculate the ratio of the gap between the size of the population with local hukou (registered population) and the size of the population who are regular residents (resident population) to the size of own registered population from the 2010 population census to

measure the outflow rate of the labor force. Besides, local governments cannot immediately enforce the pension collection in responding to the impact of labor migration on the pension balance, so we calculate the pension contribution rate of firms in 2011, 2013, and 2015 as the dependent variable, respectively, shown in columns (1)-(3). As indicated in [Table 9](#), the outflow of the labor force would prompt the local government to enforce the pension collection for the local firms. The estimated coefficient of the variable “Outflow rate \times Aging” is statically significant and positive. This implies that the population aging increases more pension contribution burden of the firms in the cities with the outflow of the labor force.

Second, we investigate that the heterogeneous effects of population aging on enforcement of pension contributions across firms. We proceed by dividing our sample across two indicators of ex-ante enforcement of pension collection faced by the firms and then performing separate estimations for each set of firms. These two indicators of enforcement of pension contributions include the ownership and the size of the firm.

In panel A of [Table 10](#), we clarify our sample into three groups: state-owned enterprises (SOEs) and Non-SOEs, including foreign firms and private firms, which concerns the heterogeneous effect of the population aging on the pension burden of the firm arising from the ownership of the firm. On the one hand, the SOEs and foreign firms generally have better capacities and compliance for pension insurance contributions. On the other hand, SOEs and foreign firms have higher pension insurance participation rates than private firms in China. We conjecture that SOEs and foreign firms should be less sensitive to the impact of population aging than private firms. In other words, the influence of population aging is more significant on the

pension contribution burden on the private firms. Panel A of [Table 3](#) reports the corresponding results for the three types of firms with different ownership. Being consistent with our conjecture, we find that estimated coefficients for both the SOEs and foreign firms are not statistically insignificant.²⁵ Facing a higher pension burden caused by population aging, the local governments have to enforce pension collection of the private firms instead of the SOEs or foreign firms with a higher participation rate and pension contributions compliance.

In panel B of [Table 10](#), we split the sample into three groups with various sizes of firms. The results indicate that population aging has heterogeneous effects on the pension burden for firms of different sizes. The results indicate that population aging has a significantly positive on the pension contribution of the small firms. [Nyland et al. \(2006\)](#) and [Nielsen and Smyth \(2008\)](#) based on firm-level data collected by the Bureau of Labor and Social Security (BOLSS) in Shanghai about the status of social security contribution, find that 71%, 81%, and 35% of the firms did not pay social security as required between 2001 and 2003, respectively. The proportion of such non-compliance behavior in small firms was much higher. Larger firms do not have the incentive to evade pension contributions because they are subject to more supervision, and their default risk is higher than others. Additionally, financial management and the system of employment for large firms are more compliant.

²⁵We use the full sample of NTSD, annually containing about 700,000 firms in all industries of the whole economy.

Table 10: The impact on pension burden: Effect Heterogeneity of firms

Pension contribution rate			
<i>Panel A: Firm ownership</i>	Foreign firms (1)	Private firms (2)	SOEs (3)
Aging	-0.0541 (0.0346)	0.3134*** (0.0696)	-0.0589 (0.0403)
<i>N</i>	116,743	758,594	201,960
R-squared	0.7689	0.7854	0.7383
<i>Panel B: Firm size</i>	Large (1)	Medium (2)	Small (3)
Aging	-0.0366 (0.0267)	-0.0610* (0.0385)	0.2738*** (0.0611)
<i>N</i>	71,458	157,764	725,344
R-squared	0.7480	0.7720	0.8172
Controls	YES	YES	YES
Firm fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Province-year fixed effect	YES	YES	YES
Industry-year fixed effect	YES	YES	YES

Notes: The dependent variable is the pension contribution rate. In panel A, we split the sample based on the ownership of firms. In panel B, we split the sample based on two indicators, including the operating revenue and the number of employees, according to “China’s Regulations on the Standards for Classification of Large, Medium-sized, and Small Enterprises” issued by the National Bureau of Statistics in 2011. All columns include control variables at the firm level and the city level, firm-specific fixed effects, year-specific fixed effects, province-year interactive fixed effects, and industry-year interactive fixed effects. Standard errors are clustered at the city level for all regressions in parentheses. Levels of significance: *10%, **5%, ***1%.

7 Conclusion

Population aging has been raising concerns about the problems of the pension burden in China. Our results add to the literature by providing evidence from China on the impact of population aging. This paper uses a large and unique firm-level dataset from the years 2008-2015. Firstly, we find that population aging increases the pension contribution burden of the firms. Quantitatively, the pension contribution rates increase by two percentage points if the population aging increases 0.1. Therefore, the

firms eventually bear the pension contribution burden caused by population aging.

Furthermore, this paper finds that fiscal pressure is the channel through which population aging affects pension enforcement on firms. Our findings show that population aging increases the budget deficit ratio of local governments. Besides, the “PMC” reform could increase the fiscal stress of local governments at the city level. We investigate that the influence of the “PMC” reform on the impact of population aging, and then we find that population aging has a more significant effect on the pension contribution burden of the firms in the cities with severer financial pressure.

Finally, we explore the mechanism of pension administration and the extent to which the impact of population aging reform varies across regions or firms. The local taxation bureaus significantly intensify more the impact of population aging than social insurance agencies. The “provincial pooling” would eliminate the contribution burdens of firms caused by population aging. The heterogeneous effect of the firms mainly arises from the size of the firm and firm ownership. The local government enforces the pension contribution of the private firms or small firms because these types of firms have lower compliance rates. The heterogeneous regional effects mainly reflect whether the local governments can maintain the pension balance. If the areas lose too many workers who outflow to the developed areas, the local government will face severer fiscal pressure caused by the population, which leads to enforcement of pension contribution collection on the local firms. Therefore, the “localized management” of the pension causes regional inequality issues in China.

Future research will further discuss the effects of population aging on firm performance. [Ono \(2003\)](#) analyses a social security policy with public debt in overlapping generations growth model and finds that the effects of population aging on capital

accumulation are entirely different between the two equilibria. Additionally, the extended family system probably should be noted because the behavior of household savings and endogenous fertility would provide a good fit with the empirical results. We would contribute to the literature by modeling the relationship between the aging population and firm investment in future research.

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Availability of data and material Not applicable.

Code availability Not applicable.

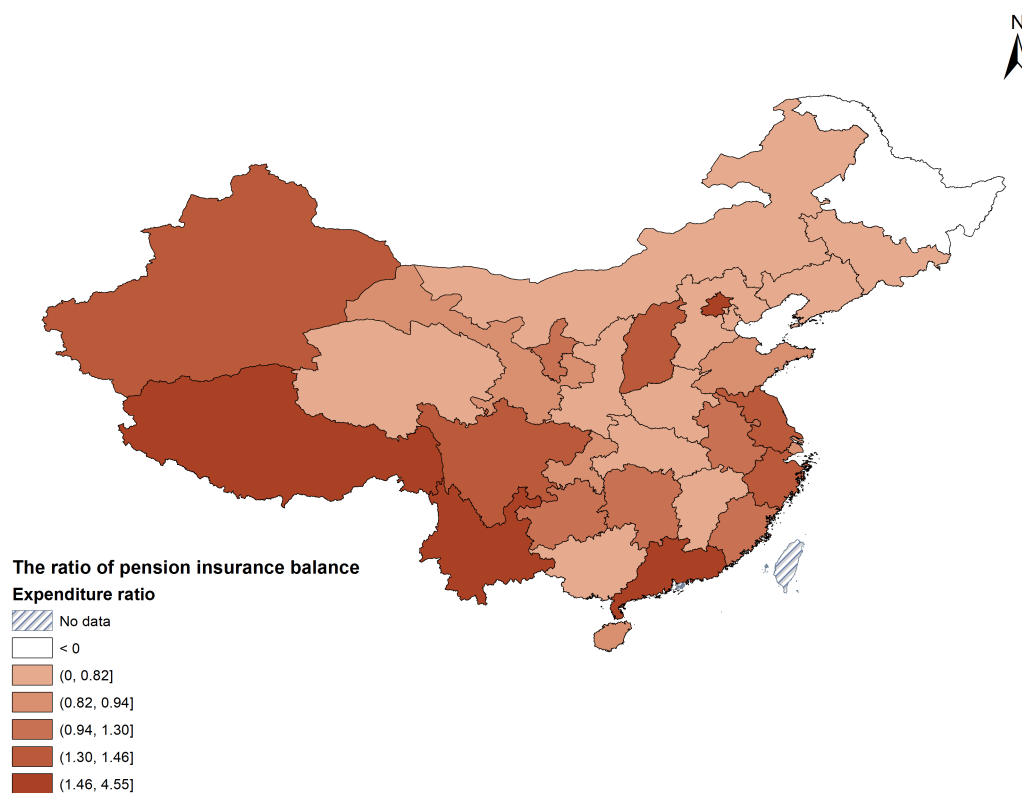
Authors' contributions Not applicable.

Appendix

Table A1: Variable Definitions

Variable	Definition
Pension contribution rate	Pension contribution rate: the ratio of pension contribution to the wage of the employee
Aging	The ratio of registered population aged 60 and over to total registered population at the end of year
Size	Logarithm of number of employees in the end of year
Debt-asset ratio	The total amount of liabilities relative to the total amount of assets
Profit rate	The ratio of total profit to operating revenue
Wage	The ratio of total wages to the number of employees. (The average wage of employees in each firm)
$\ln(\text{GDP per capita})$	Logarithm of regional GDP per capita
Share of secondary industry	The share of secondary industry to GDP
Fiscal Revenue/GDP	The ratio of public Budgetary revenue (the revenue of tax and majority fee) to GDP
$\text{PMC}_{\text{number}}$	The ratio of the number of counties implementing PMC reform to the total number of counties in a city
Budget deficit ratio	The ratio of the difference between budget expenditure and budget revenue to the budget revenue for local governments
Provincial Pooling	Dummy for the “Provincial pooling” reform (1 if the provincial governments are responsible for the administration of the pension insurance benefits and expenditure for the city; 0 otherwise)
LTB	Dummy for the local taxation bureaus (1 if the local taxation bureaus collect the pension contributions; 0 otherwise)
$\Delta \text{Aging}_{2010}$	The change in the level of population aging between 2005 and 2010.
$\Delta \text{Aging}_{2015}$	The change in the level of population aging between 2010 and 2015.
Pension insurance balance ratio	The accumulated surplus of pension relative to pension expenditure at the provincial level
Outflow rate	The ratio of the gap between the size of the population with hukou (registered population) and the size of the population who are residents (resident population) to the size of registered population

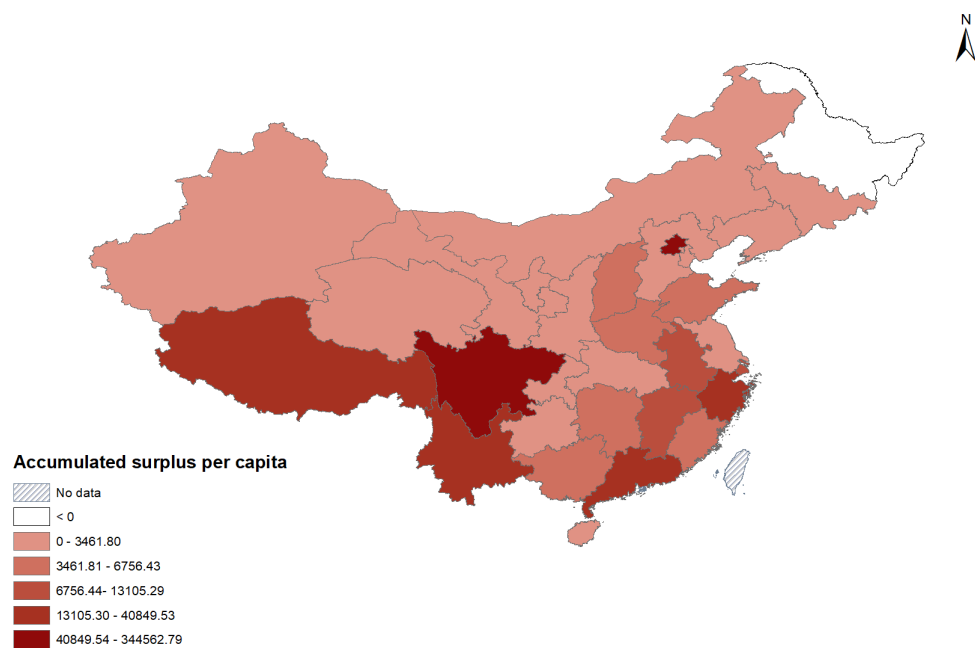
Figure A1: The ratio of pension insurance balance, 2018



Notes: The ratio of pension insurance balance = The accumulated surplus of pension insurance / Expenditure of pension insurance.

Source: Authors' calculations using data from the National Bureau of Statistics (NBS) of China.

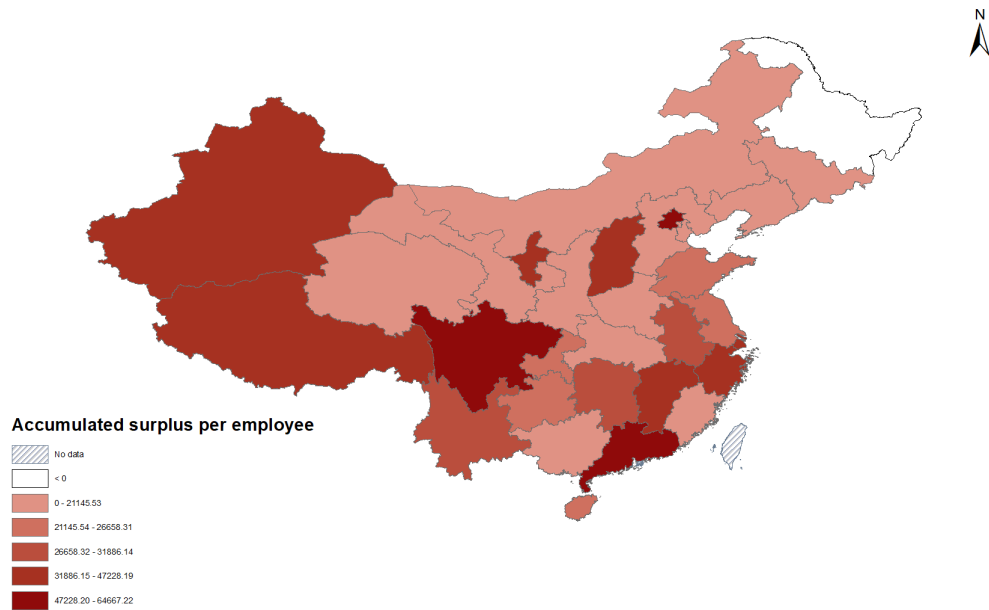
Figure A2: Accumulated surplus per capita of pension insurance, 2018



Notes: The ratio of pension insurance balance = The accumulated surplus of pension insurance / Urban population.

Source: Authors' calculations using data from the National Bureau of Statistics (NBS) of China.

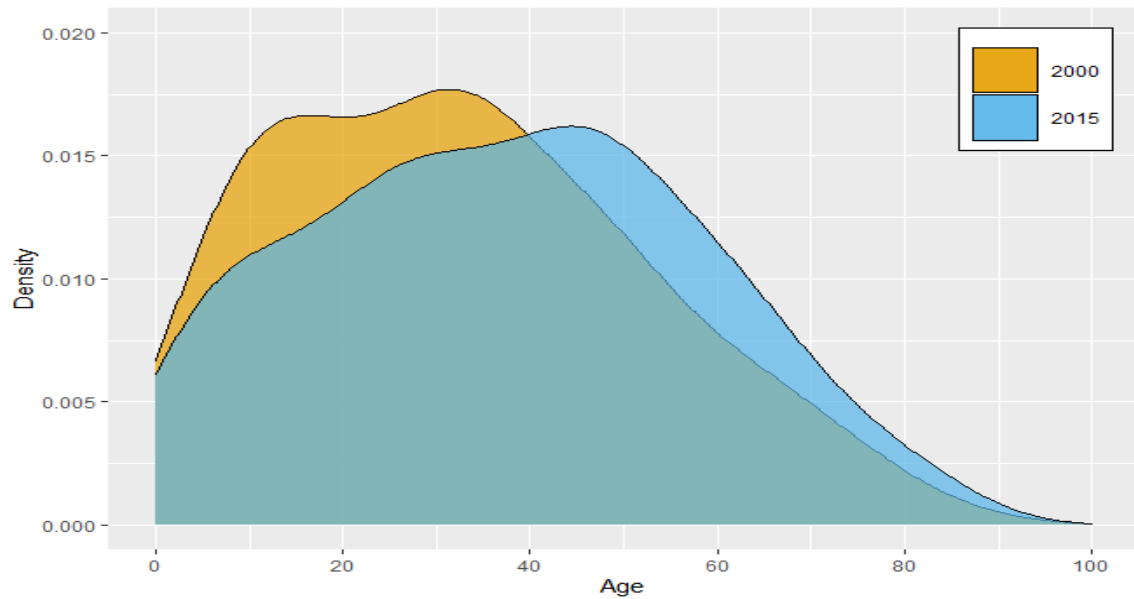
Figure A3: Accumulated surplus per employee of pension insurance, 2018



Notes: The ratio of pension insurance balance = The accumulated surplus of pension insurance / Number of employed persons in urban units.

Source: Authors' calculations using data from the National Bureau of Statistics (NBS) of China.

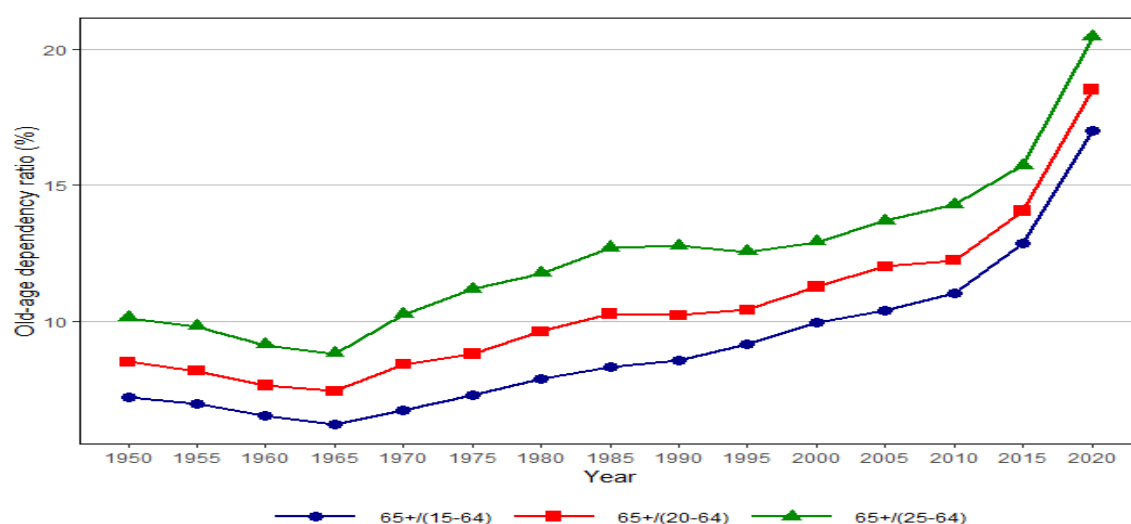
Figure A4: China population distribution by age group in 2000 and 2015



Notes: The figure shows the population distribution by age in 2000 and 2015 using census data in 2000 and 2015. The population distribution by age in 2000 looks like a right-skewed distribution and mode is 25 years old. The kurtosis of population distribution is relatively smaller over time and the population distribution by age become skewed left (mode =40 years old) in 2010, which represents proportion of young, working-age people is shirking and more 65 or over population dramatically increases in China.

Source: Authors' calculations using data from National Population Census of China in 2000 and 2015.

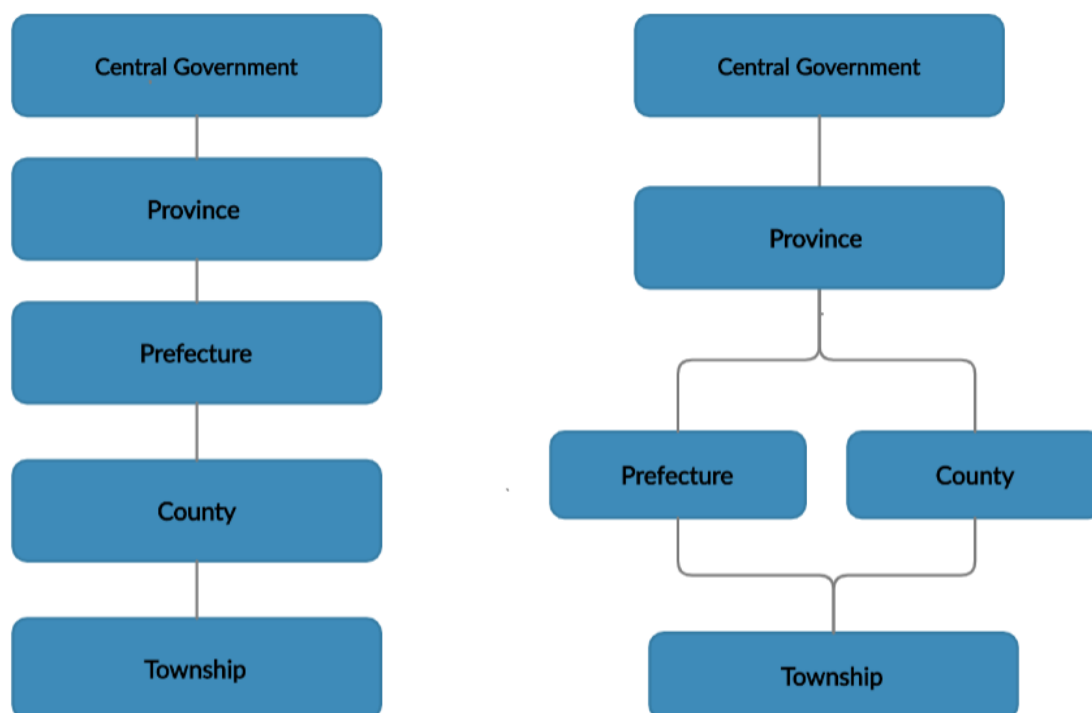
Figure A5: Old-age dependency ratio 1950-2020



Notes: The old-age dependency ratio denotes the relationship between an old-age group to those of working age. Those who are defined as being able to work are people between the ages of 15 and 64. This figure also shows two another measures of the old-age dependency ratio because of the increasing average of schooling years.

Source: Authors' calculations using data from MOHRSS

Figure A6: China's governance structure before and after the PMC reform



Notes: The left of the figure shows that the administrative structure under the “City Managing County” (CPC) system. The right of the figure shows the new administrative structure under the PMC system.

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