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Pension funds' Asset Allocation and Population Ageing Issue

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Abstract

Population ageing issue is an urgent demographic and social security problem for Chinese regulators. It links the status of the pension system to the strategic asset allocation and investment policies for the Chinese pension system and gives them incentives to change the proportion of equity investment. By comparing the different pension systems in China, United Kingdom, United State, Japan and some other OECD countries, I find that Chinese pension system determines the strategic asset allocation on the status of the pension system and the investment policy. The more elderly people covered by the pension system, the fewer proportion regulators invest in the equity investment; however, the decreasing long-term interest rate leads to the higher proportion of equity investment for the pension system. The findings proof that population ageing issue and the scale of retired participant have impacts on the risk-taking of the Chinese pension system and the decline of long-term interest rate gives an incentive for the pension system to increase the equity exposure.

1. Introduction

1.1 Objective and Relevance

Since the 20th century, the ageing population becomes one of the severe problems for governments and the society. As the life expectancy (Figure 1 in the appendix) and the scale of the elderly population (Figure 2 in the appendix) is growing, social security system, especially pension system, faces a significant challenge on the administration and management. The pension system is a fund system into which money is added in people's employment period and from which money come to support the individual's retired life. Similar to other investment funds, pension funds need to invest the pooled money in various asset classes to preserve and increase the value of assets for the pension members. Under the circumstance of the ageing population, the pension system in each country is confronted with a stable payment. In other words, investment management for pension funds is crucial to guarantee the retired life for the labour force and solve the population ageing problem. My research in this paper tries to shed light upon the determinants for the investment allocation of the pension scheme.

The main aim of this paper is to explore whether the strategic asset allocation of the Chinese pension system depends on the status of the retired members and the ageing population. The pension investment regulation and policy could reflect the obligations of the pension funds, but the efficient asset allocation may depend on the asset price fluctuation because pension funds do not continuously rebalance the portfolios (Bikker, Broeders and De Dreu, 2009). In this paper, I focus on the Chinese strategic asset allocation to equity, the percentage of retired members in the pension fund, and the ageing dependency ratio, as representing the equity investment of the pension system, the pension status and the population ageing issue. The argument that the ageing population and the percentage of retired members affects the asset allocation to the equity investment starts from the regulatory incentive hypothesis research in Andonov, Bauer & Cremers (2017). One of the essential outcomes of the regulatory incentive hypothesis shows that the proportion allocated to risky assets is negatively related to the percentage of the retired members for U.S. public pension fund. In this

benchmark paper, the core argument is that the fund maturity of each pension system does have impacts on the strategic asset allocation, and pension funds with a large proportion of retired members invest less in risky assets, but U.S. public pension funds go in the opposite direction. It offers the main inspiration for this paper, due to the similar labour force structure and economic condition between the USA and China.

My investigation on Chinese pension fund system in this paper finds that this system is structurally different from the pension system in other countries, covering nearly the whole population of employees. Its decisions of strategic asset allocation come from the regulatory department directly under the administration of the State Council. Typically, the characteristics of the pension participants on boards could have impacts on the decision making of the pension investment allocation (Bikker, Broeders and De Dreu, 2009), but not in China, where the regulators directly administrate the pension management.

In this paper, I follow the mentioned benchmark paper Andonov, Bauer & Cremers (2017) and extend their methodology to run analysis on the Chinese pension system. I investigate whether the similar regulatory incentives hypothesis also works in China, that is, whether the Chinese pension system would increase the equity due to the increase of the retired members and ageing population. For Chinese pension system, one of the main features is that the funding and benefit distribution depends on the intergenerational risk-sharing, which is that pension system could guarantee the nominal benefits, indexation is considered and return premium of the pension fund are adjusted. This feature is quite similar to U.S. public pension fund, but the regulation is different. It may stem from the structure of the Chinese pension system and the investment administration policy.

Extended from regulatory incentives hypothesis, the central hypothesis I posit in this paper is that the population ageing issue and pension maturity status affect the strategic asset allocation of the Chinese pension system, and give the regulators an incentive to increase the equity allocation policy. Here I define the population ageing issue as the elderly age dependency ratio, which is an indicator measuring the percentage of the people at the nonworking age; the pension maturity status that I refer

to is the percentage of the retirees in the Chinese pension system. Generally, pension systems are possible to face future funding pressure, and they are willing to seek a higher expected return in various risky assets like equity. So the hypothesis also implies that the more "mature" Chinese pension system under the ageing population status will increase the equity allocation to preserve and increase the value of pension assets to hedge the increasing liabilities.

However, my research shows that for the strategic asset allocation of the Chinese pension fund, a continuously rising trend in the elderly age dependency ratio reduce the proportion allocated to equity investment. Based on the result of panel regression, an increase of the elderly age dependency ratio could lead to a significant and robust reduce on the asset allocation to the equity investment. The notable fact is that the elderly age dependency ratio is in a continuously rising trend, which is constant in the selected period; while the proportion of the equity investment varies due to asset price in the financial market. Considering the fact, the awareness of the population ageing-equity relationship for the Chinese pension system is remarkable. Another variable, the percentage of retired members, is not linear in the pooled panel regression in the following analysis, which is inconsistent with the outcome in Andonov, Bauer & Cremers (2017). The negative relation between the percentage of retired members and the proportion allocated to equity investment only exists in the Chinese pension system. This paper also presents some analysis of this relation.

I also find that some other determinants are affecting the asset allocation for pension funds, the inflation protection policy and ten-year treasury yield. The inflation protection policy is statistically and economically significant for the investment allocation for the Chinese pension system, as well as the ten-year treasury yield. These findings are in line with the research in Campbell and Viceira (2005), which is that asset allocation of pension funds depends on the indexation policy; and the research in Andonov, Bauer & Cremers (2017), which is that the treasury yields affect asset allocation of U.S. public pension fund.

1.2 Outline

The structure of this paper is as follows. Section 2 focus on the literature review to highlight the relevant research about the theoretical relationship between the percentage of retired members and the proportion of equity investment, as well as the elderly age dependency ratio and the proportion of equity investment. Then I proceed with the description of characteristics of Chinese pension funds, showing the specific structure of the Chinese pension system, as well as the investment regulation of the current system. Section 3 constructs the methodology to investigate the theoretical relation of the mentioned variables. The next section empirically investigates Chinese pension system and other pension systems in 11 OECD countries in the selected period from 2008 to 2018. Section 5 indicates the empirical results from the constructed methodology. Section 6 presents the conclusion. In the end, I shall present some thoughts for further research on the Chinese pension scheme.

2. Theoretical background

2.1. Literature review

This section presents some theoretical research about the literature on the determinants of the strategic asset allocation of equity investment for pension funds. In this section, I start with the theoretical argument on the suitability of equity investment in pension asset allocation; then the discussion goes to the research about the determinant of asset allocation.

The state pension system contains either defined benefit or defined contribution pension fund, or both of them. This infers that each pension system has different characteristic due to the structure. Early research shows that the defined benefit pension fund pools the assets from different generations, and provides the intergenerational and intragenerational risk-sharing (Merton 1983). It needs to maintain the balance of interest between the current beneficiaries or different generations, especially when the value of the assets is less than the value of liabilities. Meanwhile, defined contribution

pension fund pools the individual contributions in his working period, and use these to invest in various assets to preserve and increase the value of this personal account. No matter what type of the pension system is, each of them faces the asset allocation issue.

Starting with the suitability of the equity investment in pension asset allocation, the pension funds are usually long-term investors, the duration of the accrued benefits of these pension plans are usually an extended period. Campbell and Viceira (2002) find that the portfolio selection for the long-term investors is different from the short-term investors, due to the different risk of asset classes. It also finds that stocks are less risky in the extended period. Some financial instruments, like bond, treasury, are safer than stock in the short run, but not for long term investors because of the reinvestment risk. Another view about the equity investment for the pension fund is shown in Lucas and Zeldes (2006). It indicates that the equity could be a hedge for the increasing wage liabilities, as well as the inflation-indexed liabilities. In Black (1989), the author infers that stock could be a good pension asset help the regulators hedge the incremental liability value and salary inflation. To deal with the growth of workforces, the pension regulators may need to hold more proportions of stocks to hedge the salary and pension benefit inflation and also the uncertainty of the workforce.

When it comes to the determinant of the pension asset allocation, Bikker, Broeders and De Dreu (2010) point out some for equity investment in the strategic asset allocation in the pension fund. It examines the influence of the pension members' age distribution on the asset allocation of the Dutch pension fund, which indicates a negative effect of age on equity exposure. This finding is consistent with the traditional life-cycle model, indicating that young workers should invest more in equity than older workers due to their sizeable human capital.

In Andonov, Bauer & Cremers (2017), the authors analyse the link between the liability discount rate and the expected return on assets under the regulation of United State public pension funds (GASB guideline). They posit that this link encourages U.S. public pension fund to invest more in risky assets, which is the central "regulatory incentives hypothesis" in the research. To prove that, the authors define the proportion allocated to risky assets as the investments in public equity, alternative assets, and high-

yield bonds. And they relate this proportion to the percentage of retired pension plan members, which is the “fund maturity”. Then the authors apply several pooled panel regressions to test the relation between the proportion allocated to the risky assets and the percentage of retired members, as well as the relation between fund maturity, allocation to risky assets and discount rate. As a result of panel regressions, the outcomes document that the increase in the percentage of retired members has a relation with the increase in the allocation to risky assets, which is positive for U.S. public pension fund and negative for pension funds in other countries. The allocation to risky assets has a positive relation with liability discount rates, that is, when interest rates are declining, the U.S. public pension fund will increase the investment in risky assets. Moreover, the regressions result also indicate that the ten-year treasury yield is also negatively associated with the proportion of risky asset investment of U.S. public pension fund. This empirical research finds that the U.S. public pension fund with a higher underfunding level of pension members take more investments in risky assets and hold higher liability discount rates, which support the regulatory incentives hypothesis. It also shows how the fund maturity and discount rate affect the asset allocation of U.S. public pension fund under the GASB regulation.

All in all, the reviews of all previous literature about an equity investment in asset allocation and the determinants for equity investments suggest that what kinds of economic indicators is associated with equity exposure for asset allocation strategies of the pension system. From these, I conclude that the age-relevant indicators and pension maturity would also have some impacts on equity allocation in the Chinese pension system, as well as the "fund maturity" and ten-year treasury yield. Meanwhile, the offered empirical approach in Andonov, Bauer & Cremers (2017) is also a suitable methodology for the Chinese pension system to test the determinates for asset allocation.

2.2 The Characteristic of Chinese Pension System

2.2.1 The structure of Chinese pension system

As one of the largest industrial countries in the world, China has a relatively particular institutional structure of the pension system, which consists of three pillars. The first pillar comprises the public pension sector organized on the pay-as-you-go base. It provides the primary pension benefits to all the retired people, and guarantee the benefit linked to the minimum wage level. The second pillar offers retirees the additional income as a supplementary scheme for the public sector. The third pillar is designed as an individual savings account scheme, which is a tax-deferred system undertaken by individuals. The three-pillar pension system is popular in the world, but this Chinese version is unique because of the undeveloped status and also the distinctive characteristic. It combines a full-coverage state-managed pay-as-you-go scheme in the first pillar with occupational plans in the second pillar.

The first pillar is the state-dominated public pension sector, which plays a vital role in the three-pillar system. Organised by the pay-as-you-go scheme, it is directly administrated by the relevant departments in each provincial government. The first pillar guarantees relatively fair wealth redistribution for the urban workers in enterprises and employees in national institutions. It provides the most comprehensive coverage for all participants in the whole system, offering the pension income to pensioners (Males reaching the age of 60 and females 50 should retire and be able to obtain pension income[1]). Under the current system, this public pension sector is further subdivided into two portions—pay-as-you-go[2](social pooling) and the funded part (individual account). The pay-as-you-go portion gets financed through employer contributions, which take 16 percentage of overall wages, while the funded portion gets eight percentage in 2019 (Chen, 2019). Moreover, future pension payments from the funded portion (individual accounts) will take 24 about percentage proportion of

[1] The State Council, *State Council Provisional Regulations on Retirement and Resignation of Workers*

[2] Pay-as-you-go plan is a conventional pension plan, of which pension benefits are not accumulated during the pensioners' working period, but financed by the working pension participants (Breyer, 1989).

average wages of employees, while the pay-as-you-go portion offers a replacement rate of 35 per cent of the average wages (Agarwala, 1998). This stable pension replacement rate could be able to reduce the retirees' income gap and provide a subsistence life level. This feature shows that the first pillar also implies that young pension participants in the pension system cede some human capital (or interest) to the older participants in the exchange of the future human capital (or interest) from next generation of participants. This kind of intergenerational risk sharing comes from the traditional life cycle theory, and it explains that younger participants prefer to invest in equity (Heeringa, 2008).

The second pillar is the enterprise annuity (or career annuity) sector. The basic principle for this pension sector is to construct a sufficiently accumulated mandatory individual accounts for each potential pensioner on the corporate level. It is designed as a supplementary or occupational pension sector and organised in the form of the funded defined benefit pension plan. As an essential component of the Chinese pension system, the second pillar follows the guiding rule of Measures for Enterprise Annuities. The measures allow that the proportion for enterprises is legally fixed below eight per cent of total employees' income, while the total contribution for enterprise and employee should be 12% or lower compared to the total income of employees[3]. Providing about 36 percentage of replacement rate for the final net wages for each employee in enterprises, it could ensure that the return rate of pension fund could equal the rate for wage growth (Agdarwala, 1998). This implies that the pension benefit is determined by the employment years and the reference wage (the final payment or the average wage in the employment period) in each industry. As enterprises take limited obligations in this pillar, the residual risk is transferred to the pension participants. It shows that the DB structure of the second pillar base the funding and benefits on the intergenerational risk-sharing. The fluctuation of the funding ratio is smoothed due to the long-term horizon of this pension sector. Meanwhile, the intergenerational risk-

[3] Ministry of Human Resources and Social Security and Ministry of Finance, *Measures for Enterprise Annuities*, 2019

sharing also increase the risk-tolerance level of the pension fund. The literature shows that the positive intergenerational risk-sharing could contribute to more risk-taking by the pension plans than individual plans.

The third pillar is a voluntary pension sector, mainly funded by individual participants. This voluntary pension for the social security system consists of individual private savings and voluntary commercial pension plans. Pension participants divide their contributions in different commercial pension plans to maximise their pension return and improve their future income. Meanwhile, the State Administration of Taxation also provides the tax reduction to the participants of the third pension sectors on the payment for any commercial pension products[4]. However, the construction of the third pillar is in the process, and it is currently unfunctional.

An additional supplementary pension sector, which is the National Social Security Fund (NSSF), is a backup financial buffer to support the pension system and social welfare, such as underlying medical aid, employment injury, unemployment and maternity. It is financially supported by central government budget, transfer of state-owned capital, fund investment proceeds and some other means of the fund raised by State Council[5]. The NSSF provides supplement and regulates pension expenditure when facing the substantial financial burden of demographic increase. NSSF has more freedom and higher risk tolerance for investing the various assets in the financial market. Its investment regulation restricts the scale of high-risk investment, and it determines that this fund must hold bank deposits and government bonds (at least a combined total of 50 per cent of overall assets). And the combined limits for stocks and shares of mutual funds is 40 percentage, while the other 10 per cent can be invested in corporate bonds.

These three pillars and a financial buffer constitute the current hybrid funded system in China. Compared with the different pension system, this imperfect system

[4] the State Administration of Taxation, *Announcement of the State Administration of Taxation on Issues concerning the Administration of Tax Collection in the Pilot Program of Personal Tax-Deferred Commercial Pension Insurance*

[5] the State Council, *Regulation on the National Social Security Fund*;

has complexity and inefficiency, showing that an obvious structural imbalance exists in the development of the Chinese pension system. The first pillar—public pension sector almost takes all the responsibility of raising the retired population, while the second (enterprise annuity) and the third pillar (voluntary pension) are still undeveloped. For instance, the number of employers who participate in the enterprise annuity takes less 10 per cent of the total number of corporations in China. In comparison, the number of employees participating in enterprise annuities accounts for 5.49 per cent of the total urban working population. The third pillar is almost unfunctional. The current status makes that the whole system have to rely on the first and second pillar. This feature makes the Chinese pension system have a firm reliance on intergenerational risk-sharing, leading to high expectation about investing more in risky assets, such as equity. The Chinese pension system is the most extensive social security system in the world, covering over 0.94 billion people. The Cumulative balance of the pension sector is over 5,800 billion yuan in 2018. The increasing scale of the pension participants also brings higher liabilities. However, Chinese pension plans are still organised as final-pay plans with unconditional indexation. It leads to more pressures on the solvency power on the pension system. To increase the solvency ability of the pension sector, the State Council established a specific investment policy for the pension sector to regulate the investment behaviour of Chinese pension system and use more asset classes to hedge the increasing liabilities, wage fluctuation and inflation.

2.2.2 The investment regulation assessments

In 2015, “Measures for the Administration of Investment in Basic Pension Insurance Funds”, came out as the new regulation for the public pension sector, supervising the investment behaviours of this pillar.

Quoting the essential obligations from "Measures for the Administration of Investment in Basic Pension Insurance Funds", it infers that the investment goal is to maintain the central capitals for pensioners and hold a well-managed reasonable quota

of investment. To fulfil this requirement, the administers set up a series of regulations to manage the investment of the pension system, involving the proportion of investment, available financial instruments, assessment principles, reporting system and some other legal regulations to keep every provincial administration department legally manage the public pension affairs.

"Measures for the Administration of Investment in Basic Pension Insurance Funds" indicates the detail investment proportions in the pension investment procedure. The primary investing principle for pension capital is that the trustees must keep the investment range limited in the mainland. The investment range consists of stock investment product, mixed pension investment, fixed income investment, currency-type investment, and some other investment plan or instruments (the national investment project or stock rights of national enterprises). For currency-type investment, the administrative limit is that bank deposit, central bank bills, one-year or shorter government bonds, and bond repurchase should be held no less than 5%. As for the other fixed income instruments, like interbank deposit receipts, more than one-year deposits or some other bonds, the proportion limit should be less than 135% of the net value of the public pension fund, while stock investment product, like equities, stock funds, mixed funds and stock-type pension products, the total proportion should be kept within 40%.

2.2.3 Liabilities

The hybrid funded pension system is promised to offer a relatively high coverage of pension benefits to both current and potential pensioners in China; therefore, an estimation for pension benefits is required. For this hybrid funded system, future cash flow should account for the liabilities on the balance book of the pension fund. The total liabilities are determined by pension benefits in the future, the life expectancy of pension participants, replacement rates, and discount rates.

Both the income of a pensioner and the level of his contributions decide the general amount of pension benefits. In this hybrid funded system, these benefits result from a fixed percentage of an accumulating wage of the pension participants. Another two vital components that could determine the future benefit payments are the retiring age and the life expectancy after retirement. The current retiring age is males at the age of 60 and females at the age of 50 with seniority of ten years of continuous service, while the life expectancy has been increasing since 1949. Based on the critical characteristics of the current pension liabilities, the current one-child policy and the trend of Chinese population increase, the future cash flow can be plotted through Figure 3 in the Appendix. The expected pension payouts are going to be larger and keep a high, increasing rate.

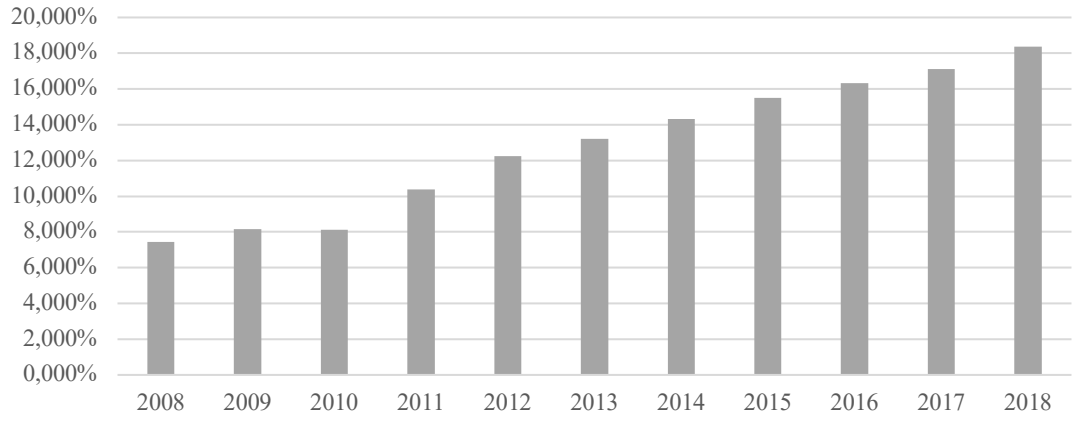
2.2.4 Assets

The ongoing cash flow of pension funds depends on the pension revenue (or pension incoming cash flow), which consists of the current pension contributions and return on the assets compensating for the previous pension investments. The core goal of pension investment policy is to obtain the maximum investment return by utilizing various financial instruments, maximize the pension benefits for all plan participants, and maintain the pensioner contributions in a reasonable range.

In investment regulation(“Measures for the Administration of Investment in Basic Pension Insurance Funds” and some other relevant regulatory documents), the Chinese pension system has to follow strict restrictions to invest in risky investments, like equities, stock funds, mixed funds and stock-type pension products, of which the total proportion should be limited within 40%. However, due to the low development of the financial market and conservative attitudes towards risky assets, most of the pension capital flows into bank deposits and government bonds, contributing to a meager return rate. However, the return of bank deposits and government bonds has been around 2 per cent in the long term, making the increase of return rate of pension

investment lower than the CPI rate. Compared with the CPI rate, the total scale of loss should be between 300 and 500 billion CNY (Zheng, 2019). Facing a tremendous depreciation risk, the assets for the Chinese pension fund is particularly vulnerable and unsustainable. Figure 4 presents that the Chinese pension system has increased its investment exposure to the equity investment over time. Since 2005, the Chinese pension system has extended the investment range from bank deposit and government bonds to equity investment and mutual funds. This increase is a mixed effect of the gradually looser investment policies and the new asset allocation strategies.

Figure 4 the increase of the equity exposure of the Chinese pension system (Yearly)



From the investigation in this section, I infer that the Chinese pension system provides comprehensive social security through the full-coverage state-managed pay-as-you-go scheme in the first pillar and occupational plans on a corporate level in the second pillar. It has a similar feature as the defined benefit pension scheme due to the structure and regulation of the whole system. This hybrid structure takes the public scheme into account, and also construct the unique style of the funding and benefits on the intergenerational risk-sharing. This feature could extend the risk-bearing of the whole system and increasing the risk-taking level of the pension participants. It is consistent with the relevant literature about the optimal intergenerational risk-sharing （Gollier, C. 2008). And this feature also implies that there exist some special links

between the demographic indicators of the pension system and risk-bearing feature of the pension system.

3. Methodology

3.1 Approach construction

The construction of the basic methodology of this paper starts with the analysis of the mentioned hypothesis in the previous section. To test the hypothesis the population ageing issue and pension maturity status affects the strategic asset allocation of the Chinese pension system, I start with exploring the relationship between population ageing issue and the proportion of equity investment in the asset allocation. The typical life-cycle theory shows that the age of participants is negatively related to the proportion of equity investment. As the pension participants become elder, the equity investments of pension funds will decline during their active year; but it will remain constant after retirement. Instead of following this theory, I use another demographic indicator, elderly age dependency ratio, to represent the population ageing issue. It gives insights on the percentage of people at nonworking age, as represent the scale of the ageing population in China. In Chinese regulation, people at nonworking age are treated equally as retiree due to full coverage feature of the pension system.

As for “pension maturity”, previous literature also presents various hints about the relationship between the allocation to risky investments and the percentage of retired members. Rauh (2008) shows that the risk-taking is negatively correlated with the fund maturity among the US corporate pension fund. The benchmark research for this paper, Andonov, Bauer & Cremers (2017), build the panel regression with various control variables to explore “fund maturity” issue in U.S. pension system, including the public and corporate pension funds. In the regression, the dependent variable is the proportion allocated to the risky assets based on the strategic asset allocation of pension funds. As the regulation (GASB guidelines), the risky assets contain various asset

classes, like equities, risky fixed income and alternative assets. And the independent variable is the percentage of retired members from the total pension fund. Other variables follow the characteristic of the U.S. pension system and act as the control variables in the regression. The central methodology for the regulatory incentives hypothesis is to run the pooled panel regression on the mentioned variables and the interaction terms. It starts from the previous economic theory about the dynamic inner relation between risk-taking, fund maturity and inflation protection. The authors interpret this relation with the following regression equation, which is also the benchmark approach for the analysis of Chinese pension scheme.

$$\%Risky_{i,t} = \beta_0 + \beta_1 \%Retired_{i,t} + \beta_2 X_{i,t} + \beta_3 YFE_t + \beta_4 FFE_t + \mu_{i,t}$$

(The benchmark equation)

They double-cluster the robust standard errors in all the regressions process separately and include the interaction terms created from the dummy variables, as well as the control variables inside. The control variable contains fund size, inflation protection policy, and the plan type. Log of pension fund assets is defined as the fund size that captures the effects of the investment decision of the pension funds; inflation protection policy indicator follows the Campbell and Viceira (2005), and the dummy variable of the pension type indicates that the tested pension plans are public or private due to the different career risk and life-cycle patterns of the pension participants. The results of the regressions show that there is the positive relationship between the percentage of retired members and the proportion allocated to the risky assets in U.S. public pension funds, that is, the more mature U.S. public pension fund is, the more they invest in risky assets.

The Chinese pension system has similar characteristics as the U.S. public pension fund, but the difference is that the Chinese pension system is a compulsory pension plan for all the social labour force. And its regulation of pension asset allocation is also different from the U.S. regulation (GASB regulation). The original methodology of benchmark literature (Andonov, Bauer & Cremers, 2017) is not the

perfect fit for Chinese circumstance, but it is still a right approach for the pension scheme with some adjustments of life cycle theory. Here I combine this methodology with the traditional life-cycle theory to explore the determinants of stock allocation for the Chinese pension system. The percentage of retired members represents the pension maturity, following the mentioned methodology in Andonov, Bauer & Cremers (2017). I add the elderly age dependency ratio into the following analysis as the indicator of the participants' age, following the life-cycle theory.

Therefore, the following analysis provides an improved pooled panel regression to explore the relationship between the proportion allocated to equity investment and elderly age dependency, as well as the percentage of retired members in the pension system. I relate the proportion allocated to stocks ($\%Stock_{i,t}$) by each country i in year t to the percentage of retired people ($\%Retired_t$) and the elderly age dependency ratio ($\%Ageing_{i,t}$) with the pooled panel regressions in equation (1),

$$\%Stock_{i,t} = \alpha_0 + \alpha_1 \%Retired_{i,t} + \alpha_2 \%Aging_{i,t} + \alpha_3 X_{i,t} + \alpha_4 YFE_{i,t} + \alpha_5 CFE_{i,t} + \theta_{i,t} \quad (1)$$

where $X_{i,t}$ represents all the control variables, as well as the interaction terms; and $\theta_{i,t}$ is the idiosyncratic error for this regression model. The robust standard errors in all regressions are independently double clustered by pension fund ($YFE_{i,t}$) and by years ($CFE_{i,t}$). Based on the equation (1), I gradually include one control variables and several interaction terms in the following ten regression, separately run these ten regressions and compare the regression result.

3.2. Methodology specification

Based on the basic approach in the upper subsection, here I come up with ten specifications for the basic pooled panel regression model to analyze how the model act under different condition. In these specifications, I create several interaction terms

with the dummy variables and the independent variables and use them to clarify the relationship between the independent variables (the percentage of retired members, the elderly age dependency ratio, and ten-year treasury yields) and dependent variable (the proportion allocated to equity investment).

Regression 1 contains three main variables, the percentage of retired members, the elderly age dependency ratio, and ten-year treasury yields. There is no control variable or interaction terms inside. The first regression explores what the relation is between the dependent variable (the proportion allocated to stock investment) and the independent variables (the percentage of retired members and the elderly age dependency ratio). Regression 1 could demonstrate how the pension maturity and population ageing issue affect the scale of equity investment in all tested countries. It is the underlying regression model.

To analyse how independent variables relate to the dependent variable in specific countries, I gradually add the interaction terms into the regressions. Regression 2 include $Retired \times China$, which is an interaction term to capture the percentage of retired members in China. This interaction term equals variable$\%Retired_{i,t}$ times a dummy variable $China$ (taking value one if it is Chinese pension system). Based on Regression 1, Regression 2 could figure out how the percentage of retire members associate with the equity allocation in China with the interaction term $Retired \times China$. In Regression 3, I add another interaction term into Regression 2 and re-run the regression process. This interaction term is $Retired \times DB \times OECD$, which captures the percentage of retired members in the OECD countries with the DB pension scheme. It equals the percentage of retired members times the dummy variable $DB \times OECD$ (taking value one if the pension scheme in this country is defined benefit scheme). Regression 4 includes all the variables in Regression 3 and two extra variables, the interaction term $Retired \times Hybrid \times OECD$ and the control variable. The interaction term equals the percentage of retired members times the dummy variable $Hybrid \times OECD$ (taking value one if the pension scheme in this country contains both defined benefit plans and defined contribution plans). The control variable $Inflation\ is$ a dummy variable that captures the inflation protection policy, following the argument

in Campbell and Viceira (2005) and Andonov, Bauer & Cremers (2017) that the indexation policy affects the pension fund asset allocation. As for the inflation protection policy, this dummy variable presents that the indexation policy could decide the asset allocation of the pension fund. It takes value one if the pension system in the country *i* provides the contractual inflation protection policy and zero otherwise. This regression is mainly to explore the relation between the percentage of retired members and equity allocation in different countries under the inflation protection policy.

Regression 5~7 mainly explore the relationship between the elderly age dependency ratio and the equity allocation based on Regression 1. Regression 5 includes all the variables in Regression 1 and also the interaction term on the elderly age dependency ratio in China, the $Aging \times China$ (equals $Aging$ times dummy variable $China$). It shows how Chinese elderly age dependency ratio affects the equity allocation. Regression 6 incorporate interaction term $Aging \times DB$ (equals $Aging$ times dummy variable $DB \times OECD$) and all the variables in Regression 5. It shows how the elderly age dependency ratio is correlated to the equity allocation in both China and OECD countries with a DB scheme. Regression 7 contains all the variables in Regression 6 and two extra variables, the interaction term $Aging \times Hybrid$ (equals $Aging$ times dummy variable $Hybrid \times OECD$) and the control variable $Inflation$. This regression interprets the correlation between the elderly age dependency ratio and the equity allocation in China, OECD countries with DB scheme and the OECD countries with the hybrid pension system, extending the research on age determinant for the asset allocation of pension plans in life cycle theory.

Regression 8~10 mainly shows the relation between the ten-year treasury yields and the equity allocation based on Regression 1. Regression 8 includes all the variables in Regression 1 and also the interaction term $Yield \times China$ (equals $Yield$ times dummy variable $China$). It presents the regression analysis on the relation between Chinese long-term treasury yield and the equity allocation of the pension sector. This could offer a new analysis angle for the determinants for strategic asset allocation strategy of the Chinese pension system. Regression 9 incorporates all the variables in Regression 8 and interaction term $Yield \times DB$ (equals $Yield$ times dummy variable

$DB \times OECD$), showing how the ten-year treasury yields associate with the equity allocation in both China and OECD countries with DB scheme. And Regression 10 contains all the variables in Regression 9 and $Yield \times Hybrid$ (equals $Yield$ times dummy variable $Hybrid \times OECD$), showing how the ten-year treasury yields affect the equity allocation. Regression 8~10 is also consistent with the benchmark methodology in Andonov, Bauer & Cremers (2017).

The year effect and country effect are also included in these regressions. $YFE_{i,t}$ represents the year effect, indicating how the tested variables affect the equity allocation in the equation across year. $CFE_{i,t}$ represents the country effect, as control for the difference between all the tested countries. With these fixed effects involved in the estimation, the results could be more precise on the changes of time and countries. Another estimation with year effect is also presented in the Appendix, which also offers a sufficient explanation on the year effect.

These sets of pooled panel regression models estimate how pension maturity and the ageing population affect the scale of stock investment in the strategic asset allocation of the Chinese pension system. With the created interaction terms, the results present the different impacts of pension maturity and the ageing population on the equity allocation in China, OECD countries with DB scheme and the OECD countries with the hybrid pension system.

3.3 Structural break testing

Considering about the basic features of the pension system in each tested country, I find that social security policy, the regulatory standards, and the status of pension members in the tested countries have been changing significantly during the tested period (2008~2018). Moreover, China and some other OECD countries keep deepening the pension and economic reform. As mentioned earlier, the State Council published "Measures for the Administration of Investment in Basic Pension Insurance Funds" in 2015, announcing the increase of the equity investment for the Chinese pension system.

Meanwhile, other OECD countries also started to promote some reform on the pension sector. These changes could contribute to the unusual movements of the data in the selected dataset, showing that this year (2005) could be the suspected break date for the whole dataset. The methodology needs a test for structural break point to make sure that the data from tested countries could be well pooled in the regressions.

To test the presence of the structural break in the pooled panel regression, I run the Chow-test to check whether there is a structural break point in the dataset of the regressions (Cantrell, Burrows & Vuong, 1991). First, I posit that there is no structural break point for data of all tested countries. The test hypothesis should be:

H_0: There is no structural break point in the pooled regression.

H_1: There are structural break points in the pooled regression.

Then, to run this test, I separately run the regressions on each half of the dataset and collect all the residuals from each regression. Then I calculate the Chow F-statistics with the following equation (2):

$$Chow = \frac{(RSS_E - RSS_1 - RSS_2 - RSS_3)/k}{(RSS_E + RSS_1 + RSS_2 + RSS_3)/(T - 2k)} \quad (2)$$

where:

- RSS_E is the residual from original pooled regression;
- RSS_1 is the residual from the regression on China;
- RSS_2 is the residual from the regression on OECD countries with a full-coverage DB pension system;
- RSS_3 is the residual from the regression on OECD countries with the hybrid pension system countries (covered with both DB and DC pension plans);
- T is the total amount of the observations;
- k is the total amount of the regressions;

Finally, I compare the estimation of F-statistics in Chow test and the F-critical value from the F-table. And I reject the null hypothesis if the calculated F-statistics falls into the rejection region (i.e. if the calculated F-statistics is higher than the F-critical value).

4. Data

In order to study the effect of the increasing retired members and optimal asset allocation, this research introduces the data from three primary sources: National Bureau of Statistics, Thomson Reuters, and OECD Statistics. The dataset comprises the yearly data of Chinese pension system and pension systems in other 11 OECD countries. The data covers the mentioned demographic and economic indicators in the period from 2008 to 2018, and enable me to observe cross-sectional and time-series variation in this area.

On the liabilities side, National Bureau of Statistics in China and OECD Statistics offer information about the number of active and retired pension members in each country, inflation protection policies and ten-year treasury yields. They also offer statistics on elderly age dependency ratio. I test the percentage of retired members as a proxy for "pension maturity" with the information on the number of active and retired pension members. Although the dataset does not include the information about life expectancy and the average age of the pension members, the percentage of retired members and the elderly age dependency ratio could reflect the increase of participants' longevity.

On the asset side, the National Bureau of Statistics in China and OECD Statistics offers the data about the strategic asset allocation of each pension system. For the Chinese pension system, the data for the equity investment is in the annual reports of the regulation departments of the pension system. As for the strategic asset allocation of pension funds in other 11 OECD countries, OECD Statistics achieves the relevant data from the regulatory departments of the pension fund in each country.

Table 1 presents the summary statistics about the relevant data

Variable	Obs	Mean	Std.Dev.	Min	Max
Panel A Total numbers of the observed countries					
Country	12				
Year	2008~2018				
Panel B Summary statistics					
Stock	132	0.235	0.108	0.032	0.491
Retired	132	0.282	0.045	0.199	0.384
Ageing	132	0.255	0.065	0.113	0.462
Yield	132	0.02	0.02	-0.078	0.054
Inflation	132	0.667	0.473	0	1

Table 1 provides the summary statistics for the general pension data during the period 2008~2018. The dataset contains data of the following variables: the percentage of the share allocated to stock (*Stock*), the proportion of the retired members in total pension participants (*Retired*), the elderly age dependency rate (*Ageing*), the treasury yields in the previous years (*Yield*), and the dummy variable for the inflation protection policy (*Inflation*).

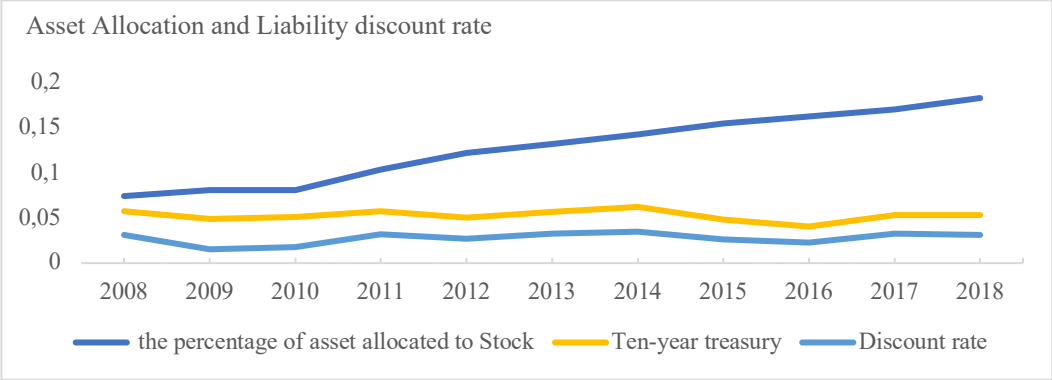
Table 2 Summary statistics for the pension system in each country

Panel B Summary Statistics for each country					
	China	Europe	US	Canada	Japan
Stock	0.128	0.247	0.298	0.309	0.113
	(0.012)	(0.012)	(0.006)	(0.006)	(0.005)
Retired	0.255	0.282	0.315	0.275	0.275
	(0.004)	(0.006)	(0.005)	(0.002)	(0.007)
Ageing	0.135	0.282	0.211	0.224	0.395
	(0.005)	(0.006)	(0.005)	(0.006)	(0.014)
Yield	0.050	0.020	0.028	0.025	0.008
	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Inflation	0.545	0.807	1.000	1.000	0.000
	(0.157)	(0.042)	(0.000)	(0.000)	(0.000)

Table 2 provide the panel statistics for the pension system in each country. It could present more detail than Table 1. I document that the proportion allocated to the stock of the Chinese pension system is much lower than the European, U.S. and Canadian pension system in the period from 2008~2018. And the elderly age dependency ratio and the percentage of retired people in the Chinese pension system are also much lower than in other countries.

For the Chinese pension system, Figure 5 demonstrates that the average proportion allocated to the equity assets, the liability discount rate, and the ten-year treasury bond in China in the period from 2008~2018. It plots a relatively flat line for the discount rate used by the central financial system and pension fund in China. Under the circumstance where the discount rate is around 3% for a long term, the public sector of Chinese pension fund offset the low risk-free rate with the increased investments to the stock investment based on the relevant policy. Based on the regulation and policy from the State Council, the public sector of the Chinese pension fund has the obligations to protect the accrued benefits of the pension system.

Figure 5 Allocation to stock investment and a discount rate of the public sector



As a result, the liability discount rate could not show the uncertainty of the pension liabilities, and also low discount rate and the ten-year treasury yields could enable the public sector of the Chinese pension fund to understate the value of pension benefit. The following section offers a detailed analysis of the empirical results.

5. Empirical result

This section presents the outcome of the empirical analysis based on the methodology. It presents the empirical exploration on how the pension maturity and the elderly dependency ratio affect equity investment of Chinese pension system, which is the relation between the percentage of retired members of the Chinese pension fund and the percentage of the allocation to the stocks.

To test the hypothesis, I examine the relationship between the proportion allocated to equity investments and the fund maturity with the approach mentioned in the methodology section. In the previous section, I relate the proportion allocated to the equity investments by the country *i* and the year *t* ($\%Stock_{i,t}$) to the percentage of the retired members ($\%Retired_{i,t}$) and the elderly age dependency ratio ($\%Ageing_{i,t}$) with the pooled panel regression with the fixed effects of the year (YFE_t) and country(CFE_t):

$$\%Stock_{i,t} = \alpha_0 + \alpha_1 \%Retired_{i,t} + \alpha_2 Aging_{i,t} + \alpha_3 X_{i,t} + \alpha_4 YFE_{i,t} + \alpha_5 CFE_{i,t} + \theta_{i,t} \quad (1)$$

The result of this regression set in the following table shows that there is no significant relationship between the proportion of the retired members ("pension maturity") in the pension system of one country and the percentage of the shares invested in the equity investments. Only the Column (2), (3), and Column (4) present that the percentage of retired members in the Chinese pension fund is negatively related to the proportion allocated to equity investment. It proofs that for the Chinese pension fund, a negative relationship between these variables seems statistically and economically meaningful. This means that an increase in the percentage of retired members in the Chinese pension system leads to a decrease in the allocation of equity investment. For the pension system of other OECD countries, the percentage of retired members is positively related to the proportion allocated to equity investment, showing that the pension system with more retired members would invest more in equity. This result is partially consistent with the findings in Rauh (2009) and Andonov, Bauer & Cremers (2017). The main reason for this result is probably that the data for this research covers the whole pension system, including all the pension plans in each

selected country. Rauh (2009) and Andonov, Bauer & Cremers (2017) use data for individual public and corporate pension plans.

Additionally, based on Table 3, the elderly age dependency ratio is negatively related to the proportion allocated to equity investment. According to Column (2), for all the systems except Chinese pension fund, a 1% increase in the percentage of the elderly age dependency ratio is associated with 1.061% lower allocation to equity investment. However, for Chinese pension sector, a 1% increase in the percentage of the elderly age dependency ratio leads to 0.359% decrease in the allocation to equity investments $[0.01 \times (-1.033) + 0.01 \times (-1.392) = -0.359]$. The interaction term *Ageing* $\times$ *China* is statistically and economically significant in all estimations. Moreover, according to the regression result in Table 3, the independent variable *Ageing* has the significant result in all columns, meaning that the elderly dependency ratio is negatively correlated with the proportion allocated to equity investment in all sample countries. Combined with the previous finding of "pension maturity", these two findings reject the previous hypothesis in the first section. That is because the proportion allocated to equity investment declines when the percentage of retired members in the pension system increase; as well as the elderly age dependency ratio. However, these findings are in line with Rauh (2009). It infers that there is a negative correlation between the allocation to risky assets and pension fund maturity. Also, the life-cycle theory implies that pension funds with more elder members would like to invest in safer assets like government bonds, rather than equity.

Figure 5 shows that the continuous low yield on the government bond in the sample period has an impact on the asset allocation of the Chinese pension system. For instance, this low yield maintains around 5% from 2008 to 2018, leading to the low expected return on almost all pension assets, including the equity investments. The reason is that the risk-free rate is low. As the previous introduction about the investment policy of the Chinese pension system, the regulation from State Council allow the pension system to maintain and increase expected return by increasing the percentage of equity investment. To explore whether the trends of long-term interest rate is related to the allocation of the pension system,

Table 3 Regressions: Proportion allocated to equity investment

Equity allocation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	0.611***	0.316	0.186	0.187	0.342	0.181	0.220	0.281	0.174	0.273
	(0.222)	(0.237)	(0.268)	(0.293)	(0.235)	(0.272)	(0.248)	(0.242)	(0.272)	(0.240)
Yield	-1.912***	-1.439***	-1.314***	-0.892***	-1.480***	-1.355***	-0.890***	-1.353***	-1.126***	-1.452**
	(0.401)	(0.351)	(0.355)	(0.322)	(0.355)	(0.360)	(0.320)	(0.348)	(0.367)	(0.706)
Ageing	-0.649***	-1.061***	-1.040***	-0.696***	-1.033***	-1.001***	-0.720***	-1.074***	-1.067***	-0.709***
	(0.140)	(0.125)	(0.115)	(0.125)	(0.125)	(0.114)	(0.139)	(0.125)	(0.119)	(0.132)
Retired×China		-0.786***	-0.744***	-0.583***						
		(0.099)	(0.103)	(0.085)						
Retired×DB×OECD			-0.093	-0.019						
			(0.071)	(0.052)						
Retired×Hybrid×OECD				0.053						
				(0.077)						
Inflation				0.087***			0.089***			0.086***
				(0.015)			(0.015)			(0.017)
Ageing×China					-1.392***	-1.393***	-1.114***			
					(0.202)	(0.211)	(0.149)			
Ageing×DB						-0.104*	-0.031*			
						(0.067)	(0.050)			
Ageing×Hybrid							0.057			
							(0.067)			
Yield×China								-4.103***	-3.595***	-2.824***
								(0.476)	(0.595)	(0.604)
Yield×DB									-0.814	0.180
									(0.648)	(0.551)
Yield×Hybrid										0.600
										(0.683)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	132	132	132	132	132	132	132	132	132	132
R-squared	0.187	0.349	0.357	0.471	0.336	0.347	0.471	0.457	0.364	0.467

Standard errors are in parenthesis ****** p<0.01, ** p<0.05, * p<0.1***

Here I estimate a panel model with data of each pension scheme. The dependent variable (%Stock) is the proportion allocated to equity investment in each country. For the independent variable, I use %Retired, the percentage of retired members in the pension system of each country; %Retired×China, an interaction term capturing the percentage of retired members in Chinese pension system; %Retired×DB, an interaction term capturing the percentage of retired members in full-coverage DB pension system countries among OECD; Retired×Hybrid, an interaction term capturing the percentage of retired members in the hybrid pension system countries (covered with both DB and DC pension plans); Yieldt-1, the ten-year treasury yield in the previous year, Yieldt-1×China, an interaction term capturing the effect of the previous ten-year treasury yield on the Chinese pension system; Yieldt-1×DB, an interaction term capturing the effect of the previous ten-year treasury yield on the pension systems in full-coverage DB pension system countries among OECD; Yieldt-1×Hybrid, an interaction term capturing the effect of the previous ten-year treasury yield on the pension systems in the hybrid pension system countries (covered with both DB and DC pension plans); Ageing, the percentage of elderly dependency ratio; Ageing×China, an interaction term capturing the percentage of the elderly population at the retired age compared with the population at working age in China ; Ageing×DB, an interaction term capturing the percentage of the percentage of the elderly population at the retired age compared with the population at working age in full-coverage DB pension system countries among OECD; Ageing×Hybrid, an interaction term capturing the percentage of the percentage of the elderly population at the retired age compared with the population at working age in the hybrid pension system countries (covered with both DB and DC pension plans) among OECD; Inflation, a dummy variable taking a value of one if a pension system has a contractual inflation protection. In the regression, I include the year dummy and country fixed effect. I independently run the double-clustering for the robust standard errors by country and year. The standard errors in each bracket, ***, **, and * indicate significance levels of 0.01, 0.05 and 0.1.

Table 4 Regression: the proportion allocated to equity investment (Robust)

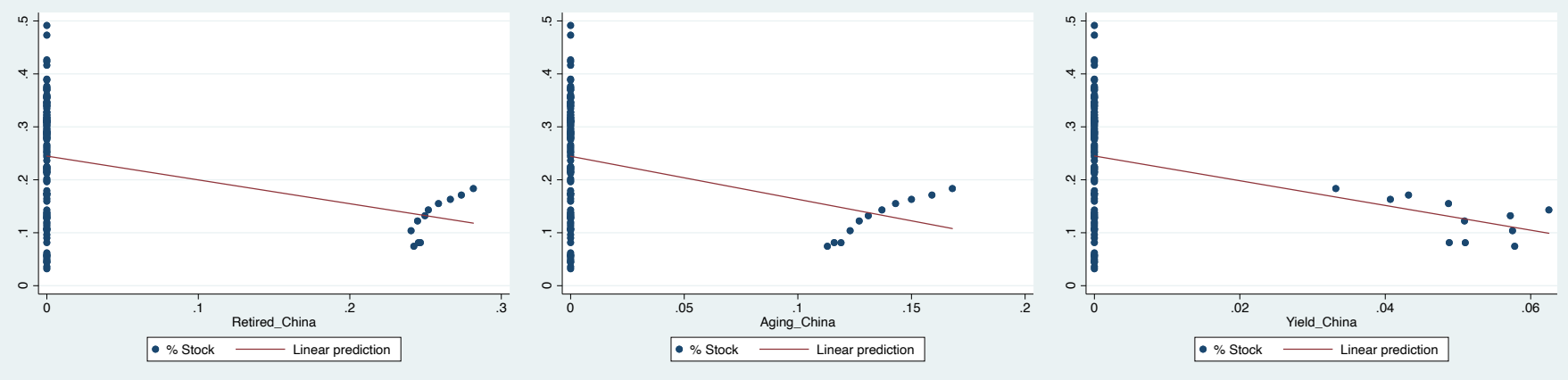
Equity allocation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Retired	0.611***	0.316**	0.186	0.187	0.342**	0.181	0.220	0.281**	0.174	0.273
	(0.106)	(0.129)	(0.207)	(0.265)	(0.129)	(0.209)	(0.194)	(0.123)	(0.194)	(0.175)
Yield	-1.912***	-1.439***	-1.314***	-0.892***	-1.480***	-1.355***	-0.890***	-1.353***	-1.126***	-1.452**
	(0.238)	(0.170)	(0.177)	(0.140)	(0.168)	(0.171)	(0.138)	(0.182)	(0.221)	(0.521)
Ageing	-0.649***	-1.061***	-1.040***	-0.696***	-1.033***	-1.001***	-0.720***	-1.074***	-1.067***	-0.709***
	(0.050)	(0.074)	(0.054)	(0.057)	(0.073)	(0.052)	(0.102)	(0.066)	(0.052)	(0.055)
Retired×China		-0.786***	-0.744***	-0.583***						
		(0.103)	(0.081)	(0.045)						
Retired×DB			-0.093	-0.019						
			(0.056)	(0.040)						
Retired×Hybrid				0.053						
				(0.076)						
Inflation				0.087***			0.089***			0.086***
				(0.003)			(0.003)			(0.003)
Ageing×China					-1.392***	-1.393***	-1.114***			
					(0.219)	(0.220)	(0.120)			
Ageing×DB						-0.104*	-0.031*			
						(0.052)	(0.039)			
Ageing×Hybrid							0.057			
							(0.069)			
Yield×China								-4.103***	-3.595***	-2.824***
								(0.388)	(0.382)	(0.433)
Yield×DB									-0.814	0.180
									(0.459)	(0.355)
Yield×Hybrid										0.600
										(0.560)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	No	No	No	No	No	No	No
Obs.	132	132	132	132	132	132	132	132	132	132
R-squared	0.187	0.349	0.357	0.471	0.336	0.347	0.471	0.357	0.364	0.467

Standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1

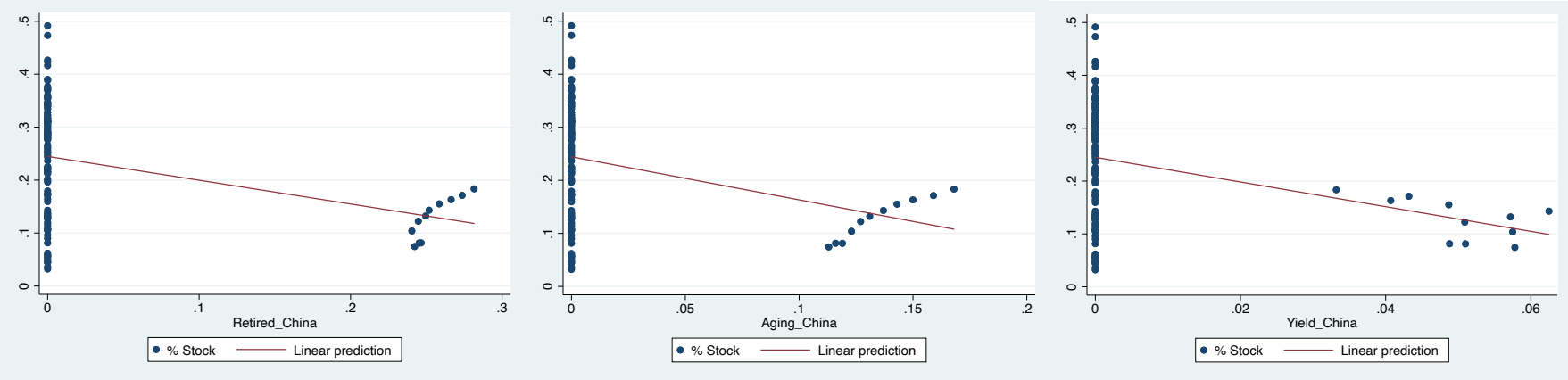
In this table, I estimate a panel model with the pension scheme data for each country. The dependent variable (*%Stock*) is the proportion allocated to equity investment based on the regulation of the pension system and strategic asset allocation in each country. As for the independent variable, I use *%Retired,* the percentage of retired members in the pension system of each country; *%Retired×China,* an interaction term capturing the percentage of retired members in Chinese pension system; *%Retired×DB*, an interaction term capturing the percentage of retired members in full-coverage DB pension system countries among OECD; *Retired×Hybrid,* an interaction term capturing the percentage of retired members in the hybrid pension system countries (covered with both DB and DC pension plans); $Yield_{t-1}$, the ten-year treasury yield in the previous year, $Yield_{t-1}$×*China*, an interaction term capturing the effect of the previous ten-year treasury yield on the Chinese pension system; $Yield_{t-1}$×*DB,* an interaction term capturing the effect of the previous ten-year treasury yield on the pension systems in full-coverage DB pension system countries among OECD; $Yield_{t-1}$×*Hybrid,* an interaction term capturing the effect of the previous ten-year treasury yield on the pension systems in the hybrid pension system countries (covered with both DB and DC pension plans); *Ageing*, the percentage of elderly dependency ratio; *Ageing×China*, an interaction term capturing the percentage of the elderly population at the retired age compared with the population at working age in China ; *Ageing×DB,* an interaction term capturing the percentage of the percentage of the elderly population at the retired age compared with the population at working age in full-coverage DB pension system countries among OECD; *Ageing×Hybrid,* an interaction term capturing the percentage of the percentage of the elderly population at the retired age compared with the population at working age in the hybrid pension system countries (covered with both DB and DC pension plans) among OECD; Inflation, a dummy variable taking a value of one if a pension system has a contractual inflation protection. In the regression, I also include the year dummy and country fixed effect. I independently run the double-clustering for the robust standard errors by country and by year. The standard errors in each bracket, ***, **, and * indicate significance levels of 0.01, 0.05 and 0.1.

Figure 6 The Graphs for the Year Effect and Country Effect

Year Effect



Country Effect



here I put two additional interaction terms with ten-year treasury yield in the previous year to the panel regression model. The Column (8), (9) and (10) present the result of this regression. It indicates that the ten-year treasury yield has a negative correlation with the proportion allocated to equity investment in the Chinese pension system. As the yield of ten-year treasury goes down, the pension regulators will increase the allocation to equity. In Column (8), the result shows that around one per cent decrease in the yield on the Chinese ten-year treasury is related to a 5.456% increase in the allocation to equity investment[-0.01×（-1.353-4.103）=0.05456].

For year and country effect, here I separately test these two fixed effects and presents how the interaction terms of the independent variables (the percentage of retired members, the elderly age dependency ratio and ten-year treasury yields) associate with the proportion of equity investment for the Chinese pension system. In Figure 6, the negative correlations remain between the interaction terms of independent variables (the percentage of retired members, the elderly age dependency ratio and ten-year treasury yields) and dependent variable under the single year or country effect. Furthermore, the estimated year and country effect show similar prediction trends in Figure 6, which is consistent with the regression results in the previous analysis.

Moreover, I also perform a robustness check with a single cluster year (Table 4). I separate China from other OECD countries with the dummy variables, and cluster year in the regression. And I keep the same interaction terms and explore the difference of the conclusion under the only year fixed effect. The result documents that with the elderly age dependency ratio increase, the Chinese pension system should allocate more in equity investment. And this relation is economically significant based on the introduction of the current status of the Chinese pension fund in the previous section. Moreover, the relation between the ten-year treasury yield and the allocation to equity investment is only significant for the Chinese pension system, not for another pension scheme in OECD countries.

Finally, I run the Chow test with the mentioned approach above in the previous section. Through the calculations, the F-statistic of the Chow-test is smaller than the value of F critical

value. It shows that the F-statistics of the Chow test follow the F-distribution. H_1 is rejected by the calculation from this equation. And the result of Chow-test proves that there is no structural break point in the pooled regressions. The separate regressions for China and other OECD countries with DB and hybrid pension system could be pooled together in this paper.

In summary, the finding in this section shows that the population ageing issue and pension maturity, as represented by elderly age dependency ratio and the percentage of retired members in the pension system, are both negatively associated with the proportion allocated to equity in the strategic investment for the Chinese pension system. It rejects the hypothesis I mention in the beginning, but it is consistent with the literature on the risky investments and pension fund maturity, as well as life-cycle theory. Additionally, this finding is reasonable because the principal obligation for the Chinese pension system is to preserve the value of total pension assets for all the participants. Furthermore, another finding shows that the ten-year Treasury yield is also negatively related to the proportion allocated to equity investment. This is supported by Andonov, Bauer & Cremers (2017). In the next section, I provide the conclusion and enlightenment on the empirical results.

6. Conclusion and Discussion

I. Conclusion

In this paper, I use the examine the central hypothesis mentioned in the beginning; that is, whether and how the population ageing issue and pension maturity affect strategic asset allocation of the Chinese pension system. To do this research, I compare the data of the pension system in different countries with the various structure of pension plans, including China, European countries, USA, Canada and Japan. My investigation in the research shows that, after years' development, the Chinese pension system have already been the most significant institutional risk-taker among all the pension systems globally. With the most significant number of pension participants and the retired members covered, the Chinese pension system

has its unique pattern of strategic asset allocation. I find that, as the increase of the elderly age dependency, the proportion allocated to equity investment decline. This negative correlation is particularly weak for the Chinese pension system. As for "pension maturity", the finding shows that there is a negative relationship between the percentage of retired members and the share of equity investment in the Chinese pension sector. However, this relationship in other sample countries is not significant.

These findings are partially inconsistent with the hypothesis that the population ageing issue and pension maturity would affect asset allocation of the Chinese pension system and give an incentive to increase the equity investment. Both of these two variables are negatively associated with the equity allocation in the Chinese pension system, which reject the primary hypothesis. However, these findings coincide with the typical life-cycle model that the percentage of assets invested in equity will decline over the life cycle, and the share of safer investments, such as government bonds will increase.

Furthermore, these findings also present that long-term interest rates have a substantial impact on equity investments. The empirical results mention that a slight decrease in ten-year Treasury yields, which is, the long-term interest rates, could cause a significant increase in the proportion of equity investments. It implies that the ten-year treasury yield has a more reliable negative link with the scale of equity investment in the Chinese pension system. It is because the ten-year treasury yield is a proxy for the long-term interest rates, affecting the price of risky and non-risky assets in the financial market. The decline of long-term interest rate could give pressure to strategic asset allocation, making the pension portfolio rebalance the exposure of different asset. For Chinese regulators of the pension sector, they have to take the long-term interest rates into account when investing in equity.

The evidence that the population ageing issue and pension maturity are linked with strategic asset allocation for Chinese pension system offers the State Council necessary implications for designing retirement policies and running the investment governance for the long-term period. The population ageing issue, pension maturity (the percentage of retired members in the pension system), as well as the long-term interest rate, could affect the

intergenerational risk-sharing and taking. It also infers that social welfare and wealth transfer depend on these three indicators. Furthermore, given the number of assets managed by the pension system, these co-movements also leave some implication for the regulators to explore the optimal asset allocation for a better hedge.

II. Limitation

There are also some limitations in this research about the pension system asset allocation and population ageing issue. Firstly, the time horizon of the applied data in my research is not precise enough for further research. The data for Chinese pension system is updated yearly (the proportion allocated to equity investment), and the data like the elderly age dependency ratio is also updated annually in the relevant report of Chinese Census Database. The similar problem also exists in the dataset of OECD countries in the research. The accessible database could only offer the yearly data, rather than quarterly or monthly. It forces my research stays on the annual level analysis.

Secondly, the equity investment for Chinese pension system starts in recent two decades, and the statistically significant raise on the proportion allocated to equity investment began in 2015 after the "Measures for the Administration of Investment in Basic Pension Insurance Funds" came out. It makes this research only analyse the changes in the strategic asset allocation of the Chinese pension system in the last decade. However, the related literature on the life-cycle theory and other pension system research typically follow the strategic asset allocation for one or several countries in two or three decades. With the longer time ranges, the research could include more policy changes, the development of the population status, and the adjustments of the strategic asset allocation in the tested countries. It could offer more explanatory power.

Thirdly, considering about the model, although the pooled panel regression could present a good explanation of the several determinants for the allocation to equity investment in each pension system, the current empirical results are so general that it could only show the real correlation between the population ageing issue and the equity investment of the pension

system. It hardly shows how the strategic asset allocation for other assets changes when the population ageing issue is getting worse. On the other hand, the elderly age dependency ratio could explain the population ageing status, but it is too ambiguous to cover the whole ageing population in each country. It is one of the core limitations for the applied methodology above.

7. Further research

The findings in this paper also point out some enlightenments for further exploration of the investment strategies for the Chinese pension system. My research presents the long-term interest rate (ten-year treasury yields), population ageing issue and fund maturity could affect the asset allocation of the Chinese pension system, showing how these determinants affect the allocation to equity investments for strategic asset allocation in China and other OECD countries. For the improvement of the applied methodology and analysis in further research, the following suggestion could help:

First, future research splits some efforts to refine the pooled panel regression model above with more precise data from various countries. The researchers could follow and extend the issue of how the long-term interest rate associate with the strategic asset allocation in China and other countries around the world. The long-term interest rate has impacts on the equity investment, but it is still unknown whether the long-term interest rate would affect the proportion of other risky and riskless assets in investment allocation. The future research could do more investigation on this sub-issue, extending the current pooled panel regression approach on the proportion of other asset classes in the pension asset allocation.

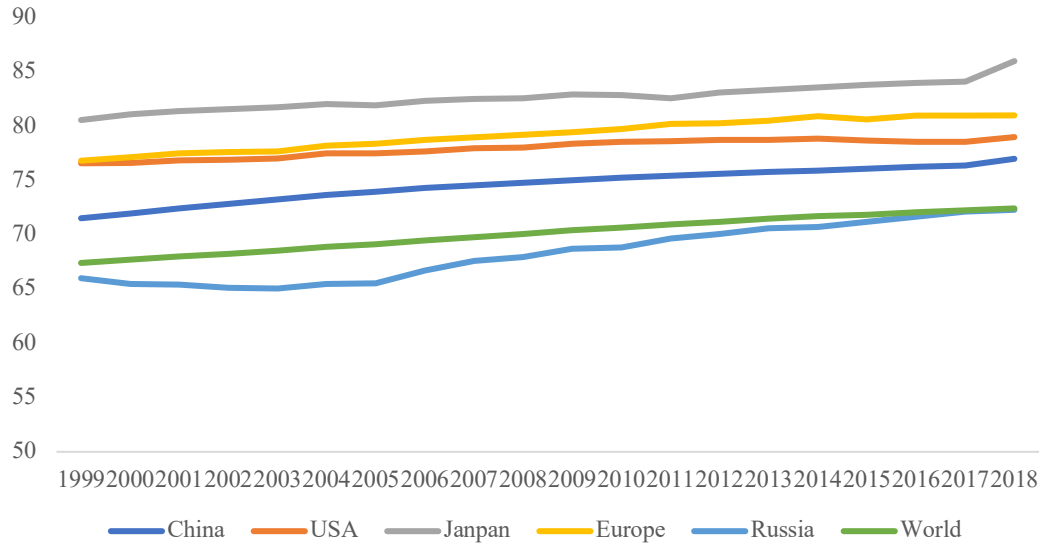
Second, further research could add more indicators to the current model to explore the impacts of other economic and demographic indicators on the strategic asset allocation in China and other countries. In this paper, the elderly age dependency ratio is set to be the leading indicator for the population ageing issue. It could only describe a defined group of people in the whole population of each country. The future research could look into the proportion of

other age groups, and analyse the relationship with pension fund strategic asset allocation and investment policy.

Third, despite the sufficient analysis on the determinants of equity investment in the Chinese pension system, I seldom mention the performance for the investment decision of the Chinese pension system. The main reason is that there is no relevant data about how the Chinese pension system perform in a certain period. The missing data contains the detailed portfolio allocation of Chinese pension sector, the monthly or quarterly return rate of each pension asset class in last ten or twenty years, and also the frequency of the investment proportion adjustments on risky and riskless assets. With these extra pieces of data, further research could examine how the performance of the Chinese pension system is associated with its preference for riskier or riskless assets. It could deepen the research about the determinants for the asset allocation of the Chinese pension system.

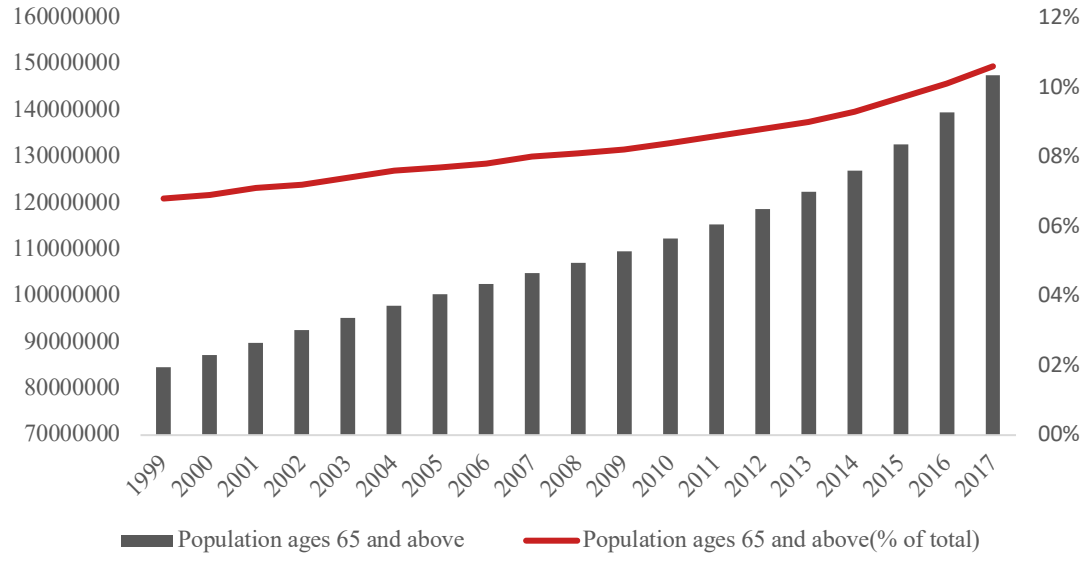
Appendix

Figure 1 Life expectancy at birth, total (years)



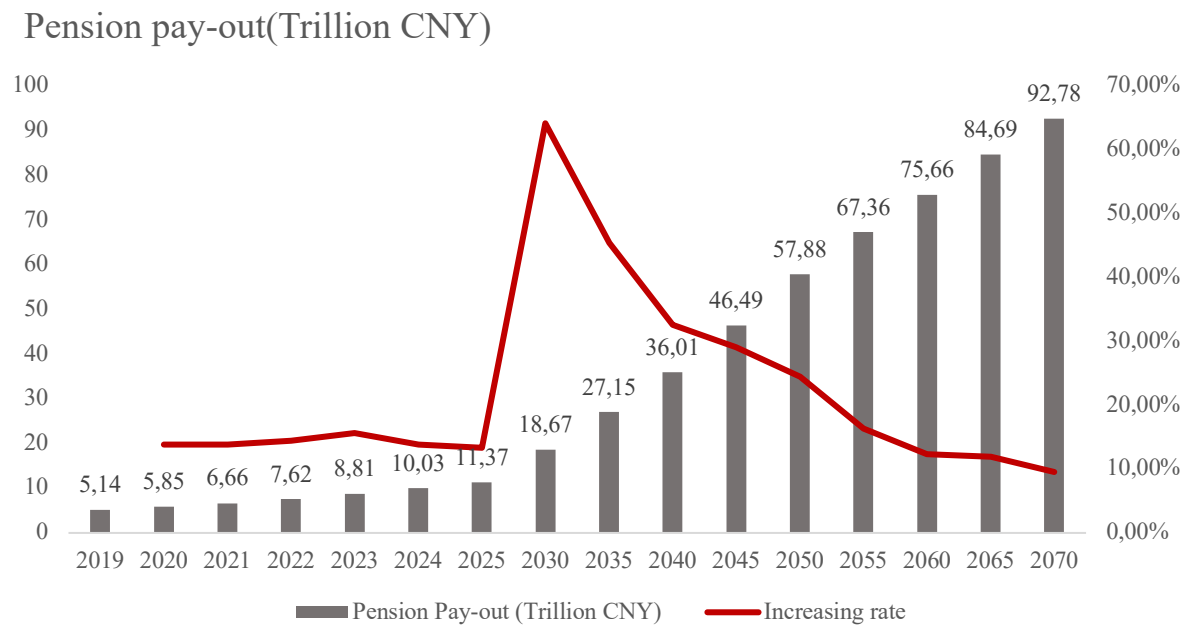
Source: World Bank

Figure 2 The population ages 65 and above, and the proportion of the total population



Source: World Bank

Figure 3 Forecast of future pension pay-out



Source: (Wang, Huang & Yang, 2019)

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