Pension Investment in China

Finance

Master's thesis

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Abstract of master's thesis

Abstract

PURPOSE OF THIS STUDY
Basic pension fund in China began investing in the capital market recently. This master's thesis describes pension investments' impact on the development of China's capital market. Based on existing literature, it is shown that if the pension investment has a positive effect on the capital market, capital market development will enhance overall economic development, and it can in turn increase pension output. This phenomenon can be used as evidence to support pension investment in China. Besides, I also explore the optimal asset allocation and make risk assessment of pension investment in China.

DATA AND METHODOLOGY
Data consists of international and domestic historical data. It is extracted from *International Financial Statistics, Knoema Data Statistic website, etc.* International data in this thesis includes GDP, Market capitalization, Stock value traded, Inflation, Real rate of return for pension investment and Pension investment scope in 20 sample countries from 2005-2014. China's own historical data includes National Society Fund's investment scope, Market capitalization, GDP, Stock value traded and ROI on treasury bond, bank deposits, stock and enterprise bond from 2001-2014.

I use two methods to explore the relationship between pension funds and China's capital market. Main variables used for matching include PINVEST (pension assets under management/GDP), MCG (Total market capitalization/GDP), STG (Total stock value traded/GDP), Dummy variable, Inflation, Variation and ROI. I established a static OLS regression between PINVEST and MCG, PINVEST and STG in sample countries. And I use Granger Causality test to study pension investment impact on capital market in China. Besides, I apply portfolio theory to find optimal asset allocation and use Value at Risk method to make risk assessment.

FINDINGS OF THIS STUDY
Pension funds impact on capital market development differs according to level of financial development. In those "high" financial development countries, pension funds' positive impacts are stronger. As China possesses "high" financial development, pension assets will contribute to capital market development. Meanwhile, I find out that pension investment in China Granger cause the development of capital market, this result provides further evidence to support basic pension fund investment. In addition, refer to risk tolerance of pension fund in America, it is optimal to limit the investment proportion of stock under 20%, invest the majority into enterprise bond and the rest into bank deposits at present in China. Under such asset allocation, there is 5% probability that loss will exceed 12.4% of total amount.

Keywords Pension fund, Capital Market, Asset Allocation, Risk Assessment
"high" financial development, "low" financial development

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1. Introduction

In recent years, there is an increasing interest in pension management, which create a need to explore optimal pension investment. Pension system is of great importance as it forms the cornerstone of social stability, a sound pension system creates good environment for the country's development. In the global view, those developed countries such as America and UK possess a long history of pension fund investment, and most of them succeed in good investment results (see Appendix 1). Pension management are on agenda for both developed and developing countries because aging population trend becomes more obvious in the world (Adair Durner, 2006). Typical responses toward aging problem involve higher contribution rate, later retirement and lower replacement ratio[1]. In addition, more resources are pooled into pension fund to support retirement. Considering the increasing size and importance of pension fund, an adequate pension investment is necessary to enhance the value of pension fund and compensate for possible pension deficit in the future.

Compared with other countries, pension system in China is different and more complex. Till 2015, establishment and reform of China's new social pension insurance system has gone through more than 60 years. After years of exploration, pension system combined social pooling and individual accounts, established a multi-level pension insurance system. Because there are huge imbalance in urban and rural income, China's pension system has been divided into major two components: Urban residents pension systems and Rural residents pension system. Urban residents pension system consists of Enterprise Workers' pension system and Agencies&Institutions pension system. Take Enterprise Workers' pension system for example, it contains three pillars, in which government, employees and employers all make contributions to individual's retirement plan. The first pillar is called basic pension insurance, it has been divided into a pay-as-you-go (PAYG) system and Funded Individual Accounts. The second pillar is Enterprise Annuities, it is a form of

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[1] Pension replacement rate is an important indicator of the level of pension after retirement.

voluntary occupational pensions. The third pillar is Voluntary Private Savings made by individuals. (See Appendix 2)

Current pension system in China is now faced more severe challenges. The accelerated aging population problems, narrow coverage, low replacement rate, implicit debt problems and empty accounts have made the existing pension system powerless. In pillar 1, the basic pension insurance has been overwhelmed. By the end of 2015, urban basic old-age insurance covered 340 million people, urban and rural residents in the basic old-age insurance covered 500 million people, the overall coverage of 80%. However, the replacement rate kept decreasing in recent years. In 1997, Chinese government planned to decrease the target replacement rate from 80% to 58.5%, and gradually adjust the structure of the entire pension system. That is, to replace part of the original pension fund with other forms of pension insurance. In fact, the basic pension system reform in China is not smooth, despite the use of national financial subsidies, the actual replacement rate is decreasing year by year, from 73.2% in 2001 to 49.79% in 2015 (see Appendix 3). As for pillar 2, the enterprise annuity coverage is low, and it is difficult to change this phenomenon in a short term. The enterprise annuity was introduced in 2004, till now, more than ten years have passed. According to the report of Human Resources and Social Department, the number of enterprises which establish enterprise annuity plan is only 73300, the number of participants is 2292.78 million and the cumulative fund is approximately 118.29 billion dollars. However, the number of urban employees is more than 23 million, which means the coverage rate was only about 6%. In developed countries, the subtropical annuity rates were above 30%, while numbers in the United States, Japan, Britain and some other countries were over 50%. For pillar 3, commercial pension insurance started late in China, participation rate is far below that of developed countries. And most people have not raised an awareness to establish their own retirement planning. I focus my research on pillar I of Enterprise Workers' Pension System in this thesis.

What more, pension fund in China has little investment history till now. Basic pension fund only invest in bank deposit, which face high risk of depreciation. In recent years,

China has already entered into an aging society. Main characteristics of Chinese population structure are large amount of aged group, fast growth rate, and this trend becomes more obvious in the future. These phenomenons lead to the consequence of grim pension issues. Till the end of 2015, according to the report of National Social Security Fund, the 2015 pension insurance "deficit" was more than $46.1 billion after removing the government financial subsidies. In recent research made by People's Bank of China[2], Yao Yudong points out that after 15 years, the pension gap will reach $96.9 billion; 35 years later, this gap will be about $144.6 billion if no action taken. By 2050, China will enter the super-aging society, the aging group of the total population will be over 400 million people, the proportion of people aged over 60 will exceed 30%. China will possess the highest degree of aging population in the world. Under such circumstance, pension fund management and investment become the top issue at hand. Chinese government should seek ways to enhance the value of pension fund, update the pension system and emphasis the risk management of pension fund. On the other hand, Chinese residents should develop concept to build their own retirement plan (Wang Zhi, 2014).

Faced with these problems existing in pension fund in China, diversified investments are necessary to make pension value imperative (Hao Shouyi and Gao Zhihai, 1998). In recent years, whether the basic pension fund should be invested into capital market becomes a hot topic. In order to increase the value of pension fund, in the economic restructuring background, the investment of basic pension fund come to the front. In August, 2015, " The Basic Pension Fund Investment Regulation" introduced relevant investment provisions. It allows the investment of pension funds in stocks, stock funds, hybrid fund. And it also pointed out that the equity ratio of pension products shall not exceed 30% of the total net assets of the fund. The proportion of pension fund investing in major national projects and key enterprises equity, shall not exceed 20%. Pension fund investing in stock index futures and bond futures are only for hedging purposes.

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[2] http://www.xue163.com/zhuanti/11791/11796/

This new regulation has leaded to hot debate in China since its release. Yu Yong (2012) pointed out that entering the capital market is the best way for pension fund to enhance its value. Although it may face some challenges, it is a reciprocal action in the long term for both pension fund and capital market in China. However, Lian Fafang (2012) doesn't agree. In his research, he clarified that although the investment of pension into capital market has indeed been proven to be a good idea in developed countries, it is extremely unrealistic in China because of the lack of fundamental institutional guarantee. China's capital market has a history at about 20 years, there exists a large distance with developed countries in regulations and supervision. Pang Diye (2012) presents that the main characteristics of China stock market is that it has obvious sign of human control and most investors possess speculation attitudes. From 2007 to 2014, more than 80% of investors suffer from loss, if the basic pension fund enter the capital market act as an investors, it will face high risk of loss.

This thesis provides further evidences to classify whether pension fund should enter the capital market. I made the preliminary assumption that if pension fund investment in China have a positive impact on capital market development, it can be used as one important evidence to support pension investment. This assumption is based on existing literature that capital market development will in turn increase pension fund output (Holzmann, 1997). Besides, investment risk can be controlled by limiting the equity ratio in investment (Lintner. J, 1965). Consequently, I base my study on the relationship between the pension investment and capital market development. In developed countries, Claudio Raddatz and Sergio L. Schmukler (2008) present that the accumulation of pension investment can facilitate the development of capital market. Pension fund, used as institutional investor, make large contribution to a country's economic development. The main hypothesis I try to explore in the paper is that the basic pension fund investment also has a positive impact on the capital market development in China. After proving this hypothesis, I use it as further evidence to support pension investment into the capital market.

This thesis contains two major parts. In Part I, I use two methods to test the hypothesis. Channarith Meng and Wade Donald Pfau (2010)' use a dynamic approach to study the relationship between pension investment and capital market, they found that the pension fund only have a positive impact on the capital market in "high" financial development countries. In the first method, I based on their methodology and use static OLS regression to prove pension investment impact differs according to the level of financial development. As pension investment has a long investment history in many countries, I take 20 countries' investment history as a sample. The main data I collect in this part includes GDP, Market capitalization, Inflation, Real rate of return for pension investment and Pension investment scope. Data is collected from *International Financial Statistics, Knoema Data Statistic website, Trading Economics website, and the World Bank website.* I apply these data into the OLS regression to test whether there exists a positive relationship between pension investment and capital market. In the first place, I analyze the situation of sample country group as a whole and include level of financial development as dummy variable. Then I classify them into "high" and "low" financial development countries by Market capitalization over GDP ratio and Stock value traded over GDP ratio, each group has 10 countries, and analyze the pension and capital market relationship in these countries separately.

In the regression result, I find out that pension fund impact on capital market differs according to the level of financial development. In "high" financial development countries, the positive impact is stronger. According to the criteria I choose here, China belongs to the "high" financial development countries, investing basic pension fund will have positive impact on the capital market. This result is consistent with Channarith Meng and Wade Donald Pfau (2010)' study and support pension investment in China.

On the other hand, I use the investment history of National Social Security Fund to study the relationship between pension and capital market in China. Basic pension fund possesses the same characteristics as the National Society Security Fund, which already had more than ten years investment history. Pension fund investments' positive impact on

mature capital market have been widely documented. For example, Cosmin Enachea, Laura Raisa Milo and Marius Cristian Milo (2015) use central and eastern European countries as samples, and found out that there exists an obvious short-term, and a lower magnitude positive long-term effect between pension fund investment and capital market capitalization. However, in China, the capital market is not that mature, it contains high risk and large fluctuation compared with those in developed countries. So my objective in this part is to prove there also exists such a relationship between the pension fund and China's incomplete capital market. I use ADF, Cointergation and Granger Causality test in the second method to study the relationship between pension investment and capital market based on China's own experiences. In the calculation results, I found that the pension investment Granger cause the development of capital market, so this result provides further evidences to support pension funds enter the capital market.

In Part II, I explore the optimal asset allocation of pension fund in China. Based on developed countries' experiences, I found out that the majority of investments are in these four fields: Bank deposit, Stock, Treasury and Corporate bonds. Assuming that the basic pension fund in China will invest only in these fields, I try to find the optimal asset allocation. Fixing the expected return, optimal asset allocation can be found when minimizing the variance of the portfolio. In results, I present investment portfolio possesses good diversification effect. Then I refer to risk tolerance of pension fund in America, I find that when limiting the proportion of pension fund investing in stock at about 20%, investing the 69.5% into enterprise bond and the rest into bank deposits, pension investment in China can maximize its expected return.

In the final step, I apply Monte Carlo Simulation and Value at Risk approach to make risk assessment for the asset allocation I choose. Assuming that the ROI on treasury bond, stock, bank deposit and enterprise bond follow the normal distribution, I use Eviews to test the hypothesis based on historical data and find out real distribution. By fixing the replication at 1000 time, Monte Carlo Simulation is used to calculate the expected return. Then I apply VaR method and get maximum losses under different confidence level. In the

calculation results, under 95% confidence level, there is 5% probability that the loss will exceed 12.5% of the total pension investment. Compare to the investment performance of other countries, this risk level is within tolerance. Based on results, I provide recommendations toward pension investment in China.

Limitations of this study include lack of historical data, bias in data collection, refer only to pension funds' risk tolerance in America and use only two ratios to rank countries' financial development level. Although there are some limitations, I believe the two methods I use are good enough for explanation. The rest of the thesis is organized in the following order. Section II is literature review, Section III presents the hypotheses, Section IV describes the data. Section V explains the methodology. Section IV shows the results. Section VII provides suggestions and discusses limitations. Section VIII draws conclusions.

2. Literature Review

This section reviews previous literature about pension fund, pension system in different countries, relationship between pension fund and capital market, pension investment in China and key factors influence pension investment policy. Main arguments includes that pension funds include two main investments methods: "traditional" and "alternative" methods. This thesis focus on "traditional" investment methods. Pension funds has a positive impact on capital market, such impact is obvious especially in mature capital markets. And the development of capital market will in turn boost pension funds' output. As for the arguments toward pension investment in China, supports emphasis the simulating impact pension funds possess on capital market, while opponents are out of security consideration. Pension investment policy are affected by many factors, including inflation, different types of pension, historical investment outcome, etc.

2.1 Pension Fund

Dearborn (1999) defines pension fund as a sum of money paid by state or enterprises to ensure employees' retirement lives. Pension fund investment scope in this thesis refer to the total amount of pension asset under management. Although there are many types of employer pension programs, in general, pension system is classified into defined benefit (DB) and defined contribution (DC) plan in the law under ERISA.[3] DB plan establishes a retirement account for which employers are responsible for regular contributions and promise employees a set payout after retirement. The level of final benefit is calculated using a formula linked with employees' salary and years of service. However, DB plans decrease in recent years worldwide. John A. Turner and Gerard Hughes (2008) exam the phenomenon of large declines in DB plan in Canada, Ireland and the United States. In their research result, they found out that such transitions shift pension costs to employees and away from enterprises. White (2003) made a survey in Britain and classified the primary

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3 The Employee Retirement Income Security Act (ERISA) 1975 is a federal law that sets minimum standards for voluntarily established pension plans in private company to offer protection for employees in those plans.

reasons for employers who terminate DB plan are due to increasing cost, lower investment returns and greater longevity. On the other hand, NCPERS Research Series (2011) list ten reasons for retaining DB plans, including less cost compared with switching to DC plan, providing disability and survivor benefits at lower cost, etc.

As for DC plans, like a 401(k)[4] or 403(b)[5], require employees to make their own contributions. It is fully funded by nature, which means the market value of the fund's assets equals the liability of the sponsor to the plan's beneficiaries. (Zvi Bodie, Alan J. Marcus, Robert C. Merton, 1998). Aihua Zhang (2009) defined it as a defined amount of payment bear by employees and employers, often as a fixed part of salary. The pension benefit is decided by the accumulation amount at the time of retirement. In the view of Peter J. Ferrara (2003), the most obvious advantage of DC plan for employees is portability. As payment are made directly into individual accounts, it is more convenient for employees to take the accumulated funds with them when they change their jobs. However, DC plans possess the disadvantages of employee bearing the financial risk of outliving accumulated assets (Alan Sonnanstine, Brian Murphy and Paul, 2003)

Till now, many countries have long history of pension fund investment. Zvi Bodie (1988) researched on the investment policy of pension fund. He concludes that the investment policy depends on the type of pension plan. For DC plan, it use efficient diversification to maximize expected return under certain risk level. For DB plan, if they try to maximize shareholders' wealth, extreme policy may be applied. And for health plans, majority is invested into fixed-income securities to ensure full funding. According to OECD report, pension funds are mainly invested into equities, bonds, cash and deposits. These are considered "traditional" investment while others are considered "non-traditional" or "alternative" investment. OECD (2015) found that the non-OECD countries tend to prefer "traditional" investment sightly more than the OECD countries. Inderst, Georg (2010) study on the "non-traditional" investment, he showed that although investment into

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4 401(K) is the tax-qualified, DB account in US

5 403(b) is tax-advantaged savings plan for public education organizations in US.

infrastructure has gained a good return and low correlation with other investment, its performance decreased dramatically after 2008 financial crisis. E. Philip Davis (2005) focus on clarifying the role of international investment in pension fund management. Based on OECD countries' experiences and emerging markets, he concluded that international investments should be an indispensable part of pension fund investments, for it provides superior investment performance and take the advantage of diversifying risk. In this thesis, I focus my study on "traditional" investment methods. Fiona Stewart (2007) outlined concerns relating to pension fund investment in hedge funds. Sona Kilianova. Georg Ch. Pflug (2008) finds out a multi period stochastic model to solve the optimal selection of pension investment problem. E. Philio Davis (2005) clarifies the importance of international investment in pension fund management strategies. OECD guidelines on pension fund management (2006) suggests regulators include quantitative limits of the asset allocation. Zhng et al. (2007) points out that investing part of pension fund in the index bond can help protect against the risk of unexpected inflation.

2.2 Pension Systems in Different Countries

Pension system varies in different countries. For the United States, its pension system mainly contains of five components, in which Society Security Benefits represents the largest part of retirement resources. For some retirees, home ownership represents the second important factor to support their retirement, because this group of people own their own house, they have no pressure to pay the rent. Besides, employers sponsored plans and IRAs act as supplementary to social security. And retirees may rely on other assets such as financial holdings. Peter Brady (2012) clarified that the importance of these five components vary in different households. For some of them, DB and DC plans are even more important than the Society Security Benefit. In American Benefit Council Survey 2014, they concluded that such retirement system has achieved a good performance, and Americans' retirement well being increased in recent years.

In Europe, Hindocha, Divyesh (1997) presents that the pension systems in Western Europe mainly contain three similar pillars of retirement benefits, including State pension, employer related plan and private contribution. Pressure transform form public to individual will results in more allocation of income into bank deposits.

By comparison, Australia's pension system is quite different from countries. It contains three pillars, the first pillar is called government aged pension. It provides income for those who earns income lower than a certain threshold. The second pillar is the "Superannuation Guarantee" program created in 1992, it requires employers to contribute about 10% of earnings to each employees' tax advantage retirement plan. The total accumulated amount in the Superannuation fund should be withdrawn when people reach a specified age. The third pillar is voluntary savings. Hely S (1990) pointed out that Australia's pension system worth emulation. However, Dan Scheiwe (2012) clarified that pension system in Australia fail to adequately support most people's retirement because there is a mismatch between the pension system and supervision. Julie Agnew (2013) clarified that such system depends too much on DC plan and is vulnerable to weaknesses in such programs.

In China, Pension System is very complex. Because of the large imbalance in people's income and living standards in urban and rural areas. Chinese government divided the pension system into two major parts: Urban residents pension systems and Rural residents pension system. The basic principles of the rural residents pension system was "wide coverage, flexibility and sustainability." In such pension system, every people establish his or her own account. Annual contributions including individual contributions, collective benefits and government subsidies are made to this personal accounts. Once a retiree reach 60 years old, he or she is able to began pension withdrawn, the withdrawn amount consists of basic pension fund provided by the government and a specified part from his or her own retirement account. This withdrawn will last the whole life.

As for Urban residents pension system, it has been divided into Enterprise Workers' pension system and Agencies&Institutions pension system. Enterprise Workers' pension system, as I mentioned in Section I, is similar to those three pillar system in Europe. For those work in government institutions, their pension system is different. The pension contribution is made by government, so individuals don't have to make their personal contributions. Pension benefit after retirement is directly based on his or her salary and length of working. This papers mainly study on the Enterprise Workers' system and basic pension fund refers to the pillar I of it.

In addition, Chinese government established a National Social Security Fund in 2000, this fund is operated separately from the pension fund by a special council. National Social Security fund is financed by central government budget allocations, the main objective of it is to compensate the pension fund gap during the serious aging problem in the future. As a result, this fund possess many similarities as the pension fund, and it has been invested into the capital market for about 15 years. Li Lei (2014) clarified that the pension system in China is unfair. Different groups in different areas get different pension benefit and the biggest challenge faced by the pension system is a wide range of institutional design issues. Xu Lin (2011) pointed out that it is an unavoidable trend for Chinese government to cancel the Agencies &Institutions pension system, and combine this group of people with enterprise workers.

2.3 Relationship Between Pension Fund And Capital Market

Pension funds, acted as an institutional investors, possess large amount of money. It has advantage of pooling risk for small investors and diversifying risk to generate higher rate of return. There are widespread researches describe its positive impact on capital market. Davis and Steil (2001) present that institutional investors' assets in the G-7 countries keep increasing, ratio over GDP increased from 23% in 1970 to 108% in 1998, with pension fund assets at approximately 43 % of GDP. They find a degree of contemporaneous correlation between pension fund and capital market. Impavido, Musalem and Tressel

(2003) show that the increasing amount of assets managed by pension funds has a positive impact on stock and bond market capitalization, and such impact is stronger if the financial system is market based. Channarith Meng and Wade Donald Pfau (2010) use a dynamic approach to study the relationship between pension fund and capital market, in their report, they found out that although pension fund has a positive impact on the development and liquidity of capital market in general, such conclusion is rejected when they split the country into two groups. The positive impact is only obvious for countries with "high" financial development. This thesis go further based on Channarith Meng and Wade Donald Pfau's methodology. I take historical data for 20 countries as a sample, use static OLS linear regression to find the relationship between pension investment and capital market development.

Claudio Raddatz and Sergio L. Schmukler (2008) pointed out that pension fund hold large amount of bank deposits, stocks and bond, it contributes to the primary market. However, pension investments is not a dynamic driving force for the development of the whole capital market. Milos Laura Raisa (2012) use members of Europe Union to study the impact of pension investment on capital market, he use panel data regression and find a positive connection between the them. Based on the study of central and Eastern European countries, Cosmin Enachea, Laura Raisa Milos and Marius Cristian Milos (2015) presented that there is a strong positive short term impact, as well as a lower magnitude positive long-term effect of pension investment on capital market. Dimitri Vittas (1999) present that although the private pension fund is not sufficient to push the development of capital market, once they reach a critical mass and are operated pluralistic structure, they have a positive influence.

Meanwhile, E Philip Davis (2005) describes the role of pension fund in emerging markets. In his findings, the behavior of pension funds in emerging markets differ from those in developed markets. The "direct effect" of pension funds on capital market is limited in emerging markets. He clarified that pension funds bring increased specialization in the investment decision, contribute to financial innovation, increase governance and

transparency of equity market. As equity market development will enhance the overall economic development (Demirguc-Kunt and Levine, 1996), such development will in turn raise pension investment output, thus contribute to solve the aging issue in the future (Holzmann, 1997). This forms the preliminary assumptions of this thesis, if pension investment in China will have an obvious positive impact on capital market, it can be used to support pension investment, risk can be limited by adequate asset allocation, and development of capital market will in turn boost pension funds' performance.

For the circumstance in China, in Li Zheng (2001) and Shi Jiangxiang (2004)'s report, pension fund and capital market, especially with the stock market, are interactive development relationship, pension fund can get average return only after entering the capital market. Meanwhile, investing pension in capital market can promote its development, which is a win-win consequence. Song Xiaozhong (2012) analyzes the deep impact once pension fund enter the capital market from the game theory view, he clarifies that pension fund is an important participant in the financial market. Its steady, long-term investment philosophy is the cornerstone of building a stable and healthy capital markets.

2.4 Pension Fund Investment in China

Debates about whether basic pension fund should enter the capital market become more fierce since the release of regulation in 2015. Many researches describe the necessary for pension to enter the capital market, including popular websites such as *Fenghuang Website* and *Xinhua Website*[6]. Supporters emphasis on the stimulating effect the pension fund has on the capital market, and they say it is the best way to avoid depreciation of pension fund in China. Li Shaoguang (2001) presented that it is the ultimate choice for pension fund to enter the capital market. Wu Xue (2003) pointed out that pension fund should apply diversified investment based on Japan's experiences. In addition to those point of view, there are two main support evidences for pension fund to enter the capital market: From developed countries' experiences, it is rare to put all pension fund in bank savings (Zhen

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[6] http://news.ifeng.com/a/20150630/44070236_0.shtml

  http://news.ifeng.com/a/20150824/44498086_0.shtml

http://news.xinhuanet.com/fortune/2015-12/25/c_128565435.htm

Bingin, 2011). And from China's own experiences, Chinese government use pension fund in Shandong province to do experiment, and those parts entering the capital market have achieved good results. In the past three yeas, average investment return per year reached 9.17%, which largely exceed the corresponding inflation rate.

A majority of those who oppose basic pension fund enter the capital market are out of security considerations. In their opinion, China's capital market is not mature, they are worry about possible loss of pension investments. Lin Yi (1995) early proposed that a mature capital market is the basic institutional conditions for the effective operation of pension fund. Zhen Bingwen (2004) said pension fund should not rush into the stock market, because the market conditions are not ripe yet in China. In Zhu Fulin (2006)' report, he clarified that pooling accounts and personal accounts have different functions, the former has to satisfy PAYG needs, steadily increasing the number of low-risk investment is optimal, stock and other equity products are not necessarily included at present. Ye Shan (2010) proposed prerequisites for pension fund to enter the capital including the capital market is relative mature, pension fund voluntarily enter the market and there is a guarantee for basic earnings after entering the capital market.

In general, the security of pension fund investment leads to the debate. Zhou Xiaochuan and Wang Lin (1993) put forward that the investment of pension fund should follow security principle, enhance value on the basis of hedging, investment strategies should be diversified. Li Zheng (2005) classified pension fund investment risk into systematic and unsystematic risk, in her opinion, unsystematic risk of investment can be avoided by choosing appropriate asset allocations. Hu Jihua (2007) pointed out that investing in stock is the only way to guarantee rate of return for pension funds, however, the proportion should not exceed 40%, or else the risk is too large for pension to bear. Yang Changhan (2012) presented that Chinese government should establish pension fund index to be used as foundation of choosing investment asset allocation. Ma Honghe (2012) suggests basic pension fund should enter the capital market step by step, Chinese government should strictly control the proportion invested into stock market, such limits can be unbended as

capital market ripens. In addition, basic pension fund should focus on long term investment. Most of existing literature toward this topic in China analyze in theoretical level. In this thesis, I analyze this issue based on quantitative method, using the investment history of National Social Security Fund to explain the impact of pension investment.

2.5 Factors Influence Pension Fund Risk Taking Policy

There are many researches on factors influence pension fund risk preferences. Nancy Mohan and Ting Zhang (2012) measure risk taking as either the percentage invested in the equity market or pension asset beta. The higher the beta, the more sensitive the fund fluctuate with the market. In their research, they found out that accounting standards is the main factor affecting pension fund investment risk, as higher return assumptions are accompanied by higher risk and betas. Mariba Rogers K (2009) found that historical asset allocation is a direct influencing factor. Legislation and asset returns are also significant factors influencing pension fund investment decisions. Adeoti, Johnson Olabode (2012) carried out a research on the pension fund investment in Nigeria. In his result, economic, risk and security of real estate factors are main determinants of pension fund investment.

Considering about the pension fund investment in China, Xu Chunlan (2011) analysis this problem from three aspects. In her opinion, Pension fund investment is closely tied with the historical aspect of the pension system reform, institutional system and economic system reform. With the rapid development of economy, inflation is inevitable. When inflation occurs, the accumulated pension funds will suffer great loss. As a consequence, to meet the need of payment, enhancing the value of pension fund becomes a pressing issue. This will directly affect pension investment strategy (Zhen Bingwen, 2003). In near future, China will enter the super aging society, which means pension fund face the risk of larger deficit. In order to ensure retirement payment, Chinese government should take action to invest pension fund in an effective way, accompanied by other methods such as deferring retirement age, encouraging development of commercial pension insurance (Gao Liman, 2005).

Yang Yiyong (1999) first proposed the establishment of specialized investment company in China, which takes the response to manage pension funds operations. From China's national conditions, Lin Yi (1999) advocates the implementation of a centralized pension fund investment management system. However, Wang Xing (2001) opposed the creation of specialized pension fund management companies, hoping pension funds to be invested by existing financial institutions. Huang Qin (2003) summed up the "Prudent Person Rule"[7] and conditions to apply "Quantitative Portfolio Regulation". He proposed that strict limit on the number of investment possess a negative impact on institutional investors' behavior patterns, and pointed out that the "Prudent Person Rule" should be the future trend of pension fund investment in China. Song Ming and Pu Xionghong (2007) clarify that different pillars should apply different risk level and asset allocations.

2.6 Pension Fund Investment And Risk Control

Pension Funds often have large amount of money to invest. According to the OECD report 2015[8], in OECD countries, pension funds has about 25.2 trillion dollar under management, so it acted as the main financing method for private pension plan. And in most non-OECD countries, the asset under pension fund management also constitutes a large proportion of their GDP. And it is shown that such rate is keep increasing in recent years.

There are widespread research on optimal investment methods for pension fund. Sona Kilianova and Georg Ch. Pflug (2009) presented a model aimed at determining optimal balance strategies between different pension funds, which possess different risk profiles. In their report, they showed that pension saving leads to a linear program when minimize the value at risk deviation. In Aihua Zhang and Christan-Oliver Ewald's (2009) research, they assumed that the pension contributions are invested in three fields: risk-free bond, index bond and stock. They deal with the optimization problem using the martingale method. Paolo Battocchio, Francesco Menoncin and Olivier Scaillet (2003) clarified that the

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[7] http://www.investopedia.com/terms/p/prudentmanrule.asp
[8] Pension Market in Force 2015, OECD

optimal asset allocation of pension investment varies in different phases. In the accumulation period, investment in risky asset decrease with time to meet future payment requirement. In the decumulation period, risky investment keep increasing through time because of the closeness of death. Fabio C. Bagliano, Carolina Fugazza and Giovanna Nicodano (2009) established a life-cycle model to find the optimal pension fund asset allocation. They assumed that the financial assets consist of one riskless asset and two risky assets. In their conclusion, they found out the link between optimal asset allocation and investors' risk aversion, and they also explored the replacement ratio. Carins (2000) made a continuous time stochastic model combined with Markov control strategies to find the optimal asset allocation and contribution rate. Blake. D. Carins. A (2001) summarize existing asset allocation strategies and estimate VAR under different asset allocation strategies. Most of existing research are working on the optimal asset allocation from the view of individual or single pension fund, standing from macro level, this thesis apply portfolio theory to provide optimal asset allocation suggestions for pension investment in China.

Meanwhile, pension fund should effectively manage the potential investment risk they are taking to ensure future payment (Fiona Stewart, 2010). With the development of financial market, pension fund investment face more complex risk. For example, Franzen, D. (2010) clarified that the main risk DB pension fund face are investment methods, inflation and longevity risk. Risk management of DB pension fund should focus on minimizing the pension costs of contributors, and minimizing the risk of beneficiaries' benefit. Groups in different ages often have different risk preferences (Hitt, Michael A., and Beverly B. Tyler, 1991). For active participants, they want to maximize their benefits and are willing to take more risk. However, for those retired people, they emphasis benefit security as they can't make up any loss. To solve this problem, Asset-liability modeling (ALM) is used to make time models move from "one-period static type" to "multi-period dynamic type" (S. Blome, K. Fachinger, D. Franzen, G.Scheuenstuhl, J. Yermo, 2007). On the other hand, from the view of DC pension fund members, they try to maximize their expected utility from consumption and bequests. Liu Lie and Cheng Lie (2006) use the long term VAR

method as the risk constraint to minimize the replacement ratio and solvency ratio under general conditions. In this thesis, I use Monte Carlo Simulation and Value at Risk method to analyze make risk assessment under optimal asset allocation.

3. Hypotheses

Based on the preceding literature review, hypotheses to be explored in this paper are described in this section. The main objective is to find results to the question "Whether China's basic pension fund investment has a positive effect on capital market development? ". And if the answer is "yes", I use it as one important evidence to support pension investment in China. Then I will go further toward the optimal asset allocation and risk control of pension fund.

Pension fund, acted as the institutional investor, can pool risk and diversify investment, thus increasing rate of return for end investors. Jorge E. Roldos (2004) pointed out that pension fund investors can enhance transparency and governance of the capital market, the development of capital market can in turn boost the performance of pension fund (Holzmann, 1997). According to existing literature, its positive impact on the capital market has been widely documented. Davis and Steil (2001) confirmed a degree of contemporaneous correlation between the two. I base my first hypothesis on the research carried out by Channarith Meng and Wade Donald Pfau (2010). In their study, they take 32 countries as sample, classify sample counties into "high" financial development group and "low" financial development group, and study the pension impact on capital market in these countries base on a Least Square Dummy Variables (LSDVC) estimator. In their conclusion, they presented that pension investment impact differ significantly in different capital markets. Based on their methodology, this thesis diversify the sample country groups into "high" and "low" financial development countries. Such diversification is based on the median number of total stock value traded over GDP ratio and total market capitalization over GDP ratio, those whose ratio is higher than the threshold belongs to

"high" Financial development group. Then I apply a static OLS regression between pension investment and capital market. As a result, I phrase my first hypothesis as follow:

H1: *Pension fund investment impact on capital market development differs according to different level of financial development. Positive impact is stronger in countries with "high" financial development.*

The first hypothesis analyzes the situation in 20 sample countries. If the first hypothesis hold, I move forward to verify that China possess "high" financial development, thus proving that pension investment in China have a positive impact on capital market development. After analyzing the performance in other countries, I focus on China's own experiences. National Social Security fund has an investment history for more than ten years, the main objective of it is to compensate the pension fund gap during the serious aging problem in the future, and the surplus part of basic pension fund can be invested together with it. As it possess many similarities as the basic pension funds, I take National Social Security Fund as a sample to study the relationship between the basic pension investment and China's capital market. Based on investment history of National Social Security Fund, Granger Causality test and Cointergation test are applied. Consequently, I present my second hypothesis as follow:

H2: *Basic pension fund investment Granger cause China's capital market development.*

If the first two hypotheses hold, I can conclude pension investments' positive impact on capital market development support its investment. It is consistent with Li Zheng (2001) and Shi Jiangxiang (2004)'s opinion, pension fund can get average return only after entering the capital market. Meanwhile, investing pension in capital market can promote its development, it is a win-win consequence.

After proving that pension investment in China is a wise idea, I move forward to study the pension fund investment asset allocation. In order to limit risk and maximize expected

return, I apply portfolio theory to find out the optimal asset allocation. According to the recently published regulation, the equity ratio of pension products shall not exceed 30% of the total net assets of the fund. Assuming that the basic pension fund in China invest only in stock, treasury bond, bank deposit and enterprise bond, I refer to the risk level of pension assets in the United States and test whether such 30% equity limit can take risk under control. The main reason why I fix the risk tolerance at the same level as pension assets in US is because US has a long pension investment history and it has achieved an outstanding investment results compared with other countries. Its average expected rate of return is 7.1% and standard deviation is approximately 9.6% since 1988. Based on US's experiences, fixing risk level under 10% is adequate. When fix the standard deviation of asset allocation at 9.6%, I calculate the optimal asset allocation based on historical data. And compare the equity ratio I get in optimal asset allocation with the 30% limit in regulation. In the last step, I take Monte Carlo Simulation and Value at Risk test to make risk assessment of the optimal asset allocation. The final hypothesis to be explored in my paper is as the following:

H3: *Apply a 30% quantitative limit to stock investment is an efficient way to control the risk of pension fund investment in China.*

4. Data And Variables

This section summaries the variables and data collection in the thesis. I include three main variables: PINVEST, MCG and STG. PINVEST is used to size of pension assets under management while others are used to capture capital market development. Data contains two major parts, international data include the Market capitalization, GDP, Pension investment scope, Stock value traded, Inflation and Rate of return data from 2005-2014 for 20 sample countries. There is 1186 international data in total after removing the missing data. Domestic data include National Social Security Fund historical investment data and relevant capital market data from 2004 - 2014, rate on investment for treasury bond, enterprise bond, stock and bank deposits data from 2001 to 2014. There are 117 domestic observations in total.

4.1 Relationship Between Pension Fund And Capital Market

PINVEST is defined as pension investment variable to measure the size of pension assets under management as a portion of GDP (PAUM/GDP). Besides, I also control for the overall development of sample countries with a proxy of GDP per capita in constant dollars.

Dicle (2010) presented that a well developed capital market promote growth by encouraging increased savings and lower transaction costs. By comparison, Market capitalization over GDP ratio and total stock value traded over GDP ratio are higher in higher income countries (Filer 1999). In this thesis, I use MCG and STG to proxy capital market development. MCG is the total market capitalization over GDP (MC/GDP) while STG is the total stock value traded over GDP (SVT/GDP), total market capitalization I mention here refer to the sum of bond and stock market capitalization. Both of these two variables are widely used indicators for capital market depth and liquidity, respectively.

Other independent variables I apply in the regression include variation, inflation, real return, and a dummy variable. Variation is the changes in asset allocation for sample

counties. Inflation is used to capture country specific effect. Real return is the product of rate of return and pension assets under management, it is used to capture pension investment outcome. Dummy is a vector of explanatory variables characterizing the financial development level of sample countries.

4.1.1 International Data

The international data takes 20 countries' investment history as sample, collect their Market capitalization, GDP, Pension investment scope, Stock value traded, Inflation and Rate of return data from 2005-2014. There is 1186 data in total. The real return per year is product of Rate of return and Pension Investment Scope. Data for pension investment scope, rate of return is collected from *OECD Global Pension Statistics*. Market capitalization, GDP, Inflation data is collected from *Knoema Data Statistic website, Trading Economics website and the World Bank website[9]*.

This thesis use Market Capitalization over GDP ratio (MCG) and Stock Value Traded over GDP ratio (STG) to rank the countries. As it shown in Table 2, the median number of MCG is 53.11% and the median number of STG is 56.17%, countries whose ratios are higher than these thresholds possess "high" level of financial development. And countries whose ratios are lower than these thresholds possess "low" level of financial development.

Table 1: International Average Data from 2005-2014

This Table reports average statistics from data collection for sample countries from year 2005 to 2014. There is 1186 data in total after removing missing data. The first row describes sample countries that are taken into consideration in this thesis. It includes both OECD countries and non OECD couturiers. The second row describes the average rate of return for pension investment in sample countries. Variances describes the changes in asset allocation for sample countries. Real return is calculated by the product of pension assets under management and real return. Inflation is used to capture country specific effects. PINVEST is used to capture size of pension assets, it is the ratio of pension assets under management over GDP in sample countries.

Unit: billion $

Country	Rate of return	Variance	Real return	Inflation	GDP	Pension assets under management	PINVEST
Hungry	3.09%	-6.20%	0.48	3.57	211.63	17.08	8.07%
New Zealand	3.55%	2.02%	0.95	2.69	140.81	21.04	14.94%
Portugal	2.54%	14.50%	0.84	1.35	273.90	30.08	10.98%
Poland	2.65%	0.90%	1.96	2.45	755.62	101.88	13.48%
Austria	1.62%	3.40%	0.34	1.76	347.84	17.87	5.14%
Germany	2.73%	-0.20%	5.03	1.31	3218.80	181.04	5.62%
Ireland	2.03%	14.00%	3.08	-0.25	200.56	96.27	48.00%
Peru	6.34%	3.50%	3.30	3.55	278.73	49.00	17.58%
Egypt	3.10%	2.07%	0.51	10.88	768.40	16.69	2.17%
Brazil	3.29%	8.90%	13.08	7.27	2711.27	395.22	14.58%
Norway	3.71%	-5.80%	0.82	4.03	291.31	21.56	7.40%
Thailand	1.64%	0.40%	0.90	2.80	872.16	50.37	5.78%
Japan	0.77%	-3.90%	13.35	-0.85	4307.89	1143.35	26.54%
Netherlands	5.30%	4.60%	57.13	1.35	736.80	1010.31	137.12%
Korea	1.26%	2.54%	1.01	1.77	1463.36	63.51	4.34%
Canada	4.79%	8.00%	37.67	2.05	1365.74	770.26	56.40%
Australia	3.89%	3.60%	23.86	3.33	861.16	709.66	82.41%
US	7.19%	4.50%	813.44	1.83	15121.32	11313.56	74.82%
UK	6.53%	12.80%	129.45	2.36	2324.66	1982.33	85.27%
Switzerland	3.67%	6.00%	58.40	0.68	1195.92	1334.21	111.56%

Table 2: Rank using two different methods

This two tables describe two subgroups: "High" financial development countries and "Low" financial development countries. The table on left ranks sample countries based on STG ratio, table on the right ranks sample countries based on MCG ratio. STG refers to the ratio of total stock value traded over GDP while MCG refers to the total market capitalization over GDP. I use the median index of STG and MCG as the threshold, those whose ratio is higher than the threshold belongs to "High" financial development countries, and those whose ratio is lower than the threshold belongs to the "Low" financial development countries. Using both two methods, although there is some changes in the ranking results, two subgroups remain unchanged. China belongs to "High" financial development countries under both ranking results.

Country	STG	Country	MCG
"Low" Financial Development		**"Low" Financial Development**	
New Zealand	3.80%	Hungry	19.96%
Peru	4.03%	New Zealand	32.78%
Ireland	5.54%	Portugal	35.05%
Poland	14.11%	Poland	35.37%
Austria	15.43%	Austria	37.71%
Hungary	17.25%	Germany	44.04%
Portugal	25.00%	Ireland	48.50%
Egypt	26.21%	Peru	48.88%
Brazil	34.85%	Egypt	50.05%
Germany	55.68%	Brazil	51.08%
Median	56.17%	Median	53.11%
"High" Financial Development		**"High" Financial Development**	
Thailand	56.66%	Norway	55.13%
Norway	59.75%	Thailand	71.75%
United Kingdom	72.58%	**China**	**76.63%**
Netherlands	84.79%	Japan	82.47%
Canada	89.57%	Netherlands	83.34%
Australia	91.01%	Korea	85.32%
Japan	102.16%	Canada	107.91%
China	**103.60%**	Australia	111.23%
Korea, Rep.	138.16%	United Kingdom	121.99%
Switzerland	165.17%	United States	128.36%
United States	250.02%	Switzerland	212.91%

Table 2 shows sample countries' classification by two ranking methods. It shows that "low" and "high" financial development groups remain unchanged using the two methods.

When I rank the countries using the stock value traded over GDP, China belongs to "high" financial development countries with a ratio of 103.60%. When I rank countries using MCG, China also belongs to "high" financial development countries with a ratio of 76.63%.

4.1.2 Domestic Data

National Social security fund in China began investing in capital market more than 10 years ago. According to "National Social Security Fund Investment Management Regulation", investments of social security fund are limited to bank deposits, treasury bonds and other financial instruments with good liquidity. The main function of National Social Security fund is to compensate the huge pension gap during the serious aging issues in the future, and the surplus of basic pension fund can be invested together with it, so it possesses many similar characteristics as the basic pension fund. This paper selects the National Social Security Fund historical investment data and relevant capital market data from 2004 - 2014 as samples. Besides, capital market in China mainly includes stock and bond markets. Bonds mainly include government, financial and corporate bonds. This paper uses the Shanghai and Shenzhen market capitalization to measure the scale of China's stock market, and uses the total issue amount of government, financial and corporate bond to measure the size of bond market. The data is collected from *Annual Report of National Council for Social Security Fund*[10] and *China Securities&Futures Statistical Yearbook*. Relevant data for bond market capitalization is collected from *Bond Market Statistical Analysis Annual Report.*

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[10] http://www.ssf.gov.cn/

Table 3: Pension fund and capital market data in China

This table summaries domestic statistics for pension investment and capital market in China from 2004 to 2014. There are 44 observations in total. The second row describes the investment history of National Social Security Fund in China, it is used to represent the pension investment history of basic pension fund. Market capitalization is the sum of stock market capitalization and bond market capitalization. I use Shenzhen and Shanghai stock market capitalization to measure the scale of stock market in China, Bond market capitalization is the total issue amount of government bond, financial bond and enterprise bond. PINVEST is use to measure size of pension assets, and it is the ratio of pension assets under management over GDP. MCG and STG are used to capture capital market development, MCG is the ratio of market capitalization over GDP while STG is stock value trade over GDP.

Unit: billion $

Year	Pension assets under management	GDP	Market capitalization	STG	PINVEST	MCG
2004	26.33	2459.66	9853.85	56.47%	1.07%	40.06%
2005	30.07	2860.57	11441.85	56.39%	1.05%	40.00%
2006	43.50	3327.91	22462.31	95.15%	1.31%	67.50%
2007	67.65	4089.38	62455.69	215.30%	1.65%	152.73%
2008	78.94	4831.46	29649.38	86.51%	1.63%	61.37%
2009	119.48	5244.65	50826.00	136.61%	2.28%	96.91%
2010	131.80	6177.11	55493.54	126.65%	2.13%	89.84%
2011	133.66	7278.52	45727.85	88.57%	1.84%	62.83%
2012	170.16	7991.85	47784.92	84.29%	2.13%	59.79%
2013	191.01	8751.46	50346.92	81.10%	2.18%	57.53%
2014	236.25	9791.74	76215.38	115.50%	2.41%	77.84%

Resources: China Securities Depository and Clearing Statistical Yearbook 2014

4.2 Data For Basic Pension Investment Risk Control

Considering risk management of pension investment, this thesis collects data of ROI on stock, enterprise bond, treasury bond and bank deposits from 2001 to 2014. With reference to the risk level of US's capital market, I establish a risk control system in pension fund investment. Average ROI and co-variances between different investment vehicles are shown in Table 4 and Table 5 below. Shanghai stock market index historical data and average return on treasury bond and enterprise bond is collected from *China*

Securities&Futures Statistical Yearbook and *Bond Market Statistical Analysis Annual Report.* I use the average return for 10 years treasury bond to represent the performance of treasury bonds. ROI on bank savings is average one year deposit interest rate in Bank of China, it is collected from *Zongtou website[11]*. Besides, I use the stock market index at the end of the year and stock market index at the beginning of the year to calculate average rate of return on stock each year from 2001 to 2014.

Table 4: Average ROI for different investment tools

This table summaries the average return on investment for bank deposits, treasury bond, stocks and enterprise bond in China from 2001 to 2014. There are 73 observations in total. In this thesis, I use the performance of 10 year treasury bond to measure the performance of treasury bond. ROI on bank savings is the average one year deposit interest rate in Bank of China. ROI for stock is calculated using Shanghai stock market index in the beginning and end of each year. For enterprise bond, ROI data is missing for year 2001 and 2002. The last row describes the inflation rate in China to make a comparison with investment return.

Year	Bank saving	Treasury bond 10 years	Stock	Enterprise bond	Inflation rate
2001	2.25	3.03	-20.56	-	0.7
2002	1.98	2.93	-17.50	-	-0.8
2003	1.98	3.15	9.58	-4.25	1.2
2004	2.25	4.52	-14.86	-4.09	3.9
2005	2.25	3.78	-8.29	24.07	1.8
2006	2.52	3.04	130.40	0.87	1.5
2007	3.33	4.02	96.67	-5.49	4.8
2008	3.87	4.03	-65.41	17.30	0.9
2009	2.25	3.38	80.05	0.68	-0.7
2010	2.60	3.48	-14.31	7.52	3.3
2011	3.25	3.86	-21.69	3.52	5.6
2012	3.50	3.38	3.18	7.65	2.6
2013	3.00	3.49	-7.89	3.61	4
2014	2.75	3.65	54.74	7.23	3.3
Average ROI	2.70	3.55	14.58	4.89	
Standard deviation	0.60	0.46	54.71	8.80	

Resource: National Council for Social Security Fund Website

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[11] http://www.zt5.com/cunkuanlilv/47914.html

Table 5: Covariance between basic pension fund investment variables

This table describes the co-variance between the four basic investment methods including bank deposits, treasury bond, stocks and enterprise bond. Co-variance is calculated using Excel based on the ROI statistics for bank deposits, treasury bond, enterprise bond and stock form year 2001 to 2014 in China. This co-variance results will be applied in section 5.2.1 to calculate the optimal assets allocation.

Variables	Bank saving	Treasury bond	Stock	Enterprise bond
Bank saving	0.33	0.11	-4.07	1.13
Treasury bond	0.11	0.21	-4.68	0.20
Stock	-4.07	-4.68	2993.52	-220.78
Enterprise bond	1.13	0.20	-220.78	77.38

5. Methodology

5.1 Part I: Relationship Between Pension Investment And Capital Market

5.1.1 Other Countries' Performance

In this part, this thesis try to find the relationship between pension investment and capital market based on other countries' experiences. Channarith Meng and Wade Donald Pfau (2010) use a dynamic approach to study the relationship. In this thesis, I establish an static OLS regression between PINVEST and MCG, PINVEST and STG. MCG and STG are dependent variables while PINVEST is used as independent variables in the model. In addition, I also use independent variables including Variation, Inflation, Real return and Dummy. Variation is used to characterize their changes in pension investment asset allocation, Real return measures investment performances of pension funds, Dummy is vector characterizing level of financial development, and Inflation is applied to capture country specific effects.

For the 20 sample countries, the model created is shown in the following formula:

$$STG = \alpha_1 PINVEST + \alpha_2 Dummy + \alpha_3 Variation + \alpha_4 Inflation + \alpha_5 real\_return + \mu ....1)$$

$$MCG = \beta_1 PINVEST + \beta_2 Dummy + \beta_3 Variation + \beta_4 Inflation + \beta_5 real\_return + \xi ....2)$$

- STG and MCG are indicators used to measure capital market development.

  STG=(Total stock value traded)/GDP

  MCG= (Total market capitalization) / GDP

- PINVEST is the indicator used to measure the size of pension assets under management as a proportion of GDP.

  PINVEST=(Pension assets under management) / GDP

- D is dummy variable. D=1 for countries with "high" level of financial development. D=0 for countries with "low" level of financial development.

- Variation is the change of pension investment asset allocation in the past 10 years for sample countries.

- Inflation is the inflation rate in past 10 years for sample countries.

- Real return is return of pension funds in past 10 years for sample countries.

- ξ and μ are random error term.

To find out the pension investment impact on capital market in different countries, I then diversify the 20 sample countries into two groups: Countries with "high" economic growth rate and countries with "low" economic growth rate. Each group has 10 sample countries. This classification is made based on the MCG and STG ratio, when use the median index value as the threshold, those exceed the threshold possess "high" financial development. I analyze the pension investment impact on their capital markets separately. In the final step, I explore the relationship between pension investment and capital market in China by assorting China into the "high" financial development group. In this regression, dummy variable is not applied.

5.1.2 China's Own Performance

Walker and Lefort (2002) show that in developed countries, the capital market and pension assets have a positive correlation. On the one hand, increase in pension assets will promote the development of the capital markets, on the other hand, a sound capital market is able to improve the rate of return of pension fund. Davis and Steil (2001) suggest that the development of capital markets is a precondition to support the growth of institutional investors. However, compare with those mature capital markets in developed countries, those in emerging countries are usually incomplete markets. In those markets, it is more likely to face liquidity problems, regulatory legal insufficiency, large market volatility, higher investment risk. In China, capital market possesses 20 years history, and it is lack of transparency compared with mature markets. Zhen Bingwen (2004) presented that it is risky to for pension fund to invest in China's capital market, especially considering the large fluctuation in stock market.

The main objective in this section is to test the relationship between pension fund and China's incomplete market. If pension investment also has a positive impact on China's

capital market, just as those investing in the developed countries, I can use it as evidence to support that basic pension fund in China should enter the capital market. As basic pension in China has little investment history, I use National Society Fund to represent it. National Social Security fund, as a national response to aging problem in China, has investment history for more than 10 years. It possess similar characteristics as pension fund and the surplus part of pension can be invested in the same mode as the National Social Security fund.

Therefore, considering their similarities, I based my calculation on National Social Security and its relationship with capital market. I use Granger causality test and co-integration test to reflect the relationship between pension investment and capital market development in China, thus offer evidence for whether basic pension fund should enter the capital market.

Assumption:

- *The investment history of National Social Security Fund can be used to represent the investment of basic pension fund.*

In Granger Causality test, if variables X is said to Granger cause variable Y, X values can provide statistically important information about the future value of Y. One the other hand, if Y also Ganger cause X, X and Y are reciprocal causation. And this test is often taken through t test and F test on lagged value of X or Y. Besides, the prerequisite for Granger test is that variables should be stable. So the first step is to take unit root test, the method I use here is ADF method.

To test x Ganger cause y:

$$y_t = \sum_{j=1}^{m} b_j y_{t-j} + u_{1t} \text{......................................3)}$$

$$y_t = \sum_{i=1}^{k} a_i x_{t-i} + \sum_{j=1}^{m} b_j y_{t-j} + u_{2t} \text{......................4)}$$

To test y Ganger cause x:

$$x_t = \sum_{j=1}^{r} \lambda_j x_{t-j} + u_{1t} \quad \text{.........................5)}$$

$$x_t = \sum_{i=1}^{q} \delta_i y_{t-i} + \sum_{j=1}^{r} \lambda_j x_{t-j} + u_{2t} \quad \text{......................6)}$$

Null hypothesis for 3) is $\sum_{i=1}^{k} a_i = 0$ and null hypothesis for 4) is $\sum_{i=1}^{q} \delta_i = 0$

F test is used to test the null hypothesis, suppose RSS_1 and RSS_2 are residual sum of squares for formula 3) and 4). k is lagged number of x, n is the sample size of y, and p is number of variables to be estimated in 4).

$$F_1 = \frac{(RSS_1 - RSS_2)/k}{RSS_2/(n-p)} \quad \text{..........................7)}$$

$$F_1 = \frac{(RSS_3 - RSS_4)/q}{RSS_4/(q-p)} \quad \text{..........................8)}$$

Under certain confidence level, if value of F is larger than the critical value, we can reject the null hypothesis, which means x Granger cause y.

5.2 Risk Control of Basic Pension Fund Investment

5.2.1 Optimal Asset Allocation

The nature of basic pension fund makes security of investment property the first element of consideration, its main goal is to pursue certain investment income under the strict risk control. If the risk of pension fund investment allocation is too low, it is difficult to obtain the purpose of enhancing pension fund value. If the configuration of risk is too high, pension fund face large probability of loss. Therefore, the core issue of risk control is to find an adequate assets allocation.

America and some other developed countries provide successful pension investment experience and offer feasible reference for China. However, as the capital market in China is an emerging market, it has greater volatility, so the investment risk is significantly higher than that in mature markets. According to the portfolio theory, I can adjust the weight of different risky assets within the efficient frontier to get the risk level of

investment I want. In China's current situation, national social security fund can invest in stocks, treasury bonds, bank deposits and other financial instruments with good liquidity. According to other countries' performances, the majority of pension assets are invested into bank deposits, bonds and stocks (see Appendix 4). Based on existing information, this thesis assume bank deposits, treasury bonds, stocks, enterprise bonds as the basic pension investments. I use portfolio theory, by fixing the expected return at different level, I get different optimal asset allocations to minimize risk.

Assumption:

- *Basic pension fund will only invest in stock, treasury bond, bank deposit and enterprise bonds. I use w_1, w_2, w_3, w_4 to present the proportion of this four parts respectively. $w_1 + w_2 + w_3 + w_4 = 1$*

When I consider pension funds management in different countries, pension funds in United States has a long investment history back to 1988. After years of exploring, pension funds in United States has achieved good investment results, its average expected rate of return is 7.1% and standard deviation is approximately 9.6% (Waldo Tapia, 2008), such performance is outstanding compared with other countries. In this thesis, I based my study on the experience of pension fund management in United States. An another assumption I make here is that China's basic pension market risk tolerance is similar to those pension funds in US. Under such assumption, I present the proportion of portfolios in high-risk assets such as stocks, and strictly control the upper limit of the stock asset allocation. Consequently, I obtain certain expected return for basic pension fund under the certain risk level.

Assumption:

- *Basic pension fund in China has similar risk tolerance as those pension assets in the United Ststes.*

According to related regulations[12] made by Chinese government, surplus of basic pension fund should be enough to compensate two months expenses. Till the end of 2014, the accumulated amount of basic pension fund is 546.69 million dollars, and the total expenses for the whole year is 358.46 million dollars, average monthly expense is \$29.87 million, two months expense is \$59.74 million, which takes 10.9% of accumulated value (*Sources: China Social Security Fund Council Website*). In order to satisfy payment requirement, at least 10.9% of basic pension fund should be pooled into the bank deposit.

As it shown in Table 4, I suggest r_1, r_2, r_3, r_4 represent the return on investment for the four investment tools. r_1 is the average return for Shanghai stock market from 2001 to 2014. r_2 is the average rate of return for ten year treasury from 2001 to 2014. r_3 is average bank deposit in the past 15 years. r_4 is average rate of return for enterprise bond from 2003 to 2014. In order to find the optimal asset allocation, I try to minimize the variance under expected return and then compare the results with those in America:

$$\min \sigma_p^2 = \sum_{j=1}^{4} \sum_{i=1}^{4} w_i w_j COV(r_i, r_j)$$

$$w_1 r_1 + w_2 r_2 + w_3 r_3 + w_4 r_4 \geq E$$
$$w_1 + w_2 + w_3 + w_4 = 1$$
$$10.9\% \leq w_3 \leq 1$$
$$0 \leq w_i \leq 1$$

E is the minimum acceptable return for the portfolio.

5.2.2 VaR Test of Optimal Asset Allocation

This paper uses VAR model to make risk assessment of the optimal asset allocation I get in Section 5.2.1. Because VAR itself represents the possible investment losses in our model, I can get a deep understanding about the maximum pension gap at a certain confidence interval. In this VaR model, 99%, 95% 90% and 85% confidence levels are applied. As China's capital market is not mature, there exists a lack of historical data. Historical data simulation and analysis parameters are not suitable in this model. This paper uses Monte Carlo simulation, according to the distribution of historical data, I

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[12] "Regulation on Establishment of United Basic Pension System For Employees", 2000.

generate a random number of the same distribution, and then use this data to make simulation.

Monte Carlo simulation can compensate for insufficiency of historical data and get more reliable results. I follow the following steps to use Monte Carlo simulation:

a. Determine the target variable. In pension investment, I use the expected return as target variable.

b. Distribution of ROI are assumed. This paper assumes ROI on bank deposits, treasury bond, stock and enterprise bond follow normal distribution. Based on historical data, this thesis uses *Eviews* to test this assumption.

c. Set the number of simulations at one thousand times and make Monte Carlo Simulation.

d. Analyze the simulation results. The results outputs in frequency distribution. In this way, the distribution of the observed accumulated total pension is presented.

e. Calculate the Value at Risk using the simulation result.

● **Null Hypothesis**: *The ROI on bank deposit, treasury bond, stock and enterprise bond follows the normal distribution.*

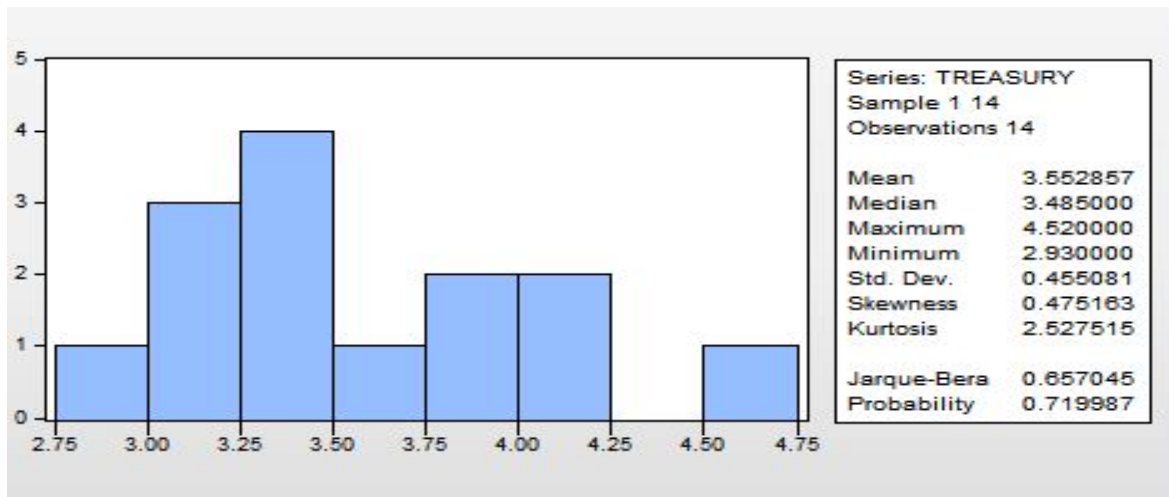**Table 6: Distribution of ROI for Bank Deposit**

This graph reports the distribution of ROI for bank deposit. Based on average rate of return statistics for bank savings in China from 2001 to 2014 described in Table 4, Eviews is used to test whether the ROI on bank savings follows the normal distribution here under 5% confidence level. ROI on bank savings refers to the average one year deposit interest rate in the Bank of China. There are 168 observations in total for the one year deposit interest rate every month from 2001 to 2014, which results in 14 sample for return on bank deposits. I can reject the hypothesis if P value is smaller than 0.05.
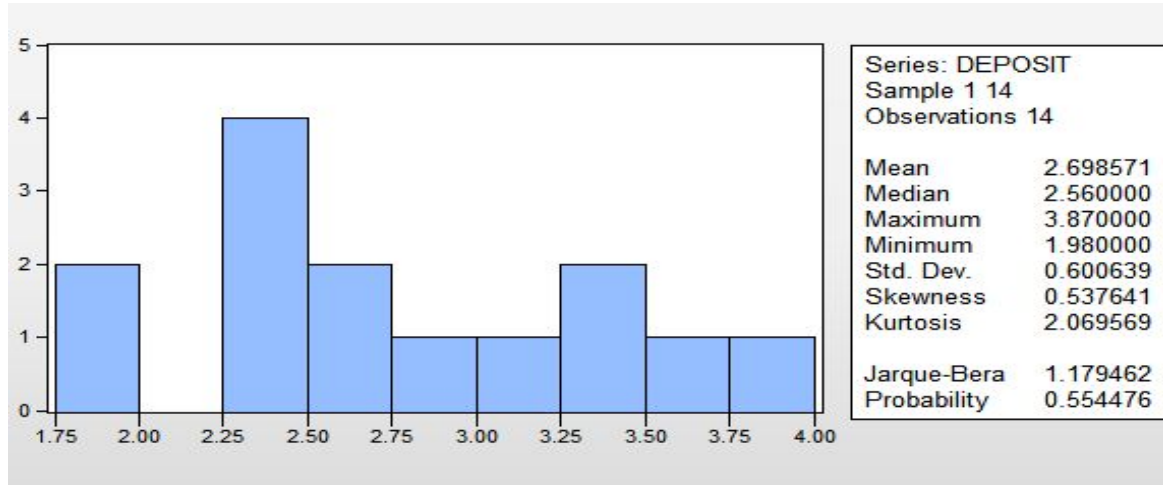
In the calculation result, I can see the JB factor is 1.179462 while the P value is 0.5544, which is larger than 0.05. So I can't reject the null hypothesis, the ROI of stock follow the normal distribution. $ROI_{bank\_deposit}$ follows $N(2.699, 0.601^2)$

Table 7: Distribution of ROI for Treasury Bond

This graph reports the distribution of ROI for treasury bond. Based on average rate of return statistics for Treasury bonds from 2001 to 2014 described in Table 4, Eviews is used to test whether the ROI on treasury bonds follows the normal distribution here under 5% confidence level. In this thesis, I use the average return for 10 years treasury bond to represent the performance of treasury bond. There are 14 observations in total for return on treasury bond. I can reject the hypothesis if P value is smaller than 0.05.

In the result for the treasury bond, the JB factor is 0.6657 while the probability equals 0.719987, which is larger than 0.05. So I can't reject the null hypothesis, the $ROI_{treasury\_bond}$ follows $N(3.553, 0.455^2）$
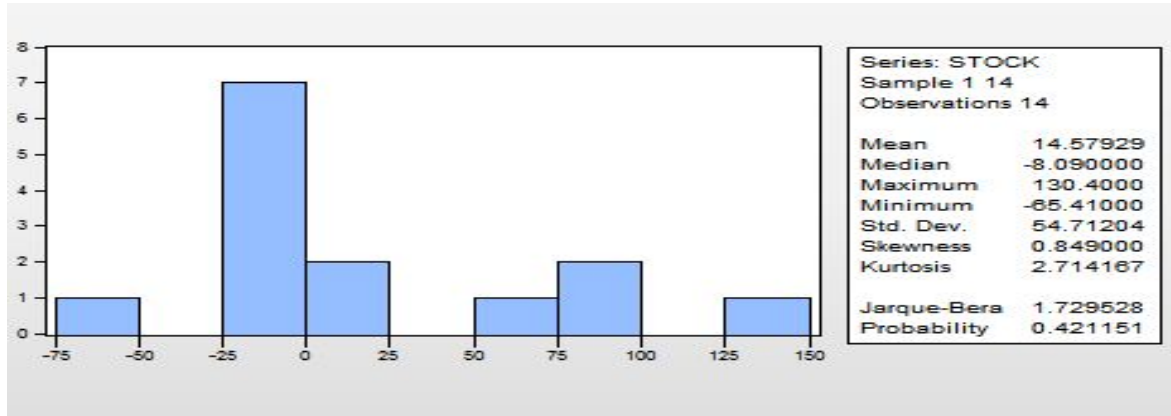
Table 8: Distribution of ROI for Stock

This graph reports the distribution of ROI for stock. Based on average rate of return statistics for stocks from 2001 to 2014 described in Table 4, Eviews is used to test whether the ROI on stocks follows the normal distribution here under 5% confidence level. In this thesis, the ROI for stock is calculated using Shanghai Stock market index in the beginning and end of each year from 2001 to 2014. There are 15 observations in total for Shanghai stock market index, which results in 14 samples for return on stock. I can reject the hypothesis if P value is smaller than 0.05.

In the result for stock, the JB factor is 1.729 while the probability equals 0.421. I can't reject the null hypothesis, the ROI_{stock} follows $N(14.579, 54.712^2)$

Table 9: Distribution of ROI for Enterprise Bond

This graph reports the distribution of ROI for enterprise bond. Based on average rate of return statistics for enterprise bonds from 2003 to 2014 (data in 2001 and 2002 is missing) described in Table 4, Eviews is used to test whether the ROI on enterprise bonds follows the normal distribution here under 5% confidence level. There are 12 observations in total for average return on enterprise bond. I can reject the hypothesis if P value is smaller than 0.05.
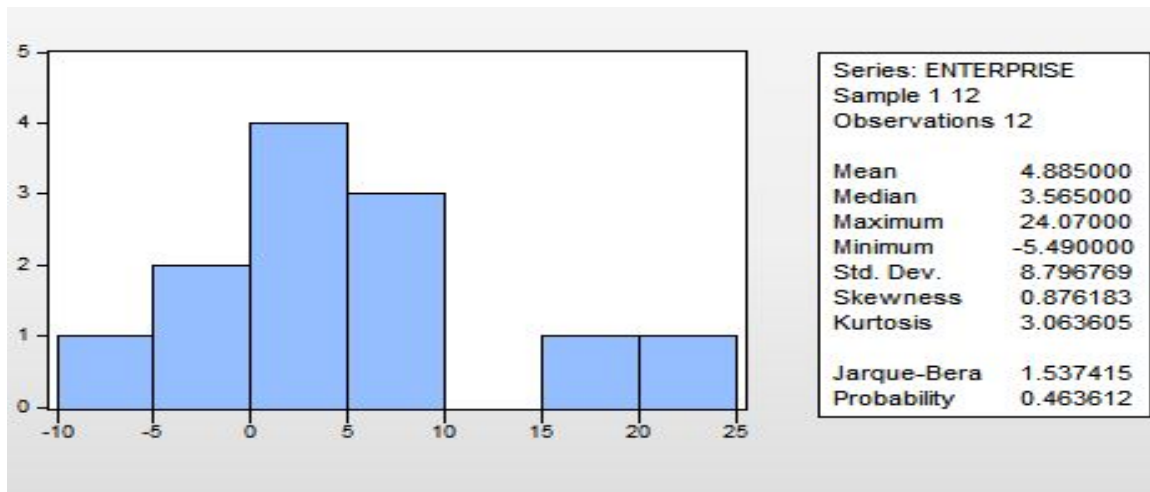
In the test result for enterprise bond, the JB factor is 1.537 while the probability equals 0.436, which is larger than 0.05. So I can't reject the null hypothesis, the $ROI_{enterprise\_bond}$ follows $N(4.885, 8.797^2$）

Till now, I know the distribution of ROI. The next step is Monte Carlo simulation process. I use Eview to do Monte Carlo simulation, and set the number of replication at 10000 times. I choose the optimal asset allocation when fixing the risk at the same level as those pension funds in United States.

6. Results

6.1 Pension Fund And The Capital Market

6.1.1 Other Countries' Performances

Using historical data of 20 sample countries, I apply static OLS regression to study the relationship between the pension fund investment and capital market development. Table 10 shows that PINVEST has a positive impact on both STG and MCG. It means in those sample countries, the pension investment has a positive impact on the development of capital market. One unit change in PINVEST will cause 0.386 unit change in MCG on average, and one unit change in PINVEST will cause 0.128 unit change in STG on average.

Meanwhile, Dummy variable also has a positive impact on MCG. It suggest that as a whole, the country financial development level has a stronger positive impact on capital market development. For variation, it possesses positive impact in MCG estimate while it is insignificant in STG estimate. Inflation is insignificant in both estimates. Real return's effect is significant but its coefficient is low. R squared values are low in both estimate, this is due to the fact that capital market development are affected by many factors, the number of variables I choose here have limited explanatory power.

Table 10: Sample Countries OLS Regression results

This table reports the OLS regression results for the whole 20 sample countries. There are 200 observations in total. Dependents variables include STG and MCG, STG is the ratio of total stock value traded over GDP and MCG is the total market capitalization over GDP, both variables are used to measure capital market development. Exploratory variables are: PINVEST, INFLATION, VARIATION, DUMMY and REAL RETURN. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP*. D is dummy variable used to capture the level of financial development in sample countries. D=1 for countries with "high" level of financial development. D=0 for countries with "low" level of financial development. Variation is the change of pension investment asset allocation in the past 10 years for sample countries. Inflation is the inflation rate in past 10 years for sample countries, it is used to capture country specific effects. Real return is used to measure pension funds performance for sample countries and it is the product of real rate of return and pension investment scope in from 2005 to 2014.

Dependent Variable: STG		Dependent Variable: MCG	
Variable	Coefficient	Variable	Coefficient
C	0.163**	C	0.263***
PINVEST	0.128**	PINVEST	0.386***
INFLATION	0.003	INFLATION	0.008
VARIATION	0.218	VARIATION	1.320**
DUMMY	0.844***	DUMMY	0.503***
REAL_RETURN	0.0004**	REAL_RETURN	0.0002*
R-squared	0.477	R-squared	0.595
F-statistic	35.402	F-statistic	56.934

Note: Included observations: 200

***,** and * represent significance level at 1%, 5% and 10%, respectively.

After analyzing the pension investment impact on capital market as a whole, I classify the sample countries into "high" and "low" financial development groups and analyzes the pension investment impact separately. Classification using MCG and STG ratio results in the same country groups.

As it shown in Table 11 and 12 below, for "low" financial development countries, the coefficient of PINVEST in STG estimate is negative while it in MCG estimate is 0.236. For "high" financial development group, the coefficient of PINVEST in STG estimate is 0.109 while it in MCG estimate is 0.368. This results suggests that "high" financial development countries do a better job in taking advantage of their pension fund. Overall, I can conclude that the impact of pension fund investment on capital market differs because

different countries possess different level of financial development. This results is consistent with Channarith Meng and Wade Donald Pfau (2010)'s findings. As China belongs to the "high" financial development countries, investing the basic pension fund in the China's capital market has a positive impact on capital market development.

Table 11: "Low" Financial Development Countries Regression Outcome

This table reports the OLS regression results for "Low" financial development countries, this subgroup include 10 sample countries including New Zealand, Peru, Ireland, Poland, Austria, Hungary, Portugal, Egypt, Brazil and Germany. There are 100 observations in total. Dependent variables include STG and MCG, STG is the ratio of total stock value traded over GDP and MCG is the total market capitalization over GDP, both variables are used to measure capital market development. Exploratory variables are: PINVEST, INFLATION, VARIATION and REAL RETURN. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP*. Variation is the change of pension investment asset allocation in the past 10 years for sample countries. Inflation is the inflation rate in past 10 years for sample countries, it is used to capture country specific effects. Real return is used to measure pension funds performance for sample countries and it is the product of real rate of return and pension investment scope in from 2005 to 2014.

Dependent Variable: STG		Dependent Variable: MCG	
Variable	Coefficient	Variable	Coefficient
C	0.278***	C	0.278***
PINVEST	-0.768***	PINVEST	0.236**
REAL_RETURN	0.006***	REAL_RETURN	0.006***
INFLATION	-0.003	INFLATION	0.015***
VARIATION	0.530	VARIATION	0.525**
R-squared	0.214	R-squared	0.255
F-statistic	6.461	F-statistic	8.162

Note: Included observations: 100

***,** and * represent significance level at 1%, 5% and 10%, respectively.

Table 12: "High" Financial Development Countries Regression Outcome

This table reports the OLS regression results for "High" financial development countries, this subgroup include 10 sample countries including Thailand, Norway, United Kingdom, Netherlands, Canada, Australia, Japan, Korea, Rep, Switzerland and United States. There are 100 observations in total. Dependent variables include STG and MCG, STG is the ratio of total stock value traded over GDP while MCG is the total market capitalization over GDP, both variables are used to measure capital market development. Exploratory variables are: PINVEST, INFLATION, VARIATION and REAL RETURN. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP.* Variation is the change of pension investment asset allocation in the past 10 years for sample countries. Inflation is the inflation rate in past 10 years for sample countries, it is used to capture country specific effects. Real return is used to measure pension funds performance for sample countries and it is the product of real rate of return and pension investment scope in from 2005 to 2014.

Dependent Variable: STG		Dependent Variable: MCG	
Variable	Coefficient	Variable	Coefficient
C	1.020***	C	0.832***
PINVEST	0.109*	PINVEST	0.368**
REAL_RETURN	0.0003*	REAL_RETURN	0.0002
INFLATION	-0.012	INFLATION	-0.020
VARIATION	1.129	VARIATION	3.222**
R-squared	1.152	R-squared	0.335
F-statistic	2.461	F-statistic	11.965

Note: Included observations: 100

***,** and * represent significance level at 1%, 5% and 10%, respectively.

6.1.2 China's Own Performance

6.1.2.1 ADF Test

PINVEST and MCG data in China is shown in Table 3. I use ADF test to test stability of variables. The null hypothesis here is that the original series is unstable and has unit root. The following table is the ADF result. When test unit root in level, PINVEST, STG and MCG have a unit root. I test again in 1st difference. This time all results are stable under the confidence level at 5% and 10%.

Table 13: ADF test results

This table summaries the ADF test result using Eviews in level and 1ˢᵗ difference for variables including PINVEST, MCG and STG. STG and MCG. There are 60 observations in total. STG is the ratio of total stock value traded over GDP while MCG is the total market capitalization over GDP, this two variables are used to measure capital market development. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP*. The t statistics for variables are compared with the critical value under 1%, 5% and 10% confidence level. In the test results, it is shown that PINVEST, MCG and STG are unstable in level while all of them are stable under the 1ˢᵗ differences.

Null hypothesis: PINVEST has a unit root	t statistics	probability
ADF test statistics:	-0.916	0.749
Null hypothesis: MCG has a unit root	t statistics	probability
ADF test statistics:	-2.727	0.096
Null hypothesis: STG has a unit root	t statistics	probability
ADF test statistics:	-2.990	0.070
Null hypothesis: D(PINVEST) has a unit root	t statistics	probability
ADF test statistics:	-4.553***	0.005
Null hypothesis: D(MCG) has a unit root	t statistics	probability
ADF test statistics:	-5.253***	0.0017
Null hypothesis: D(STG) has a unit root	t statistics	probability
ADF test statistics:	-4.388**	0.001

Note: ***,** and * represent significance level at 1%, 5% and 10%, respectively.

6.1.2.2 Cointegration Test

In ADF result, PINVEST, STG and MCG are not stable, but the 1ˢᵗ difference of them are stable. In this step, I use cointegration test to find whether there exists a stable linear relationship between the non-stationary series. Under confidence level 5%, PINVEST and MCG, PINVEST and STG have no cointergation relationship. Under confidence level 10%, T statistics 14.31 and 14.37 are larger than critical value 13.42. In this situation, PINVEST and MCG, PINVEST and STG have a cointergation relationship. In the Section 6.1.2.3, Granger Causality test is applied under confidence level at 10%.

Table 14: Cointegration test result

The table summaries the unrestricted cointergation test results for MCG and PINVEST, and STG and PINVEST. There are 60 observations in total. STG is the ratio of total stock value traded over GDP while MCG is the total market capitalization over GDP, this two variables are used to measure capital market development. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP*. Compare the Trace Statistics with 5% and 10% critical level. It is shown that the the conitergation relation exists between PINVEST and MCG, PINVEST and STG under the 10% confidence level.

Eigenvalue	Trace Statistics	0.05 Critical Level	0.1 Critical Level	Probability
Series: MCG PINVEST				
0.6637	14.316*	15.495	13.429	0.0747
Series: STG PINVEST				
0.657	14.370*	15.495	13.429	0.0733

Note: ***,** and * represent significance level at 1%, 5% and 10%, respectively.

6.1.2.3 Granger Causality Test

In order to find interactive relationship between PINVEST and MCG, PINVEST and STG, Granger Causality test is used, the test result is in the following table:

Table 15: Granger causality test result

This table reports the Granger Causality test results for MCG and PINVEST, and STG and PINVEST. There are 60 observations in total. STG is the ratio of total stock value traded over GDP while MCG is the total market capitalization over GDP, this two variables are used to measure capital market development. PINVEST is the indicator used to size of pension assets under management as a proportion of GDP. *PINVEST=(Pension assets under management)/GDP*. The second cow describes the F statistics under different null hypothesis and the third cow list the P values for different null hypothesis.

Null hypothesis	F statistics	P value
MCG doesn't Granger Cause PINVEST	0.5914	0.716
PINVEST doesn't Granger Cause MCG	675.36**	0.028
STG doesn't Granger Cause PINVEST	0.592	0.717
PINVEST doesn't Granger Cause STG	2221.7**	0.016

Note: ***,** and * represent significance level at 1%, 5% and 10%, respectively.

F statistic 675.36 and 2221.7 are larger than the F statistics under confidence level 10%. PINVEST Granger cause MCG, but MCG doesn't Granger cause PINVEST. PINVEST Granger cause STG, but STG doesn't Granger cause PINVEST. In conclusion, Pension fund investment makes some contribution to the development of the capital market in China. This model result is in support of the basic pension fund investment.

6.2 Risk Control of Basic Pension Fund Investment

6.2.1 Optimal Asset Allocation Results

According to Table 4, bank deposit has the lowest rate of return at 2.7%, and stock investment possess the highest rate of return at 14.58%, so the expected return of the whole portfolio should between these two numbers. I equally divide this interval into 12 parts, then use EXCEL to do solver. When fixing expected return, I can find the optimal asset allocation to minimize the variances. And when fixing the risk at the same level as that in America, I can find optimal asset allocation to maximize expected return. When expected return is at 13.392% and 14.58%, proportion invested in the enterprise bond result are negative, which is impossible. So the last two asset allocations are removed.

Table 16: Basic pension fund investment optimal asset allocation

This table describes the optimal asset allocation for pension assets under management in China under different expected return. The minimum rate of return is for treasury bond at 2.7%, and the highest average rate of return is for stock at 14.58%, I equally divide this interval into 11 parts and fix expected return. This optimal assets allocation is calculated base on statistics for ROI from 2001 to 2014 and co-variance between different investment methods described in Table 4 and 5. When fix expected return, I get the optimal asset allocation to minimize variance. The 6th row is the optimal asset allocation when refer to the risk level of pension assets in the US.

Bank saving	Treasury bond	Stock	Enterprise bond	St.d	EX
100.00%	0.00%	0.00%	0.00%	1.83%	2.70%
33.94%	19.30%	0.00%	46.75%	4.27%	3.89%
10.90%	0.00%	4.38%	84.72%	6.72%	5.08%
10.90%	0.00%	16.64%	72.46%	8.39%	6.26%
10.90%	**0.00%**	**19.59%**	**69.51%**	**9.60%**	**6.55%**
10.90%	0.00%	28.90%	60.20%	14.19%	7.45%
10.90%	0.00%	41.16%	47.94%	20.92%	8.64%
10.90%	0.00%	53.42%	35.68%	27.92%	9.83%
10.90%	0.00%	65.68%	23.42%	35.03%	11.02%
10.90%	0.00%	77.94%	11.16%	42.20%	12.20%
10.90%	0.00%	90.20%	-1.10%	49.39%	13.39%
10.90%	0.00%	100.00%	-10.90%	55.15%	14.58%

From the calculation results, I can conclude that under the same risk level, rate of return on portfolio is higher than ROI on a single investment tool. For example, when standard deviation is at 8.39%, under optimal asset allocation, the expected return is about 6.26%. This result is higher than investing only in enterprise bond, which possess a return of 4.89% and a risk of 8.88%.

Then I take risk control of basic pension fund investment in China refer to the risk tolerance of America's pension asset. According to OECD statistics, the average expected rate of return is 7.1% and standard deviation is approximately 9.6% since 1988 in America

(Waldo Tapia, 2008). Its asset allocation is consisted of approximately 50% stock, 30% bonds, and the rest are invested in other tools such as real estate. As we can see from results, when fixing the risk at the same level as those pension funds in America, expected return for pension fund investment in China is about 6.549%, this is achieved by investing 10.9% in bank deposits, 19.59% into stock market and 69.51% into corporate bonds. Compared with asset allocation in other countries and their average annual return (see Appendix 4 and 5), such expected return is good.

To conclude, based on America's pension investment experiences, Chinese government should limit the proportion of basic pension fund investing in stock under 20%. Under such limit, basic pension fund in China bears approximately the same level of risk and achieve similar rate of return as America, so the investment is relatively safe.

6.2.2 VAR Test Results

Using Eviews to do Monte Carlo simulation, I get the distribution of expected return for the pension investment under 9.6% risk level. The formula for expected return under the risk level and simulation results is shown in Table 17 and 18 below:

### Table 17: Expected return of optimal asset allocation

This table describes the formula of expected return for optimal asset allocation. The optimal asset allocation for pension investment in China is shown in Table 16. When fix the risk level at the same rate as those pension assets in United States, investing 10.9% into bank deposits, 19.59% into stock and the rest into enterprise bond in China can maximize expected return.

Bank saving	Treasury bond	Stock	Enterprise bond	St.d
10.90%	0.00%	19.59%	69.51%	**9.60%**

$Expected\_return = 0.109 ROI_{bank\_deposit} + 0.1959 ROI_{stock} + 0.6951 ROI_{enterprise\_bond} \dots \dots 9)$

Table 18: Monte Carlo Simulation for optimal asset allocation

This graph summaries the Monte Carlo Simulation Results for the expected return on optimal asset allocation described in table 17. Eviews is used to do Monte Carlo Simulation, and I set the replication at 1000 times. In the simulation results, it is shown that the expected return for pension assets in China also follow the normal distribution.
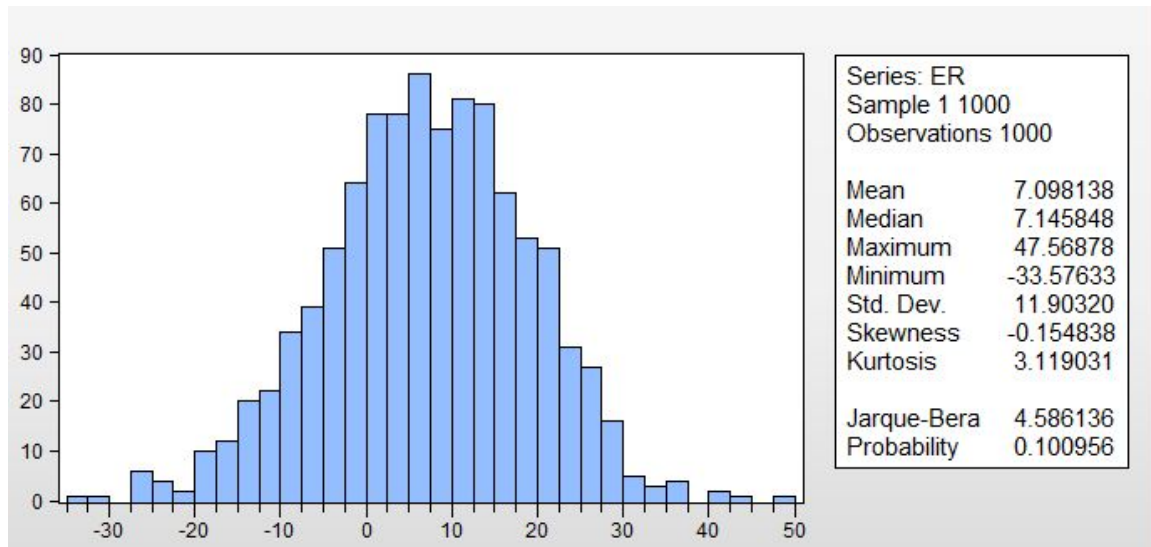
According to the simulation result, when investing 10.9% in bank deposits, 19.59% into stock and the rest into enterprise bond 69.51%, the real risk level is at about 11.9% and the rate of return is at 7.098%. Standard derivation in Monte Carlo simulation results is higher than 9.6%, this is because 9.6% st.d is based on historical data while 11.9% is based on simulation. If I use the 12.1% standard deviation of US long term treasury bond fund (eg: Amer Cent Benham: Target Mat 2010)[13] as a reference, when limit the stock investment at about 20%, the volatility of pension fund is at about 11.9%, it is close to that of long term treasury bonds.

Then VaR method is applied based on the simulation results. As the expected return distribution is normal, I calculate the value at risk using a parametric estimation: $VAR = \mu - z\sigma$ (Thomas J. Linsmeier and Neil D. Pearson, 2000), which is the possible maximum losses under different confidence level.

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[13] https://www.aaii.com/journal/article/treasury-bond-funds-a-risky-riskless-investment-

Table 19: Value at risk under different confidence level

This table reports the Value st Risk results for the expected return under 99%, 95%, 90% and 85% confidence level. Based on the simulation results shown in Table 19, the expected return follow the normal distribution, so I use empirical method to calculate value at risk in this possess. This results can not be rejected after back-testing.

Confidence level	99%	95%	90%	85%
VaR	20.593%	12.481%	8.156%	5.239%

According to the VAR graph above, I can conclude that if pension fund are invested according to the asset allocation I get using the portfolio theory, under the 99% confidence level, there is 1% probability that loss will exceed 20.593% of the total investment. Under the 95% confidence level, there is 5% that loss will exceed 12.481% of the total pension investment. When I do back-testing and compared with historical events, Z statistic is within the confidence interval, it means the VAR test results I get can't be rejected.

By comparison, stock brings high risk at the same time it generate higher return (Fischer Black, 1993). Investing in bond and real estate is more safe, but it will increase government pressure. By fixing the proportion invested in stock at about 20%, 69.51% into enterprise bonds and the rest into bank deposit, basic pension fund investment in China can achieve a good results. The 30% quantitative limit of equity investments in hypotheses III is too high.

7. Discussion

In Section IV, the results provide further evidence to support the investment of China's pension fund into capital market to enhance its value. Pension fund, acted as institutional investors, increase transparency and governance of capital market (Jorge E. Roldos, 2004). On the other hand, the development of capital market in turn boost pension fund performance. When strict quantitative limits are applied to asset allocation, pension investment risk is under control. This section provides suggestions toward pension investment and describe limitations of this paper.

7.1 Suggestions For Basic Pension Fund Investment

The main objective of pension investment is to manage it effectively, to enhance its value and limit its risk. Meanwhile, Pension fund, as institutional investors, will inevitably affect the stock price when purchase in stock market, which enables government to stable securities market and prevent excessive speculation. Based on my research results, I give following recommendations toward basic pension fund investment in China:

● **Diversified Investments**

A basic principle of investing in securities is "Do not put all your eggs in one basket" (Evers J L H, 2011), this is aimed at hedging the risks associated with the securities. Reasonable asset allocation structure of pension fund investment can greatly reduce non-systemic risk. Therefore, considering the current situation of China's capital market, basic pension fund can be invested in enterprise bonds, treasury bonds and other fixed-income securities. Besides, it can also be invested in a good performance stock and mutual fund products, but the proportion of assets invested in stock market should be strictly limited.

In addition to those "traditional" investment methods, based on other countries' experiences, basic pension fund can also seek to invest in "alternative" investments such as loans, infrastructures and mutual fund. According to OECD report 2015, Pension fund

in some of the largest pension market have largely increased allocation in "alternative" investments to "search for yield." Considering the large stock market fluctuation and low interest rate in China recently, more investment methods will be helpful, but the proportion invested in these part should be limited.

- **Improve The Market Mechanism**

The main characteristics of China stock market is that it has obvious sign of human control and most investors possess a speculation attitude (Pang Diye, 2012). In such market, investment is likely to face high risk. To solve this problem, Chinese government should strength information disclosure system. Transparent information can not only reduce the "shady fund", but also plays an important role in increasing investors' confidence. In order to protect the public's right to supervise, the government should urge pension managers, custodians and other information disclosure obligors to accurately disclosure pension fund's operations. In addition, Chinese pension system possess "empty account" and hidden debt problem, in order to ensure investment return, increasing transparency in personal account is the prerequisite.

- **Strengthen Government's Macro-control on The Capital Market**

As we know, the capital market in China is young and not mature yet, it is difficult to achieve the optimal allocation of resources relying solely on market mechanisms. Under such circumstance, government should stand out to strengthen macro-control of the capital market to reduce risk. Supervision should be taken especially toward listed companies' credit status and operating results. In this way, the capital market can develop in a smooth way, which creates a good investing environment for basic pension fund. Besides, another obstacle that prevent basic pension fund entering the capital market is lacking of relative law. It requires relevant departments to strengthen the pension fund's financial review, and let fund companies bear part of the revenue risk. On the other hand, Chinese government should speed up the legislative process of the pension market.

- **Control Proportion of Pension Investment**

Pension fund accumulation by the end of 2015 is about 553.85 billion dollars. With such large amount, Chinese government possess a cautious attitude toward pension investment. I suggest that pension fund should enter the capital market step by step, instead of pooling majority into the capital market at once, government can start by investing a small part of it and gradually increase investment proportion. Besides, there should be strict regulation toward pension funds asset allocation. Current regulation clarified that equity ratio of pension products shall not exceed 30% of the total net assets of the fund. According to my calculation results, such limit is relatively high, it is optimal to limit the equity ratio under 20% at present.

7.2 Limitations

As with other studies, some limitations is unavoidable. When interpreting the calculation results, it is important to keep these limitations in mind. And identifying limitations clearly will promote future improvement.

There exists a lack of data in this study. This paper take 10 years historical data of 20 countries as sample to study the relationship between pension fund and capital market. Although I believe such sample size is large enough to describe, a larger sample will make results more accurate. Besides, as some data is missing in the sample, it also decreases accuracy of the study. In analyzing China's own experience, I use historical data of bank deposits, treasuries bond, stocks and corporate bonds from 2001 to 2014. The data collection period is short. I use the historical data of 10 year treasury bond to represent the performance of treasury bonds, it may lead to some deviation in the calculation results. In addition, National society security fund in China is used to represent basic pension fund in the data collection, although it possesses many similar characteristics as pension fund, they are not some. Due to these reasons, there are some bias in data collection.

Furthermore, I use only two methods to rank the financial development level of sample countries. It would be better if different criteria can be used to evaluate. And I assume pension invest only in the four traditional filed, actually there are some other investment methods in reality. Besides, In the risk control of basic pension fund investment, I assume that the risk tolerance is at the same level as America's pension funds, and use the risk level to maximize expected return and find optimal asset allocation. Though I believe such comparison do an adequate job, more comparison with other countries will improve the results.

8. Conclusion

The main objective of this thesis is to describe pension funds' investment impact on capital market development in China and explore pension investment asset allocation. According to Jorge E. Roldos (2004)'s findings, pension fund, acted as institutional investors, can enhance transparency and governance of the capital market, the development of capital market can in turn boost the performance of pension fund. So the preliminary assumption in this thesis is that if the basic pension fund has a positive impact on the development of capital market, it can be used as an important evidence to supports pension investment.

Pension funds exert a positive impact on capital market are widely documented. Based on existing literature, I use two methods to test the relationship between China's pension fund and capital market. On the one hand, I take pension investment historical data of 20 sample countries, use a static OLS regression to find the effect of pension investment. By classifying sample countries into "high" and "low" financial development, I conclude that pension investment impact differs according to the level of financial development, and in "high" financial development countries, positive impact is stronger. According to my criteria, China belongs to "high" financial development countries, so this finding support pension investment.

On the other hand, I analyze pension fund and capital market relationship based on China's own experiences. The main methodology is that as pension investment have a positive impact on mature capital market (Walker and Lefort, 2002), if I can prove there also exists such relationship in China's incomplete capital market, it can be used as evidence to support pension investment. I use the investment history of National Society Fund to represent pension fund performance, and apply ADF, Granger Causality test and Cointergation test in calculation. In calculation result, I find that pension investment Granger Cause capital market development, this finding provides further evidence to support basic pension investment in China.

Then I go further to apply the principle of portfolio to study the optimal asset allocation of pension investment. I assume that the basic pension fund can only invest in bank deposits, stock, treasury bond and enterprise bond. As US has a long pension investment history and it has achieved an outstanding investment results compared with other countries. I refer risk to level of pension funds in America which is 9.6%, then I clarify that invest 19.59% into stock, 69.51% into enterprise bond and rest into bank deposit can maximize expected return. In the last step, Monte Carlo Simulation and Value at Risk test are applied to make risk assessment of such allocation. Under 95% confidence level, there is 5% that loss will exceed 12.48%, compared to other countries' performances and risk tolerance, such asset allocation can effectively control the risk level under 10% and achieve good expected return at 6.55%.

Based on calculation results, I provide pension fund management and risk control suggestions for government, including diversifying investment, improving transparency and strengthen macro control. Limitations of this study include lack of historical data, bias in data collection, use only two criteria to rank sample countries and refer only to pension funds' risk level in America. However, I am convinced that my study provide some meaningful insights into basic pension fund investment in China.

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10. Appendix:

Appendix 1: Pension Fund Investment in OECD Countries

The graph describes the changes in the annual growth rate and total investments of pension assets under management in OECD countries from 2004 to 2014. It is shown that the growth rate of investment and total investment amount reached the bottom in 2008 because of the financial crisis. Although the annual growth rate fluctuate a lot, the total investment amount of pension funds keep increasing from a long term perspective.

Level and annual growth rate of total assets of pension funds in the OECD, 2004-2014
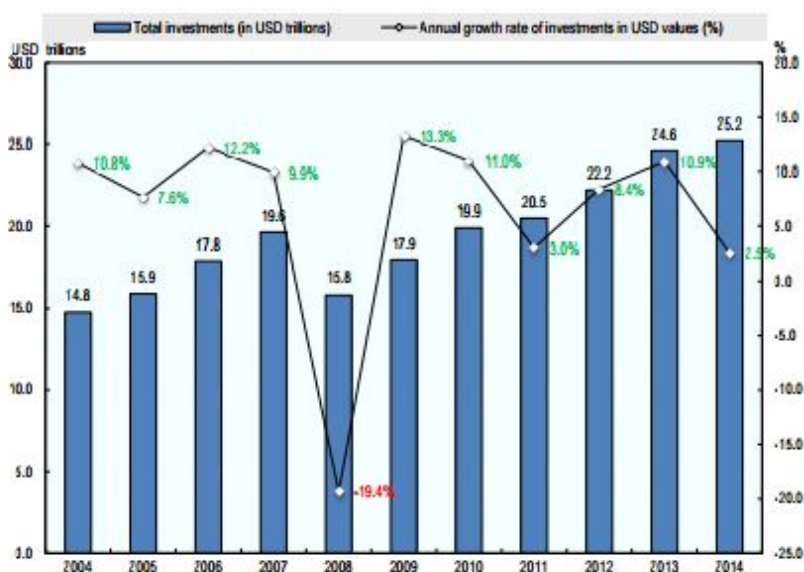
Sources: OECD[14] Global Pension Statistics

Pension fund asset grew constantly in OECD countries after 2008 financial crisis. Pension investments' good performance is one of main reasons why it keep increasing. According to OECD global pension statistics, pension investment in OECD countries has gained an average return of 5%, while outside OECD countries, pension investment has an average return of 1.2%.

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[14] Organisation for Economic Co-operation and Development (OECD)
http://www.oecd.org/

Appendix 2: Three Pillar Enterprise Workers' Pension System

The table describes the constitution of Enterprise workers' pension system in China. It contains three pillars, pillar I is the basci pension fund, which is the study target of this thesis. Pillar II is enterprise annuity while pillar III is voluntary contribution.

Type	Component	Characteristics	Contributors	Risk Management	Tax discount	Investment	Rate of Return
Pillar 1A	PAYG System	Mandatory, Defined benefit, Partially funded, unstable	Enterprise, Individual, Subsidies	Government bears aging risk and investment risk	Corporate income tax and personal income tax deduction	Mainly invest in bank savings	2%-2.5%
Pillar 1B	Funded Individual Accounts	Mandatory, Defined contribution, Fully funded					
Pillar 2	Enterprise Annuities	Voluntary, Defined contribution, fully funded	Enterprise, Individual	N/A	Corporate income tax deduction, personal income tax defer	Fixed income, equity investment	5%-10%
Pillar 3	Voluntary Private Savings	Voluntary, Often insurance based	Individual	Insurance companies bear aging risk and market risk	N/A	Fixed income in majority, equity investment	2.5%-4.5%

# Appendix 3: Pension Fund Replacement Rate Change in China

This graph describes the changes for basic pension fund replacement rate in China from 2000 to 2015. It is shown that the replacement ratio keep decreasing year by year from about 75% in 2000 to 48% in 2015.
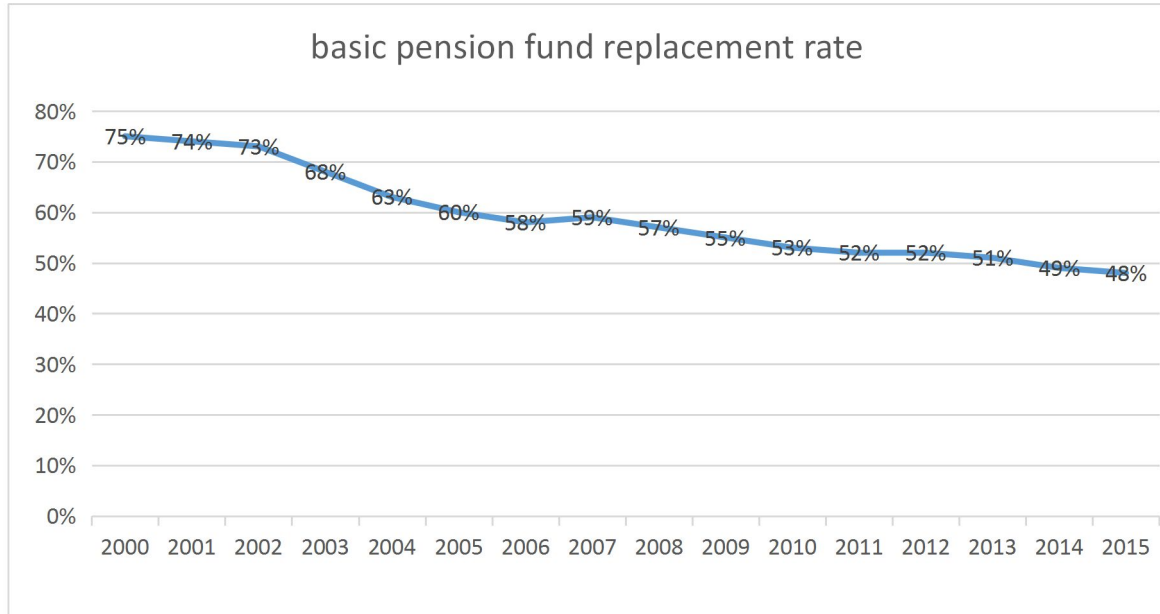
Note: Basic pension fund replacement rate= The average pension of retirees / The average wage of workers in the same year

Appendix 4: Pension Assets Allocation in Selected Countries

This two graphs describes the asset allocation for pension assets under management   in both selected OED countries and non-OECD countries in year 2014. Main investment methods taken into consideration include equities, bond and bills, cash and deposits and other investments.
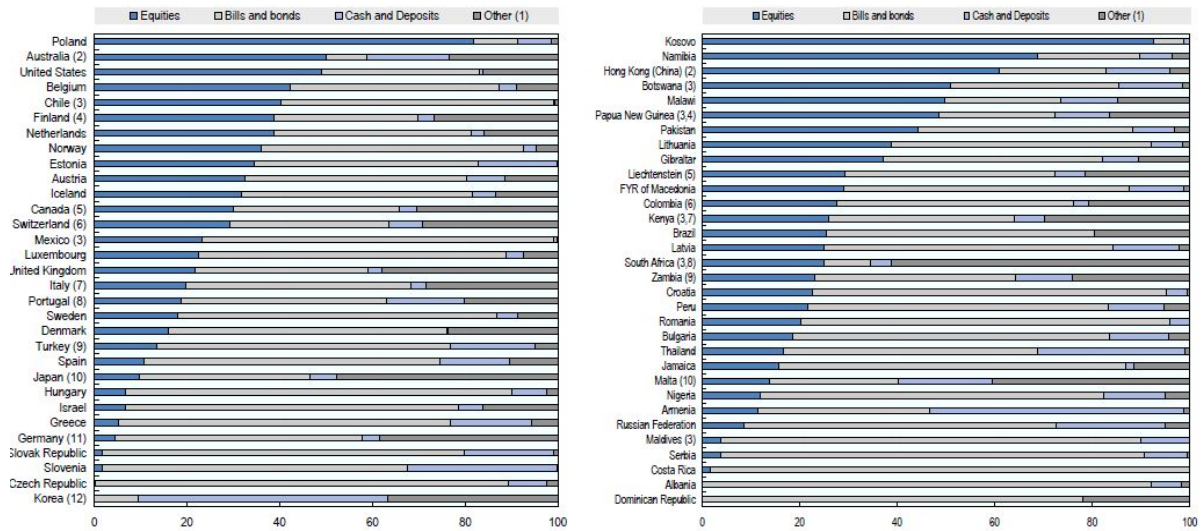
As percentage of total investment %