Essays on Public Pension Systems, with Special Reference to China

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A thesis submitted to

The University of Birmingham

for the degree of

DOCTOR OF PHILOSOPHY

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Department of Economics

The University of Birmingham

September 2009

ABSTRACT

This thesis studies the provision of public pension system through three different approaches. Part one focuses on demographic change and pension system reforms in China. It reviews the historical reforms and the problems and suggestions associated with the current system. More importantly, by applying a calibrated overlapping generations general equilibrium simulation model, it investigates the impact of the demographic changes and the choice of pension system to the individual choices and macroeconomic variables in the future.

As with all social insurance programs, the provision a public pension system involves a trade-off between protection and distortion. The second part is a theoretical study about the optimal level of public pension system. It derives the optimal pension benefit level by considering the welfare loss imposed by the saving and labour supply distortion.

The third part of the thesis, is an empirical study investigating the reasons for different choices in pension systems. There are three types of public pension systems popular throughout the world: Pay-As-You-Go (PAYG), Funded and Mixed. The latter two have grown up largely since 1980s, after Chile successfully built its Funded system. By applying logistic regression tests, we examine the likely social and economic variables which have been affecting the choices.

ACKNOWLEDGEMENT

I would like to take this opportunity to thank my supervisors, Mr. Richard Barrett and Professor Somnath Sen, for their patience, guidance and ready advise which helped me to craft the thesis. Their time, effort and knowledge involved is much appreciated.

I would also like to thank my parents and friends for their understanding, support and encouragement.

Finally, I would like to extend my thanks to my internal examiner Dr. Siddhartha Bandyopadhyay and external examiner, Professor Subrata Ghatak. By taking the time to thoroughly read my thesis, they provided stimulating discussion during the viva and constructive suggestions, the incorporation of which has helped me to improve my thesis.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

The social security retirement programme, also called the pension system, is a specific scheme to provide for retirement income. It is a part of the social security system which, as its name implies, is a scheme established to enhance the well-being of an individual against any misfortune caused by accidents, the inability to work or in the case of dependants, even death. In some literature, economists tend to differentiate social security retirement programmes from pension schemes[1]. In this thesis social security retirement programmes and pensions are treated as one, so long as their purposes are to provide income during one's retirement.

The importance of the provision of a proper pension system can never be over emphasized. By 2007, more than 170 countries had adopted some form of public pension systems. Public pension expenditure are often the largest fiscal programme in many countries. For example, in 1990's, in Europe, it's about 12.1 percent of total GDP; in North America, it's about 7.1 percent; and it's relatively low in Asia, about 3 percent.

The country which draws me to this topic is China. Over the past three decades, China has transformed itself from a socialist, central planned economy to one increasingly based on market principles. The economic reforms has been bringing

[1] The social security retirement programme is often seen as a government incentive programme whereas provision of a pension is seen as a private retirement programme.

China an extended period of rapid economic growth, but it has also created many challenges, especially for the social security system. With the implementation of the one child policy and rapid medical improvement, China gets old before it gets rich. The economic reforms combined with the aging population makes the reform of the pension system a top priority. In 1997, under the advice of the World Bank, China adopted a three-pillar pension system, which includes a defined benefit PAYG, a funded defined contribution individual account and a voluntary social insurance part. With low compliance rate and lack of adequate social security fund, it's too early to call the current pension system a success. A proper social security system is vital for the future sustainable growth for the country. In the past three decades, the fast economic growth is supported by the high level of fixed asset investment and export growth, and the growth of consumption has been lagging behind the GDP. China had a high savings rate and it also has been on a upward trend. This is attribute to the lack of proper social security system.

Aging population and pension system reform is not a phenomenon only in China. Historically, social security systems were almost all PAYG. However, it is widely recognised that these systems generate many problems such as rising payroll tax rates, evasion and early retirement. Many countries have undertaken major or minor reforms of their pension systems in the past 30 years, Some countries went through radical reforms and changed into fully funded pension system, some chose a mixed system with a combination of both, and the rest stayed with the original PAYG pension systems and modified parameters such as contribution rate and retirement age.

This thesis tries to address the following questions:

- What is the impact of the demographic change and the choice of public pension systems to China?

- What is the optimal level of public pension benefit?
- Why have some countries reformed away from the original PAYG pension system and some have not?

1.1 Thesis Structure

The thesis unfolds as follows: Chapter 1, as a foundation for further study, includes a basic introduction to pension systems around the world, The topics addressed here are: how to classify pension systems, the main characteristic of each kind of system, examples of major systems and the important reforms that have been implemented. The rest of the thesis is formed into three parts.

The first part of the thesis focuses on demographic change and pension system reforms in China. Chapter 2 reviews the major changes the Chinese pension system has undergone since its inception in the 1950s, the demographic change and also the various problems saddled with the current system. Chapter 3 looks into the future by applying a calibrated overlapping generations general equilibrium simulation model to investigate the impact of the demographic changes and the choice of pension system to individual choices and the economy. Interestingly, welfare of different age cohorts can also be calculated. We show which age cohort benefits most from the demographic change.

The second part is a theoretical study about the optimal level of public pension systems. As with all social insurance programs, the provision of a public pension system involves a trade-off between protection and distortion. Social security benefits protect the aged from poverty and, more generally, from a sharp decline in the standard of living that could occur when regular earnings cease. But the provision of benefits that are conditioned on income or employment and the collection of the

taxes needed to finance those benefits also create deadweight losses that result from changing the behaviour of both the aged and the younger population. Chapter 4, derives the optimal pension benefit level by considering the welfare loss imposed by the saving and labour supply distortion. The purpose of the study is not to derive practical parameters, but to understand better how different factors influence the optimal level of a public PAYG pension system. To provide a standard of reference, it begins with a simple economy in which individuals have perfect foresight and inelastic labour supply. Then, myopia and elastic labour supply are introduced and the optimal public pension payroll tax is calculated by applying a log linear utility function.

The third part of the thesis is an empirical study investigating the reasons for different choices in pension systems. By applying logistic regression tests, Chapter 5 examines the likely social and economic variables which affect the choices significantly. Superior to the past literatures, sample countries is selected based on data availability.

Finally, in Chapter 6 we draw conclusions related to the three questions asked.

Before starting we here review some pension system fundamentals which will be referred to throughout the remainder of the thesis.

1.2 Social Security Retirement Programmes

Four criteria are normally used to classify pension systems around the world:

1. who manages the system (public or private)
2. how the coverage is decided (Employment-related, Universal and Means-tested)
3. how benefits are calculated (defined contribution or defined benefit)

4. how benefit are financed (PAYG, Fully Funded) [2]

The balance within any retirement system, whether between private and public administration; flat-rate and earnings-related benefits; universal or employment-based and means tested access, can provide evidence on the principles underpinning pension policy and the different roles for the family, the state and the market in providing for the elderly (Arza and Johnson 2004).

Employment-related, Universal and Means-tested

Employment-related systems generally base eligibility for pension benefits on length of employment. The level of pension is usually related to the level of earnings. Such programmes are financed entirely or largely from contributions (usually a percentage of earnings), made by employer and worker. In many countries the national government also participates in the financing. It either acts as the ultimate guarantor of the benefits by contributing via an appropriation of funds from general revenues based on a percentage of the total wages paid to insured workers. Or the government pays a subsidy to make up any deficit of an insurance fund. In some cases, the government pays the contribution outright for low-paid workers.

Universal programmes provide flat-rate cash benefits to residents or citizens, without consideration of income, employment, or means. Most social security systems incorporating a universal programme also have a second-tier earning-related program. Universal programmes tend to be financed from general revenues, although some whilst still receiving substantial support from income taxes, are also financed in part by contributions from workers and employers.

Means-tested programmes differ however from the employment-related and universal systems, in which the beneficiary can claim benefits as a matter of right.

[2] In this thesis, is focused on public pension systems, and most discussions be around the choice of PAYG or Fully Funded. The previous three are not much addressed.

Eligibility for benefits is established by measuring individual or family resources against a calculated standard usually based on subsistence need. Benefits are limited to applicants who satisfy a means test.

Defined Contribution V.S. Defined Benefit

Davis (1995) outlines the difference between defined contribution and defined benefit as the distribution of risk between the beneficiary and the sponsor. Under the defined benefit system, benefit calculation is based on partially replacing income level, defined as what an individual had earned over a particular period of time and/or the economy-wide average wage. Individuals can estimate their pension benefits according to their years of service, income level and a benefit formula. The revenues of such systems depend on demographic changes, the rate of wage growth, and the rate of return on investments if a fund is accumulated. Any shortfall in revenues relative to expenditures is covered by the sponsor, which is the government in the case of a public plan, or an employer in the case of a private occupational plan. In theory, individuals bear almost no risk. However, in practice the parameters of such systems are changed so often that an individual who begins work and begins contributing under one set of pension rules rarely retires under them.

In the defined contribution schemes, contributions are fixed and benefits vary with market returns. The benefits are considered less defined, because they depend on an individual's complete work history and the accumulated rate of return. The individual receives what is in his account upon retirement, so there is no possibility of shortfalls. However, all risks are borne by the individual in the form of higher or lower pensions.

PAYG V.S. Fully Funded

Under pay-as-you-go (PAYG) financing, the current working generation's contributions are used to pay benefits to current retirees. While under a fully funded (FF) system, current workers' contributions are accumulated in pension funds and invested. Their pensions are paid from the stream of returns earned by the pension funds.

Defined benefits can be financed either through PAYG financing or through funding. Defined contributions are mostly fully funded. People receive only what they have accumulated, resulting in no shortfalls, although there may be public costs associated with any minimum pension or rate of return guarantees (if offered).

The Basic Economics of Pay-As-You-Go Social Security

Paul Samuelson (1958) explained a PAYG system produces an implicit rate of return equal to the rate of growth of the tax base. In a two period overlapping generations model with homogeneous individuals, assume that the number of workers at time t is L_t and the wage rate is w_t. The number of workers of each generation grows at the rate of n, and the wage rate grows at the rate of g. $L_{t+1} = (1+n)L_t$, and $w_{t+1} = (1+g)w_t$. The payroll tax rate under the PAYG system is θ. So the aggregate tax paid by the working generation at time t is $T_t = \theta w L_t$. This generation retires at $t+1$ and the aggregate benefit they receive is B_{t+1}. The pension system self-finances every generation, so

$$B_{t+1} = T_{t+1} = \theta w_{t+1} L_{t+1} = \theta w_t (1+g) L_t (1+n).$$

The implicit rate of return of the contribution to this pay-as-you-go is:

$$r_{PAYG} = \frac{B_{t+1}}{T_t} = \frac{\theta w_t (1+g) L_t (1+n)}{\theta w_t L_t} = (1+g)(1+n), \tag{1.1}$$

while under a fully funded system,

$$r_{FF} = \rho, \tag{1.2}$$

where ρ represents the real rate of return of capital, which is equal to the marginal product of capital at equilibrium.

Samuelson (1958) suggested that in an economy with a constant population growth and without a capital stock, a programme of PAYG pension is a desirable policy. The initial generation of retirees receive a windfall of T_0 and each generation of workers thereafter receive an implicit rate of return of $(1+n)(1+g)$ on the tax T_t that it pays. However, the existence of a capital stock implies that individuals could instead finance their retirement by saving and investing in actual capital goods where they would earn ρ. In a dynamically efficient economy, the real rate of return ρ must exceed the rate of growth of the economy $(1+n)(1+g)-1$ (Cass 1965). Equation 1.1 shows that the rate of return of the PAYG system is vulnerable to an aging population resulting from the secular trend of decreased fertility and increased life expectancy. The financial imbalances become serious if the elderly become a disproportionately large share of the population. Moreover, a PAYG system has a crowding-out effect on savings (Feldstein 1974) and distorts labour supply. Hence, it may slow down the economic growth (Wigger 2001).

On the other hand, an FF system can prevent the adverse affects that may occur to public finances from an aging population. However, the potential risks implicit in an FF system, such as financial risk and inadequate regulation should not be overlooked. Also an FF system has no redistributive function, unlike PAYG.

A recent innovation called the Notional Defined Contribution (NDC) system applies PAYG financing to the Defined Contribution system (DC). Under a NDC

pension system, the worker pays a contribution as a percentage of their earnings, which is credited to a notional individual account. The cumulative contents of the account are credited with a notional interest rate, specified by the government in advance. At the point of retirement, the value of the person's notional accumulation is converted into periodic pension payment, based on life expectancy and the rules in force for adjusting benefits (for example, inflation and discount rate). The account balance is called 'notional' because it is for record keeping only. The plan does not own matching funds invested in the financial market.

The advantages of NDC are primarily threefold: Firstly, compared with the PAYG system, it encourages labour supply and contribution by tying benefits to contributions rather than to income. Secondly, it discourages early retirement. The pension provision depends on both the accumulated sum in one's notional account and on the average life expectancy at the age at which the pension is started. Early retirement will reduce the level of pension benefit. The individual has to delay their retirement as the life expectancy increases if they want to reach a target pension level. The NDC system shares the risk more equally between the sponsor and the beneficiary. As mentioned earlier, a PAYG defined benefit system puts almost all risks on the sponsor, whereas under a fully funded defined contribution system the beneficiary shoulders all the risks. Under an NDC system, individuals collectively bear the cohort-specific longevity risk, rather than the government bearing the risk as in the conventional PAYG defined benefit system. It additionally provides an interest rate specified by the government, which isolates individuals from a violated capital market, although it may also put them away from a higher rate of return. Thirdly, the transition issue of financing the payments to current pensioners when current contributions are diverted to individually funded accounts does not arise since the contributions are not actually diverted. (Schwarz and Demirguc-Kunt 1999)

However, NDC systems also have some drawbacks. Firstly, compared with FF system, there are no additional savings generated in the economy to stimulate investment and growth. Secondly, the government still holds an unfunded liability which is clearly defined and difficult to change. In the traditional Defined-Benefit systems, most individuals are only vaguely aware of the monetary equivalent of their acquired rights. Reducing them is politically feasible. From past experience, many governments have reduced their implicit pension liabilities by changing the benefit formulas. NDC systems force government to accurately prepare for all future contingencies when adopting such a system, since subsequent changes would be much more difficult to achieve.

1.3 Public Pension Systems Around the World

Germany is the first country in the world to introduce a compulsory national public old age pension scheme in 1889. The system was compulsory and contributory, both employers and workers were required to make income-related contributions, the state also added a small flat-rate subsidy. Benefits were paid out to disabled workers and to former workers who lived beyond the age of seventy. It covered a large part of the workforce, 40 percent at inception and 54 percent by 1895 (Arza and Johnson 2004).

In the following three decades many other European countries followed Germany's example by introducing public pension systems. Australia and New Zealand were also both early pioneers of public pension provision, as was Argentina, which was one of the world's richest economies at the beginning of the twentieth century. Over the following 100 years public pensions were adopted by almost every country as part of a global expansion of social security systems. By 2007, more than 170

Tab. 1.1: Date of first pension law in selected countries[a]

EUROPE		**NORTH AMERICA**	
Germany	1889	United States	1935
UK	1908	Canada	1927
France	1910		
Sweden	1913	**ASIA**	
Italy	1919	Japan	1941
Netherlands	1919	Turkey	1949
Spain	1919	China	1951
Poland	1927	India	1952
Greece	1934	Singapore	1953
		Saudi Arabia	1962
OCEANIA		Pakistan	1972
New Zealand	1898		
Australia	1908	**AFRICA**	
		South Africa	1928
LATIN AMERICA		Egypt	1955
Argentina	1904	Tunisia	1960
Brazil	1923	Nigeria	1961
Chile	1924	Ethiopia	1963
Costa Rica	1941	Gabon	1963
Mexico	1943	Kenya	1965

[a] Source: compiled from the Social Security Worldwide database and the International Social Security Association.

countries had adopted some form of public pension scheme, although the coverage of many of these schemes are still very narrow. Table 1.1 reports the date at which a selection of countries around the world took their first legislative steps to introduce public pension schemes. There is a general correlation between the level of economic development of a country and the timing of pension legislation. Perhaps the most striking exception is the United States, who adopted the pension system far later than South Africa, Brazil and Greece.

The coverage of the pension systems are also related to the level of economic development. In most developed countries, mandatory old-age pension plans cover more than 90 percent of the labour force. However, it covers a much smaller fraction of labour force in developing countries. In many cases, coverage is restricted to certain categories of workers such as civil servants, military personnel, and employees in the formal economic sector. Rural, predominantly agricultural workers have little to no pension coverage in much of the developing world.

Table 1.2 presents a comparative illustration of pension spending as a proportion of GDP in different regions. In less developed regions, like Africa and Asia for example, the aggregate value of benefits has always been, and still remains, very small. Middle incomes in Latin America allocate a somewhat higher share of GDP to pay for retirement. European countries are at the top of the distribution, with expenditures over 10 percent of GDP in 1990. In North America, the United States and Canada, the pension budget is smaller than in European countries. Among developed countries, where full coverage usually exists, differences are mostly related to demographics, but also to the institutional structure of pension schemes, particularly the rules regulating eligibility and benefit levels. The institutional and demographic structures also affect the growth of pension expenditure. Countries with high expenditure growth typically face the challenge of an aging population on generous

Tab. 1.2: Aggregate levels of social security expenditure, 1990[a]

Region[b]	Total social security expenditure percentage of GDP	Pensions expenditure percentage of GDP
All countries	14.5	6.6
Africa	4.3	1.4
Asia	6.4	3.0
Europe	24.8	12.1
Latin America and the Caribbean	8.8	2.1
North America	16.6	7.1
Oceania	16.1	4.9

[a] Source: World Labour Report 2000, ILO.
[b] Averages refer only to countries for which data are available.

pension systems. These are mostly European countries with earnings-related benefits. While countries containing means-testing schemes, such as Australia, or low benefit levels, for example the United Kingdom, or a combination of the both, like Canada and United States, have a lower pension expenditure growth. The expenditure growth rate is the lowest in countries having young demographic structures and an effectively restricted level of pension coverage, such as Mexico, Kenya, Ethiopia and India.

1.3.1 Programme Variation in Different Regions

Income insecurity in old age is a worldwide problem, but it varies in different parts of the world. In Africa and parts of Asia, the elderly are only a small part of the population and have long been cared for by extended family members, mutual-aid societies, and other informal mechanisms. Formal arrangements that involve the market or the government are rudimentary. But as urbanisation, mobility, wars and famine weaken extended family and communal ties, informal systems feel the

strain. This is especially so in countries where the proportion of the population is old is growing rapidly as a consequence of medical improvements and declining fertility. To meet these rapidly changing needs, several Asian and African countries are considering fundamental changes in the way they provide old age security. The challenge is to move toward a formal system of income maintenance without accelerating the decline in informal systems and without shifting more responsibility to government than it can handle. (World-Bank 1994)

Latin America, Eastern Europe, and the former Soviet Union can no longer afford the formal programmes of old-age security they introduced long ago. The need to re-evaluate policy is even more pressing. Liberal early retirement provisions and generous benefits have required high contribution rates, leading to widespread evasion. The large informal sector in many Latin American countries, for example, reflects in part the efforts of workers and employers to escape wage taxes. The resulting labor market distortions reduce productivity, push contribution rates and evasion even higher, limit long-term saving and capital accumulation and further dampen economic growth. As a result many of these counties have not been able to pay their promised benefits. Most have cut the cost of benefits by allowing inflation to erode their real value. When Chile faced these problems fifteen years ago, it revamped the structure of its system. Other Latin American countries are now undertaking similar structural changes, and some Eastern European countries are also contemplating them. The challenge is to devise a new system and a transition path that is acceptable to the old, who have been led to expect a certain standard, while also being sustainable and growth-enhancing for the young.

Countries that belong to the Organization for Economic Co-operation and Development (OECD) are also facing the problems of an aging population and slow economic growth. Public old-age security programmes covering almost the entire

population have paid out large pensions during the past three decades of prosperity. But over the next two decades, payroll taxes are expected to rise by several percentage points and benefits are expected to fall. Intergenerational conflict also exists between old retirees (some of them rich) who are receiving public pensions and young workers (some of them poor), who are paying high taxes to finance these benefits and may never recoup their contributions. Such social security arrangements may in addition have discouraged work, saving, and productive capital formation–thus contribution to economic stagnation. Many OECD countries appear to be moving toward a system that combines a publicly managed pension plan, designed to meet basic needs, with private occupational pension plans or personal saving accounts to satisfy the higher demands of middle- and upper- income groups. The challenge is to introduce reforms that are good for the country as a whole in the long run, even if this involves taking expected benefits away from some groups in the short term.

1.3.2 Examples of Pension Systems

Social Security System in the United States

Established in the 1930s, the US Social Security system is a mandated, public defined benefit system with very wide and compulsory participation. Few groups are permitted to opt out. The average pension benefit represents a replacement rate of approximately 50 percent of the best 35 years of salary history. Some adjustment is made to redistribute pensions to poorer participants; hence, individual replacement rates may differ from the average. To this end, the replacement rate offered to those with a poor income history is higher than for those with a higher income. Benefits are paid until death, include substantial indexation to inflation (since 1972), and are extended to survivors. The system was designed along the lines of a PAYG

system with current contributors largely financing pension payments. Today, the Social Security system is not the pure PAYG system, it was in the mid-1970s. With the prevailing contributions, the system was unavoidably heading toward insolvency. As a result, the Greenspan Commission in 1982-1983 recommended a sharp rise in contributions, which would permit building up a reserve, the so-called Trust Fund, to cover future shortages. Unfortunately that reform is insufficient and new reforms are needed to avoid insolvency in the twenty-first century.

401(K) Plans and Individual Retirement Accounts in the United States

These schemes are most prevalent in the United States and are most commonly referenced when discussing funded defined contribution plans. Under the 401(K) schemes, both employers and employees contribute to these funds from pre-tax income. Participants are free to choose investment strategies from within a set of chosen private providers who manage the assets for the participants. They are allowed to borrow from their account, within limits and at their discretion, but must repay under established rules.

Under the Individual Retirement Accounts, individuals set up the plan directly if they meet certain eligibility criteria. Participants have sufficient choice in the structure (i) to select their asset allocation (a mix of bonds and equities; international and domestic assets) and (ii) to select preferred manager(s) from a short list of managers and mutual funds. Participants either have full discretion over asset allocation and fund selection (self-directed plans) or can delegate the responsibility to the service provider. Withdrawal of funds is permitted to finance certain activities, but if these monies are not returned before retirement, the participants incur a tax event because the Individual Retirement Accounts is no longer a tax-deferred saving. The pension is the annuity that can be purchased from service providers

given the accumulation at retirement.

In both systems, participants have some discretion over the level of contributions, but there are limitations on maximum contributions. These caps on contributions exist because such savings are tax deferred. However, the caps have changed over time, allowing participants to change the amount they contribute to these plans.

The Chilean Defined Contribution Model

The Chilean model, implemented in 1981, involves gradual phasing out of the PAYG plan and replacement by a mandatory DC plan. New workers can participate only in the DC plan, whereas participants in the PAYG plan can still choose between the old and new plans. Assets are managed by private companies chosen by the participant from a list approved by the government with individuals largely bearing the risk of investment performance. There are some guarantees in the Chilean system including: a low social assistance benefit to those not covered by the mandatory plan, a state-guaranteed minimum pension of approximately 25 percent of the average wage if contributions are made for at least 20 years, a minimum profitability rate guaranteed for each pension fund relative to the average for the country, and state-guaranteed annuity payments if the insurance company fails. Variations of the Chilean Scheme adopted in other parts of Latin America - in Argentina, Colombia, and Peru - offer a choice in the second pillar between a privately managed defined contribution system and a public PAYG defined benefit system. However, individuals are permitted to make voluntary contributions to their funds to allow for early retirement.

Mexico's Reform

There are many similarities between the pension schemes in Mexico and Chile. The main exception being that Mexicans, who were once under the old PAYG DB

scheme and had switched to the DC plan, have been offered (at retirement) the choice to get a pension based on either their actual accumulation or an assumed equivalent participation in the old DB scheme (i.e., what the accumulation would have been if they had earned the PAYG internal rate of return). Hence, the DC component of Mexico's reform can be viewed as being similar to that of Chile's, with an explicit retirement guarantee for current participants. Future participants are given a minimum pension linked to the minimum wage at the time of retirement, as in the Chilean scheme. At retirement, participants can choose either to purchase an annuity from a private vendor or receive programmed withdrawals from the fund manager. The annual amount is based on the balance, including interest, divided by life expectancy. The annuity from the private vendor cannot be less than the minimum pension guarantee.

The Italian Scheme

Italy has long relied on a PAYG scheme, supplemented by a severance pay fund, which are both noted for their oppressiveness. Mandated pension contributions account for more than 40 percent of a worker's pay. An interesting facet is that the benefits are based on the realised rate of income growth, giving the scheme a defined contribution flavour. Most recently, Italy has been experimenting with a reform that allows workers to shift their severance pay fund contributions to individual accounts in the common funds of their profession. These investments are for an initial period, after which workers are permitted to switch to the mutual fund of another profession or to funds that are broader. Hence, despite being privately managed individual accounts, there is a limited choice of investment vehicles and a somewhat arbitrary grouping of participants by profession (rather than age, income, or risk-bearing capacity).

Australian Superannuation Schemes

In Australia, the "Superannuation Guarantee" was introduced in 1992 by the Keating Labor government. Before that, reasonably widespread superannuation arrangements had been in place for many years under industrial awards negotiated by the union movement between 1986 and 1988, with support from the federal government as part of a wage-tax trade off, allowing a non-inflationary means of wage increases.

The compulsory "Superannuation Guarantee" system was introduced as part of a major reform package addressing Australia's retirement income policies. It was anticipated that Australia, along with many other Western nations, would experience a major demographic shift in the coming decades, resulting in the anticipated increase in age pension payments placing an unaffordable strain on the Australian economy. The proposed solution was a "three pillars" approach to retirement income:

- A safety net consisting of a means-tested Government age pension system
- Private savings generated through compulsory contributions to superannuation
- Voluntary savings through superannuation and other investments

Since its introduction, employers have been required to make compulsory contributions to superannuation on behalf of most of their employees. This contribution was originally set at 3 percent of the employees' income, and has been incrementally increased by the Australian government. Since 1 July 2002, the minimum contribution has been set at 9 percent of an employee's ordinary time earnings[3].

[3] The 9 percent is thus not payable on overtime rates but is payable on remuneration items such as bonuses, commissions, shift loading and casual loadings.

After over a decade of compulsory contributions, Australian workers have accumulated over AUD 1.177 trillion in superannuation assets (*Quarterly Superannuation Performance* 2007).

In Australia, employers are directed to provide the defined contribution plans, and superannuation companies can compete for participants. As a result, there are superannuation schemes at the company or industry level, but private firms can set up master trusts to offer accounts to individuals. There is little by way of investment restrictions or guarantees. Compulsory superannuation has turned Australia into a 'shareholder society', where most workers are now indirect investors in the stock market. Consequently, a lively personal investment marketplace has developed, and many Australians take an interest in investment topics.

Mandatory Provident Funds

Mandatory Provident Funds are prevalent in countries formerly under the Commonwealth (such as India and Malaysia). Under these schemes, individuals contribute to the system, which then aggregates funds in a central pool. Such schemes are generally offered to private sector employees. The pooled fund is then invested in different assets, and the participants earn dividends on their contributions, which are essentially equal to the returns of the investment strategy. In some countries, dividends are smoothed over a few years of returns to reduce volatility, which leaves open the possibility that the system will be "underfunded" if a series of negative returns occurs. In Malaysia, a minimum guaranteed of 2.5 percent is offered to participants. Participants have individual accounts but no choice. Generally, participants are allowed to borrow against these funds to purchase house or make other investment that are deemed socially useful.

Hungary's Model

Hungary offers an interesting twist to the three-pillar model. Pension reform, initiated in 1997, created a system with a mandatory PAYG DB and a mandatory-funded second pillar (which is DC in broad structure), as well as a voluntary DC third pillar. The second pillar is the responsibility of nonprofit mutual funds, wherein contributing members are also owners of the fund. The fund organisations create the appropriate oversight structure and staff key positions with professionals. These organisations then have the freedom to delegate any of the responsibilities (from administration to asset management) to for-profit third parties. The appointment of a master custodian, though is mandatory. Guarantees for the mandatory DC component are provided by a central guarantee fund (GF), and a minimum pension of 25 percent of the first-pillar pension is offered to eligible participants. The pension funds pay the GF an insurance premium equal to 0.3-0.5 percent of a member's contributions, and although the government provides the ultimate backup, the GF is expected to cover all payments via the internal reserve created by the collection of premiums. A series of regulations recommend portfolio diversification and other matters relating to prudent investment of assets, including the need to link assets with liabilities. In addition, the pension fund is required to offer a minimum return guarantee through an internal reserve fund, suggesting an element of smoothing of earned returns versus returns credited to member accounts. Payments to the first pillar are largely from employers, whereas payments to the second pillar are largely from employees. Employees in service before 1997 had the choice of not contributing to the second pillar, but new entrants have no such choice.

1.3.3 Reforms around the World

Many countries have undertaken major or minor reforms of their pension systems. Most formal pension systems are publicly managed with pay defined benefits

according to a formula, and are financed by payroll taxes on a PAYG basis. This implies that contributions made by today's workers are used to pay the pensions of today's retirees. It is now widely recognized that these systems generate many problems such as rising payroll tax rates, evasion and early retirement due to incentive problems, misallocation of public resources, a lost opportunity to generate long-term savings, unintended intergeneration transfers (often due to higher income groups that live longer), and the growth of a large implicit pension debt and financing gap in the face of an aging population.

To address the short and long-term fiscal viability problem, as well as economic and distributive concerns, the World Bank (1994) has been recommending multi-pillar systems which many countries (including China) have also been moving toward. These multi-pillar systems contain the following provisions:

- A mandatory, tax-financed and publicly managed pillar for redistributive and coinsurance objectives
- A mandatory, fully funded, defined contribution and privately-managed pillar (individual) accounts for savings
- A voluntary, fully funded pillar funded via personal savings or commercial insurance for people who would like more protection for their retirement years.

The multi-pillar pension system is defended by three main theoretical arguments that are thinly supported by limited empirical evidence. First, it is often argued that the multi-pillar pension system will facilitate economic efficiency and growth, through removing labour market distortions and by providing better incentives, increased savings, and better allocation of resources. For example, a high payroll tax could cause workers and employers to shift from the formal to the informal

sector, thereby hurting productivity. Corsetti and Schmidt-Hebbel (1997) show that a payroll tax of 20 percent could lead to a 47 percent shift to the informal sector and reduce the economy-wide growth rate by more than 1 percent a year. Thus, a fully funded, DC pillar would reduce this distortion. Following Chile's Pension reform, the share of the informal sector actually dropped, unemployment fell and wages rose between 1980 and 1990. Evidence is not conclusive as to whether pension reform leads to a rise in national savings. Haindl Rondonelli (1996) indicates that Chile's pension reform accounts for 6.6 of the 9.9 percentage point increase in the national saving rate, up from 16.7 percent of the GDP in the period 1976-1980 to 26.6 percent in 1990-1994. However, the fiscal cost of financing the pension transition initially may have cancelled-out the positive effect on private savings. On the other hand, it is considered that there are positive effects with a fully funded second pillar (individual accounts) by means of on financial market development, and hence, resource allocation and growth.

Another argument for the multi-pillar system is that it enhances the financial sustainablility of the pension system and thereby provides better long-term protection for the elderly. Further, a multi-pillar system has a redistributive impact and could improve intergenerational equity in particular (James 1999). In principle, the entire population should have access to old age income, at the very least to a level above the poverty line, and all workers should have a portion of their earnings replaced, consistent with their work history and contribution. The PAYG system, however cannot ensure the protection of the elderly and leads to unintended income transfers from the poor to the rich (who live longer). Overly generous benefits in some countries have led to unfair intergenerational redistribution, putting a heavy burden on future generations.

How have countries reformed their pension systems? Schwarz and Demirguc-

Kunt (1999) provide a typology of pension reforms around the world. According to their classification, some 82 countries have carried out reforms, of which 21 implemented a major structural reform. Among the major reformers, 10 countries are moving toward fully funded individual accounts (the Latin American model); three OECD countries are adopting an employer-sponsored, DC system; and three countries (Latvia, Poland and Sweden) are using NDC systems. Several other developing countries are moving in the opposite direction, from DC provident funds to the PAYG defined benefit system. Please see table 1.3[4] for more information regarding this matter.

Change from	To	Examples (countries)
PAYG Defined Benefit	Fully funded defined contribution (Individual accounts)	Chile, Argentina, Bolivia, Colombia, Mexico, Peru, Hunguary, Kazakhstan
	Notional defined contribution	Latvia, Poland, Sweden
	Employer-sponsored defined contribution system	OECD countries (e.g. Australia, Denmark, Switzerland)
DC-Provident Funds	PAYG system	Indonesia, Nigeria
No formal pension system	New system	Angola, Guatemala, Mozambique, Oman, Zimbabwe

Tab. 1.3: Classification of Pension Reforms

[4] Source: Based on Schwarz and Demirguc-Kunt(1999)

Chapter 2

THE EVOLUTION OF CHINA'S PENSION SYSTEM

2.1 Introduction

Over the past three decades, China has transformed itself from a socialist, highly central planned economy to one increasingly based on market principles. This transformation has been bringing China an extended period of rapid economic growth, but it has also created many challenges for Chinese society, especially for the social security system in general.

Today China has a highly fragmented social security system confined primarily to the workers in urban state-owned enterprises (SOEs). It is in the transition process between the old and new systems. Before the reform, the formal pension system of China is largely urban-based, pay-as-you-go (PAYG) system. The enterprises provide for defined benefit pension to their retirees. Covered retirees also receive housing, medical benefits, other services and inflation subsidies. Only a minority of workers in the non-state sector (joint ventures, joint stock companies, private companies, foreign enterprises and the self-employed) as well as very few workers in rural areas (township and village enterprises) are included in any formal pension

plan [1].

Such a pay-as-you-go system is very sensitive to the changing old-age dependency ratio. If the replacement rate stays unchanged, with the quickly increasing dependency ratio, the contribution rate will have to be increased quickly. China's population is aging rapidly, due to a combination of the implementation of the one child policy that has markedly decreased the number of children being born, and rapid medical improvements that have prolonged life for the old. Moreover, after the Cultural Revolution, China's economy became more market oriented. Declining SOEs found it difficult to keep their pension promises. The uneven pension burden exacerbated their inability to compete with other kinds of enterprises. That demographic structure change combined with the inability of SOEs to cover the pensions of current retirees makes the reform of the system a top priority. In 1997, under the advice of the World Bank, China adopted a three-pillar pension system. It includes a defined benefits PAYG pillar, a funded defined contribution individual account and a volunteer social insurance part.

In this chapter, I will introduce the changes the Chinese pension system has undergone since its inception in the 1950, the demographic change, and the various problems saddled with the current system. The pension system is largely motivated by the reform of SOEs and it is also limited to the demands of the SOE reform. As a result, the pension reform has failed to devise an incentive mechanism for participation, meaning the pension system is plagued with widespread noncompliance and evasion, resulting in renewed financial crisis and high administrative costs. The need for further reforms are still urgent.

[1] The government has started to work on building the social security system for the rural area. But even today, the majority of the rural population is yet covered by the current system.

2.2 The Reform in Context

2.2.1 Economic, Social and Labour Market Reforms

The ongoing process of China's economic reforms springs from the "open door" policy in 1978. In the early 1980s, the government created four special economic zones as windows to the outside world, in which special and more liberal policies were applied. It was further extended to the fourteen largest costal cities in April 1984. This policy greatly encouraged foreign investment.

In the rural areas, prior to 1980, Chinese agriculture operated collectively by way of a network of local communes. The communes controlled production decisions and the allocation of farm labour. The social protection was provided via the farmer's link to the land and through the commune system. The system started to fade away in 1979 and had disappeared from rural China completely by the mid 1980's. A new system took its place, called "Household Responsibility" or the "Contract System", under which an individual farming family was counted as a single unit and allocated a plot of land. Each family retained all profits from the sale of their output after delivering a fixed amount of produce to the collective at a given price. The new system provides more individual incentive for hard work and has proven to be effective in increasing agricultural output. However, with the fading of the commune system, the social protection for the rural area also disappeared. For example, the rural cooperative medical programme existing in the late 1970's covered as much as 90 percent of the total rural population, by the end of the 1980's, the coverage had reduced to around 5 percent of the population (Drouin and Thompson 2006).

China has historically discouraged the rural-urban migration. The *Hukou System*

[2] was served for this purpose. It has contributed significantly to this labour immobility and the growing inequality between urban and rural residents. The system was first established in 1952 and implemented nationwide according to the "Regulations on *Hukou* Registration in the People's Republic of China" in 1958. It classified *Hukou* according to the place and the status of the *Hukou* registration, basically referring to agricultural and non-agricultural *Hukou*. Urban residents have access to jobs in SOEs and social benefits, for example: housing; schooling; medical care and pension eligibility through the system known as the "Iron Rice Bowl", whereas rural dwellers on the other hand are bound to their respective communes. Their access to urban employment and social and pension insurance is thereby restricted.

To reduce the pressure of rural to urban migration and to absorb the excess labour supply in the rural areas, local government operates non-farm enterprises located in the rural areas, which are still known collectively as township and village enterprises (TVEs). Later on, private individuals have also been allowed to organise such enterprises. Until 1995, the total TVE employment had reached 128 million (Drouin and Thompson 2006).

Further changes were introduced in 1986, one of the most important ones being the winding down of the so called "Iron Rice Bowl" system. This term refers to the guaranteed life-time employment in SOEs or other institutions of the state sector, with all connected benefits (like the provision of a social security net, including guaranteed pension claims). In place of the Iron Rice Bowl, a system of labour contracts came into effect. It allows the existence of limited duration contracts and gives the factories greater flexibility in matching their labour forces to enterprises needs. Further to that, in 1995 the government adopted the new Labour Law.

[2] A *Hukou* refers to a household registration record. It officially identifies a person as a resident of an area and includes identifying information such the name of the person, date of birth, the names of parents, and name of spouse, if married.

Moreover, the 15th National Congress of the Communist Party of China (CPC) in 1997 finally confirmed the adoption of an employment strategy based on the principles of the market economy (a labour contract system) and was implemented in full.

Following the economic reforms, the economic activity and employment patterns began to change rapidly, especially after 1992, in which the 14th Congress of the CPC officially announced the "Decision on the Socialist Market Economy". This announcement clearly established the direction for the further economic reforms. The role played by the SEOs and collectively owned sector of the urban economy declined dramatically. This is clearly demonstrated in Table 2.1. In 1978, the SOEs are almost the only form of urban employment, however, in 2004, the number of employment under SOEs and other collectively controlled enterprises only counts about 28.7%. China entered the World Trade Organization (WTO) in 2002 and is committed to opening more sectors of the economy to foreign investment and to curtailing subsidized lending to the remaining SOEs. This further reduces the role of the SOEs and collectively owned enterprises.

2.2.2 An Ageing Demographic Structure

China's population is aging rapidly due to advances in medicine and care that have prolonged people's life expectancy [3]. This combined with the implementation of a one child policy has depressed the proportion of children in the population of China. The life expectancy for the whole Chinese population increased from 35 years in 1949, to 71 years in 2005. Table 2.2 shows the increasing life expectancy over the past 50 years and the UN's prognosis for the next 50 years.

[3] Life expectancy at birth is the number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life.

Tab. 2.1: Employment in urban enterprises, 1978-2003 (millions)[a]

Year	State and collectively controlled	Foreign, joint and private	Self -employed	Other	Total	State and collected controlled divided by total
1978	94.9	0	0.2	0	95.1	0.998
1980	104.4	0	0.8	0	105.2	0.992
1985	123.1	0.4	4.5	0	128.1	0.961
1990	139.0	2.2	6.2	23.1	170.4	0.816
1995	144.1	13.7	15.6	17.0	190.4	0.757
2000	96.0	32.5	21.4	81.6	231.5	0.415
2002	82.8	45.8	22.7	96.4	247.7	0.334
2003	78.8				256.4	0.307
2004	76.1				264.7	0.287

[a] Source: China Statistical Yearbook, 2005 (Table 5-1).

Tab. 2.2: Life Expectancy At Birth (Number of Years)[a]

Year	1949	1955	1960	1970	1980	1990	2000	2005	2015	2050
Life expectancy	35	40.8	44.6	59.6	65.3	67.1	69.7	71	72	76.7

[a] Source: UN Common Database.

Tab. 2.3: Fertility Rate - China

Year	Total	Urban	Year	Total	Urban
1950	5.81	5	1985	2.2	1.21
1955	6.26	5.67	1990[a]	2.31	
1960	4.02	4.06	1995[b]	1.46	1.13
1965	6.08	3.75	2000[c]	1.8	
1970	5.81	3.27	2005	1.83	
1975	3.57	1.78	2015	1.85	
1979	2.75	1.37	2050	1.85	
1980	2.31	1.15			

[a] Data for 1950 to 1992 were compiled by Yao (2005), p3.
[b] Date for 1994 to 1998 were computed from China's Population Statistical Yearbooks published in these years.
[c] Date for 2000 to 2050 comes form UN Common Datebase (estimates and projections).

After the founding of the People's Republic of China, the communist party set a high value on an abundant supply of labour. Following Mao's idea of "Many hands make light work.", the Chinese population increased dramatically. With exception of the great famine period from 1959 to 1961, the fertility rate [4] continued to be high. The adverse effect of a high fertility rate on economic growth was recognised even before the one-child policy was taken into effect. For birth control purposes, the government raised the minimum marriage age to 25 for women and 27 for men. The total fertility rate dropped from 5.81 in 1970 to 2.75 in 1979 (see Table 2.3).

The one-child policy was introduced in 1979 stipulating that all couples could

[4] Fertility rate represents the average number of children that would be born per woman if all women lived to the end of their childbearing years and bore children according to a given fertility rate at each age. This indicator shows the potential for population growth in the country.

have one child only [5]. This policy reduced the fertility rate further to a much lower level (see Table 2.3). It successfully controlled the growth of China's population in the past 20 years. However, it also sped up the demographic aging process.

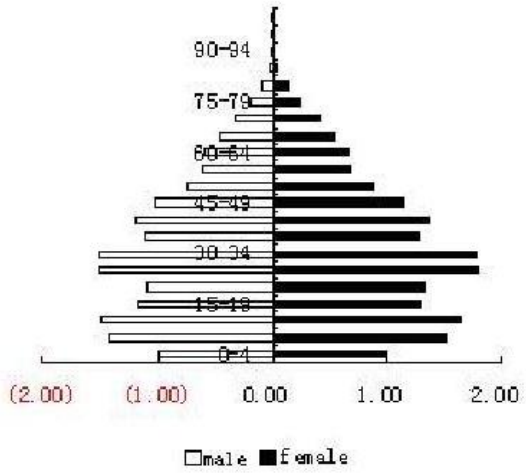
Compared to other countries' experience China's population is aging at a much faster rate and at a much earlier stage of economic development. Those aged over 60 accounted for only 9 percent of China's population in 1990, they will represent 22 percent in 2030 and 26 percent in 2050. It will take China a mere three decades to reach the 1990 OECD level of 18 percent, while in most OECD countries it took nearly a century for the proportion of over 60 to double from 9 percent to 18 percent (World-Bank 1997). The severity of the quickly aging problem can be seen in Fig 2.1 [6]. The age pyramids clearly illustrate the changing age structure and the growth of a maturing population.

In the rural areas, since the Commune System was abandoned, a pension system for peasants was near non-exist until quite recently. The only old-age insurance for the people in the country-side was their children. However, the one-child has made this a huge burden to the younger generation. The one-child policy created a so called "4-2-1" pattern, which means one child has to take care of two parents and 4 grand-parents.

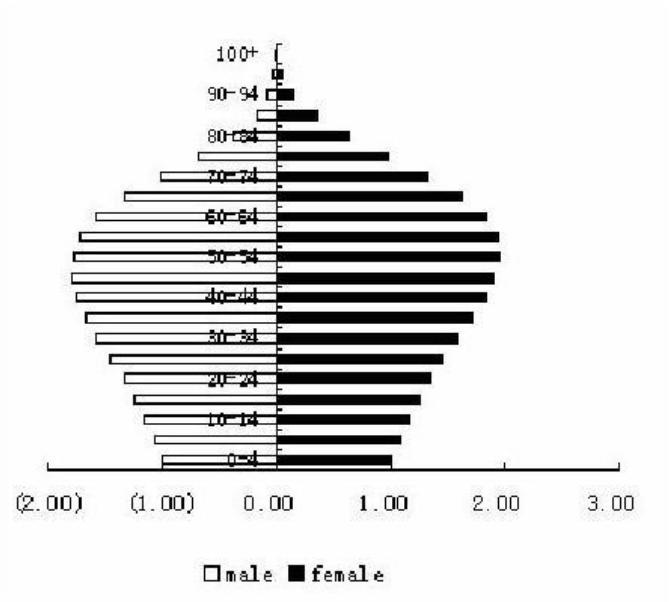
In the urban areas, this aging process has rendered the original pay-as-you-go pension system of China unsustainable. The sustainability of a pension system, is related to the demographic structure of the labor force which are involved in the pension system. For a PAYG system that has a quickly increasing dependency ratio,

[5] The one-child policy does not apply to the Chinese ethic minority groups, which account for only 8% of the total population. For the less economically developed western tribal area, each family can have 3 children and in some places like Tibet, the number of children in a family is not restricted. The policy was changed looser for the rural families later. For families live in the country side, it is allowed to have two children if the first child is female.

[6] Source: U.S. Bureau of Census, International Data Base



(a) Demographic Structure in 1998



(b) Demographic Structure in 2030

Fig. 2.1: Change of Demographic Structure in China
Source: The World Bank Population Projections

Tab. 2.4: Population Aging in China [a]

	1995	2000	2030	2050	2100
Proportion of population over 60	9	10	22	26	30
Demographic dependency rate[b]	17	18	43	53	63
System dependency rate[c]	21	24	42	55	71
Average age of population	30	31	38	40	42
Expected duration of retirement	19	20	23	25	26

[a] Source: The World Bank Population Projections.
[b] Population over age 60/Population aged 20-59
[c] Pensioners/covered workers

if the replacement rate stays unchanged, the contribution rate has to be increased quickly. Based on the World Bank's projection (see Table 2.4), the mean of the national age will reach 40 in 2050 and the dependence ratio for both the total population and those covered by the pension system will increase without pause. The actual systematic dependence ratio is even worse than the numbers shown in Table 2.4 due to the low retirement age in China. The official retirement age is 60 for men (65 for those at executive levels in SOEs) and 50 for women (55 for those in managerial positions).

2.3 The Evolution of the Pension System of China

2.3.1 The First Formal Pension System: From 1951 to 1966

The pension system along with other social security systems in China has undergone through several distinct phases: Soon after the new People's Republic of China

was founded in 1949, a comprehensive system of social insurance was established. The first formal pension system was established in 1951 under the State Council's Regulations on Labor Insurance. It was a very small programme. The regulation only applied to urban enterprises with more than 100 workers and the enterprise sector of China was small and had few retirees at that time. In 1952, one year after the start of the programme, there were only 8 million enterprise workers and 20,000 retirees covered the by this regulation. It means that every retiree was supported by more than 400 workers.

The system was financed entirely by employers. The contribution was explicitly levied on the enterprise wage bill and was administered by local trade union committees. The local committees operated under the administrative jurisdiction of the All China Federation of Trade Unions (ACFTU) under the supervision of the Ministry of Labour (MOL) in Beijing. A contribution rate of 3 percent of the wage bill was sufficient to finance the system on a pay as you go basis, covering 50 to 70 percent of a workers' wages.

In 1954, 30 percent of the contributions were transferred to a national pension fund that was managed by the ACFTU while 70 percent were retained locally to pay pensions. The national fund was prepared for subsidizing future pensions costs in regions experiencing unfavorable economic or demographic developments, thereby producing a nationally-uniform pension system. (World-Bank 1997).

The programme soon spread to government and government-related institutions. By 1955, a separate system had been set up to cover government employees and party institutions. "The Temporary Regulations on the Retirement of Workers and Staff" of 1958 further extended the coverage to all urban enterprises, regardless of size. However, the coverage did not extend to farmers and enterprises located in rural areas. This system continued until the Cultural Revolution, which began in 1966

(World-Bank 1997).

2.3.2 During the Cultural Revolution (1966 to 1976)

The cultural revolution ruined many things in China. Not surprisingly, the pension system was one of them. During the Cultural Revolution the All-China Federation of Trade Unions and the Ministry of Labor were abolished. The pension funds that had accumulated were used for other purposes, thus eliminating any pre-funding that had built up. Supervisory responsibilities were transferred to local labor bureaus, while responsibility for managing payments was transferred to enterprises. Pooling ended and so did pre-funding, since each enterprise paid the pensions of its own workers from their current revenues (World-Bank 1997).

2.3.3 Reforms in the 1970s

When the economic reforms began in 1978, the State Council issued new pension regulations [7] which established the employer's responsibility for financing and providing social insurance benefits. These regulations were applied to SOEs, the government and government related institutions. The collective enterprises and nonprofit organisations were encouraged to follow regulation and most did so.

It was a very generous system and was clearly intended to encourage early retirement in order to create jobs for a large influx of new workers into the urban labor force. Compared with the previous system, the 1978 regulation provided a higher replacement rate relative to the standard wage, the minimum years of service required to qualify for retirement were reduced, and for a time there was even a rule to guarantee a job position for a worker's child following his or her retirement.

[7] Document 104 of 1978, Third Plenary Session of the 11th Party Central Committee.

The prevailing retirement ages were reaffirmed-60 for men and 55 for women with additional adjustments for hazardous jobs, which allowed a worker to retire after ten years of continuous service rather than twenty. New higher benefits were related to length of service and to the final standard wage. Someone who had worked for at least twenty years continuously would receive a pension of 75 percent of the standard wage, someone who had worked for fifteen to twenty years would be given a 70 percent pension, and someone who had worked for ten to fifteen years would be entitled to a 60 percent pension. There was also a minimum guaranteed pension of 30 yuan per month. Disability pensions were related to the final standard wage and the extent of care needed.

Basing the pension on the final standard wage has provided for a great incentive for workers to jack up their final wage in preparation for retirement. With such a generous pension system, problems soon appeared. The number of retirees jumped fivefold from 1978 to 1985, and pension costs soared from 2.8 percent of the urban wage bill to 10.6 percent.

2.3.4 Reforms in the 1980's

Post mid-1980's, the reform towards market oriented economy accelerated. China's pension system changed step by step with the reform of the economy, especially with the amendment of SOEs.

With the economy reformed, more kinds of enterprise ownership were allowed to exist. Besides SOEs and collective enterprises, a new non-state sector appeared, which included joint venture, joint stock companies, private companies, foreign enterprises and the self-employed. In the rural areas, township and village enterprises were developing quickly. They introduced great pressure to the SOEs. Before the reform, the government implicitly assumed responsibility for all firms. However, af-

ter that the SOEs were made to take responsibility for their own profits and losses. The inequality in social obligations among firms began to impact on financial performance of the firms and the welfare of workers and pensioners. The original enterprise-based social security system, in which all pensioners received pensions directly from previous employers simply could not work well any more. Moreover, the pension system could not provide enough labor mobility for the new market oriented economy. A higher level of financial pooling for pensions across firms was greatly needed.

The State Council Document 77 of 1986 established pooling across state enterprises and retained responsibility for distributing pensions. The pool operated by setting a contribution rate (or formula) for participating enterprises. If the pension costs of an enterprise were less than the contribution rate, the difference was remitted to the pool. If pension costs were higher, the pool would make up the difference. To boot, 1986 also saw formal contracts replacing the permanent employment system. New workers were to be hired on a contract basis, while existing workers would continue on as permanent workers. The reformed system established separate city pension pools for contract workers and permanent workers. Contract workers were required to make individual contributions, while, at least initially, permanent workers did not. Enterprises contributed to both pools.

In the late 1980's contribution pooling was extended to workers in other enterprise types, such as joint ventures, joint stock companies, and foreign enterprises; while this was certainly the case in some cities, a holistic participation was far from complete. Some provinces were moving toward a provincial level pooling, generally only for state enterprise workers, but participation remains fragmentary (World-Bank 1997).

2.3.5 Reforms in the 1990's

During the 1990's the reform of the SOEs went on further. A lack of portability of pension benefits became a major stumbling block to the restructuring of SOEs. Making pension benefits portable became a pre-requisite for the enterprise reform. The government was seeking a proper pension system to adjust to these requests. It allowed decentralised experimentation with the expectation that a consensus on the best approach for the pension system would emerge form the various approaches being tested in different parts of the country. However, this lead to a fragmented system, with myriad different approaches to its structure and finance.

In 1991 the State Council Document 33 was issued. It was considered milestone for China's pension reform history for a number of reasons and resulted in a series of new reform efforts.

Fundamentally, because for the first time, it encouraged an establishment of three pillars pension system that required individual contribution by all workers (including the remaining permanent employees in the state sector) in addition to enterprise contributions and encouraged experimentation including a role for individual accounts. The three pillar pension system is comprised of

1. a basic statutory pension financed by employer and employee contributions,
2. supplemental pensions financed by enterprises from an operating surplus,
3. individual pensions financed on a voluntary basis by workers and available at the time of retirement as either a periodic payment or lump sum.

Secondly, it had a view of establishing a coherent framework for the developing process of decentralised reform. It permitted municipal and prefecture governments to select a reform plan. Provincial governments were given the right to approve

the programme design chosen by lower level government. For the first time, this document formally defined the nature of the pension system in terms of highly decentralized in financing as well as administration (State Council: (1991)). Also it was in this year that the government approved five key industrial sectors to establish specific industrial pooling. It was completely outside the sphere of provincial pooling system (MOLSS: (2001)).

However, the reform of 1991 did not state exactly what the level of operational standard of benefit eligibility requirement should be, the principles of the benefit replacement rate and the benefit structure. It only provided an overview, rather than a programme of specific pension reform provisions.

In 1995, the State Council issued a new circular on pensions with a goal to create one unified national pension system. Its target was that by 2000, all workers should be participating in a single national system with the support of the central government. This would entail, as far as possible, uniform rules, provisions and procedures. However, in order to encourage the provinces' administrations to adopt the policy, the document also outlined three different approaches [8] that provinces might take. They are allowed to adopt any of the three models outlined or use any

[8] Plan I : to build schemes around individual accounts to be financed by 16 percent contribution rate. The contribution rate would be shared between employees and employers, on a basis to be gradually adjusted until one-half was paid by each. Contributions would be deposited in accounts accruing interest on an administered basis to be specified later, but reflecting a combination of the rate of return on bank deposits and the rate of growth of local average earning. Pooled employer contributions would also finance additional benefits for workers combined a in mid- career at the time the new system was established.

Plan II: combined a flat-rate "base" pension to be set at 20 to 25 percent of each locality's average wage with an earnings-related pension equal to 1.0 to 1.4 percent of the individual worker's standard wage for each year of service and a pension derived from an account built by voluntary individual contributions.

Plan III is a modified approach of plan II. Under which the earnings-related component of plan II would be omitted, but retaining the combination of a flat-rate base pension and the individual account.

In all three approaches, "floor" and a "ceiling" earing levels were to be established for the calculation of each worker's contribution. The suggested floor was 60 percent of the local average wage, with the ceiling to be set at either 200 percent or 300 percent of the local average wage.

combination of the various features outlined (Sta 1995). This resulted in a further fragmentation of the pension system.

Following a series of discussions and having learned from past experience and experiments, unifying the fragmented system and extending coverage to non-state sectors was the vital step to continued reform and clearly action was needed immediately. Three factors forced the government to speed up the inclusion of non-state workers in the pension system and to unify standards.

One was the massive layoff of workers in 1996 and 1997. In 1996 there were 8.2 million workers laid off ; the number increased to 14.4 million in the following year (Sta 1997a). However, the downsizing process was extremely difficult. Fearing the loss, workers struggled to cling to their original employers and refused to sever ties. The laid-off workers had to face an uncertain job market, they also worried about the fact that they would lose their social security benefits upon leaving the state sector. Changing employment often involved a change of industry and pension pools; leaving the pool meant losing all previously accumulated pension benefits promised for the future. To compound the problem, no other pension pools were willing to provide for new employment to older workers because it was patently obvious they would become net burdens to their PAYG pension system. This concern is confirmed by a sample survey conducted by the Ministry of Labour and Social Security in July 1999. It revealed that 83 percent of all workers given a furlough were worried that cutting employment ties with original employers would mean losing pension and health insurance benefits. It was thus unequivocally urgent to set up a pension programme in non-state sectors so that the social security scheme for former state workers would continue after they had shifted to the non-state sector (Zhao and Xu 2002).

The second factor was the serious financial crisis of the government-sponsored

Tab. 2.5: Dependency Ratio for China's Urban Public Pension System [a]

Year	System Workers (10,000 persons)	System Retirees (10,000 persons)	System Dependency Ratio (Retirees per Worker)
1993	7,336	1,628	0.22
1994	8,494	2,079	0.24
1995	8,738	2,241	0.26
1996	8,758	2,358	0.27
1997	8,671	2,533	0.29
1998	8,476	2,727	0.32
1999	9,502	2,984	0.31
2000	10,448	3,170	0.30
Growth 93-98(%)	15.5	67.5	10 percent point

[a] Sources: Ministry of Labour and Social Security and State Statistical Bureau, Statistic Report of Labor and Social Security, various years.

pension systems. Between 1993 and 1998, while the system participants grew by 15.5 percent, the number of retirees went up by 67.5 percent (see Table 2.5). The system dependency ratio rose by 10 percentage points in mere 5 years, which led to a shrinking pension surplus and the emergence of deficit in 1998. Many areas experienced payment delays and protests by pensioners. Increasing the coverage ratio of the pension system was the way to improve this situation. As Seen in Table 2.6, the formal pension system in China, during the 1990's, covered mainly the state sector in urban areas. The non-state section, which accounted for more than half the employment in many localities, had only spotty coverage. However, compared with SOEs, these non state sectors had much younger employees and less retirees. If they were to be incorporated into the pension system, the system dependency ratio would be reduced and the financial crisis relieved to some extent.

The third factor was that the pension system had failed to provide the same level playing field for enterprises. Similar enterprises in two provinces may have had to

Tab. 2.6: Contributions to Pension Funds by Ownership (1993) [a]

Ownership	Staff Covered by the Fund	Percentage of those Eligible(%)
State-owned firms	402,238	95.7
Urban collective firms	163,400	74.7
Others	21,960	30.2
Total	587,598	82.3

[a] Source: 1994 Statistical Yearbook of Chinese Labour

pay vastly different payroll taxes ranging in difference from 20 to 30 percent. And a different ownership of the enterprise meant different pension obligations. Compared with SOEs, non-state enterprises had much fewer retirees and a lower compliance rate. For the thirteen provinces and twelve municipalities for which data is available, the simple average of contribution rates in state enterprises in 1994 was 23.5 percent for the provinces and 25.9 percent for municipalities - well above the international norm. Moreover the contribution rate varied from region to region and from industry to industry. It ranged form 19 percent in Guangdong to 28 percent to Henan. For the eleven sectors that were exempted from municipal pension pools, the average is just 15.9 percent, with lows of 10-15 percent for civil aviation, construction, banking, electric power, and petroleum and natural gas, with a high of 24.5 percent for coal mining (World-Bank 1997).

2.3.6 1997 Document No.26

In order to unify the fragmented pension systems and to extend coverage to the non-state sector in 1997, the principal arrangement of the new pension system for urban employees was laid down in the State Council Document No.26. It called for the four unifications - a unified system, a unified standard, a unified management, and a unified fund usage (Sta 1997b). The following three important changes were

made:

- It extended pension coverage to the entire urban labor force, including the self-employed. Various industrial-specific pension schemes were incorporated in the provincially unified scheme. There was a uniform contribution and benefits rate within a province.

- The responsibility for the operation of the pension scheme, including the keeping of employee records and payment of pensions was to transferred from enterprises to social insurance agencies. The agencies at the municipal and provincial levels were territorial subsidiaries of the Ministry of Labour and Social Security (MOLSS).

- The old age pension was to be multi-tiered, a defined benefit public pillar for redistribution, a mandatory funded defined contribution pillar for each worker, and a voluntary supplement pension pillar managed by each individual firm or private insurance company (see Table 2.7).

This pension system draws funds from various channels, and based on multi-layers, with rights and obligations corresponding, management and services work socialized. Pillar 1, a mandatory pay-as-you-go pillar, had a redistributive element. It kept the elderly above the poverty line and involved some redistribution from higher to lower wage earners. It imposed a payroll tax of 17 percent paid by employers to ensure that all the employees who had worked for more than 15 years would receive the basic pension benefit, amounting to 20 percent of the average wage of the local employees in the previous year.

Pillar 2 handled savings and linked benefits closely to contributions. As a mandatory funded pillar, the second pillar established an individual account for each employee at a level of 11 percent of their wages. It was jointly contributed to by

both employees and employers. Initially, it paid in 7 percent from employers and 4 percent from employees. The employees's contribution increased 1% every 2 years and was up to 8% by 2005; the employer's contribution decreased correspondingly. After retirement, the employee received a monthly benefit from this account of accumulated value divided by 120. (This assumed that the average life expectancy after retirement was ten years. It also meant that the scheme redistributed income from those with short lives to those with longer lives. In addition, if the average life expectancy of retirees exceeds ten years, these 'funded' pensions will in fact be financed on a PAYG basis.) If one contributed to the system for 35 years, then the individual account could provide 38.5 percent replacement rate. So, jointly, the two pillars have a replacement rate of 58.5 percent.

Besides these, a third voluntary insurance pillar, which was to be managed by individual firms or private insurance companies was encouraged.

In the case of the retirement system applying to employees in government organisations and parts of institutions, pensions were funded by the State without individual contributions and the pensions were calculated on the basis of salary and years of service. This system currently covers 30 million employees. Military personnel have a similar but independent pension scheme.

The document also included the transition issue. The benefit formulas were grouped into three main categories based on three types of workers defined in the system.

- New workers, who entered the labour force after 1997 would receive a pension income combined of a social pool pension benefit and an individual account-related monthly benefit, provided they had 15 years of creditable service.

- Middle workers, who started work before 1997 but had not retired by 1997,

Tab. 2.7: Three-Pillars Pension System of China

Pillar	Pillar 1 (social pooling)	Pillar 2 (individual account)	Pillar 3
Benefit Contribution	13% of employer contribution of per-tex of total enterprise revenue	7% of employer contribution of pre-tax of total enterprise revenue 4% of employee monthly wage	employee contributions
Benefit Financing	PAYGO. Paid from a social pool financed by employer contribution with the government making up any deficit	per-funded, in principle but not as yet in practice. financed jointly by employers and employees	NA
Benefit Eligibility	a minimun of 15 years of contribution	a minimum of 15 years and lump-sum if it is less than five years	NA
Benefit Payment	Defined benefit replacement rate of 20% of the prevailing average wages at retirement	defined contribution replacement rate of 38.5% of the prevailing average wages at retirement	voluntary
Status	Operational	operational in principal, but individual accounts are notional	limited experience

would get a mixture of the new and old system credit service. They would receive the same two components as new workers plus a transition benefit.

- Old workers, who retired prior to 1997 were entitled to benefits defined by the former system, would receive an average replacement rate of 80%.

2.4 The Current Pension System

2.4.1 Law/Regulations

Currently, in China, there is no pension law in force [9]. The pension system is regulated by a series of decisions by the State Council and of the MOLSS. The

[9] It may be subject to the change of government regulations.

current urban pension system is based on the frame work set by *Decision No. 26* of the State Council in 1997, *Establishment of a Unified Pension Insurance System for Enterprises Employees*. Its structure continues to evolve as the programme is gradually expanded, administrative arrangements are adjusted and new approaches are piloted in selected regions.

2.4.2 Coverage

The current pension system covers all enterprises and individual workers in the urban areas, however, it does not apply to the rural population. There is debate about whether the current pension system should extend to the rural enterprises. The effective impact of it is still questionable in both the short and the long term. The rural enterprises have a relatively younger workforce, and the whole rural population is aging slower than the urban population. The extension will lead to income transfer of pension income from the rural to the urban population to meet their benefit obligations. The long-term effect may benefit the rural workers, however, it requires their effective participation throughout their lifetime, which is a difficult challenge for lot of rural workers.

For farmers, there is almost no social security system after the diminishing of the commune system. Old-age provision in rural areas is mainly based on family support. In 1991, the Ministry of Civil Affairs established voluntary pensions. Over the next few years, it was gradually extended to most provinces. However, it hasn't gained widespread acceptance. It is more popular in the higher income level counties, with participation rates of up to 50 percent of eligible individuals in some parts of the country, than in the poorer areas, where hardly any members have joined. This system is still in its infancy and has received very limited attention and resources. Its administrative costs are not being met from government budgets, but through

a fee levied on contribution collections. This programme is still controversial at the national level. Its responsibility was transferred to the MOLSS in 1998. At the same time, the State Council called for a pause in the expansion of the voluntary rural pension pilot while consideration was being given to possible alternative modes of provision. As yet agreement has been reached.

2.4.3 The Administrative System

The Central Government and local governments are jointly responsible for administering China's pension system. The main responsibilities of the Central Government are: formulating national regulations, policy and standards; and providing financial assistance to areas in extreme poverty. Whereas local governments have the following responsibilities: formulating local regulations, policy and standards in accordance with national policy; collecting contributions; and distributing benefits.

The central government organisations that are involved in the pension system are mainly MOLSS and the Ministry of Finance (MOF). MOLSS is in charge of pension insurance and the MOF is responsible for formulating the financial social security policy and accounting system, supervising the income and expenditure of social security funds and providing financial subsidies for social security schemes. Similar institutional arrangements have been set up at the provincial, municipal and country levels, with corresponding responsibilities.

2.4.4 Financing

Contribution

Pension financing basically follows the structure set by the No. 26 Documentation, however, the unified contribution rate can not satisfy the current situation,

in which the prevailing financial burden of the programme differs from province to province. Currently, the employer's contribution rate also varies from province to province. Generally, it is around 20 percent [10]of the employer's total payroll. Depending on the province and the employer type, this may be the total payroll in the preceding year adjusted to reflect average wage trends or the total payroll in the preceding month. Also, the contribution rates paid by the self-employer vary by province. Some provinces levy the equivalent of the combined employer and employee rate while others charge the self-employed a lower rate.

The contribution payable by an employee is levied on his or her actual earnings, including subsidies and bonuses with the application of floor and ceiling. The total earnings used in the calculation of pension contributions and individual accounts can not be less than 60 percent, or more than 300 percent of the average wage.

Each employee's individual account is credited with an amount equal to 11 percent of that employee's wage. In most cases, this means that the entire amount of an employee's contribution is credited into his or her account, together with a share of the employer's contribution equating to three percentage points of the relevant earnings. In all provinces, except those participating in the pilot programme, the individual accounts are essentially notional, being simply records of the contribution paid and investment accumulations. The actual contributions collected are held in the pooled account and most have been used in recent years to pay benefits to current retirees. Accounts earn interest at a rate declared each year by the MOLSS; which is usually set at or close to the prevailing bank deposit interest rate.

Liaoning Pilot Program

[10] Provinces wishing to set employer contribution rate significantly above or below 20 percent should, in principle, need to seek the prior approval of the State Council, although it is not clear that all local jurisdictions observe this requirement at all time.

The government attempted to address the problem of empty individual accounts: The State Council Document No. 42 of 2000, an *Experimental Project for Improving the Social Security System* launched a pilot programme in Liaoning Province as a modification of Document 26. The major reason for choosing Liaoning is that this province is a rustic industrial province and is heavily burdened with a large number of both unemployed workers and retirees.

The major features of the experiment are: that an enterprise's 20 percent basic contribution would go to the social pooling fund, aimed entirely to reduce the funding pressure for basic social accounts in light of a large number of old and middlemen pensioners, and individual accounts would be financed by 8 percent from individual contribution. This experiment required the segregation of the management of individual accounts from the administration of the socially pooled funds in order to restrain the growth of notional individual accounts. The basic benefit would be increased by up to 30 percent for workers whose contributions exceeded 30 years as an attempt to constrain evasion. Workers would receive a flat benefit of 20 percent for their first 15 years of work, and an additional accrual rate of 0.6 percent for years 16 to 32, until 30 percent was reached.

The success of this programme required a big subsidy from the central government. So far it seems likely that the experiment may gradually be extended to other provinces. The result of this pilot project will determine the future development of China's pension system. The possibility of implementing a notional defined contribution system is also under discussion.

Pooling and Subsidy

In principle, all pension contributions collected in a given province should be pooled at the provincial level and all benefit payments should be made from the

single, pooled fund. However, only the four provincial-level municipalities and one province have consistently followed this practice. In the other provinces, the contributions collected and benefit payments have been pooled at lower levels (cities or counties). Currently, the ultimate guarantor of unemployement and pension benefit payments is the government administration that is managing the relevant social pool, even though lower levels of government may play a role such as the collection of contributions. In such cases, the lack of connection between the responsibility for guaranteeing benefits and that of collecting contributions may in fact represent a significant barrier to improved geographic pooling. Ultimately, resolving this difficulty may require that either the point of responsibility for collecting contributions (or the administrative responsibility for managing county-level employees) should be changed, or the subsidy rules should be changed to match the financial responsibility for the guarantee of administrative responsibility for collecting contributions.

At present, however, there is no basis for reference to any formula for determining the level of central government assistance, and allocations have been determined administratively. In 2003 alone, governments at all levels contributed a total of 54.4 billion yuan from their general budgets to help finance pension payments; this represents some 20 percent of the total cost of the pension programme. Of the total, almost 87 percent (47.7 billion yuan) was paid by the central government (Drouin and Thompson 2006). In 2000, 24 of the 31 provincial-level governments collected less in pension contributions than they had paid in pension benefits.

The National Social Security Fund

The National Social Security Fund was set up in 2000 and was managed by the National Council for Social Security Fund (SSF). Its main aim is to create a national long-term strategic reserve fund to finance future social security expenses, and acts

as a last resort if some provinces have insufficient funds for their pension obligation [11]. Its fund are derived from the allocations from the central government budget (67% in 2004), the sale of state shares (15%), investment returns(6%), and "capital raised in other manners with approval of the State Council". In 2004, 39 percent of its 171.1 bn RMB funds were invested in bank deposits, 43% in government bonds, 11% in stocks and 7% in other equity investments [12].

According to the original plan, 10 percent of the all of the proceeds of SEO share sales should be deposited into the Fund. From the estimation of ILO, if all SOE shares were sold now, 10 percent of it would pay about two years pension benefit payment. This would provide a useful cushion against future unforeseen development and help to finance the current transition cost. However, there is a strong reluctance to follow this plan. Also, the fund is following a relatively conservative investment policy, the rate of return is considerably less than the rate of growth in wages.

2.4.5 Benefits

The benefits are still in line with Document 26. From June 1998 onwards, the retirement benefits consisted of two parts: a basic benefit and an individual account benefit. The basic benefit is equal to 20 percent of the average wage in the year prior to the individual's retirement. The figure used in this calculation is the average for the pooling area in which the worker resides at the time of retirement.

The monthly benefit based on the individual account is the balance in the worker's account at the time of retirement divided by 120 [13]. Initial retirement

[11] The rules for distribution of subsidies to the worst-off provinces by way of loan or grant are not yet determined

[12] Source: National Council for Social Security Fund website: www.ssf.gov.cn

[13] It is assumed that average retirement life is about 10 years.

benefits are supposed to be adjusted by taking into account changes in wage and price levels and the financial condition of the programme in the respective provinces. However, there is no set formula for the calculation of adjustment now. Payment continues for as long as the worker lives. The dependents of workers who die before the account is exhausted inherit the balance of the account, while continued benefits to those who live long enough to exhaust their account balance are financed from the pooled pension fund.

Workers with earnings credits prior to July 1998 who retired after July 1998 are entitled to a two-part transition benefit. One part is a flat amount equal to 10 percent of the average wage in the respective province during 1997. The other part is calculated by multiplying the worker's career average indexed earnings by 1 percent for each year of service (prior to 1998) between ten and 15 years and by 1.2 percent for each year of service in excess of 15 years. The first of these two transition benefits adjust for the fact that before 1998 the flat benefit was equal to 30 percent of the provincial average wage. The second transition benefit is designed to compensate for the fact that no contributions were actually credited to individual accounts prior to 1998.

In principle, pension rights are "portable" from employer to employer and from province to province, so that an individual's retirement benefits are based on his or her full career record. A worker's individual account balance is transferred from the sending province to the receiving province when the worker migrates. However, in practice it is not clear whether the procedures actually exist to enable this to happen in real life.

Tab. 2.8: Investment Return VS. Wage Growth

Year	2000	2001	2002	2003	2004	2005	average
Deposit Interest Rate[a]	2.25	2.25	1.98	1.98	2.25	2.25	2.16
China Treasury Bond Trading Rate[b]	2.6	2.52	2.15	2.62	2.79	1.86	2.42
Real manufacturing wage indices change % [c]	3.31	0.8	2.28	19.98	11.88	12.21	8.41

[a] Definition: Deposit interest rate is the rate paid by commercial or similar banks for demand, time, or savings deposits.
Source: International Monetary Fund, International Financial Statistics and data files.

[b] Source: Organisation for Economic Development and Cooperation (OECD), Main Economic Indicators (MEI) Vol. 2004 Release 3, ESDS International, (MIMAS) University of Manchester.

[c] Source: International Labour Organisation (ILO) Table: Manufacturing wage indices

2.4.6 The Investment of Pension Asset

According to current regulations, 80 percent of any reserve funds (the excess over a two month liquidity reserve) must be invested in government bonds. The remaining 20 percent must be deposited with one of the four state-owned banks [14] or the postal saving system. Real deposit rates and real yields of long-term government bonds are around 2-3 percent on average. The investment returns on pension reserves have failed to keep pace with wage growth (see Table 2.8), workers' wages have grown faster than their individual account balances and the system's liability have grown faster than its reserves.

[14] The four state-owned banks include the Industrial and Commercial Bank of China, the Agriculture Bank of China, the Bank of China and the China Construction Bank

2.5 The Reality and its Transition Features of China's Pension Reform

How does this new system work? The answer is it works badly with high contribution levels, delayed pension payments and a low compliance rate. Even the contribution of the so called funded individual account is used for current expenditure. In the following, some major reasons causing the problematic situation are discussed.

2.5.1 The Transition Cost is not Well Financed

According to the reform framework for those who had already retired before 1997, the original PAYG system was retained, while for those who had entered the labor market in or after 1997 the new three-pillar pension system is applicable; to those who started work before 1997 and retired, or will retire after 1997, a transitional plan is applied. In practice, these transition arrangements differ regionally, but in most areas, the replacement rates for these retirees are similar to those for retirees who retired before 1997 (on average 75-80 percent). Thus the transition cost consists of two parts: one is the pension commitment to those who retired before 1997, which is subtracted from the amount that could be received by others from the new pooling account; the other part is equivalent to the amount needed to establish the individual accounts for those to whom the transition plan applies.

Initially, the government counted on the multi-pillar system with a higher contribution rate and the extension of coverage to absorb the transition costs. The benefits for the pre-1997 retirees were not to be downsized. A plan designed to extend the pension scheme to cover more employees was also supposed to increase

the influx into the system and keep the system in financial check. According to the State Council Document 26 of 1997, a 4 percent percent contribution rate of the first pillar is for transitional purposes. The current workers and employers bear the cost, which means a double burden for present workers: simultaneously contributing to individual accounts and paying for the current generation of retirees.

However, it is very hard to expand its coverage. A deficit in the first pillar soon emerged. Instead of financing the transition costs by other means, the funds in the individual's account were used to pay for the benefits to current retirees. This transformed what had been intended as an actually funded system into a (partially) notionally funded system. Although this makes the fiscal situation look better than it is, the deficit of the individual accounts is ultimately a liability of the state budget. Moreover, these empty accounts with an uncertain interest rate undermined confidence in the system and also greatly reduced the incentives of individuals and enterprises to participate in the pension system. The empty account scenario has already become one of the biggest problems of the current pension system.

A high rate of return for the pension fund investment is another way in which the transition costs can be financed. However, according to Chinese regulation, no less than 50% of social security funds must be invested in risk-free assets which are bank deposits and government bonds - both are having a very low rate of return [15]. It is obvious now that neither the contributions of current workers nor the anticipated higher investment return solved the problem of transition cost.

[15] Chinese financial market is still under developed. It's lack of investment tools and expertise. The share of social security funds, which are invested in riskier asset will be increased gradually as the financial market is more mature, and more investment expertise is available.

Tab. 2.9: Participation Rate for Urban Pension System [a]

Urban Employment (10,000 person)	1998	1999	2000
Total	20,678	21,014	20,274
Government and nongovernment institutions	3,877	3,930	3,801
Business sector(A)	16,801	17,084	16,473
Actual participation(B)	8,476	9,502	10,448
Participation Rate (B/A) (%)	50.4	55.6	63.4

[a] Source: Ministry of Labour and Social Security and State Statistical Bureau, Statistical Report of Labor and Social Security, various years

2.5.2 Widespread Noncompliance and Evasion

Widespread noncompliance and evasion exists in the current pension system. For enterprises already in the pension system, the primary form of noncompliance is reporting less employment and lower wage bills to the government in order to reduce pension contributions. According to the Ministry of Labour and Social Security, participating enterprises owed the system 30.2 billion yuan in social security payments by the end of 1998. It rose to 38.3 billion by November 1999 and reached 41.4 billion yuan by the end of June 2000 (Zhao and Xu 2002). For businesses traditionally excluded from the pension system (private firms and the self-employed), refusing to participate is the main form of noncompliance. These firms usually have a relatively young work force. According to official statistics of 1998, the pension programs covered 80.5 percent of workers in state-owned and urban collective enterprises, while 98.5 percent of retirees were covered. The evasion is clearly demonstrated by the slow pace of the expanding coverage. In January 1999, the State Council set a goal that all workers in the urban business sector would be included in the system by the end of June 1999. However, by the end of 1999 the participation rate had only expanded from 50.4 percent to 55.6 percent, and by the end of 2000 the rate had reached only 63.4 percent(see Table 2.9).

The major reason behind the noncompliance and evasion is the lack of incentives for enterprise and individuals to participate in the system. Contrary to the popular perception of China by the West, the government of China lacks enforcement capacity over enterprises. Tax evasion is pervasive and regulations are routinely ignored. Therefore, mandatory participation will not produce the desired results unless incentives are provided (Zhao and Xu 2002). Moreover, because of the massive extra labour that exists in the market combined with a weak labour union, employees are generally in a very bad bargaining position. If their employers decide not to adhere to the pension system, then most of them have to accept this situation.

The first disincentive is the large redistribution first pillar, which is equal to a 17 percent payroll tax. The second and most important disincentive is the low rate of return on contributions to personal accounts. According to official projections, the 11 percent defined contribution rate is expected to provide an annuity equal to 38.5 percent of the pre-retirement wage. With a 7 percent growth of real wages, the relationship between the defined contribution rate and the replacement rate implies an actual rate of return of only about 4 percent. It is much lower than the 12 percent marginal product of capital. If the defined contribution accounts could earn a real return equal to the marginal product of capital, the proposed crediting of a four percent real return is equivalent to an effective tax rate of 65 percent on the defined contribution return (Feldstein 1998). Actually, a large part of the contribution to personal accounts is not invested. It being used instead to pay current pensioners and thus the accounts become accounting tools. The rates of return are determined administratively. In order to reduce the future pension obligations, the government is tempted to set the rate low. Even worse, because of the bad situation of the current pension system, people are feeling more and more uncertain about future benefits. This has already became a vicious circle, the more evasion, the more

empty individual accounts, the more uncertainty about future pension benefits and the more evasion once again.

2.6 Suggestions for the Reform of Individual Accounts

A few countries, for instance Indonesia and Nigeria changed their public pension system from a fully funded defined contribution system to a PAYG-defined benefit system in order to halt the mismanagement of the provident funds. Their reasoning is that if the public authorities have no fund accumulation to manage, the abuses will be fewer. Orszag and Stiglitz (1999) claim that less developed countries usually have less developed capital markets, with less informed investors and less regulatory capacity, making the scope for potential abuse all the greater. China is one of these less developed countries, with very immature capital market. Until recently, China's state pension funds were controlled locally with little independent auditing or oversight. These provincial schemes have been open to abuse. Rather than following the rule of investing in safe treasury bonds and deposits, some local leaders chased the higher returns of China's booming economy, putting cash into riskier overseas investments and construction projects. In 2006, Chen Liangyu, Shanghai's ex-major was arrested and charged with lending 3.2 billion yuan (about USD 400 million) in pension funds to illegal entrepreneurs. An audit investigation by China's National Audit office, which is thought to have been triggered by the pension scandal, shows as much as 7.1bn yuan (USD 900m) of pensioners' money has been misused. Although the government has been considering plans to tighten the governance of China's fractured social security system, there is still little evidence to show that

the pension fund is in safe hands.

Funding is desirable if it:

1. leads to increased national saving in a country with a shortage of savings
2. strengthens financial markets
3. intergenerational redistribution is desired.

Based on the above criteria, would the funding system be desirable for the current Chinese situation?

China has high savings and rapid economic growth. Increased savings requires a drop in consumption today in order to have an even higher consumption tomorrow. This is contradictory to the desire of China's policy makers. Although consumption has continued to grow robustly in recent years, it is still slower than the overall GDP. At the annual session of the National People's Congress in March, the government presented its Work Plan for 2007, which included several initiatives to rebalance the pattern of economic growth. Rebalancing aims to make growth less intensive in resources and energy, less damaging for the environment, more evenly distributed and more led by domestic demand and domestic consumption.

Funding individual accounts may well contribute to further improvement in the financial sector, particularly if it strengthens the pressure for improved regulation and greater reliance on market forces. For example Chile used a budget surplus to introduce funded individual accounts, which strengthened the function of capital markets. However Chile's situation was different from China's when its pension system was reformed. Chile had a long-standing market system and a system of administration that was strong for the country's level of development. The pension reform added political will to strengthen regulation. By contrast, China's financial

markets are at an early stage of development. Reforms of the banking system have only just been initiated, interest rates are still not determined by the market, effective regulation is only just being established. Given the state of the financial markets in China today, a mandatory public pension system should not be the pilot for major innovations. This would put the retirement income of a large population at risk and mistakes would set-back reforms of the pension system as well as the financial market. Also with the current extraordinarily high saving rates, there is already a largely unsatisfied demand for long-term and relatively risk-free investment vehicles, therefore, it is not clear how increased demand, through the accumulation of financial assets in individual accounts, would contribute to further financial market reform.

From the intergenerational distribution aspect, funding benefits future generations at the cost of the current one. Given the same level of benefit, future generations will profit from the higher rate of return and pay lower contributions. However, for the current generation, in addition to the contribution to their own individual account, they need to bear the burden of financing the transition cost. Today's workers are relatively poor and subject to great economic uncertainty, while growth rates are high, so that workers in future generations are likely to be richer. It's not a reasonable objective to transfer from the current poorer generation to the future one.

Funding of individual accounts does not seem desirable in China's present situation. Probably in ten or twenty years from now, it will all be different. But for now, basing individual accounts on the NDC approach has significant advantages. It offers consumption smoothing to today's contributors in a similar way to fund DC schemes, and hence maintains the purpose of individual accounts. But, because no fund is built up, it does not require today's poorer workers to make larger

contributions so that future generations of workers can make smaller contributions, thus avoiding unsatisfactory intergenerational redistribution. It does not require the considerable private-sector financial and administrative capacity of funded schemes, since it is run by the public authorities. It is less risky for workers, since the rate of return avoids the short-run volatility of assets in the capital market; this is particularly important at a time when banking and financial-market institutions are still developing. Finally, the NDC approach will not require an increase in the contribution rate, or an increase in subsidies from the central Budget, as will be necessary if the 'empty' individual accounts are to be funded under the present scheme. Moreover, the NDC individual account can be designed to allow a smooth transition to funding.

2.7 Summary

This chapter is a survey about China's pension system. It introduces the whole evolutionary process, the current situation and suggestions for the future. The pension system's reform goes hand in hand with the economic reform of China. It has been greatly motivated and dictated to by problems in SOEs, for example the labor immobility and financial crisis in pension programs. Over the past 5 decades, it changed from a purely PAYG enterprise contribution defined benefit system to a more complicated three-tiers system with higher coverage. The reform has successfully established portability of pensions and relieved the heavy pension obligations of the SOEs. However, it has failed to overcome financial imbalance in the system, which has resulted in repeated delays in paying pensions to retirees, and almost empty individual accounts. This damages the credibility of the whole system, and needs to be fixed. A notional defined contribution system can be a

good alternative for the current Chinese. Further reforms are urgently needed as well, such as increasing the retirement age, increasing the age at which a worker receives a full pension over time, and synchronizing the retirement age for men and women, adjusting pensions on an actuarial basis for the age at which the pension starts, strengthening encouragement and regulation of voluntary and supplementary pensions.

Chapter 3

DEMOGRAPHIC CHANGE AND PENSION REFORM: A SIMULATION MODEL

3.1 Introduction

As mentioned in chapter 2 China's population is aging rapidly due to the implementation of the one child policy and rapid medical improvements. Reforms of the pension system are undergoing.

In this chapter, I analyze the impact of the change in demographic structure and to compare the results under different pension systems. I used a calibrated overlapping generations general equilibrium model to analyze its impact upon individual choices such as individual consumption, assets and labour supply overtime. As an aggregate of individual choices macroeconomic variables, for instance, total capital, total labour supply, interest rates, and economic growth rates can be calculated. By comparing the welfare of different cohorts, it answers the question of which cohort better off from this demographic change. Due to the lack of a plan about how to involve the rural population into the pension system in China, only the urban population is being considered here.

The calibrated overlapping generations general equilibrium model which I use is of a similar type to that developed by Auerbach and Kotlikoff (1987). I modify it in the following aspects:

- introduce technological progress and hold labour supply constant. Individual labour supply tends to decrease when technological progress increases the productivity. In order to focus on the impact of demographic change on labour supply, it is held constant. Also, this is a reasonable assumption given the inflexible labour market in China. There is a lack of choice of flexible working hours and part time positions.

- introduce bequests to justify China's strong family values and high savings rate.

- apply Chinese demographic data, rather than assume a constant population growth rate.

Also, I calibrate the parameters to take into account Chinese characteristics.

The model consists of three sectors: household, production, and government. The supply of the capital and labour in the production sector decides the interest and wages rates. The aggregate labour supply and capital are the result of summing individual decisions (consumption, individual labour supply and savings), each of which are based on an explicit decision-making procedure by maximizing some multi-period objective functions. The government chooses the social security system. It collects tax and pays benefits to retirees. The tax rate and pension benefits affect the individual's lifetime budget constraint and then affects their choice on consumption and labour. By jointly solving the equations of these three sectors, we can obtain a solution for the equilibrium path of the economy.

The model is theory based and widely used for policy simulation. However, its properties and results are often sensitive to parameters such as rates of time preference, degrees of intertemporal substitution. These parameters are considerably uncertain. Then there are the inevitably wide confidence intervals around simulated projections and they are difficult to be quantified (Miles 1999). Despite this drawback and the overlapping generations, the kind of general equilibrium models first introduced by Auerbach and Kotlikoff (1987) are still widely used for analyzing the impact of demographic change and pension system reform. With the calibration, it is at least possible to assess the implications of uncertainty surrounding key parameters by conducting alternative simulations. Further, for conducting experiments connected with public policy that affect different generations in different ways, calibrated, overlapping generations models is probably the only reliable tool (Miles 1999).

The chapter is arranged in the following way. Section 2 introduces the urban demographic change. Section 3 describes the model. Its solution methodology is provided Section 4. Section 5 talks about the calibration of each parameter. Finally, section 6 shows the result.

3.2 Demographic Change

The demographic data comes from the United Nation's projection, *World Population Prospects: The 2004 Revision population Database*. It provides the total population of China by five-year age groups and the percentage of the urban population from 1950 to 2050 [1]. Assuming that the urban and rural areas have the same age structure, the urban population by five-year age groups is calculated by timing

[1] The impact of rural to urban migration has been considered.

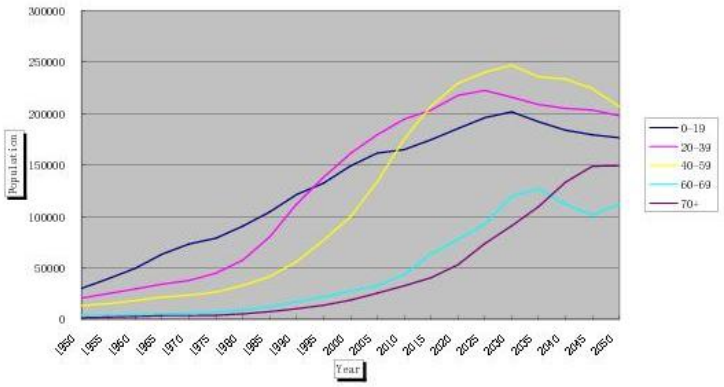


Fig. 3.1: Urban Population Over Time 1

the urban population rate of every year to population of every age group on that year.

Figure 3.1 and 3.2 show the change of the share of the population in 5 age groups. There are several striking features: China's urban population reaches its peak around 2030 and decreases slightly afterward. However, this results from the the decreasing of young generations from the population. The number of the retired population still increases quickly after 2030, especially the population over 70 years old. Therefore, over the next 45 years (from 2005 to 2050), the proportion of the young and working generations (age 0-59) declines. There is a significant rise in the proportion of the population in the second half of their working lives (aged 40-59). It reaches the peak around year 2018, remaining stable for about 5 years and then decreases gradually. The proportion of retired people increases greatly. Hence, the

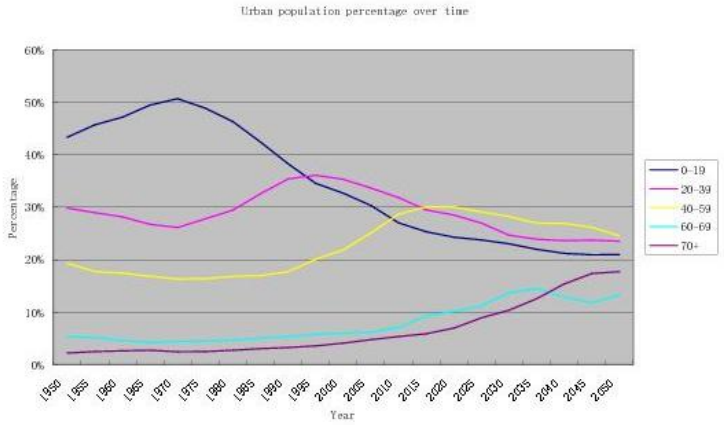


Fig. 3.2: Urban Population Over Time 2

demographic old age dependency ratio keeps rising, which affects the sustainability of a pension system, and its the generational distribution effect of a PAYG system. (See Figure: 60+ Dependence Ratio Over Time [2]).

3.3 The Model

3.3.1 Household behavior

At any given time the household sector comprises 50 overlapping generations of adults. Lifetime uncertainty is not considered in my model. Here individuals are

[2] The dependence ratio for a year is equal to the sum of population over 60 divided by the the sum of the population from age 20 to age 59 on that year . This is consistent with the assumption of my model, which is people start work at age 20 and retire at age 60. The calculation is based on the data provided by the United Nations projections, *World Population Prospects: The 2004 Revision population Database.*

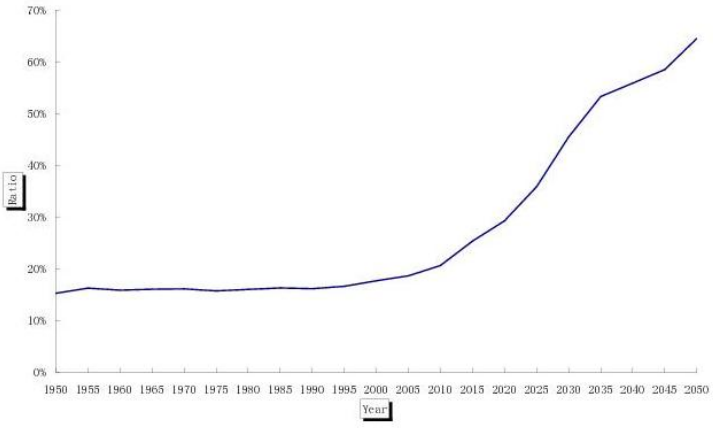


Fig. 3.3: Dependence Ratio Over Time

assumed to start working and to begin their adult life on the 20th birthday (adult age 0) and die on the 70th birthday. They have exactly 50 years of adult life, work from the start of age 20 to the end of age 59, and retire on their 60th birthday, and then take exactly 10 years pension benefits. Individuals in an age cohort are assumed to be identical, all differences in economic opportunities are cross-cohort differences.

Households are assumed to have perfect foresight about the economy. At the start of their adult life, they can correctly predict all the wage rates, interest rates and tax rates in their entire life. They make lifetime decisions by maximizing the lifetime utility function (3.1)that depends upon consumptions of goods and bequests left for the next generation, subject to the lifetime budget constraint (3.2). The excess of after-tax earning from labour and capital income is saved and added to the household's stock of assets (3.3). For simplicity, I assume the labour supply for each individual is fixed and normalized to 1. This assumption is reasonable for the

current Chinese situation with few flexible working hour choices. We assume that the life time utility function is time separable and of the nested, constant elasticity of substitution (CES) form. All individuals in an age cohort are assumed to be identical, all differences in economic opportunities are cross-cohort differences.

A household who starts working at year t (his adult age is 0) has a lifetime utility function as:

$$U_t = \frac{1}{1-1/\gamma}[\sum_{j=0}^{49}(1+\delta)^{-j}c_{j,t+j}^{1-1/\gamma} + (1+\delta)^{-49}\mu \cdot b_{t+49}^{1-\frac{1}{\gamma}}], \tag{3.1}$$

where $c_{j,t+j}$ represents the household's single year consumption when its adult age is j at year $t+j$. I assume that a household dies on the last day it is 69, and gives all the bequests to the new generation born. b_{t+49} is the bequest it leaves to the next generation on year $t+49$.

δ is a discount rate, often referred to as the "pure" rate of time preference. It indicates the degree to which, other things being equal, the household would prefer leisure and consumption in an earlier rather than later year. The larger δ is, the more of its lifetime resources a household will spend early in its life and the less it will save.

γ is equal to the household's intertemporal elasticity of substitution between consumption in different years, which is the percentage change in the ratio of any two years' consumption with respect to a percentage change in the relative price of consumption in the two years. The price of consumption is the return an investor can make from, for example, the interest from saving in banks, or return from investing in stocks or bonds. It can be measured by the response of the rate of change of consumption to changes in the expected real interest rate. The size of γ governs the responsiveness of households to changes in the incentive to save.

μ is the utility weight placed on the bequest. The bigger the μ, the higher incentive to save and the the larger the bequest.

Assuming that there is no government expenditure other than the social security system, and the payroll tax collected for financing the social security system is the only tax in the society, a person who starts working at year t, in which his adult age is 0, must fulfil the following budget constraint:

$$\sum_{j=0}^{49}\left(\prod_{s=1}^{j}\frac{1}{1+r_{t+s}}\right)[w_{t+j}\cdot e_{j,t+j}(1-\tau_{t+j})+p_{j,t+j}-c_{j,t+j}] - \left(\prod_{s=1}^{49}\frac{1}{1+r_{t+s}}\right)b_{t+49}+b_{t+0} \quad \geq \quad 0.$$

r_t represents the interest rate of year t, w_t is the standard real wage rate in year t (the real wage rate of a new adult in year t), and τ_t is the payroll tax rate at year t. We assume that the government collects a proportionate payroll tax. The tax rate may be different from year to year, but it is same for everyone in the same year. $p_{j,t}$ is the pension benefit for a household whose adult age is j at year t, and $p_{j,t}=0$ when $j<40$. The function of pension benefits and payroll tax rates will be defined later in this paper. $e_{j,t+j}$ is an individual's earning ability at age j and year $t+j$. With e, it allows for the fact that individuals of different ages in different years supply different amounts of some standard measure of labour input per unit of leisure forgone. It is an exogenous function of an individual's age and the level of labour augmenting technical progress, which grows at a constant rate η.

3.3.2 Asset

The excess of after-tax earnings from labour and capital income is saved and added to the household's stock. $k_{j,t}$ is the asset of a single household whose adult

age is j in year t, and its transition equation over time is:

$$k_{j,t} = (1 + r_t)k_{j-1,t-1} + w_t \cdot e_{j,t} \cdot (1 - \tau_t) + p_{j,t} - c_{j,t}. \tag{3.2}$$

At the beginning of a household's adult life, the bequest is passed on from the last generation (from the cohort that just died).

$$k_{0,t} = b_{0,t} = \frac{b_{49,t-1}N_{49,t-1}}{N_{0,t}}. \tag{3.3}$$

3.3.3 Production

The model has a single production sector that is assumed to behave competitively, using capital and labour subject to a constant return to scale production function. Capital is assumed to be homogeneous and non-depreciating, while labor differs only in its efficiency, That is, all forms of labour are perfect substitutes.

A standard Cobb-Douglas production function is employed to express the the total level of production in year t as:

$$\mathcal{Q}_t = AK_t^{\beta}L_t^{1-\beta}, \tag{3.4}$$

where A is a parameter greater than zero that measures the productivity of the available technology. K_t and L_t is the aggregate capital and labour supply in year t. They are the result of summing individual decisions. Total labour supply in year t is:

$$L_t = \sum_{i=0}^{49} e_{i,t} \cdot N_{i,t} \tag{3.5}$$

where $N_{i,t}$ represents the population of people whose adult age is i in year t. Total

capital input in year t is:

$$K_t = \sum_{i=0}^{49} k_{i,t} \cdot N_{i,t} \tag{3.6}$$

where $k_{i,t}$ is the asset of a single person whose adult age is i in year t, and its transition equation over time is represented by 3.3.

3.3.4 Social Security System

The results under the two kinds of pension systems are compared in this chapter. In China, there is little doubt about the existence of the first pillar PAYG defined benefit pension system which provides a safety net for the elder population. The difference is about how to finance the second pillar, the mandatory defined contribution system.

Scenario 1: **Notional defined contribution**

Individual accounts remains notional. The government pays the benefit according to its estimation published in Document No. 26 in 1997. According to the estimation, if an individual contributes to the system for 35 years, then his account could provide a 38.5 percent replacement rate. With the first pillar, the benefit of a retiree is comprised of two parts. The first is a basic pension which is equal to 20 percent of the average wage in society in the year before their retirement. The second part is related to his own income level, which is equal to 38.5 percent of their final wage. The pension for a single household who retired at year t (adult age 40) is:

$$p_{40,t} = 0.20 \times \frac{\sum_{i=0}^{39}(w_{t-1} \cdot e_{i,t-1} \cdot N_{i,t-1})}{\sum_{i=0}^{39} N_{i,t-1}} + 0.385 \times w_{t-1} \cdot e_{39} \tag{3.7}$$

Tab. 3.1: Gross savings as percentage of GDP

Year	1991	1992	1993	1994	1995	1996	1997
Gross savings as % of GDP	38.80	38.25	40.27	41.83	40.07	38.59	39.91
Year	1998	1999	2000	2001	2002	2003	2004
Gross savings as % of GDP	38.09	35.86	34.47	35.48	37.59	40.62	42.23

[a] Source: World Development Indicators (Edition: September 2006)

$p_{j,t+j-40} = p_{40,t}$ when $j = 41, 42, \ldots, 49$, and the pension is zero when the adult age is less than 40.

The tax rate τ can be acquired by the PAYG pension system budget constraints in year t:

$$\sum_{i=40}^{49} p_{i,t} \cdot N_{i,t} = \tau_t \sum_{i=0}^{39} w_t \cdot e_{i,t} \cdot N_{i,t} \tag{3.8}$$

Scenario 2: Fully funded

Individual accounts are fully invested. It earns the same rate of interest as other types of savings. It's function is to force saving. Households count the contribution to the individual account as a part of their savings. If the savings rate of all cohorts are higher than the mandatory contribution rate, the benefit function does not need to include this part as it does not change the household's choice. In reality, China has a saving rate much higher than the mandatory individual requirement. See Table 3.1. This is also proved by the model itself.

$$p_{40,t} = 0.20 \times \frac{\sum_{i=0}^{39}(w_{t-1} \cdot e_{i,t-1} \cdot N_{i,t-1})}{\sum_{i=0}^{39} N_{i,t-1}}. \tag{3.9}$$

3.4 Solution Method

Step 1: Take an initial guess at the interest rate vector for the 150 years spanning 1950 to 2099.

Although, the objective is to predict the situation from 2000 to 2050, the retrospective interest rates dating back to 1950 is needed for working out the optimal lifetime strategy of cohorts who are in their last year of life in 2000. Similar to that, the interest rate in 2099 affects the choice of the cohort whose adult life starts in 2050.

Step 2: Calculate r_t and w_t.

The initial guess at interest implies a capital labour ratio, which generates a time series for the real wage per unit of effective labour w_t. Equilibrium in production requires that the interest rate in year t, r_t, is equal to the marginal productivity of capital:

$$r_t = \beta A(L_t/K_t)^{1-\beta}. \tag{3.10}$$

Calculate the real wage in year t per unit of effective labour, w_t, by equation

$$w_t = (1-\beta)A(K_t/L_t)^{\beta}. \tag{3.11}$$

Step 3: Calculate p and τ.

Given the exogenous individual earning ability matrix $e_{j,t}$, and the demographic data (from the United Nations), by using 3.7 and 3.9, $p_{j,t}$ is obtained. The payroll tax rate τ_t is obtained from 3.8.

Step 4: Calculate $c_{0,t+0}$, $c_{j,t+j}$, and $k_{j,t}$.

A household has a lifetime horizon, it makes its current choice as part of a lifetime plan for consumption and labor supply in each future year, deciding on the path of consumption and savings over time. The household chooses only its current level of consumption, along with its planned consumption in the future years. Given that each year's current decision will be consistent with previously laid plans, with the full foresight assumptions, we can therefore consider the entire path of consumption as having resulted from a single optimization decision at the start of a household's adult life, on his 20th birthday, when he receives the bequest from the last generation.

For maximizing the lifetime utility function (3.1) of a person who starts work at year t, at which his age is 20 (adult age is 0), according to the budget constraint, first order condition for consumption in each year is:

$$(1+\delta)^{-j} \cdot c_{j,t+j}^{-1/\gamma} = \lambda \prod_{s=1}^{j} \frac{1}{1+r_{t+s}}, \tag{3.12}$$

where $j = \{0, 1, \ldots, 49\}$ is the adult age. From (3.12), an equation expressing the evolution of consumption over time is acquired:

$$c_{j,t+j} = \left(\frac{1+r_{t+j}}{1+\delta}\right)^{\gamma} \cdot c_{j-1,t+j-1} = \left(\prod_{s=0}^{j-1} \frac{1+r_{t+j-s}}{1+\delta}\right)^{\gamma} \cdot c_{0,t}. \tag{3.13}$$

Bequests can also be expressed as a function of $c_{0,t}$ as

$$\left(\mu \prod_{s=1}^{49} \frac{1+r_{t+s}}{1+\delta}\right)^{\gamma} c_{0,t} = b_{49,t+49}. \tag{3.14}$$

$c_{0,t+0}$ is solved by substituting $c_{j,t+j}$ and $b_{49,t+49}$ and in the lifetime budget constraints (3.2) by functions of $c_{0,t+0}$.

With equations 3.13, 3.14 and 3.3, the bequest and all consumption and assets for the cohort born in year t are solved. The calculating process is the same for all

cohorts.

Step 5: Calculte K_t and L_t

K_t and L_t are the aggregate capital and labour supply in year t. They are the result of summing individual decisions. Total labour supply in year t is:

$$L_t = \sum_{i=0}^{49} e_{i,t} \cdot N_{i,t} \tag{3.15}$$

where $N_{i,t}$ represents the population of people whose adult age is i in year t. Total capital input in year t is:

$$K_t = \sum_{i=0}^{49} k_{i,t} \cdot N_{i,t} \tag{3.16}$$

$k_{i,t}$ is obtained from 3.3.

Step 6: Recalculate the interest rate.

The total stock of wealth and the aggregate supply of labour forthcoming at the initial guess of the time path of interest rates generates a new time series for the capital labour ratio which implies a new pattern of interest rate. This new value provides the starting value for the second iteration. The procedure is repeated until a fixed point is reached.

3.5 Parameterizations of the model

The size of the intertemporal elasticity of substitution, γ is very controversial. Auerbanch and Kotlikoff (1987) set it to equal to 0.25, and Miles (1999) chooses 0.75. Empirical work by Hansen and Singleton (1983) suggests values a little over unity while Mankiw (1985) and Hall (1980) found values between 0 and 0.4. Here I assume that $\gamma = 0.75$.

Tab. 3.2: Parameters Calibration

Parameters represent	Value	
	Simulation 1	Simulation 2
γ: intertemporal elasticity of substitution	0.75	0.75
δ: the rate of time preference	0.0125	0.0125
μ : preference of leaving bequest	0	25
β : capital share of income	0.4	0.4
η : technological progress	0	0.03

The pure rate of the time preference discount rate δ is set equal to 0.015 by Auerbanch and Kotlikoff (1987) for the United States and and by Miles (1999) for Britain. It is consistent with the empirical evidence of Hurd (1989) who suggested a rate somewhat in excess of 1 percent. Due to the fact that a lower value of δ would lead to more saving, I assume $\delta = 0.0125$ for China to express a higher saving rate for China than that of the United states and of Britain.

μ is the utility weight placed on the bequest. Here I set $\mu = 25$. The incentive of leaving bequest will affect individual's saving behavior across his or her 50 years adult life. If we ignore the impact of time preference, averagely, the parameter governs every year's consumption is about 0.5.

In production function 3.4, factor shares are constant. β represents the capital share of income. I assume that $\beta = 0.4$ is based on the following literature: Chow and Li (2002) estimates a Cobb-Douglas production function using official Chinese Data from 1952 to 1998. The regression results suggest that the elasticity of output with respect to capital which is the β in 3.4 is about 0.6. The paper also finds that total factor productivity has zero growth from 1952 to 1978, and an average exponential rate of approximately 0.03 from 1978 to 1998. The 0.6 figure is also supported the estimation result from Chow (1993) and from N. Gregory Mankiw, David Romer and David N. Weil (1992). N. Gregory Mankiw, David Romer and David

N. Weil (1992) estimated the classic Solow growth model with a Cobb-Douglas production function using data for approximately 70 countries. However, 0.6 strongly contradicts to "1/3", which is widely accepted for the capital share of income for the world wide production function. For explaining this contradiction, it further tests the augmented Solow model by adding human capital into the regression. In this model output is produced from physical capital, human capital, and labor. The estimation result is $y = K^{1/3}H^{1/3}L^{1/3}$. Shanggen Fan and Robinson (1999) incorporates the contribution to aggregate growth of the reallocation of resources across sectors, and the used GDP by sectors at the provicial level for 1978-1995 to estimate sectorial production function. The results suggest that about 17 percent of aggregate growth in China over this period is due to structural change - shifting resources from lower to higher productivity sectors. For the urban industry, $\beta = 0.34$ in 1978 and $\beta = 0.49$ in 1995. For the urban service sector, $\beta \approx 0.38$.

An individual's earning ability profile $e_{i,t}$ is an exogenous function of an individual's age and the level of labor augmenting technical progress, which grows at a constant rate η. Individuals of different age cohorts in the same year provide different efficiency of production due to the their special skill level and human capital. This has been proven by empirical research. G. D. Hansen (1993) estimated the age specific labour productivity by using the United States labour market data. The Hansen data implies that efficiency units of labour peak at about 45 years of age and fall substantially by the age of 60. This result is very similar to that of Miles (1997). His estimation shows that if there was no aggregate, time-related productivity growth, and if the real wage per effective labour unit was constant, then the market value of the endowment would peak at 42 years of age, and by the age of 70 the labour endowment will have fallen to about 60 percent of the age 42 endowment; by age 75 it would be only half as high. Based on the regressions in Miles

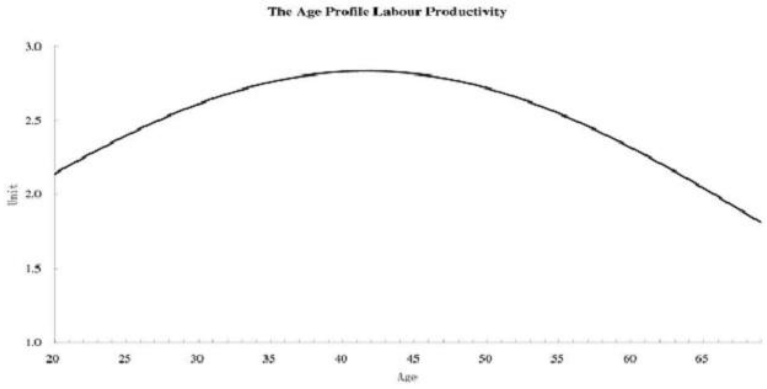


Fig. 3.4: The Age Profile Labour Productivity

(1997), the log of the age-specific part of labour productivity can be expressed by a particular quadratic function of age. Due to the lack of Chinese household survey data, and also because this factor is not very country specific, I am going to employ this function for my simulation. In my model i is the adult age, the function can be expressed as

$$ln(e_{i+20}) = 0.05(i + 20) - 0.0006(i + 20)^2. \tag{3.17}$$

With the assumption of time related labour augmentation, the technical progress grows at a constant rate η,

$$e_{i,t+1} = (1 + \eta)e_{i,t}. \tag{3.18}$$

This represents that the productivity per time unit of an age i cohort individual this year is $1 + \eta$ times of that of aged i cohort individual last year.

η is set equal to the average long-run rise in output per head. I assume that $\eta = 3\%$ for China.

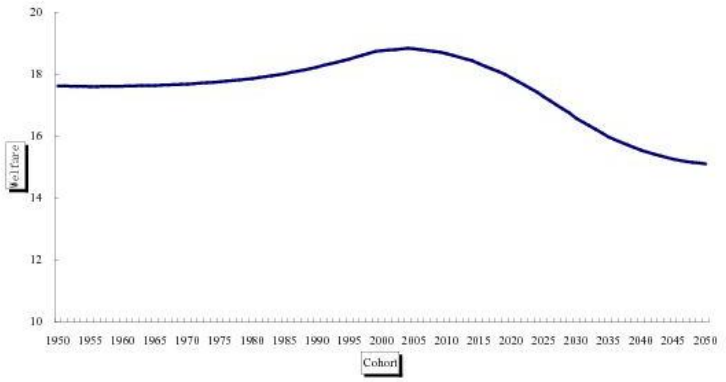


Fig. 3.5: 1: Welfare of Different Cohort

3.6 Results

3.6.1 Simulation 1: The Impact of Demographic Change

In order to answer the question of which cohorts benefit from this demographic structure change, I calculate the lifetime utility of cohorts whose adult life began from 1950 to 2050. Later cohorts normally benefit from technological progress and the choice of bequests affecting the life-time utility of later cohorts. To emphasize the demographic effect, I assume that $\eta = 0$ and $\mu = 0$, which excludes the effects of technological progress and bequests choice. The result is shown in Figure 3.5. The life time utility doesn't change much among $cohorts_{1950}$ to $cohorts_{1980}$ ($cohorts_{1950}$ represents the cohorts who turns age 20 in year 1950.). It increases gradually peaks at $cohort_{2004}$. The utility of later cohorts decreases at a sharper rate.

The difference of the lifetime utilities among cohorts results from the changes of macroeconomic variables, such as interest rates, real wage rates (See Table 3.3), which are affected by the demographic changes. It is also affected by the payroll tax rate applied during his adult life. The tax rate is more sensitive to demographic change.

Tab. 3.3: Impact of Demographic Change to Macro Variables 1

Year	Interest Rate	Real Wage Rate	Savings Rate	Tax Rate
2000	0.0574	1.4232	0.0738	0.0946
2005	0.0555	1.4436	0.0620	0.0990
2010	0.0543	1.4568	0.0510	0.1108
2015	0.0527	1.4762	0.0288	0.1359
2020	0.0513	1.4922	0.0094	0.1570
2025	0.0499	1.5101	-0.0131	0.1925
2030	0.0489	1.5237	-0.0384	0.2441
2035	0.0489	1.5239	-0.0394	0.2889
2040	0.0498	1.5115	-0.0395	0.3074
2045	0.0508	1.4993	-0.0385	0.3234
2050	0.0515	1.4898	-0.0453	0.3550

Figures 3.8, 3.7 and 3.6 show the changes in consumption, asset and savings rates of an individual in his whole adult lifetime by using $cohort_{2000}$ as an representative. The individual maintains a high savings rate earlier in their career. From age 20 to age 47, the annual savings rate is above 30 percent. It is at its highest at age 30 about 42 percent. Assets start from zero under the assumption of having no desire for leaving bequests, $\mu = 0$, and increases quickly due to the high savings rate. It peaks at age 52 and starts to decrease afterwards due to the higher consumption and lower savings rate. There is a big change in the savings rate around retirement age. The consumption during retirement comes from two parts, the pension benefit and

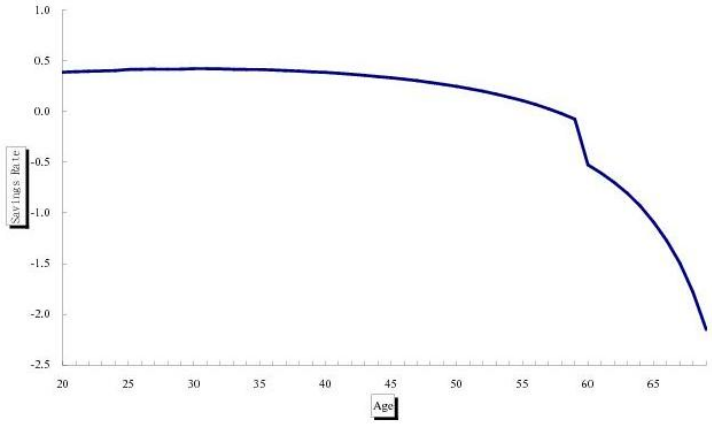


Fig. 3.6: 1: Savings Rate during the Whole Lifetime $cohort_{2000}$

one's asset. The savings rate is negative throughout the whole retirement period. The individual runs out of all his assets at the end of his life.

3.6.2 Simulation 2: Comparison of the Two Pension Systems

With the technological progress $\eta = 0.03$, all later cohorts are better off than the previous one. The lifetime utility is slightly higher for all cohorts under Scenario 2, in which the individual account is fully funded. Contribution into the individual account earns interest at the same rate as other kinds of savings. Table 3.4 shows this, the interest rate decreases all the time. However, for most of the time, it is higher than 4 percent for most of the time which is set by the government for the notional defined contribution account. The lower interest rate after 2040 closes the gap between the lifetime utility under these two scenarios.

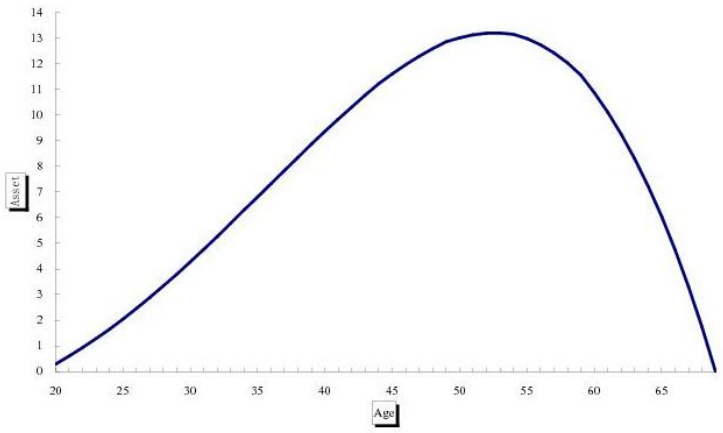


Fig. 3.7: 1: Asset during the Whole Lifetime $cohort_{2000}$

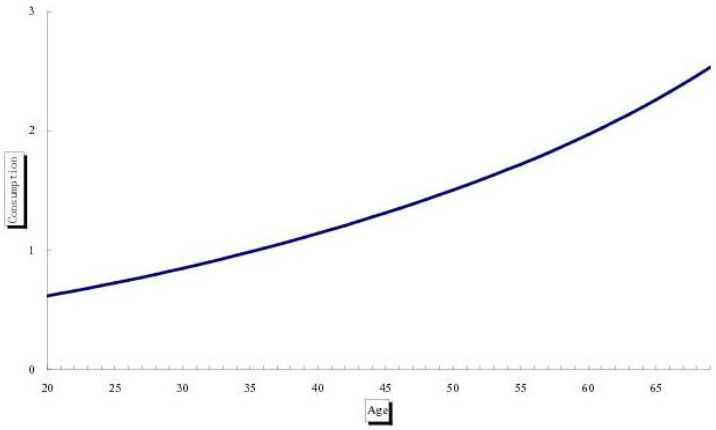


Fig. 3.8: 1: Consumption during the Whole Lifetime $cohort_{2000}$

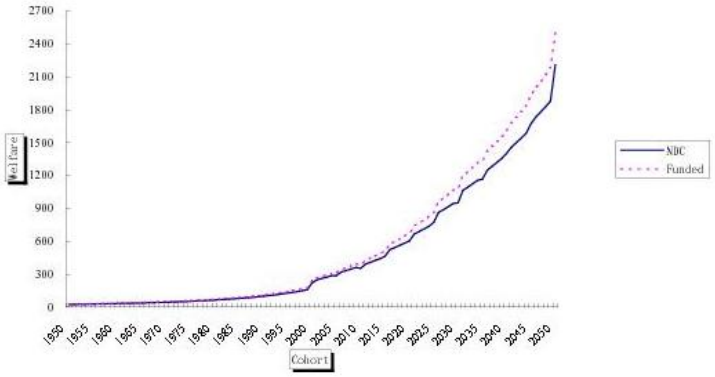


Fig. 3.9: 2: Welfare of Different Cohort

Tab. 3.4: Impact of Demographic Change to Macro Variables 2

Year	Interest(1)	Interest(2)	RWage(1)	RWage(2)	Savings(1)	Savings(2)	Tax(1)	Tax(2)
2000	0.0779	0.0739	1.7838	1.8477	0.2924	0.2773	0.0795	0.0288
2005	0.0711	0.0677	1.8960	1.9589	0.2935	0.2781	0.0810	0.0295
2010	0.0655	0.0626	2.0031	2.0636	0.2919	0.2722	0.0899	0.0330
2015	0.0609	0.0584	2.1024	2.1620	0.2950	0.2673	0.1110	0.0407
2020	0.0568	0.0545	2.2027	2.2641	0.3014	0.2659	0.1287	0.0470
2025	0.0527	0.0506	2.3149	2.3781	0.3073	0.2616	0.1577	0.0576
2030	0.0486	0.0467	2.4449	2.5101	0.3064	0.2465	0.1984	0.0725
2035	0.0455	0.0436	2.5546	2.6262	0.3160	0.2447	0.2345	0.0856
2040	0.0436	0.0417	2.6250	2.7077	0.3136	0.2352	0.2514	0.0916
2045	0.0412	0.0393	2.7277	2.8148	0.3085	0.2251	0.2632	0.0960
2050	0.0390	0.0372	2.8273	2.9212	0.3031	0.2117	0.2891	0.1053

Figure 3.10 shows that the individual holds a high savings rate throughout his entire career. It is higher than the contribution requirement.

In scenario 2, the funded individual account was treated as normal savings. The contribution was not added to the tax. Hence, individuals pay lower tax rates and receive lower benefits. This explains the slightly higher consumption level in earlier years and the lower level over retirement time (see Fig 3.12). The higher interest rate earned by the individual account contribution in scenario 2 helps individuals accumulate more assets before retirement. However, after retirement consumption relies heavily on their assets. The assets decline sharply post age 59. The bequest left for the next generation is lower (see Fig 3.10, 3.11).

Table 3.4 shows that: as population ages, the society has more accumulated capital and relatively less labour supply. As a result of that, interest rate is in a decreasing trend and per unit labour supply becomes more and more expensive; wage rate is increasing. As people in retirement has lower savings rate, society savings rate decreases over the time in scenario 2. It is more stable over the time in scenario 1, as the high level of PAYG pension system smoothes the savings rate over individual's life time.

In scenario 1, the tax rate increases significantly over time, from 8% in 2005 to nearly 29% in 2050. A high level of PAYG system [3] is rather not sustainable. Government has to increase the payroll tax rate to very high level.

[3] Funding the second pillar pension system through notional defined contribution scheme is equivalent to running a PAYG system financially. Government needs to fill the pension payment by either increasing the payroll tax rate or finance it by other kind of tax.

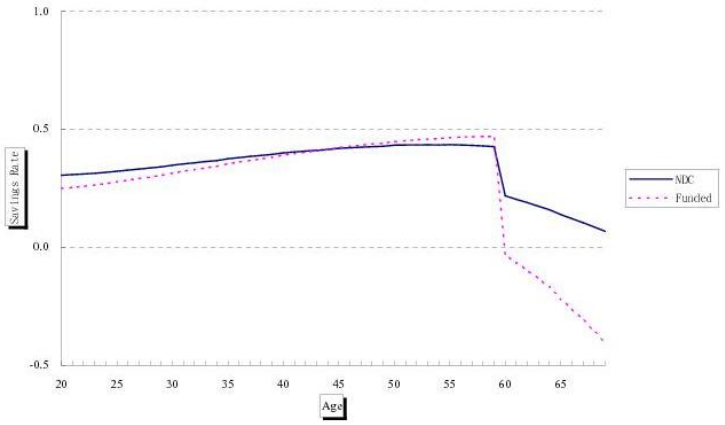


Fig. 3.10: 2: Savings Rate during the Whole Lifetime $cohort_{2000}$

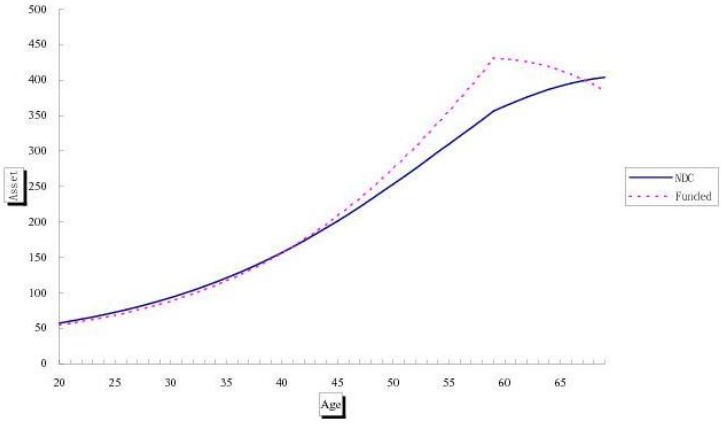


Fig. 3.11: 2: Asset during the Whole Lifetime $cohort_{2000}$

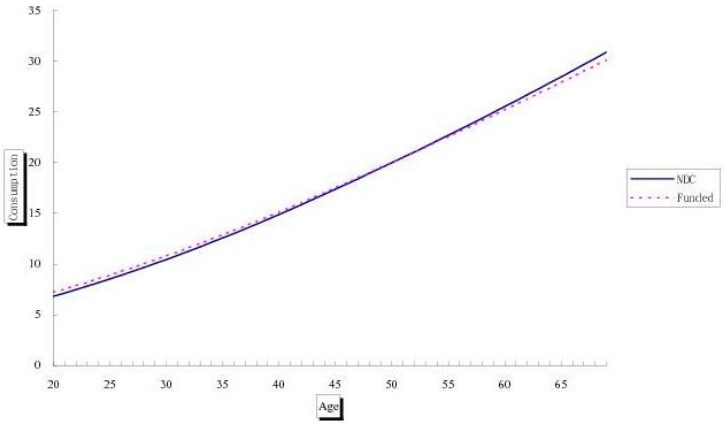


Fig. 3.12: 2: Consumption during the Whole Lifetime $cohort_{2000}$

3.7 Sensitivity Tests

Table 3.5, Table 3.7, Table 3.6, and Table 3.8 shows how sensitive the results are to the calibration of the parameters. The calculations have been done by changing one parameters each time and keeping the others at the base case.

Society benefits from a higher weight on the capital share of income (β changes from 0.35 to 0.45). As the population gets older, there is relatively more accumulated wealth and limited labour supply increase. Savings, interest and wage rates increase. The impact to the wage rate is more significant. As the labour supply is fixed, with more capital in the society, per unit of labour is rewarded most. The production growth rate (50 year average) is 5.20% in scenario 1 and 5.19% in scenario 2. This is higher than the base case scenario, 5% in scenario 1 and 4.99% in scenario 2.

The intertemporal elasticity of substitution (γ), the rate of time preference (δ) and the preference of leaving a bequest (μ) all affect individuals saving behavior.

The society savings rate increases when γ or μ increases, or δ decreases. As a result society has lower interest rate and higher wage rate.

It is shown that the calibration of the parameters does have an impact on the interest rate, wage rate and savings. But they do not alter the key features of the simulation:

- Interest rate decreases and wage rate increases over the time, as capital per worker increases as the population ages.
- Society is better off under scenario 2, where all cohorts enjoys higher utility and a more reasonable payroll tax rate.

It can also be seen that the impact to tax rate is less significant to the change of parameters.

The issue that has the greatest impact on forecasts of the effect of demographic change, is not so much the parameters governing substitutability and the rate of time preference, but rather the more fundamental assumptions in the model that individuals are forward looking and make saving and consumption decisions so as to maximise a utility function that depends on welfare in all future periods. It is in this assumption, allied with the hump-shaped age-productivity relation, that generates a profile of saving that is highly dependent on age and which causes demographic shifts to have major macro-economic impacts.

3.8 Summary

In this chapter, I used a calibrated overlapping generations, general equilibrium model to simulate the impact of demographic changes and to compare the results under two different scenarios. The results show that the demographic structural

Tab. 3.5: Sensitivity Test: $\beta = 0.45$

Year	Interest(1)	Interest(2)	RWage(1)	RWage(2)	Savings(1)	Savings(2)	Tax(1)	Tax(2)
2000	0.0841	0.0802	2.1711	2.2526	0.3045	0.2903	0.0792	0.0287
2005	0.0770	0.0737	2.3330	2.4134	0.3071	0.2925	0.0801	0.0292
2010	0.0711	0.0683	2.4912	2.5686	0.3065	0.2881	0.0888	0.0326
2015	0.0662	0.0638	2.6404	2.7167	0.3107	0.2849	0.1097	0.0402
2020	0.0619	0.0596	2.7925	2.8710	0.3177	0.2848	0.1273	0.0466
2025	0.0575	0.0555	2.9631	3.0443	0.3239	0.2818	0.1560	0.0570
2030	0.0532	0.0513	3.1614	3.2454	0.3231	0.2681	0.1962	0.0717
2035	0.0499	0.0481	3.3319	3.4248	0.3336	0.2687	0.2321	0.0848
2040	0.0478	0.0459	3.4489	3.5565	0.3296	0.2581	0.2492	0.0909
2045	0.0450	0.0432	3.6251	3.7370	0.3237	0.2477	0.2603	0.0950
2050	0.0426	0.0408	3.7926	3.9134	0.3183	0.2350	0.2861	0.1042

Tab. 3.6: Sensitivity Test: $\gamma = 0.85$

Year	Interest(1)	Interest(2)	RWage(1)	RWage(2)	Savings(1)	Savings(2)	Tax(1)	Tax(2)
2000	0.0683	0.0649	1.9502	2.0155	0.3512	0.3388	0.0795	0.0288
2005	0.0621	0.0592	2.0784	2.1416	0.3504	0.3375	0.0808	0.0295
2010	0.0571	0.0546	2.1998	2.2597	0.3460	0.3289	0.0898	0.0329
2015	0.0530	0.0509	2.3113	2.3699	0.3468	0.3222	0.1109	0.0406
2020	0.0493	0.0474	2.4238	2.4837	0.3505	0.3185	0.1286	0.0470
2025	0.0457	0.0440	2.5494	2.6110	0.3540	0.3123	0.1576	0.0576
2030	0.0421	0.0405	2.6961	2.7595	0.3508	0.2956	0.1982	0.0724
2035	0.0393	0.0377	2.8220	2.8918	0.3572	0.2912	0.2341	0.0855
2040	0.0376	0.0360	2.9038	2.9848	0.3532	0.2802	0.2510	0.0915
2045	0.0355	0.0340	3.0164	3.1027	0.3466	0.2687	0.2632	0.0960
2050	0.0336	0.0321	3.1306	3.2241	0.3401	0.2545	0.2888	0.1052

Tab. 3.7: Sensitivity Test: $\delta = 0.01$

Year	Interest(1)	Interest(2)	RWage(1)	RWage(2)	Savings(1)	Savings(2)	Tax(1)	Tax(2)
2000	0.0761	0.0720	1.8159	1.8803	0.3009	0.2866	0.0796	0.0288
2005	0.0694	0.0660	1.9295	1.9926	0.3023	0.2875	0.0810	0.0295
2010	0.0640	0.0611	2.0379	2.0983	0.3008	0.2818	0.0899	0.0330
2015	0.0595	0.0570	2.1390	2.1984	0.3035	0.2765	0.1110	0.0407
2020	0.0555	0.0531	2.2413	2.3022	0.3093	0.2746	0.1287	0.0471
2025	0.0515	0.0494	2.3557	2.4184	0.3145	0.2697	0.1577	0.0576
2030	0.0474	0.0455	2.4883	2.5529	0.3131	0.2541	0.1984	0.0725
2035	0.0444	0.0425	2.6006	2.6717	0.3222	0.2519	0.2345	0.0856
2040	0.0426	0.0406	2.6730	2.7553	0.3196	0.2422	0.2514	0.0916
2045	0.0402	0.0383	2.7763	2.8633	0.3137	0.2313	0.2633	0.0960
2050	0.0381	0.0362	2.8773	2.9713	0.3073	0.2168	0.2891	0.1053

Tab. 3.8: Sensitivity Test: $\mu = 30$

Year	Interest(1)	Interest(2)	RWage(1)	RWage(2)	Savings(1)	Savings(2)	Tax(1)	Tax(2)
2000	0.0762	0.0722	1.8139	1.8797	0.3083	0.2941	0.0795	0.0288
2005	0.0692	0.0659	1.9335	1.9980	0.3097	0.2952	0.0808	0.0295
2010	0.0635	0.0608	2.0477	2.1095	0.3078	0.2891	0.0897	0.0329
2015	0.0590	0.0565	2.1526	2.2136	0.3114	0.2848	0.1108	0.0406
2020	0.0549	0.0526	2.2586	2.3212	0.3178	0.2835	0.1285	0.0470
2025	0.0508	0.0488	2.3768	2.4413	0.3238	0.2796	0.1575	0.0575
2030	0.0467	0.0449	2.5139	2.5804	0.3228	0.2646	0.1981	0.0724
2035	0.0436	0.0419	2.6303	2.7033	0.3315	0.2622	0.2342	0.0855
2040	0.0418	0.0399	2.7060	2.7901	0.3287	0.2522	0.2511	0.0915
2045	0.0394	0.0376	2.8145	2.9032	0.3234	0.2421	0.2629	0.0959
2050	0.0373	0.0355	2.9209	3.0164	0.3180	0.2289	0.2887	0.1052

change China is undergoing has considerable effects on factor returns (interest and wage rate) and leads to changes in the saving rate.

The analysis in Simulation 1 focuses on the impact of demographic change by excluding the effect of technological progress and the incentives to leave bequests. The result is astonishing: As the proportion of retired people increases, the society savings rate turns negative after 2025, and the tax rate has to increase significantly; also later cohorts are worse off, having lower life time utility.

In Simulation 2, 3% annual technology progress is introduced. It shows that the aging problem can be hidden as long as the society can increase production efficiency over the time. In comparing the two possible alternatives for China's future pension system, we conclude that a fully funded second pillar is more desirable. The sensitivity result shows that changing the parameters to certain extent doesn't affect the key feature and conclusion of the simulation.

I have kept my calibration in line with other literature and make adjustments for Chinese characteristics, for example, a higher desirability for leaving bequests and a higher savings rate. This research can be extended by estimating the parameters based on China's historical data. However, the availability of this data, especially household survey data is still poor at the moment. For the results from 2000 to 2050, the calculation needs to be extended from 1950 to 2100. China has been and is still under significant change. It's difficult to say that the parameters estimated from the historical data, will be a good estimate for the future.

Also this chapter has not considered transaction costs. It addresses the question: 'which pension system is better if it is applied in the first place?' It does not mimic the real pension system in China, which is in a transitional phase. This remains an avenue for the future research.

Chapter 4

OPTIMAL LEVEL OF PUBLIC PENSION

4.1 Introduction

The provision of social security retirement benefits is a major government activity and a big part of a government's budget. The main functions usually assigned to public pension systems are the: saving function, to counter individual life-cycle myopia; redistribution function; and insurance function. Common observation suggests that there are many individuals who would not plan adequately for their old age and who would, in the absence of some form of government programme, find themselves in poverty or at least with a substantially reduced consumption relative to their pre-retirement years. A social security system is like a forced saving regime. It helps to smooth the consumption of a person over their lifetime. Individuals postpone some consumption when they are young and their earnings are high so that they can consume more in their old age than their reduced earnings would permit. Redistribution involves shifting lifetime income from one person to another. Insurance involves the protection against the likelihood that a recession or bad investments would wipe out savings, that inflation would erode their real value,

that people might outlive their own savings, or that the public programme would fail.

The primary cost of providing social security benefits is the welfare loss that results from a reduction in private saving. In addition, the payment of benefits distorts retirement behavior and the imposition of the tax used to finance the programme distorts the labour supply during the pre-retirement period. (Feldstein 1985)

The objective of this chapter is to find the optimal level for public pensions. The analysis is set in a two periods life cycle model. Individuals live for two periods, working in the first and being fully retired in the second. They make decisions about labour supply and savings. The government chooses the optimal public pension system, setting the optimal pension contribution rate to maximise a social welfare function. Also I assume that all individuals are homogeneous and have the same earnings and tastes. There is no uncertainty about the future rate of return or rates of population and productivity growth.

This work is inspired by Feldstein (1985), who derives the optimal benefit level by considering the welfare loss imposed by the saving distortion. I extend his analysis by introducing an elastic labour supply. Different from Feldstein (1985), which starts the analysis in the economy, in which all the individuals have complete myopia. I start by deriving the optimal level of a payroll tax rate in a economy in which individuals have perfect foresight. This establishes the general framework and provides a standard of reference for evaluating the effect of myopia, and a more realistic saving and labour supply behaviour, on the optimal level of benefits. Following this, myopia and elastic labour supply are introduced. By applying a log linear utility function, the optimal public pension payroll tax is calculated.

In the next section, I review the major literature concerning optimal PAYG pension systems. Feldstein (1985) is included in this review, but I note here that other

major difference between my work and this paper also include: I apply theoretical analysis rather than simulation study; a two periods model rather than overlapping generations models; and employ a different social security function.

4.2 Literature Review of Optimal PAYG Pension System

Optimizing a PAYG pension system is to select the parameters of a social security program that maximize a social welfare function subject to the constraints that individuals act to maximize their utility subject to the parameters of the program. The analysis is not to derive practical parameters but to understand better how different factors influence the optimal parameter value of a PAYG defined benefit program. A basic result of such an analysis is that the optimal social security program involves balancing the protection of individuals who are too myopic to save optimally for themselves against the losses that those who are not myopic incur because they are induced to provide for their retirement in a program with a low implicit rate of return. A loss is incurred to the extent that the PAYG program crowds out other savings, with the loss an increasing function of the difference between the return on capital and the implicit return of the PAYG program. More generally, the larger the social security program, the more protection it offers to those who are too myopic to save for their old age but also the more it distorts saving, labour supply, retirement, and other behavior.

One of the most important works in this area is Feldstein (1985), which focuses on the distortion to saving. It follows the base Samuelson (1958) framework of an overlapping generations life-cycle model and assume that individuals are homoge-

neous.Labour supply is fixed both during their working years and at the time of retirement. The calculation focuses on the optimal social security program in a representative year and ignores the windfall gain that would accrue to the initial generation when a PAYG program is created.

It starts the analysis and provide a baseline case, consider the extreme assumption that all individuals are completely myopic, i.e., that they consume all available income during their working years and make no provision for the future. It assumes that individuals work a fixed amount in the first period of their lives and are tired in the second. The size of the labour force grows at rate n per period. In a representative year, the social welfare function can be stated as the sum of the utilities of the working and retired population. The optimal tax and benefit ratios in this case do not depend on the marginal product of capital or the implicit return of social security contributions. With no distortion to the saving or work effort, the social security program is essentially just an income distribution program and carried to the point where the marginal utility of income is the same to the retirees and workers. If the utility functions are the same in youth and older age, the optimal ratio of benefits to the average wage is $\frac{(1+n)}{(2+n)}$. If the population were constant, n would equal zero and the optimal tax would take half of each worker's wage. With a growing population, the tax rate is less than 0.5.

The analysis is then relaxed this assumption and considers individuals who are "partially myopic", i.e., who give too little weight to the consumption. Individuals save an amount s_t during the first period of their life. The rational for social security in such a model is that individuals do not give adequate weight to their future consumption. The government select the level of social security taxes and to maximize the social utility function. With the assumptions, the optimal tax rate is

given by

$$\theta^* = \frac{(1+\lambda)(1+\gamma) - \lambda(1+\rho)(2+n)}{(1+\lambda)(1+\gamma)(2+n) - \lambda(1+\rho)(2+n)}.$$

The optimal level of taxes and benefits depends on the degree of myopia (λ), the implicit return on the social security contributions (γ), the return on real investment (ρ), and the relative numbers of workers and retirees ($1+n$). In the special case in which the individuals are totally myopic, $\lambda = 0$, $\theta^* = 1/(2+n)$ as previously derived. More generally, taking the derivative of θ^* with respect to the parameters in this equation shows that $d\theta^*/d\lambda < 0$, $d\theta^*/d\gamma > 0$ and $d\theta^*/d\rho < 0$. The optimal size of the social security program increases with the degree of myopia and the implicit rate of return on social security contributions, and decreases with the rate of return on regular investments which raises the opportunity cost of the social security program. It's optimal to have PAYG social security program in the context of the model only if $\theta^* > 0$. In the above expression, this is true only if the value of λ is less than the critical value $\lambda^* = (1+\gamma)[(1+\rho)(2+n) - (1+\gamma)]^{-1}$. At higher value of λ, the loss from substituting the low return social security benefits for the higher return real investments outweighs the protection that individual receive through increased retirement income.

The problem of whether it is optimal to have a means-tested program, which provides benefits at retirement age to those whose income would be below some threshold level is addressed by Feldstein (1987). The analysis is set in a context of the overlapping generations life-cycle model, with no labour supply distortion and no uncertainty. It is assumed that there are three types of individuals: a completely myopic group ($\lambda = 0$), a high income group that has no myopic ($\lambda = 1$ and wage w_H) and low income group with no myopia ($\lambda = 1$ and wage w_L). In an economy with a means tested social security program, all working population

pay the social security tax and only some fraction of individuals receive benefit. For the completely myopic group there is no difference between the means-tested program and a universal program. In both programs, that group would consume all of its labour income and depend completely on social security benefits provide to retirees. In contrast, the individuals with no myopia decide whether to save or to consume all of their earnings and depend in retirement on the social security benefits. They do so by comparing the utility levels achievable under the two alternatives. The public policy choice between a universal plan and a means-tested plan can be stated as a comparison of the total utility levels of the three different population groups under the two alternatives. The key disadvantage of the means-tested plan is that it induces a low-income group to avoid saving in order to qualify for the means-tested benefit and therefore leaves them with lower retirement consumption than they would otherwise have. For this group, the higher the benefit, the more likely individuals are not to save and therefore the higher the tax rate has to be. In addition, the myopic high-income individuals will be worse off if the optimal level of benefits in the means-tested program is less than they would otherwise have received with a universal program. The advantage for the high-income group of rational savers is that they may be able to pay a lower payroll tax than they would in a universal program and save at a higher real rate of return. Which system is preferable depends on the relative numbers of individuals with different degrees of myopia and different income levels.

Diamond and Mirrlees (1978) (1986) (2002) analyze models in which workers face uncertainty about the length of their working lives. In particular, there is a random chance in each period that they will become permanently disabled and therefore unable to work. In these models, the government can not distinguish between those who are unable to work due to disability and those who simply choose not to work.

Therefore, in order to optimize its social security system, the government needs to determine how best to provide benefits for those out of work in a way that balances protection for the disabled against work disincentives for the able. Diamond and Mirrless (1986) first consider the case in which benefits for those who do not work are the same regardless of the age at which a person leaves the labour force. In addition, assume that the utility an individual derives from a given combination of leisure and consumption does not vary with age, and that there is no saving. Specifically, let utility be a function of consumption and leisure $U(C, L)$, where $L = 1$ indicates that the person works and $L = 0$ indicates that person does not work. Furthermore, let C_1 indicate the consumption level from working and C_2 indicate the consumption level when retired (the level of the government provided retirement benefit). In this case, social welfare is maximized by setting retirement benefits at the highest level that will still have the able bodied remain in the workforce. Thus, the government sets C_2 so that $U(C_2, 0) = U(C_1, 1)$. While the marginal utility of additional consumption for retirees exceeds that of workers, it is not possible to increase social welfare by rasing C_2 and lowering C_1 because such a change would result in $U(C_2, 0) > U(C_1, 1)$, and cause all workers to retire.

Diamond and Mirrlees show that it is possible to raise social welfare by switching to a benefit path that rises with a worker's date of retirement. With such a benefit structure it is possible to lower C_1 and provide additional benefits to retirees, who are assumed to have higher marginal utility of consumption than workers at the same level of utility. The intuition is that in the case of retirement benefits that rise with age, a worker who decides to leave the labour force will compare the utility from not working against not only the utility from working but also the foregone opportunity to receive higher retirement benefits in the future. This extra consideration makes it possible to pay higher retirement benefits without causing

all workers to retire. Moreover, the optimum includes implicit taxation of work as part of providing insurance against a short career.

Diamond and Mirrlees (1978) consider a similar model in which saving is permitted. It yields an additional result that the optimal social insurance plan should be supplemented with an interest income tax because allowing people to reach old age with asset narrows the consumption difference between working and retiring and therefore reduces the level of retirement benefits that can be provided without causing able-bodied workers to leave the workforce.

This section reviews the major Feldstein's work is mainly focused on a pension's function as a way to counter myopia and it's cost of savings distortion. Diamond and Mirrless's includes the choice of labour supply (work or not work), and pension as an insurance for a shortened career. In my work, I derive the optimal pension benefit by considering it's function of counter myopia and include both savings and labour supply distortion.

4.3 Homogeneous Individuals with No Myopia

Individual Preference

Different from Feldstein (1985), which starts the analysis in the economy, in which all the individuals have complete myopia. I start the analysis by deriving the optimal level of a payroll tax rate in a economy in which individuals have perfect foresight. This establishes the general framework and provides a standard of reference for evaluating the effect of myopia, and a more realistic saving and labour supply behaviour, on the optimal level of benefits.

In this section, I assume that the individual's labour supply in the first period

is inelastic and normalized to 1. The utility function is:

$$U = u(c_1) + \lambda u(c_2),$$

where c_1 and c_2 are the individual's consumption in the two periods, respectively. The individual's lifetime utility is a weighted sum of their utility in the two periods, and the utility in each period is a function of that period's consumption. Individuals discount the second period utility at the rate λ. For non-myopic individuals, this is the same discount rate used by the non-myopic society. The budget constraints are:

$$c_1 = (1 - \theta)w - s$$

$$c_2 = (1 + \rho)s + b,$$

where θ is the payroll tax rate and $0 \leq \theta \leq 1$, w is wage rate, b is the pension and s represents savings. I assume that the market is perfect: the individual can borrow and lend at the same market interest rate ρ, without any constraints.

The individual chooses s to maximize their lifetime utility function.

$$\frac{dU}{ds} = u^{'}(c_1)(-1) + \lambda u^{'}(c_2)(1 + \rho) = 0$$

$$u^{'}(c_1) = \lambda u^{'}(c_2)(1 + \rho). \tag{4.1}$$

and Assume a PAYG pension system, in which the payroll tax collected from the current working generation is used to pay for the current retirees' benefit. Assume

fixed growth rates, n and g, of population and wages, so that:

$$b = (1 + \gamma)\theta w,$$

where $(1 + \gamma) = (1 + n)(1 + g)$.

The payroll tax rate θ is decided by the government whose objective is to maximize a social welfare function. As individuals are homogeneous, the social welfare function is

$$W = u(c_1) + \lambda u(c_2).^1 \tag{4.2}$$

Letting s^* denote optimal saving,

$$c_1 = (1 - \theta)w - s^*$$

$$c_2 = (1 + \rho)s^* + (1 + \gamma)\theta w.$$

Thus:

$$\frac{dW}{d\theta} = \frac{\partial W}{\partial \theta} + \frac{\partial W}{\partial s^*}\frac{\partial s^*}{\partial \theta}.$$

As W has the same form as U and:

$$\frac{dU}{ds} = 0 \ at \ s = s^*,$$

it follows:

$$\frac{\partial W}{\partial s^*} = 0,$$

[1] Comparing with Bergson-Samuelson social welfare function, which is the accumulative utility of all induviduals in the current and future periods, Feldstein's steady state calculation involves neglecting period 1, while ours involves neglecting just the retired in period 1. It implies that when the workers are taxed, their welfare is affected by both a negative effect on their current income and a positive effect through the state pension they anticipate receiving when retired.

and

$$\frac{\partial W}{\partial s^*}\frac{\partial s^*}{\partial \theta} = 0.$$

$$\begin{aligned}\frac{dW}{d\theta} = \frac{\partial W}{\partial \theta} &= u^{'}(c_1)(-w) + \lambda u^{'}(c_2)(1+\gamma)w \\ &= w[-u^{'}(c_1) + \lambda u^{'}(c_2)(1+\gamma)].\end{aligned} \tag{4.3}$$

4.1 and 4.3 imply:

- When $\gamma > \rho$, $\frac{dW}{d\theta} > 0$. Recalling that θ is constrained to lie between 0 and 1, social welfare is highest when $\theta = 1$. From an individual point of view, a pension provides higher return than the rate of interest. Individuals are better off if the government sets a 100% tax rate and converts all income into pensions. With the assumption of a perfect capital market, they can support their first period consumption by borrowing, i.e. s^* is negative. The higher return from the pension scheme more than offsets the cost of borrowing.

  This pension scheme has some similarities to a pyramid scheme: A pyramid scheme is a fraudulent moneymaking scheme in which people are recruited to make payments to others above them in a hierarchy whilst expecting to receive payments from people they recruit below them. To elaborate, it is initiated by an individual or a company that starts recruiting investors with an offer of guaranteed high returns. As the scheme commences, the earliest investors do receive a high rate of return, but these gains are paid for by new recruits and are not a return on any real investment. From the day the scheme is initiated, a pyramid scheme's liability exceeds its assets. The only way it can continue is by promising extraordinary returns to new recruits. The only way these returns can be paid is by sourcing additional investors. Eventually the

growing number of new recruits fails to sustain the payment structure, and the scheme collapses with most people losing the money they paid in. The pension system does not create any real capital with the money collected. The attainability depends on the increasing tax base, which grows at the rate $(1+n)(1+g)$. The government has the power to make the system mandatory. If all citizens participate, its sustainability would depend on the growth of population and wages.

- When $\gamma = \rho$, $\frac{dW}{d\theta} = 0$. Individual utility and social welfare are not affected by θ. The return on the payroll tax collected is equal to the rate of interest which is earned by saving. Society is indifferent as to whether there is a pension scheme or not and all tax rates θ, from society's point of view, are equally good.

- When $\gamma < \rho$, $\frac{dW}{d\theta} < 0$. Social welfare is highest when $\theta = 0$. The return provided by the pension system is lower than the interest rate. Individuals are worse-off for the government creating such a pension system. None should exist.

4.4 With Myopia and Elastic Labour Supply

In this section myopia and an elastic labour supply are introduced. It is assumed that individuals are again all alike, but now are neither perfectly foresighted life-cyclers nor completely myopic. Again they work in the first period only, and consume in both periods. Their utility is a function of consumption in both periods and leisure in the first period. Here, a log linear utility function is applied:

$$u(c_1, z, c_2) = ln(c_1) + \sigma ln(1 - z) + \lambda ln(c_2). \tag{4.4}$$

σ and λ are the weights the individual puts on leisure and future consumption. σ indicates the degree to which, other things equal, leisure is preferred to consumption in the first period. λ represents the degree of discounting of future consumption. If $\lambda = 1$, the individual is a proper life-cycler with no myopia. If $\lambda = 0$, the individual is completely myopic and has no incentive to save. w is the wage rate and z the labour supply. The individual pays payroll tax θwz and saves s. The budget constraint is again:

$$c_1 = (1-\theta)wz - s$$

$$c_2 = (1+\rho)s + b, \ where$$

$$b = (1+\gamma)\theta wz.$$

Thus the lifetime budget constraint can be written as:

$$c_1 + (1-\theta)w(1-z) + \frac{c_2}{1+\rho} = (1-\theta)w + \frac{b}{1+\rho}. \tag{4.5}$$

The individual chooses the level of labour supply and saving to maximise their lifetime utility function. Because the utility function is log-linear, at the optimum a constant proportion of full income is spent on each good:

$$c_1^* = \frac{1}{1+\sigma+\lambda}[(1-\theta)w + \frac{b}{1+\rho}]$$

$$(1-\theta)w(1-z^*) = \frac{\sigma}{1+\sigma+\lambda}[(1-\theta)w + \frac{b}{1+\rho}]$$

$$\frac{c_2^*}{1+\rho} = \frac{\lambda}{1+\sigma+\lambda}[(1-\theta)w + \frac{b}{1+\rho}].$$

The optimal levels of saving and labour supply derived from the above equations are:

$$s^* = \frac{w(1-\theta)[\lambda(1-\theta) - \theta(1+\beta)]}{(1+\lambda)(1-\theta) + \sigma(1+\beta\theta)}, \tag{4.6}$$

$$z^* = \frac{(1-\theta)(1+\lambda)}{(1+\lambda)(1-\theta) + \sigma(1+\beta\theta)}, \tag{4.7}$$

where β is PAYG pension system's relative rate of return,

$$1 + \beta = \frac{1+\gamma}{1+\rho}.$$

When $\beta > 0$, PAYG pension system provides higher return than savings.

$$\frac{dz^*}{d\theta} = -\frac{(1+\beta)(1+\lambda)\sigma}{[(1+\gamma)(1-\theta) + \sigma(1+\beta\theta)]^2} < 0,$$

I.e. the introduction of a payroll pension contribution discourages labour supply.

Here assume that the social welfare function is:

$$\begin{aligned} W &= W(c_1, z, c_2) \\ &= ln(c_1) + \sigma ln(1-z) + \delta ln(c_2) \end{aligned}$$

δ is the rate applied to the individual's second period utility by the government. Assume $\delta \geq \lambda$. If $\delta > \lambda$, individuals give a less weight than the government does to the second period utility due to myopia. The government corrects this myopia by providing a public pension system.

The optimal level of payroll tax, θ^*, is calculated from first order condition by

maximising W with respect to θ. Assuming an interior solution:

$$\begin{aligned}\frac{dW}{d\theta} &= \frac{1}{c_1}\frac{dc_1}{d\theta} + \frac{\sigma}{1-z}\frac{d(1-z)}{d\theta} + \frac{\delta}{c_2}\frac{dc_2}{d\theta} \\ &= 0.\end{aligned} \tag{4.8}$$

Since the utility function is log-linear, constant shares of full income, y, are devoted to the various goods. Let

$$y = (1-\theta)w + (1+\beta)\theta w z. \tag{4.9}$$

The detail of the calculation of θ^* is included in the appendix at the end of this chapter (see 4.6.1). Here I only list the result of θ^* and the two equations from the calculation process, which will be referred to in the later discussion.

$$\frac{dw}{d\theta} = (\frac{1+\delta}{y} + \frac{\sigma}{y})\frac{dy}{d\theta} + \frac{\sigma}{1-\theta} = 0. \tag{4.10}$$

$$(1+\delta)[\sigma(1+\beta\theta)^2 - \beta(1+\lambda)(1-\theta)^2] = (1+\beta)\sigma(1+\lambda)(1-\theta) \tag{4.11}$$

$$\theta^* = \frac{[2\beta(1+\delta)(1+\sigma+\lambda) + (1+\beta)(1+\lambda)\sigma] \pm (1+\beta)\sqrt{\sigma(1+\lambda)[4\beta(1+\delta)^2 + 4\sigma\beta(1+\delta) + \sigma(1+\lambda)]}}{2\beta(1+\delta)(1+\lambda-\sigma\beta)} \tag{4.12}$$

When $\beta = 0$, when pension system provides the same return as savings, solving 4.11,

$$\begin{aligned}\theta &= 1 - \frac{1+\delta}{1+\lambda} \\ &< 0,\end{aligned}$$

as $\delta > \lambda$, when individuals are myopic. When $\beta < 0$, the return provided by the pension system is lower than savings, the lower return makes it even less desirable. This shows that when $\beta \leq 0$, pension can not be used to counter myopia when borrowing is not restricted by $s^* \geq= 0$. When, $\beta \leq 0$, $\theta^* = 0$. When $\beta > 0$, θ^* is unique and $0 \leq \theta^* < 1$. The proof is in the appendix (see 4.6.2).

From 4.11, we can see that, as expected, θ^* decreases when λ or σ increases. When λ increases, individuals are less myopia, so the second period of consumption is less depends on the pension benefit. Lower payroll tax is needed. When σ increase, both individual and the society put more weight to the leisure. At the same level of tax rate, they will provide less labour, thus the tax base is reduced. This causes θ^* to fall in order partially to restore the tax base.

We also noticed that θ^* decreases when δ rise, which is a bit unexpected. The proof is in the appendix (see 4.6.3). The explanation is that at $\theta = \theta^*$, $\frac{dy}{d\theta}$ is negative because the falling price of leisure has a positive effect on welfare (see 4.10). When δ increases, it raises the weight of consumption relative to leisure, which makes the price of leisure a less important factor for social welfare and so moves θ^* back to where numerically $\frac{dy}{d\theta}$ is smaller.

This model doesn't deal with policy against myopia. For dealing with policy against myopia, the constraint $s \geq 0$ is imposed.

4.4.1 With Restricted Borrowing

From equation 4.6, $s^* < 0$, if

$$\theta > \frac{\lambda}{1+\beta+\lambda}.$$

With $\delta > \lambda$, at $\theta = \theta^*$ individuals would dis-save if they could, i.e. the constraint is bining at $s^* = 0$.

With this constraint,

$$c_1 = (1 - \theta)wz$$

$$c_2 = (1 + \gamma)\theta wz.$$

Individual maximizing their utility by choosing the labour supply. From the first order condition

$$\frac{dU}{dz} = 0,$$

$$z^* = \frac{1 + \lambda}{1 + \sigma + \lambda}.$$

The optimal pension contribution rate is derived from maximising the social welfare function, from the first order condition

$$\frac{dW}{d\theta} = 0,$$

$$\theta^* = \frac{\delta}{1 + \delta}.$$

The optimal level of pension contribution rate is purely a function of the weight on the second period consumption set by the government, and

$$\frac{d\theta^*}{d\delta} > 0.$$

The pension contribution rate increases with δ. If the government cares more about the consumption of the retirement period, it sets a higher the pension contribution rate.

4.5 Summary

This chapter derives the level of optimal pension benefits by considering the welfare loss imposed by the saving and labour supply distortion. To provide a standard of reference, it

begins with a simple economy in which homogeneous individuals have perfect foresight and inelastic labour supply. Individuals work, save and pay pension contribution in the first period and consumes their savings and pension benefit in the second period. The social welfare function is in the same form as individuals' utility function. With no consideration about the cost associating with borrowing and managing the pension systems, the level of the optimal public pension payroll tax is only related to the relative return provided by the PAYG pension system (γ) and the interest rate earned on the savings (ρ). When the pension system provides higher return, social welfare is highest when $\theta = 1$. The pension system acts like a 'pyramid scheme'. Although it doesn't generate real capital, the consistent population and wage growth rates support its sustainability. When the returns are the same, society is indifferent as to whether it has a pension system or not. When the return provided by the pension system is lower, it's better not to have a pension system.

In the second part of the chapter, myopia and elastic labour supply are introduced and the optimal public pension payroll tax is calculated by applying a log linear utility function. Individuals put a weight to their leisure in the first period and the consumption in the second period. As they are myopic, the weight for the second period consumption is lower than that put on by the society. Individuals choose the optimal level of savings and labour supply in the first period, incorporating those, the society set the optimal level of pension contribution rate θ^*. The result shows that θ^* satisfies $0 < \theta^* < 1$ when $\beta > 0$ and $\theta^* = 0$, when the pension system can not provide higher return than savings ($\beta \leq 0$). This is consistent with Feldstein (1985), which concludes from the simulation result that: "even with universal and extreme myopia (but not complete myopia) it may be optimal to have no social security pension..." With the introduction of an endogenous labour supply, taking into consideration of labour supply distortions, it makes the public pension even less desirable.

Without the restriction, at $\theta = \theta^*$ individuals would dis-save. For policies dealing

with myopia, the constraint $s \geq 0$ is imposed. The calculated optimal level of pension contribution is purely a function of the weight on the consumption for the retirement period set by the government, and θ^* increases with it.

4.6 Appendix: Calculation Details

4.6.1 Calculate θ^*

Maximise W with respect to θ, assuming an interior solution:

$$\begin{aligned} \frac{dW}{d\theta} &= \frac{1}{c_1}\frac{dc_1}{d\theta} + \frac{\sigma}{1-z}\frac{d(1-z)}{d\theta} + \frac{\delta}{c_2}\frac{dc_2}{d\theta} \\ &= 0. \end{aligned} \tag{4.13}$$

Let

$$y = (1-\theta)w + (1+\beta)\theta wz. \tag{4.14}$$

(i.e. y is full income.) Then

$$c_1 = \frac{1}{1+\sigma+\lambda}y \tag{4.15}$$

$$(1-\theta)w(1-z) = \frac{\sigma}{1+\sigma+\lambda}y \tag{4.16}$$

$$c_2 = \frac{(1+\rho)\lambda}{1+\sigma+\lambda}y. \tag{4.17}$$

Thus, from 4.18, 4.15, 4.16 and 4.17,

$$\begin{aligned}\frac{dW}{d\theta} &= \frac{1}{c_1}\frac{1}{1+\sigma+\lambda}\frac{dy}{d\theta} + \frac{\sigma}{1-z}\frac{\sigma}{1+\sigma+\lambda}[\frac{1}{(1-\theta)w}\frac{dy}{d\theta} + \frac{w}{[(1-\theta)w]^2}y] + \frac{\delta}{c_2}\frac{(1+\rho)\lambda}{1+\sigma+\lambda}\frac{dy}{d\theta} \\ &= [\frac{(1+\delta)}{y} + \frac{\sigma^2}{(1-z^*)(1-\theta)(1+\sigma+\lambda)w}]\frac{dy}{d\theta} + \frac{\sigma^2}{(1-z^*)(1-\theta)^2(1+\sigma+\lambda)w}y \\ &= 0.\end{aligned} \tag{4.18}$$

From 4.14 and 4.7,

$$\begin{aligned}y &= (1-\theta)w + (1+\beta)\theta w z^* \\ &= (1-\theta)w + (1+\beta)\theta w\frac{(1-\theta)(1+\lambda)}{(1-\theta)(1+\sigma+\lambda)+(1+\beta)\sigma\theta} \\ &= \frac{(1-\theta)^2 w(1+\sigma+\lambda) + (1-\theta)(1+\beta)\sigma\theta w + (1+\beta)(1-\theta)(1+\lambda)\theta w}{(1-\theta)(1+\sigma+\lambda)+(1+\beta)\sigma\theta} \\ &= \frac{(1-\theta)^2 w(1+\sigma+\lambda) + (1-\theta)(1+\beta)\theta w(1+\lambda+\sigma)}{(1-\theta)(1+\sigma+\lambda)+(1+\beta)\sigma\theta} \\ &= \frac{w(1-\theta)(1+\sigma+\lambda)(1+\beta\theta)}{(1-\theta)(1+\sigma+\lambda)+(1+\beta)\sigma\theta}.\end{aligned} \tag{4.19}$$

Differentiating,

$$\frac{dy}{d\theta} = -\frac{(1+\sigma+\lambda)[\sigma-\beta(1+\lambda)+2\beta(1+\sigma+\lambda)\theta-\beta(1+\lambda-\beta\sigma)\theta^2]}{[(1+\sigma+\lambda)(1-\theta)+(1+\beta)\sigma\theta]^2}w. \tag{4.20}$$

from y and z^*,

$$y = \frac{(1-z^*)(1-\theta)(1+\sigma+\lambda)w}{\sigma}.$$

From 4.18:

$$\begin{aligned}\frac{dw}{d\theta} &= (\frac{1+\delta}{y} + \frac{\sigma}{y})\frac{dy}{d\theta} + \frac{\sigma}{1-\theta} \\ &= 0.\end{aligned}$$

It follows that:

$$(1+\sigma+\delta)\frac{dy}{d\theta}+\frac{\sigma}{1-\theta}y=0. \tag{4.21}$$

Substituting for y (4.19) and $\frac{dy}{d\theta}$ (4.20) into 4.21,

$$(1+\sigma+\delta)-\frac{(1+\sigma+\lambda)[\sigma-\beta(1+\lambda)+2\beta(1+\sigma+\lambda)\theta-\beta(1+\lambda-\beta\sigma)\theta^2]}{[(1+\sigma+\lambda)(1-\theta)+(1+\beta)\sigma\theta]^2}w$$
$$+\frac{\sigma}{1-\theta}\frac{w(1-\theta)(1+\sigma+\lambda)(1+\beta\theta)}{(1-\theta)(1+\sigma+\lambda)+(1+\beta)\sigma\theta}=0$$

$$(1+\sigma+\delta)[\sigma-\beta(1+\lambda)+2\beta(1+\sigma+\delta)\theta-\beta(1+\lambda-\beta\sigma)\theta^2]$$
$$=\sigma(1+\beta\theta)[(1+\sigma+\lambda)(1-\theta)+(1+\beta)\sigma\theta]$$

$$(1+\delta)[\sigma-\beta(1+\lambda)+2\beta(1+\sigma+\delta)\theta-\beta(1+\lambda-\beta\sigma)\theta^2]$$
$$=-\sigma[\sigma-\beta(1+\lambda)+2\beta(1+\sigma+\delta)\theta-\beta(1+\lambda-\beta\sigma)\theta^2]$$
$$+\sigma(1+\beta\theta)[(1+\sigma+\lambda)(1-\theta)+(1+\beta)\sigma\theta]$$

$$(1+\delta)[\sigma(1+\beta\theta)^2-\beta(1+\lambda)(1-\theta)^2]=(1+\beta)\sigma(1+\lambda)(1-\theta) \tag{4.22}$$

$$\beta(1+\delta)(\sigma\beta-\lambda-1)\theta^2+[2\beta(1+\delta)(1+\sigma+\lambda)+(1+\beta)(1+\lambda)\sigma]\theta$$
$$+[(1+\delta)(\sigma-\lambda\beta-\beta)-(1+\beta)(1+\lambda)\sigma]=0$$

$$\theta^*=$$
$$\frac{[2\beta(1+\delta)(1+\sigma+\lambda)+(1+\beta)(1+\lambda)\sigma]\pm(1+\beta)\sqrt{\sigma(1+\lambda)[4\beta(1+\delta)^2+4\sigma\beta(1+\delta)+\sigma(1+\lambda)]}}{2\beta(1+\delta)(1+\lambda-\sigma\beta)} \tag{4.23}$$

4.6.2 Proof that θ^* is unique and has an interior solution.

Simplify 4.12 as

$$\theta^* = \frac{A \pm B}{C},$$

where,

$$A = [2\beta(1+\delta)(1+\sigma+\lambda) + (1+\beta)(1+\lambda)\sigma]$$
$$B = (1+\beta)\sqrt{\sigma(1+\lambda)[4\beta(1+\delta)^2 + 4\sigma\beta(1+\delta) + \sigma(1+\lambda)]}$$
$$C = 2\beta(1+\delta)(1+\lambda-\sigma\beta).$$

As θ^* increases with β, and we already know that $\theta^* = 0$ when $\beta = 0$, so $0 \leq \theta^* < 1$ can only be satisfied with $\beta > 0$. With the assumption that $1+\lambda-\sigma\beta < 0$, as $(1+\delta) > 0$, $C < 0$.

$$A^2 - B^2 = 4\beta(1+\delta)[\beta(1+\delta)(1+\lambda) + \sigma(1+\beta)(1+\lambda) - \sigma(1+\delta)](1+\lambda-\sigma\beta)$$
$$< 0,$$

so $A - B < 0$, and $\theta^* > 0$.

$$B - A + C = B - [2\sigma\beta(1+\delta)(1+\beta) + \sigma(1+\lambda)(1+\beta)]$$

Assume:

$$D = 2\sigma\beta(1+\delta)(1+\beta) + \sigma(1+\lambda)(1+\beta)$$

$$B^2 - D^2 = (1-\beta)^2 4\sigma\beta(1+\delta)^2(1+\lambda-\sigma\beta) < 0$$

As both B and D are positive, we have $B - D < 0$. Therefore,

$$B - A + C < 0$$
$$\frac{B-A}{-C} < 1 \; as - C > 0$$
$$\theta^* = \frac{A-B}{C} < 1$$

We find out that the solution for θ is unique, and $0 < \theta^* < 1$.

It is also satisfied when $1 + \lambda - \sigma\beta > 0$. If $1 + \lambda - \sigma\beta > 0$, $C > 0$; $A^2 - B^2 > 0$, so $A - B > 0$, and $\theta^* > 0$. $B^2 - D^2 > 0$, as both B and D are positive, we have $B - D > 0$. Therefore, $B - A + C > 0$. As $-C < 0$, $\frac{B-A}{-C} < 1$, and $\theta^* < 1$.

4.6.3 Proof that $\frac{d\theta^*}{d\delta} < 0$.

From 4.12,

$$\frac{d\theta^*}{d\delta} = \frac{T - Y}{\sqrt{\triangle}C^2}$$
$$T = 2\sigma^2\beta(1+\beta)(1+\lambda)(1+\lambda-\sigma\beta)[2\beta(1+\delta)+(1+\lambda)]$$
$$Y = 2\sigma\beta(1+\beta)(1+\lambda)(1+\lambda-\sigma\beta)\sqrt{\triangle}$$
$$\triangle = \sigma(1+\lambda)[4\beta(1+\delta)^2 + 4\sigma\beta(1+\delta) + \sigma(1+\lambda)]$$

$$T^2 - Y^2 = -16\sigma^3\beta^3(1+\beta)^2(1+\lambda)^2(1+\delta)^2(1+\lambda-\sigma\beta)^3$$

If $1 + \lambda - \sigma\beta < 0$, $T < 0$ and $Y < 0$. $T^2 - Y^2 > 0$, $T < Y$. If $1 + \lambda - \sigma\beta > 0$, $T > 0$ and $Y > 0$. $T^2 - Y^2 < 0$, $T < Y$ is also satisfied. So,

$$\frac{d\theta^*}{d\delta} < 0.$$

Chapter 5

THE CHOICE OF PUBLIC PENSION SYSTEMS

5.1 Introduction

Around 170 countries have some form of public pension system. Most are structured and financed differently. Some are managed under PAYG, some are fully funded; others are a combination of PAYG and a funded system, since the mixture includes provisions from both extremes.

Historically, social security systems were almost all PAYG. In those years of low life expectancy and high fertility rates, an aging population was never a issue. The PAYG system, which uses the current working generation's contribution to support the current retirees, was a sensible design. However, with the medical advances that are the hallmark of modern times, the issue of an aging population has become critical in many countries. It is an issue that is causing a large deficit in many countries' PAYG pension systems. The choice of pension system becomes important. Some countries went through more radical reforms and moved away from the PAYG system completely. Chile, for example, established a reform of pensions by changing to a fully funded system in which payroll tax was not used for paying current retiree's benefit any more, but instead accumulated in personal accounts. This system is characterised by defined contributions and the level of

benefits is affected by the success of the resulting investments. Some countries chose the combination of PAYG and fully funded, a so called 'multi-pillar' system. This is strongly supported by the World Bank, which has conducted extensive research and engaged in pension system reform work in 30 countries. The enthusiasm for shifting to a funded system, either fully or partially, is evident. However, a large number of countries still use the PAYG system even though many of them are facing the problem of an increasingly aged population. Pension expenditures are projected to increase beyond the ability of the system to pay them, unless there is a significant tax increase. This paradox raises a question of public choice.

The purpose of this chapter is to investigate the reasons for different choices in pension systems. By applying a logit model, it examines the likely social and economic variables, which affect the choices significantly. Most studies about pension systems tend to focus on analyzing the characteristics of different public pension systems and addressing their effect upon the economy. Few works consider the choice of public pension systems. This chapter has been inspired by two exceptional works, carried out by James and Brooks (1999) and Wang and Davis (2003). James and Brooks (1999) examine the influences of political and economic forces on the probability of structural reform of a pension system, as well as the share of the private sector in the entire social security system. This work also uses two dependent variables: (1) the probability that a country has undertaken a structural reform, (2) the size of the newly funded private pillar is relative to the PAYG pillar in the multi-pillar system (among the countries having undertaken reform). The independent variables include factors which prevent change from existing pension systems, for example, implicit pension debt, explicit debt, and the effective number of political parties; and factors which may encourage the change, for example, level of domestic savings, pre-exiting funded plans, and even culture and language. Their sample includes 57 countries, including all Latin American and OECD countries as well as hand-picked countries from Africa, Asia and the former Soviet Union. The results show that a large implicit pension debt from the old

PAYG system and fragmentation of political power, which was measured by the effective number of political parties, as being the most significant factors diminishing the probability of structural reform.

Wang and Davis (2003) separate pension systems into three categories: PAYG, Funded and Mixed then identify factors that affect a country's choice of these types of pension systems. The paper considers economic and political freedom as factors influencing the choice of pension systems and finds that the effect is significant. When economic freedom is higher, a country prefers to choose a more open pension system which can be a privately managed funded system. However, political freedom discourages countries from choosing funded systems. Democracy enables old aged interest groups to block changes since they are generally worse off if the system changes. Similar to James (1999), the sample countries are hand-picked. The sample being comprised of 52 countries, including 24 European, 12 Asian and Pacific, 11 Latin American, 3 African countries and 2 North American countries.

There are a limited number of countries that have reformed the pension system, also the total number of countries with public pension systems is only about 170. As social, economic and political situations differ from country to country, the result could be affected by the choices of sample countries. The two papers mentioned above both choose the sample country objectively, so the result may be subject to the risk of selection bias. In order to reduce the bias, in this chapter, sample countries are chosen according to the data availability. Comparing to Wang and Davis (2003) and to James (1999), I also have a bigger sample size, including more countries (74 countries) and longer period time (from 1980 to 2004); and test different independent variables. The variables of interest are selected by balancing the importance of their impact with the data availability. It includes age dependent ratio, GNI per capita, GINI index, political freedom, private credit to percentage of GDP and savings ratio. The likelihood of the reform based on chosen social and economic parameters will be examined by applying binary, multinomical and ordered logisitic regression for the cross-sectional data and binary logistic test for the panel

data.

In order to identify the variables which have affected the pension system choices, this chapter begins with a review of the pension reforms to find out what the main motivations are.

5.2 Reforms of Pension Systems

Over the past few years, more and more countries (see Figure 5.1) have adopted major pension system reforms. This major overhaul is defined as including a mandatory fully funded defined contribution privately managed pillar, rather than exclusively relying on a publicly managed PAYG defined benefit system. In this section, the basic characteristics of PAYG and funded pension systems, and the motivation for the major reforms will be discussed.

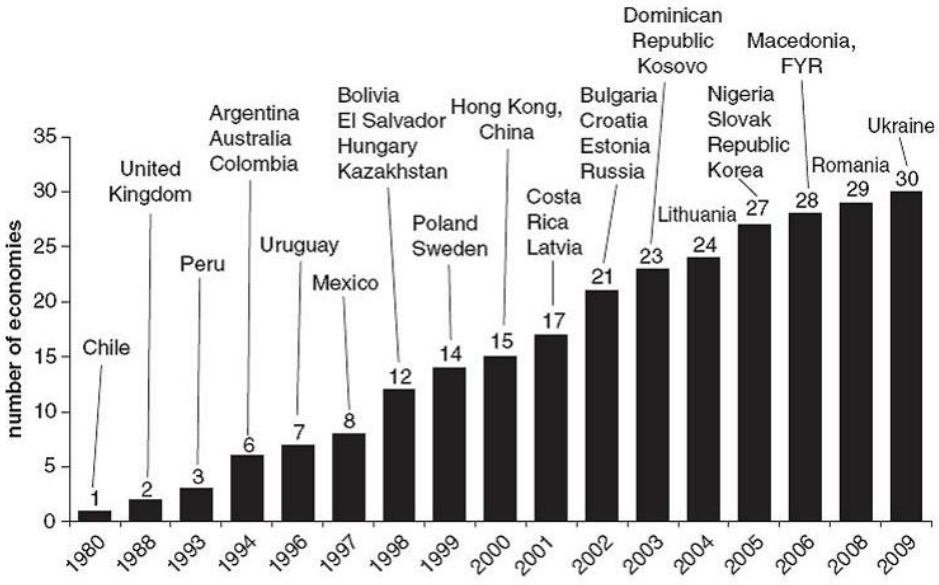


Fig. 5.1: Increase In Number of Pension Systems with Funded Pillars

PAYG VS Funded System

In a PAYG scheme benefits are paid to retirees using tax receipts from the current working population. The benefit is a function of the system dependency ration, which replies on the demographic structure of the country and the coverage of the system.

$$Average\ Benefit = \frac{Working\ Population}{Retirees} * Average\ Wage * Tax\ Rate$$

It is vulnerable to change such as an aging population. For example, when the dependency ratio changes from $3:1$ to $2:1$, it requires a 50 percent increase in taxes to maintain a constant benefit.

In exchange for the increased tax contribution, the government makes a promise to repay the working population in the future. The size of this implicit debt is quite considerable and will be met by taxing the future working population. Under an unfunded PAYG scheme, no assets are accumulated. If the tax rates remain constant, the return on a PAYG system is:

$$Return_{PAYG} = (1 + Wage\ Growth\ Rate) * (1 + Population\ Growth).$$

This is a system capable of delivering a decent return when the population and wage are growing. In terms of risks, there are additional risks associated with a negative demographic and wage growth rate. The PAYG pension systems also face political risk, which arises from the potential that a government may renege, or more commonly downplay its pension promises to retirees or worse, leave them unfulfilled (Davis 1995). Pension benefit is generally not guaranteed by law, and their continued provision is at the whim of the legislative body.

A funded system utilizes a more typical saving mechanism. Workers' contributions are collected and invested. The real return depends on inflation and the nominal return generated by the investment. Hence, it is subject to inflation and market risk (Davis 1995).

Motivations for Reforms

It is found that different forces determine the probability of structural reform and the ultimate nature of that reform. It involves the confluence of economic and political forces as well as legacies from past systems. The primary purpose of pension reform is to correct financial imbalance inherent in existing PAYG pension systems. The potential secondary effects on the broader macro-economy have also been a compelling motive for adopting structural reforms. It is argued that a funded pension system leads to both a rise in savings and to efficiency improvement in financial and labour markets, thereby resulting in higher economic growth (World-Bank 1994). However, fragmentation of political power impedes the ability to enact reforms. The existence of large implicit and explicit debt also makes it difficult to finance the transition.

Table 5.1 shows that the majority of reformers are concentrated in Latin America and Eastern Europe regions. The remainder cannot easily be grouped geographically, however, the majority of them are high income OECD countries. As with the geographic categorisation of Latin America and Eastern Europe, developed countries also have similar economic, social and political characteristics, and also share similar motivations for the pension reforms. In the following, pension reforms are grouped into these three categories (developed countries, Latin American, Central and Eastern Europe) and the reasons and motivations for the reforms are investigated.

Reforms in Developed Countries

The pension system reforms in developed countries were mostly motivated by increasing concern about the long term solvency issue due to changing demographic and economic conditions (Brooks 2001). Demographic predictions made the future look even bleaker than the present. One interesting observation is that within the context of the developed countries, the demographic problems of the reformers were not notably more severe than non-reformers, suggesting that the severity of the demographic situation was not the sole determinate of the propensity to reform. The goal of pension reform in developed countries was mainly to re-balance the finances of the system and ensure its long-term stability,

Tab. 5.1: Economies with Major Pension System Reform [a]

Economy	Reformed Year	Region	Income Group
United Kingdom	1988		High: OECD
Australia	1994		High: OECD
Sweden	1999		High: OECD
Korea, Rep.	2005		High: OECD
Hungary	1998	Europe & Central Asia	Upper middle
Kazakhstan	1998	Europe & Central Asia	Lower middle
Poland	1999	Europe & Central Asia	Upper middle
Latvia	2001	Europe & Central Asia	Upper middle
Bulgaria	2002	Europe & Central Asia	Lower middle
Croatia	2002	Europe & Central Asia	Upper middle
Estonia	2002	Europe & Central Asia	Upper middle
Russian Federation	2002	Europe & Central Asia	Upper middle
Lithuania	2004	Europe & Central Asia	Upper middle
Slovak Republic	2005	Europe & Central Asia	Upper middle
Macedonia, FYR	2006	Europe & Central Asia	Lower middle
Romania	2008	Europe & Central Asia	Upper middle
Ukraine	2009	Europe & Central Asia	Lower middle
Chile	1980	Latin America & Caribbean	Upper middle
Peru	1993	Latin America & Caribbean	Lower middle
Argentina	1994	Latin America & Caribbean	Upper middle
Colombia	1994	Latin America & Caribbean	Lower middle
Uruguay	1996	Latin America & Caribbean	Upper middle
Mexico	1997	Latin America & Caribbean	Upper middle
Bolivia	1998	Latin America & Caribbean	Lower middle
El Salvador	1998	Latin America & Caribbean	Lower middle
Costa Rica	2001	Latin America & Caribbean	Upper middle
Dominican Republic	2003	Latin America & Caribbean	Lower middle
Nigeria	2005	Sub-Saharan Africa	Low
Hong Kong, China	2000	East Asia & Pacific	High
China	1997	East Asia & Pacific	Lower middle
Kosovo	2003		

[a] Source for pension reform: The World Bank Data Base. Region and Income Group are based on The World Bank classification in 2007.

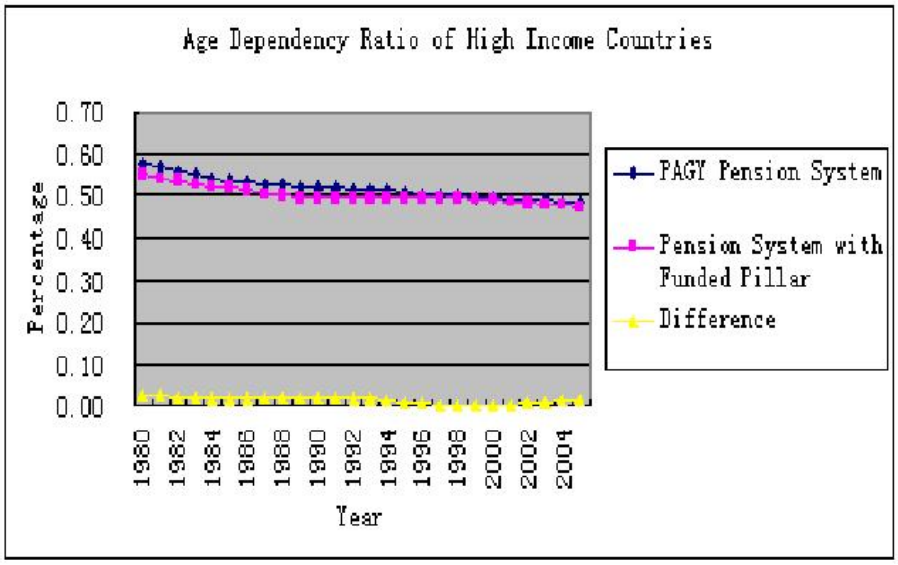
while ensuring the continuation of a reasonable levels of benefits.

Instead of adding a funded pillar or forming into a fully funded pension system, many developed countries chose instead to stabilize their pension scheme by making parametric changes, such as: raising the retirement age, changing the benefit indexation calculation and increasing payroll taxes. The difficulty of pension reform is commonly ascribed to the political sensitivity of the issue. These difficulties are believed to be particularly acute in the representative democracies of the developed countries, where the elderly often represent a large and powerful voting block. Under these circumstances, limited reforms that appease varied interested groups stand a greater chance of success. Another reason for many developed countries, which haven't reformed their public pension system is the existence of the well developed private institutional pensions. For some countries, their pension system reform is to emphasise occupational pensions as an alternative to public schemes. For example, encouraging the participation and higher contribution through tax incentives.

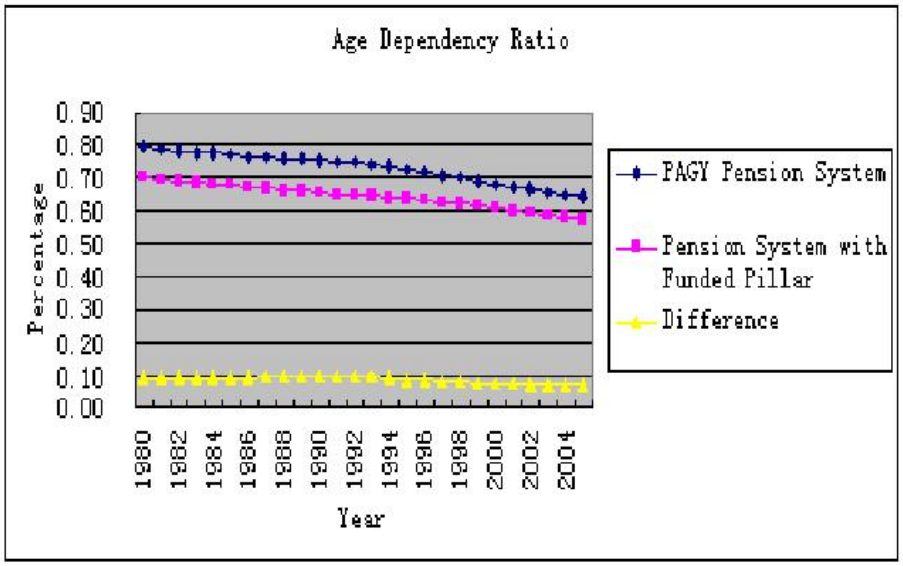
Reforms in Latin America

While reform in developed countries was motivated primarily by the harmful impact of an aging population on the economics of a PAYG pension system, this explanation is unsatisfying in the case of the Latin American reformers. Data in Table 5.2 shows that most Latin American countries have a young population and favourable system dependency ratios. How could a wave of rather similar pension reforms spread throughout the subcontinent, then? What are the motivations behind the reforms?

The origins of pension schemes in Latin America can be traced back to the first decades of the 20th century. The Pioneer groups - Brazil, Uruguay, Argentina, Cuba and Chile, set the first pension schemes in place in the 1920's and 1930's. The favorable age structure of the insured population, as well as the progressive integration of new contribution groups into the pension schemes, provided for a comfortable financial basis during the first few



(a) High Income Countries



(b) All Countries

Fig. 5.2: Age Dependency Ratio Comparisons

Tab. 5.2: Latin America: Some Relevant Pension Indicators [a]

	System dependency rate[b]	Old-age dependency rate[c]	Pensioners in % of population	Coverage rate [d]	Replacement rate [e]	Pension spending in % of GDP
Argentina	64.0	27.0	13.8	53.0	46.7	4.1
Bolivia	40.0	16.2	2.0	11.7	45.3	2.5
Chile	24.3	17.5	10.4	70.0	67.5	5.9
Colombia	11.0	16.1	1.5	33.0	63.6	1.1
Ecuador	18.0	13.9	1.7	26.0	24.5	1.2
El Salvador	8.6	14.3	0.9	26.2	67.9	1.3
Mexico	12.5	12.9	1.6	30.0	66.9	0.4
Peru	31.0	14.3	2.3	20.0	22.3	1.2
Uruguay	70.0	34.5	25.8	82.0	65.0	8.7

[a] Data are mostly for the mid-1990s.
[b] Pensioners as percentage of contributors.
[c] 60+ years old as percentage of 20-59 years old.
[d] Contributors as percentage of labour force.
[e] Average pension as percentage of average wage.
Source: World Bank (2001). ILO (2000).

decades. Yet, in a context of mounting inflation, the existing scaled premium systems [1] turned into de facto PAYG schemes. Pension reserves de-capitalized rapidly when invested largely in public bonds, rendering negative real rates of return. At the same time, the pension programmes became matured and had reached the limits of coverage expansion. In the wake of the debt crisis of the 1980's, economic stabilization and structural adjustment programmes were implemented all over the subcontinent, contributing to a further decline of available resources for social policy.

Apart from their financial problems, pension programmes in Latin America suffered from a number of other shortcomings. A weak contribution benefit link coincided with generous entitlement conditions and replacement rates, even for early retirement and invalidity benefits. Consequently, contribution rates as well as state subsidies were elevated, while coinciding with evasion and an under-reporting of income increase. Furthermore, the existing old-age security systems were highly fragmented and consisted of multiple funds, each with different legislation and management, benefits and contribution rates. This situation generated not only high costs, but also problems of equity between different groups of insurers. Moreover, a substantial part of the labour force lacked formal employment and, thus had low coverage. Most countries listed in Table 5.2 had less than half the labour force covered by the pension schemes.

It is well known that Chile was the first country in Latin America to privatise its pension system. In 1981, in the context of an anti-static ideology and the extraordinary powers of the Pinochet regime, the existing public PAYG system was replaced by a compulsory IFF scheme run by private pension fund administrators, the so-called AFPs. The significance of the Chilean reform put existing neo-liberal reform proposals into practice. In the early 1990's, when a democratic government had taken over from the Pinochet regime, reference to the Chilean pension reform became politically palatable. The Chilean

[1] Scaled premium systems amount to a variant of collective capitalization: reserves are built up over a given period (e.g. 10 years) to cover expected pension liabilities. During this period they are invested on the capital market.

precedent soon evolved as a reform paradigm for Latin America and beyond, yet without being replicated in an identical way (Muller 2003).

Among the benefits to the Chilean economy that were attributed to the reform were an apparent increase in national savings and the rapid development of modern financial markets. Chile's apparent success in these areas was an important factor in the decision by many Latin American countries to follow suit. Insulating the economy from the deleterious effects of capital flight was the primary goal of policymakers in Latin America, who had been harmed repeatedly by debt and exchange rate crises in the past. Policymakers saw pension reform as a way to address this issue by stockpiling a source of domestic capital and developing the local financial market. The president of both Mexico and Bolivia referred in public speeches to the beneficial effects of increased national savings and the capital market development they expected to accrue from pension privatisation. (Madrid 2000)

Gaining credibility with foreign lenders and the international investment community was another important reason for the privatisation (Baer 1994). Pension reform was seen as an way to signal international creditors and institutions that the country was committed to supporting policies to promote economic growth and stability. This was regarded as critical to ensure the continuation of loans and aid from international sources. The World Bank, a noteworthy advocate of pension privatisation and a major creditor of numerous Latin American countries, played an important role in the reforms.

Reforms in Central and Eastern Europe

During the socialist years, pension provision in Eastern Europe and the Soviet Union followed along similar lines. Pension schemes were unified and integrated into the state budget. Their surpluses were used to cross-subsidise other public expenditure items. Individual contributions were mostly abolished, rendering employers' contributions the only source of financing. A major achievement of the socialist years was the gradual expansion of coverage, made universal by the 1960's and 1970's. Overall, the existing contribution-benefit link was weak. Pension tended to depend on years of service rather than on

contributions made on behalf of the individual.

Economic transformation, starting around 1989, affected the existing PAYG systems in several ways. At the onset of market-oriented reforms, price liberalisation and the curtailment of subsidies on basic goods and services required a shift from indirect to direct transfers, resulting in rising expenditure for old-age security. Subsequently, the restructuring of the state owned enterprises had an effect on both the revenue and the expenditure side of public pension schemes. When state-owned enterprises were privatised, downsized or closed down, part of their former work force retired early or took out disability pensions. Designed to disguise the employment effects of structural adjustment, this policy implied that the retirement system was used as a substitute for welfare and unemployment benefits. By leading to an increased number of pensioners and a falling number of contributors to the scheme, public pension finances were de-stabilised.

By the mid-1990's, system dependency ratios had deteriorated dramatically. In all post-socialist countries, shown in Table 5.3, there were less than two contributors per pensioner. The declining revenue base and the erosion of social security are further illustrated by a dramatic drop in coverage ratios. Before 1989, with full employment and high economic activity rates of women, the coverage ratio was nearly 100 percent.

Compared with Latin America, the issue of an aging population is a more severe problem in central and eastern European countries. The demographic dependency rates of many post-socialist countries are close to EU levels. Also public pension spending was on the rise. Poland and Slovenia surpassed the EU-15 average, with pension expenditure amounting to 14.4 and 13.6 percent of the GDP. Also many countries suffered from low benefit levels.

Undoubtedly, the old-age security systems inherited from the socialist past were in dire need of reform. Besides parametric changes to the existing retirement schemes, pension privatisation has been gaining considerable momentum. So far only Kazakhastan reformed to a fully funded, Chilean model; other countries have adopted a mixed ap-

Tab. 5.3: Post-Socialist Countries: Some Relevant Pension Indicators [a]

	System dependency rate[b]	Old-age dependency rate[c]	Pensioners in % of population	Coverage rate [d]	Replacement rate [e]	Pension spending in % of GDP
Bulgaria	81.0	38.5	27.5	64.0	30.0	7.3
Croatia	61.7	37.6	19.0	66.0	46.1	11.6
Estonia	60.0	33.3	25.0	76.0	31.6	7.0
Hungary	78.1	35.7	27.5	77.0	39.1	9.7
Kazakhstan	66.0	18.9	16.0	51.0	31.0	5.0
Latvia	65.9	34.5	25.0	60.5	62.8	10.2
Lithuania	69.2	32.3	22.5	74.3	30.8	7.3
Macedonia	50.0	22.7	12.4	49.0	63.5	8.7
Poland	53.7	29.4	18.2	68.0	63.5	14.4
Romania	58.3	32.3	15.1	55.0	23.9	5.1
Russia	NA	30.3	25.1	NA	38.0	5.7
Slovakia	57.0	27.8	22.0	73.0	41.0	13.6
Ukraine	78	34.5	27.1	69.8	32.0	8.6

[a] Data are mostly for the mid-1990s.
[b] Pensioners as percentage of contributors.
[c] 60+ year olds as percentage of 20-59 year olds.
[d] Contributors as percentage of labour force.
[e] Average pension as percentage of average wage.
Source: World Bank (2001). ILO (2000).

proach. Hungary, Poland, Latvia, Bulgaria, Croatia and Estonia all implemented partial pension privatisation between 1998 and 2002. Lithuania and Macedonia have recently legislated similar reforms, and several other post-socialist countries are currently preparing a partial shift to funding as well. (Muller 2003)

In summary, economic transformation lead to the insolvency of the existing PAYG pension system. The primary motivation for reform was to escape the negative impact of a declining economy. Also people argue creating a source of capital, to absorb the shares arising from the privatisation of state owned assets, could be another motivation for the privatisation of the pension systems.

From the previous discussion, we can see that the choices of pension systems is subject to the impact from many factors, such as, demographic, economic, political and the legacy of the existing pension systems. This chapter aims to determine which, if any, of these factors play a significant role in the decision to undertake structural reforms. In this section, the methodology which is used for the regression analysis will be introduced.

5.3 Methodology

Logistic regression is widely used for models with categorical and limited dependent variables, such as binary, ordered and multinomial variables. Also it makes no assumption about the distribution of the explanatory variables. Independent variables can be a mix of continuous and categorical variables. It's estimated by the maximum likelihood method.

Similar to linear regression models, the sign of the marginal effect is determined by the coefficient of the independent variables β. However, the magnitude of it depends on the value of the other variables and their coefficient.

The Binary Logit Model

For the observed dependent variable is binary, for example, in this chapter

$$y = \begin{cases} 0, & \text{if the country's public pension system is purely pay-as-you-go;} \\ 1, & \text{if it's mixed or fully funded.} \end{cases}$$

we can assume that there is an unobserved or latent variable y^* ranging from $-\infty$ to ∞ that generates the observed y's. The latent variable y^* is linked to the observed binary variable y by a threshold τ,

$$y_i^* = \begin{cases} 1, & \text{if } y_i^* > \tau; \\ 0, & \text{if } y_i^* \leq \tau. \end{cases}$$

Since y^* is unobserved, the maximum likelihood estimation is applied and the variance of the errors can not be estimated, so the assumptions about the distribution of the errors are needed. In the logit model ϵ is assumed to have a standard logistic distribution with mean 0 and $var(\epsilon|X) = \frac{\pi^2}{3}$.

The Ordered Logit Model

When a variable is ordinal, its categories can be ranked from low to high, but the distances between adjacent categories are unknown. For instance, in this chapter, the pension system is ranked from 0 to 2, according to how it is financed.

$$y = \begin{cases} 0, & \text{if the country's public pension system is purely PAYG;} \\ 1, & \text{if the country's public pension system is a mixture of PAYG and funded;} \\ 2, & \text{if the country's public pension system is fully funded.} \end{cases}$$

As in the binary dependent variable model, the observed ordered dependent variable can be modeled by considering a latent variable y^* which depends linearly on the explanatory variables X_i,

$$y_i^* = X_i'\beta + \epsilon_i,$$

where ϵ_i is independent and identically distributed random variables. The observed or-

dered dependent variable y_i is determined from y_i^* using the rule:

$$y_i = \begin{cases} 0, & \text{if } -\infty \leq y_i^* < \tau_1; \\ 1, & \text{if } \tau_1 \leq y_i^* < \tau_2; \\ 2, & \text{if } \tau_2 \leq y_i^* < \infty. \end{cases}$$

The values chosen to represent the categories in y, in this example $0, 1, 2$ are completely arbitrary. For preserving the ordering, y needs to satisfy that $y_i^* < y_j^*$ implies $y_i < y_j$.

The Multinomial Logit Model

When a variable is nomial, the categories cannot be ordered. For example, occupation: blue collar, white collar and professional. It's hard to judge the three types of pension systems as ordinal or nomial. We can consider them having ordinal relationships as most pension systems started in a PAYG form. Countries with a fully funded system have been through reform. And the mixed system is something in the middle. However, it's also reasonable to consider they are different from the pension systems chosen by countries who had based theirs on their social and economical situation, and not on an ordered relationship. [2]

The multinomial logit model (MNLM) can be thought of as an extension of a binary logit model. It simultaneously estimates binary logits for all possible comparisons among the outcome categories. With three outcomes A, B and C, multinomial logit is roughly equivalent to running three binary logit comparing outcomes: A to B, A to C and B to

[2] Actually, models for nomial outcomes are often used when the dependent variable is ordinal. Sometimes this is done to avoid the parallel regression assumption of the ordered regression model. Other times there may be uncertainty as to whether the dependent variable should be considered as ordinal. On one hand if a dependent variable is ordinal and a model for nomial variables is used, there is a loss of efficiency since information is being ignored. On the other hand, when a method for an ordinal variable is applied to a nomial dependent variable, the resulting estimations are biased or even nonsensical. If there is any question about the ordinality of the dependent variable, the potential loss of efficiency in using models for nominial outcomes is outweighted by avoiding potential bias.

C. With

$$ln[\frac{Pr(A|X)}{Pr(B|X)}] + ln[\frac{Pr(B|X)}{Pr(C|X)}] = ln[\frac{Pr(A|X)}{Pr(C|X)}],$$

not all three binary logits are necessary. When we know how x affects the odds of A versus B, and how x affects the odds of B versus C, the information would tell us about how x affects the odds of A versus C.

5.4 Variables of Interest, Tests and Results

Dependent Variables: Choices of Pension Systems [3]

For the binary test, pension systems are categorised into two groups: 0 represents PAYG systems, and 1 represents systems with funded element (i.e. mixed or fully funded pension systems). As almost all pension systems originated from the PAYG system, [4] the classification is roughly equivalent to pension systems without structural reform vs reformed pension systems. For the ordinal and multinomial tests, they are categorised into three types: PAYG, mixed, and fully funded.

However, the categorisation is not always straight forward. A fully funded system may have some PAYG elements, such as a social insurance scheme for the low-income receiver, or have a separate defined benefit pension system for civil and military servants. Also a PAYG system may have a funded system as a supplement. Here are two examples: Chile's current pension system is widely accepted as being a fully funded system in most

[3] The main source of information comes from *Social Security Programs Throughout the world* (2007).

[4] There are a few exceptional cases in some developing countries, for example, Kenya, Nigeria and Uganda, whose pension systems started from Provident Funds systems. These funds are essentially compulsory savings programs in which regular contributions withheld from employees wages are enhanced, and often matched, by employers contributions. The contributions are set aside and invested for each employee in a single, publicly managed fund for later repayment to the worker when defined contingencies occur. Typically, benefits are paid out in the form of a lump sum with accrued interest, although in certain circumstances draw down provisions enable partial access to savings prior to retirement or other defined contingencies. On retirement, some provident funds also permit beneficiaries to purchase an annuity or opt for a pension. Some provident funds provide pensions for survivors.

literature. Actually, it is also a multi-pillar system [5] with the elements of social insurance and social assistance. Although, the major part of the pension system is owned and managed privately by AFP (Administradora de Fondos de Pensions) and a life insurance company, the government still provides a mean-tested basic pension welfare for people have not participated in the systems. A minimum pension guarantee for people who have contributed to the system but have not been able to save sufficiently for the minimum pension threshold are also provided under this system. It is financed by general government revenue which bears a PAYG characteristic. The United States has a mandated, public defined benefit system, which is widely recognised as a PAYG system. However, it also has 401(K) schemes, which is a defined contribution funded system. If we include these factors, most countries' pension systems will be counted as a mixed system. For distinguishing the governments' different choices. I will categorise the pension system according to the main pension system. Ergo, Chile's is fully funded, and the United state's is PAYG.

Enacting reforms can be a lengthy process, for example in Bolivia, the pension system reform started in 1993 and was only finalised in 2000. Here we will look for the factors that both affect a government's final decision, and keep the whole data set consistent, using the year in which the legislation or regulatory changes were made. Benefit arrangements of private employers or individuals are not described in any detail, even though such arrangements may be mandatory in some countries or available as alternatives to statutory programmes.

Independent Variables [6]

From the discussion in the section :*Reforms of Pension Systems*, we can see that the choices of pension systems are subject to the impact of many factors, such as demographic,

[5] Pillar 1 assistance and minimum pension, which are provided by the government to the low-income individuals. Pillar 2: compulsory contribution toward pension benefit based on capitalized contributions. Pillar 3: voluntary saving for old age, on top of the compulsory contributions, supported by the government tax incentives.

[6] Most data has been collected from the World Development Indicators (2007) data set. Data collected elsewhere will be noted separately.

economic, political and the legacy of the existing pension systems. To summarise, these factors and their corresponding variables are grouped below. *Age Dependent Ratio* and *Population Growth* to reflect the current and future demographic trend; *GNI per Capita* to indicate the income level; and the *GINI Index* for the level of income distribution. As mentioned before, the potential advantages of funded pension systems are: higher relative return, an improved savings ratio, and less disincentive effect to the labour supply. The relevant variables for the above factors are: *the Relative Return of the PAYG Pension System to the Funded One*, *Gross Savings as a Percentage of GNI* and *Employment Elasticity*, respectively. The transition cost (*the Implicit Debt of the Existing PAYG System*), the burden of the current pension system, such as *Social Security Expenditure as a Percentage of the GDP or Government Expenditure*, and the ability of the country to finance the transition costs are also very important. The obligations can be met by raising taxes or by converting the implicit debt to explicit debt, financing the transition with bonds. The indicators for the fiscal position of the government (*Cash Surplus/ Deficit as a Percentage of the GDP* and *Total Debt as a Percentage of total Reserves* might be relevant. Political structures, which can be represent by *Political Freedom*, the level of *Economic Freedom* and the level of the maturity of the financial development (*Domestic Credit to the Private Sector as a Percentage of GDP*) are also important. It's worth mentioning that the World Bank has not only provided the research, but also financially assisted many countries' pension system reforms. The involvement of the World Bank might be another significant factor.

This chapter aims to determine which, if any, of these factors plays a significant role in the decision to undertake structural reforms. Differing from past literature, which selected the sample countries objectively, here it is chosen according to data availability. This is believed to deliver a less biased result. It would be ideal to test all the mentioned variables, however, the choice and number of the independent variables is limited by data availability, sample size and the correlation among difference variables.

Tab. 5.4: Single Variable Test

Variables	P Value
Significant	
Age Dependency Ratio	0.0000
Total Social Security Expenditure (% of GDP)	0.0000
Employment Elasticity	0.0000
GINI index	0.0001
Political Freedom	0.0030
GNI Per Capita	0.0058
Gross Savings (% of GNI)	0.0394
Domestic Credit to Private Sector (% of GDP)	0.1009
Not Significant	
Economic Freedom	0.2658
Cash Surplus/Deficit (% of GDP)	0.4217
Relative Return $\frac{(1+n)(1+g)}{(1+r)}$	0.6777
Total Debt as % of Total Reserves	0.8841

A Single Variable Test

To begin with, the possible significant variables here were identified by applying the single variable tests by including one independent variable each time. The result is shown by Table 5.4. We can see *Age Dependency Ratio, Total Social Security Expenditure (% of GDP), Employment Elasticity, GINI index, Political Freedom, GNI Per Capital, Gross Savings (% of GNI)* and *Private Credit as % of GDP* are significant at 90% confidence interval. Unlike the result from Wang And Davis(2003), *Economic Freedom* appears not significant here. This may be due to the difference of sample countries. The variable

$$Relative\ Return^{7} = \frac{(1 + population\ growth\ rate)(1 + wage\ growth\ rate)}{(1 + interest\ rate)}$$

[7] Wage growth rate is calculated from the Manufacturing Wage Indices, which is collected from IMF, and the interest rate here is the Lending Interest Rate, also from IMF.

has been widely referred to in most literatures about pension system reforms. However, it appears to be not at all significant. *Domestic Credit to Private Sector (% of GDP)* and *Total Debt as % of Total Reserves* are also insignificant.

Ideally, it would be prudent to include all the variables that appear significant here. However, the data availability for *Total Social Security Expenditure as % of GDP* and *Employment Elasticity* is poor. The number of sample countries drops significantly, if they are included. Potentially, they are the factors, significantly affecting a government's choice, which should be tested in the future research once better data is available.

Cross Sectional Data Analysis

The Binary Logistic Test

For the cross sectional analysis, data which reflects the current pension system for the dependant variables was used, and the average of the historical data (ranging from the years 1980 to 2005) for the independent variables. This is better method than using the data for a particular year for both dependent and independent variables, because it usually takes quite a long time for a government to make the decision to reform the system. The decision is also not made based on a single year's history, as historical data matters equally. Table 5.5 lists the variables involved in the test. Table 5.6 is the correlation matrix. The correlations between each pair of variables are at an acceptable level. The highest is between Age Dependency Ratio and GNP per capita and it's at 0.6.

Table 5.7 provides the results from the Binary Logistic Test. Here three equations are included. The first one includes both dummy variables *Politically Free* and *Politically Unfree*, the second one excludes *Politically Unfree*, and the third one excludes *Politically Free*. It could be argued that the degree of political freedom could be a significant factor, which could affect the selection of the pension systems. As democracies have interest groups which might prefer the status quo, unless they are presented with overwhelming evidence that the situation is not viable. So countries with democracies are facing more

Tab. 5.5: Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation	Description
PenSysTwo	0	1	0.42	0.50	Pension Systems
AgeDep	0.45	1.10	0.70	0.18	Age Dependency Ratio
PolFree	0.00	1.00	0.38	0.49	Politically Free Dummy
PolUnfree	0.00	1.00	0.35	0.48	Politically Unfree Dummy
GINI	22.65	61.33	42.50	9.43	GINI Index
Debt_Res	1.76	2083.68	112.64	288.68	Total Debt as % of Total Reserves
Sur_GDP	-18.54	12.01	-2.27	3.54	Cash Surplus (Deficit) as % of GDP
GNI	141.88	6076.25	1828.93	1584.38	GNI per Capita
Sav_GNI	-3.93	45.56	18.71	8.52	Gross Savings as % of GNI

Tab. 5.6: Correlation Matrix

	AgeDep	Pol	Sav_GNI	GNI	Sur_GDP	Debt_Res	GINI
AgeDep	1.00						
Pol	0.34	1.00					
Sav_GNI	-0.46	0.04	1.00				
GNI	-0.60	-0.54	0.34	1.00			
Sur_GDP	-0.25	-0.05	0.48	0.29	1.00		
Debt_Res	0.21	0.21	-0.13	-0.12	0.05	1.00	
GINI	0.38	0.02	-0.07	-0.04	0.26	0.04	1.00

Tab. 5.7: Binary Logistic: Test Results

	Equation 1		Equation 2		Equation 3	
	Beta	P Value	Beta	P Value	Beta	P Value
Constant	1.43	0.51	0.35	0.86	1.60	0.44
AgeDep	-3.99	0.10	-3.62	0.13	-4.13	0.08
PolFree(1)	-1.12	0.13			-1.21	0.07
PolUnfree(1)	0.20	0.78	0.67	0.30		
GINI	0.03	0.32	0.02	0.45	0.04	0.28
Debt_Res	0.00	0.55	0.00	0.56	0.00	0.56
Sur_GDP	-0.03	0.76	-0.01	0.88	-0.03	0.72
GNI	0.00	0.59	0.00	0.82	0.00	0.60
Sav_GNI	0.02	0.57	0.02	0.63	0.02	0.58

obstacles for undertaking pension system reform. The data comes from the Freedom House Annual Survey. In the survey, it ranks the degree of political freedom from 1 to 7, 1 representing the most free and 7 the least free. It also classifies countries with ratings 1 and 2 as 'free'; 3, 4 and 5 as 'partly free'; and 6 and 7 as 'not free'. In the test, political freedom is treated as two dummy variables. For the variable *Politically Free Dummy*, countries with a rating of 1 and 2 will be given value 1 and the rest are 0. The other variable is *Politically Not Free*, with a value of 1 for countries with a rating of 6 and 7, and 0 for the rest. Parameters with a negative coefficient decrease the likelihood of that response. The result shows that the coefficient of *Politically Free* is negative and that of *Politically Unfree* is positive, which is consistent with expectations.

In all equations *Age Dependency Ratio* is the most significant factor affecting the choice of pension system. It is a measure of the age structure of the population, and relates to the number of individuals that are likely to be dependent on the support of others for their livelihood - youths and the elderly to the number of those individuals who are capable of providing such support. Its changes are a function of life expectancy, fertility rates and of net migration. If it increases, there is an increased cost on the productive part of

Tab. 5.8: Age Dependency Ratio

	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
World	0.74	0.76	0.76	0.75	0.71	0.67	0.64	0.63	0.60	0.56
Low income	0.80	0.83	0.84	0.84	0.82	0.81	0.79	0.78	0.74	0.70
Lower middle income	0.79	0.82	0.81	0.79	0.72	0.64	0.59	0.57	0.53	0.48
Middle income	0.77	0.80	0.78	0.77	0.71	0.64	0.60	0.57	0.53	0.48
Upper middle income	0.68	0.70	0.68	0.66	0.66	0.64	0.61	0.58	0.54	0.50
High income	0.60	0.60	0.59	0.57	0.53	0.50	0.49	0.50	0.50	0.49

the population to maintain the upbringing and pensions of the economically dependent. It's difficult to predict the sign of the coefficient. Intuitively, it should be positive, as the heavier the burden on society, the more likely it will reform away from the traditional PAYG system. However, the coefficient could also be negative. If the decline of youth in a population outpaces the growth of an aging population then the age dependency ratio declines, and the population is aging, which encourages pension reform. The same negative result from Wang and Davis (2003), was also found here.

From Table 5.8 and Figure 5.3, we can see that in the past 50 years the age dependency ratio has been on a downward trend. It's lower for the higher income groups, and higher for the lower income groups. The demographic structure stabilized for the high income countries. The downward trend stopped after the mid 80's.

The other variables are not significant.

Table 5.9 is the cross-tabulation of the observed response categories with the predicted response categories which helps to assess the predictive performance of the model. In the linear regression model the coefficient of determination R^2 is the standard measure of fit. However, there is no clear choice for models with categorical outcomes. There have been numerous attempts to construct a counterpart to R^2 in linear regression models, but no one measure is clearly superior and none have the advantages of a clear interpretation in terms of explained variation. Instead, the ability of a model to predict the observed outcome is a good indicator to measure the fitness of the model (Long 1997). There is no real difference in the fitness of the equations. Equation 2 is slightly better than Equation 1

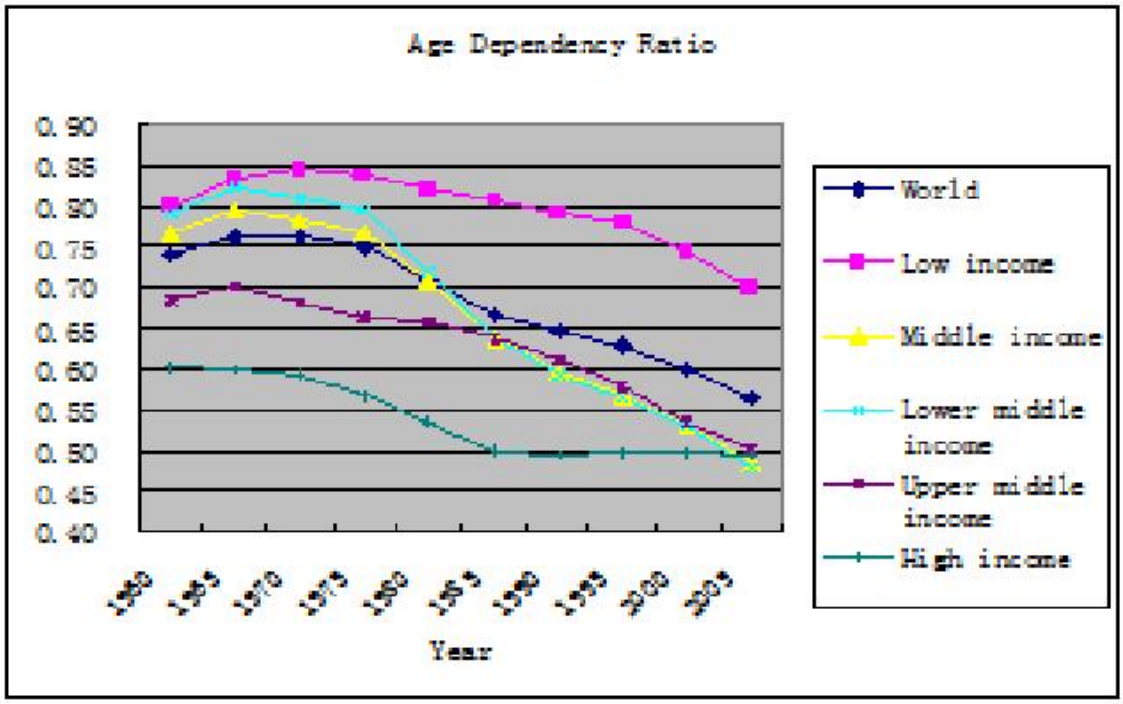


Fig. 5.3: Age Dependency Ratio Different Income Groups

and 3. For equation 2, it can correctly predict 80% of the dependent variable with a value of 0 and 68.75% with the value of 1. The overall accuracy of the prediction is 75.32%.

The Multinomial and Ordered Logistic Regression

Among all the 77 sample countries, in Table 5.10, 45 have PAYG, 17 have mixed and 15 have fully funded pension systems. As mentioned in Section 5.3, it's not clear if the choice of these three kinds of pension systems have ordinal relationships. Here both multinomial and ordered logistic tests are conducted.

A multinomial test simultaneously estimates binary logits among category 0 and 1 and 0 and 2. Please refer to Table 5.12, the result between category 0 and 1 is highly consistent with the binary logistic test. Age Dependency ratio is significant with a negative coefficient. And the second most significant variable is the dummy variable *Politically Free*, with negative coefficient. It's interesting to see in the result for category 0 and 2, GINI

Tab. 5.9: Binary Logistic: Classification

Equation 1			
	Predicted		Percentage Correct
Observed	0	1	
0	33	12	73.33
1	9	23	71.88
Overall Percentage			72.73
Equation 2			
	Predicted		Percentage Correct
Observed	0	1	
0	36	9	80.00
1	10	22	68.75
Overall Percentage			75.32
Equation 3			
	Predicted		Percentage Correct
Observed	0	1	
0	36	9	80.00
1	11	21	65.63
Overall Percentage			74.03

index [8] is significant and its coefficient is positive. The less equal countries are likely to choose a fully funded pension system.

Table 5.11 exams the fitness level of the multinomial logistic regression model. It predicts the dependent variable with the values 0 and 1 with 82.22% and 58.82% accuracy respectively. However, the prediction for the fully funded pension system with value 2 is poor.

Table 5.15 shows the result of the ordered logistic test. Not a single variable is significant if we use a 5% significant level of the criteria. The most significant one is *GINI index* at 10% and followed by *Politically Free* and *Age Dependency Ratio*.

The reason for the relatively poor result from the multinomial and ordered logistic regression is due to the small sample size. The desirable properties of the maximum likelihood estimator, such as consistency, normality and efficiency, are asymptotic. They hold as the sample size approaches ∞. While maximum likelihood estimators are not necessarily bad estimator in small samples. It's difficult to answer when the sample is large enough to use the maximum likelihood estimates and the resulting significance tests. It is considered to be risky to use ML with samples smaller than 100, when samples over 500 seems adequate. There is no firm evidence about it. These values should be raised depending on characteristics of the model and the data. First, if there are a lot of parameters in the model, more observations are needed.

A rule of thumb is that at least 10 observations per parameter. It is satisfied in this chapter. However, it also depends on the condition of the data. If the data are ill conditioned, for example, independent variables are highly co-linear, or if there is little variation in the dependent variable (e.g., nearly all of the outcomes are 1), a larger sample is required (Long 1997). With small samples, given the degree to which maximum likelihood are normally distributed in small samples in unknown, larger p-values as evidence against

[8] The GINI Index measure the level of income inequality. It ranges from 0 to 1. A low GINI coefficient indicates a more equal distribution, with 0 corresponding to perfect equality, while higher GINI coefficients indicate more unequal distribution, with 1 corresponding to perfect inequality.

the null hypothesis should be accepted (P.D.Allison 1995).

The number of countries which has been reformed the pension system is already limited. If we further classified into two groups- fully funded or mixed pension system, the number of sample countries in each group is small (17 and 14 respectively). Hence, the binary logistic will be test only for the panel data analysis.

Tab. 5.10: Multinomial Logistic Regression: Case Processing Summary

		N	Marginal Percentage
PenSysThr	0	45	58.44
	1	17	22.08
	2	15	19.48
PolFree	0	48	62.34
	1	29	37.66
PolNotFree	0	50	64.94
	1	27	35.06
Valid		77	100.00
Missing		0	
Total		77	
Subpopulation		77	

Tab. 5.11: Multinomial Logistic Regression: Classification

Observed	Predicted			Percent Correct
	0	1	2	
0	37	5	3	82.22
1	7	10	0	58.82
2	10	2	3	20.00
Overall Percentage	70.13	22.08	7.79	64.94

The Panel Binary Logistic Regression

The panel binary logistic test is superior to the cross sectional test because with 74 countries and 23 years annual data, it offers a sample size of 1776. We have a bigger sample

Tab. 5.12: Multinomial Logistic Regression: Parameter Estimates [a]

PenSysThr[a]		Beta	Sig.
1	Intercept	8.46	0.03
	AgeDep	-15.92	0.02
	GINI	0.03	0.58
	Debt_Res	0.00	0.74
	Sur_GDP	-0.09	0.62
	GNI	0.00	0.70
	Sav_GNI	0.02	0.77
	[PolFree=0]	-1.78	0.14
	[PolFree=1]	0[b]	
	[PolNotFree=0]	-0.24	0.84
	[PolNotFree=1]	0[b]	
2	Intercept	-5.37	0.11
	AgeDep	-1.05	0.72
	GINI	0.11	0.03
	Debt_Res	0.00	0.63
	Sur_GDP	-0.07	0.52
	GNI	0.00	0.21
	Sav_GNI	0.06	0.21
	[PolFree=0]	-0.89	0.30
	[PolFree=1]	0[b]	
	[PolNotFree=0]	0.37	0.67
	[PolNotFree=1]	0[b]	

[a] The reference category is: 0.
[b] This parameter is set to zero because it is redundant.

Tab. 5.13: Multinomial Logistic Regression: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	108.61	136.00	0.96
Deviance	105.55	136.00	0.98

$Sig > 0.05$. The model fits well.

Tab. 5.14: Ordered Logistic Regression: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	166.51	144.00	0.10
Deviance	136.32	144.00	0.66

$Sig > 0.05$. The model fits well.

Tab. 5.15: Ordered Logistic Regression: Parameter Estimates [a]

		Estimate	Sig.	95% Confidence Interval[b]	
				Upper Bound	Lower Bound
Threshold	[PenSysThr = 0]	0.46	0.82	-3.56	4.47
	[PenSysThr = 1]	1.67	0.42	-2.37	5.71
Location	AgeDep	-2.81	0.20	-7.15	1.53
	GINI	0.05	0.10	-0.01	0.11
	Debt_Res	0.00	0.54	-0.01	0.01
	Sur_GDP	-0.03	0.72	-0.20	0.14
	GNI	0.00	0.44	0.00	0.00
	Sav_GNI	0.03	0.38	-0.04	0.10
	[PolFree=0]	-0.97	0.15	-2.29	0.36
	[PolFree=1]	0[a]			
	[PolNotFree=0]	0.38	0.58	-0.95	1.71
	[PolNotFree=1]	0[a]			

[a] This parameter is set to zero because it is redundant.

[b] Threshold parameters are ordered, though their confidence intervals may overlap. Thresholds with overlapping confidence intervals indicate that they are difficult to separate.

size. It can also capture the effect of the trend of independent variables over time.

Data and The Expectations of the Model

The following charts show the trend of each independent variable and the contrasts between the two groups: countries with a PAYG pension system, and the ones with mixed and fully funded pension systems. Over time the population growth rate declines in both groups. It is higher for countries with PAYG pension systems. I expect this variable is significant with a negative coefficient. As an aging population is one of the primary reasons for the reforms. Countries with low and declining population growth rates tend to adopt funded elements into a pension system.

GNI per capita increased over time. In the beginning, the difference between the two groups was not very obvious. The chart shows that during mid 80's to mid 90's, GNI per capita grew faster for countries with funded pension systems.

For the GINI index, the difference between the two groups is more obvious. The average GINI index for countries with PAYG pension systems started at a higher level (just below 40) but after a period of modest increase during the 90's, fell to below 40 again. For countries with reformed pension systems, it's income distribution changed much more dramatically. The average GINI index started from below 38 and rose sharply during the period between the mid 80's to the mid 90's. After a short pause, it began to rise again, and almost reached 42 in 2003.

By the first look of the trends of GNI per capita and GINI index over the time, people raise the question of potential endogeneity. However, it is noticed that the significant change happened during mid 80s to mid 90s. During that period, only a few Latin American countries reformed the pension system. However, the significant change of GINI index and GNI per capita are mainly contributed by the dramatic changes of the ex-Soviet Union countries. However they hadn't reformed their pension systems till late 90s.

Although, the PAYG public pension system has more of an income redistribution element. However, GINI index is subject to many other factors. There is no evidence

to proof that GINI index increase due to the pension system reforms. It is reasonable to expect that countries with a relative high level of income level and income inequality (high GINI index) would face less obstacle for the pension reforms as the society has higher tolerance level for reforms. But it's a question if the government in a country with high level of inequality still want to reform the PAYG pension system. As it may further increase inequality in the future or at least gives impression of that.

The index representing the political freedom is on a downward trend. Most countries in the world have been enjoying more political rights and civil liberties over the past 30 years. From the early 80's to the mid 90's, the overall improvement for countries with a PAYG pension system is evident. The expectation being that the less political freedom there is, the more likely countries would take on reform. However, it would be unrealistic to expect a modest improvement of political freedom to have significant impact to the choice of pension system. More likely, the extreme cases have more of an impact. For example in China and Chile, where there is no or little democracy, reform is easier to be implemented.

Similar to the cross-sectional study for the panel data test, the dummy variable for the extreme cases, *politically free* and *politically unfree* was used. A negative coefficient for the *Politically Free* dummy variable, and a positive for *Politically Unfree* was expected. It's difficult to predict if this variable is significant. For most countries, the changes of the political freedom index is within the range of 1, not big enough to enable the rating to change from free to unfree or vice versa.

Domestic private credit as a percentage of the GDP is included as a proxy variable for financial market development. The level and trend are not that different between the two groups for most of the time. After 2000, however, the improvement trend is more significant for countries with funded elements in the pension systems. A reasonable developed financial market with adequate investment tools and good regulation is the foundation for adopting a funded pension system. However, countries with less developed

financial markets, may use pension reform as a tool to promote it, which suggests the opposite relationship. The sign of the coefficient is not obvious.

Gross savings as a percentage of the GNI haven't changed much for countries with funded pension systems and it's always at a higher level, although the upward trend is more obvious for the countries with a PAYG pension system after the mid 90's. This conflicts with past theoretical work, which demonstrates that pension reforms increases national savings (Feldstein 1998). Also the source of the capital is domestically based and long-term oriented, a particularly attractive feature for countries harmed by previous foreign capital flights (Brooks and James 1999). Many policy makers, particularly in developing countries, consider this a desirable effect of reform. So countries with low savings rates have more incentive to reform the pension system, and a negative coefficient is expected.

Although the variable relative return of PAYG to funded pension systems is not included in the test due to data availability, it is discussed a lot about by the theoretical work. It's worth to exam the difference between the two groups. For countries with a PAYG pension system, it has remained at a stable level which is below 1 during the past 2 decades. The return provided by the PAYG system is always lower. For countries with a funded pension system, in the early 80's, the average return was above 1, and was on a downward trend until the late 90's and drops to the level below 1.

The Results

The results of the panel binary logistic test are presented in Table 5.16. The coefficients are reported along with its significance levels. The results for 4 models are reported. Equation 1 includes all variables. As *Age Dependency Ratio* and *Population Growth*, *Politically Free* and *Politically Unfree* highly correlate to each other. Only one of them is used in the following equations. The results from the 4 equations are mostly consistent with each other and are also consistent with my expectations. *Age Dependency Ratio* is significant with negative coefficient. The impact from *Population growth* is not significant.

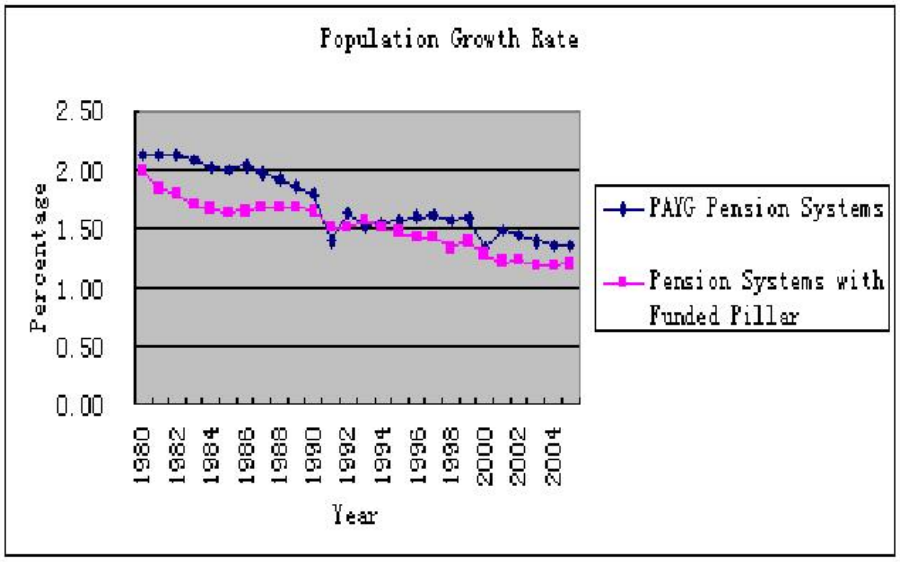


Fig. 5.4: Population Growth Rate

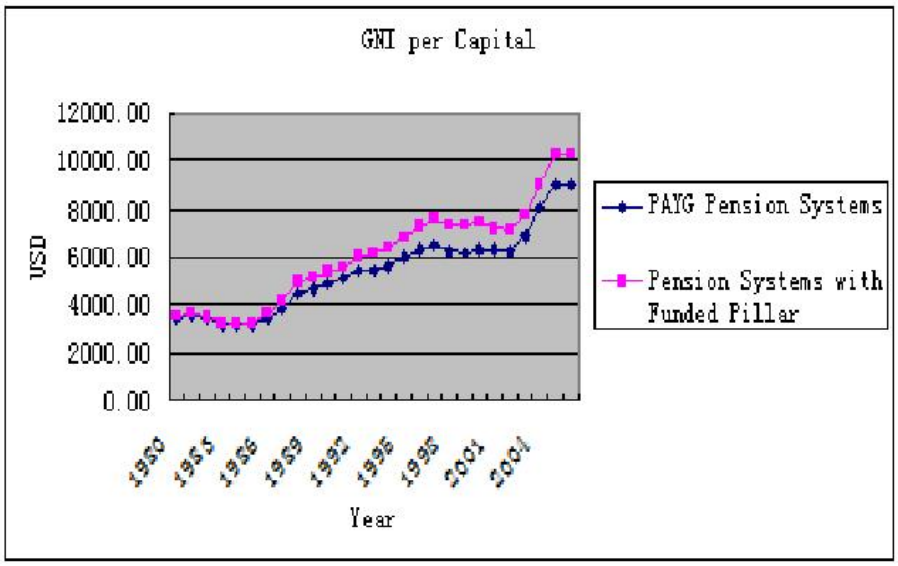


Fig. 5.5: GNI per Capital

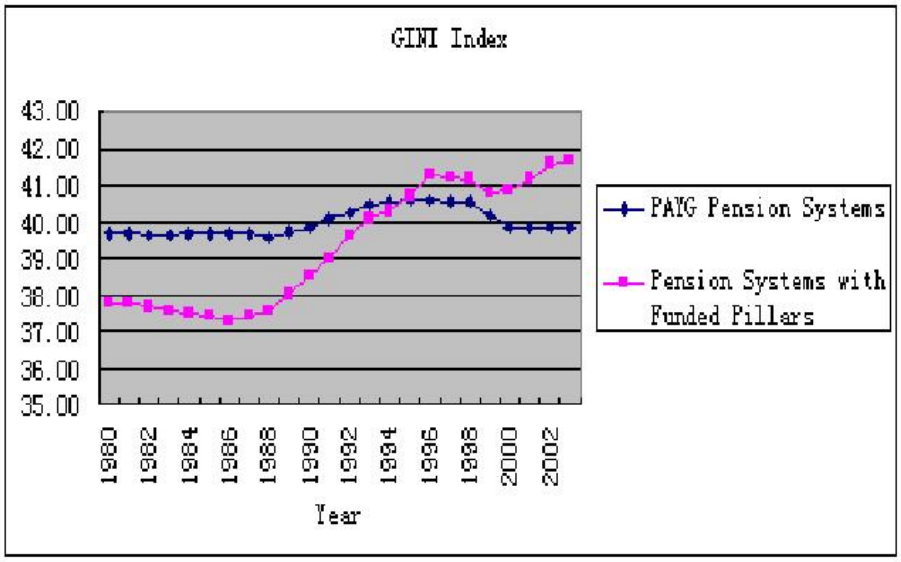


Fig. 5.6: GINI Index

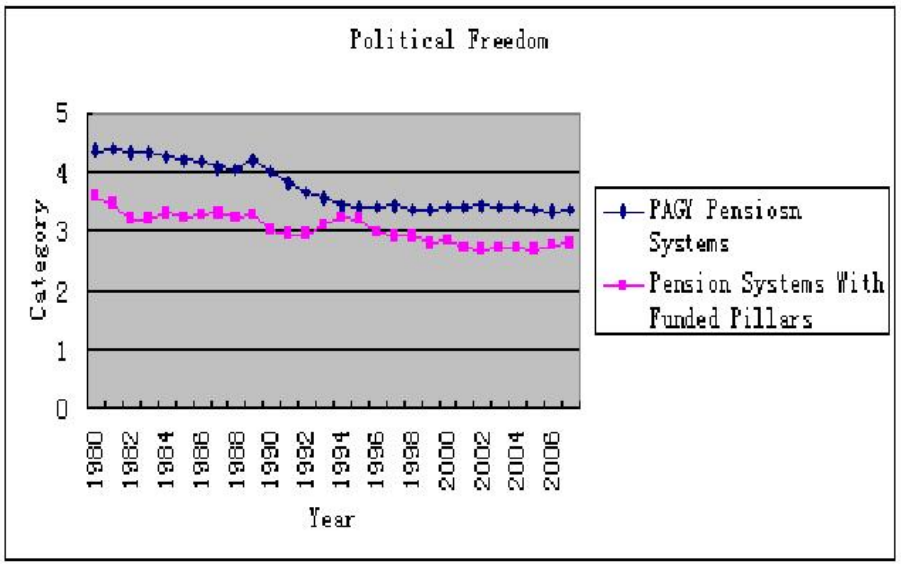


Fig. 5.7: Political Freedom

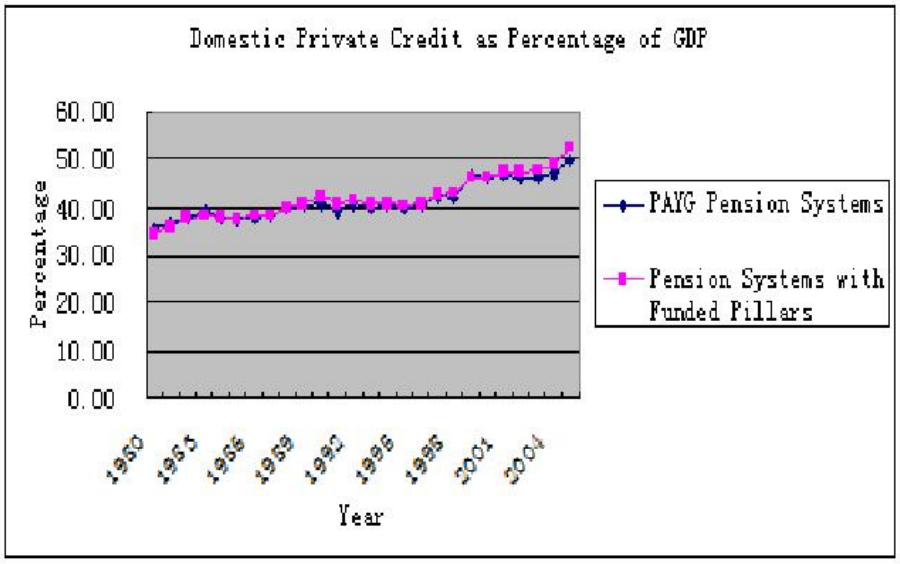


Fig. 5.8: Domestic Private Credit

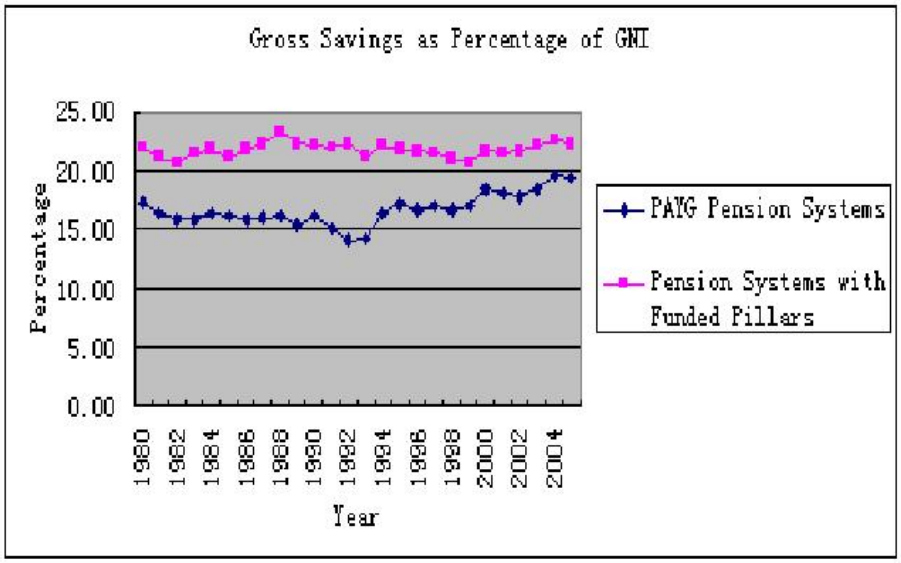


Fig. 5.9: Gross Savings Per GNI

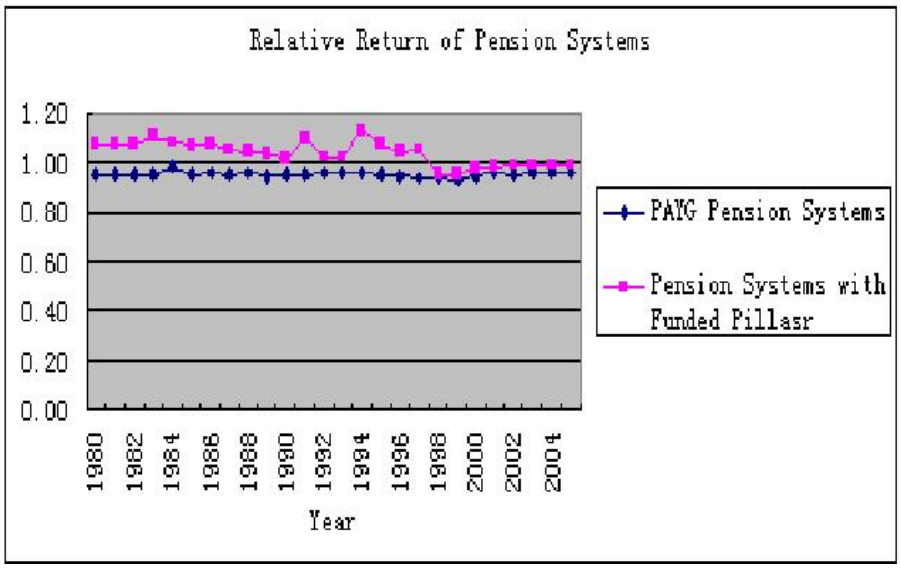


Fig. 5.10: Relative Return of Pension Systems

GNI per capital and the *GINI index* are significant. Their coefficient is positive but closer to zero. The impact is not big. Both *Politically Free* and *Politically Unfree* are not significant. This conflicts with the result from the cross-sectional test. *Private Credit as a percentage of the GDP* is significant with positive coefficient. Countries with a more advanced financial market are more likely to reform the pension system. *Gross Savings as a Percentage of the GNI* is not significant.

5.5 Summary

This chapter examined the social, economic and political factors which affect the probability of adopting different pension systems. It began with a brief comparison of PAYG and a funded pension system as well as a review of the pension reforms in developed, Latin American and Central and Eastern European countries to find out what the main motivations for the past reforms were. Independent variables were selected based on the importance of their impact and also data availability.

Tab. 5.16: Panel Binary Logistic Regression: Results

Coef. (P Value)	Equation 1	Equation 2	Equation 3	Equation 4
AgeDep **	-160.96	-63.75		-72.03
	(0.000)	(0.000)		(0.000)
PopGrowth	0.007		-0.19	
	(0.968)		(0.196)	
GNI **	0.001	0.0004	0.0001	0.0005
	(0.000)	(0.000)	(0.006)	(0.000)
GINI **	0.97	0.54	0.025	0.67
	(0.000)	(0.000)	(0.154)	(0.000)
PolFree	0.92		0.035	0.49
	(0.477)		(0.929)	(0.546)
PolNotFree	1.05	0.187		
	(0.59)	(0.854)		
PriCredit *	0.05	0.032	0.053	0.0395
	(0.021)	(0.051)	(0.000)	(0.025)
Savings	0.18	0.024	-0.06	0.097
	(0.104)	(0.67)	(-0.103)	(0.151)

From the cross sectional test, the result shows that the age dependency ratio and the politically free dummy variable have significant impact and both of their coefficients are negative. The higher the age dependency ratio, the less likely for a country to have a funded element in their public pension system. Countries with more political freedom and civil rights face more obstacles when they want to reform the pension system away from traditional PAYG schemes. Although the sample size is not large for the multinomial and ordered logistic test, the result is mostly consistent with the binary logistic test. Also the GINI index appears to be significant. The higher the GINI index, the more likely to choose a funded pension system, especially a fully funded system.

For the panel data analysis, as it enjoys a bigger sample size and also captures the changes of variables over 24 years, more variables are shown as significant. The same result was achieved from the cross sectional study; age dependency ratio is significant and also has the greatest impact. GNI per capital, the GINI index and Domestic Private Credit as a percentage of the GDP, which represents the development of a financial market, is significant with positive coefficients. Indicators for the political freedom and savings level don't appear to be significant.

This chapter searches for the general factors affecting the choice of the pension systems across the globe. The age dependency ratio appears to be the most significant among all the tests, with notably different samples [9]. Countries may have reformed pension systems due to one particular reason or event or another, for example, the financial crisis in Latin American countries, the collapse of the Soviet Union, or perhaps the assistance of the World Bank. Also, much literature has spoken about the advantages of a funded system over a PAYG one. These advantages include higher returns, the encouragement of savings, and a reduction of the distortion to the labour supply. The results shows that the fundamental motivation for countries to reform their pension system boils down to demographic trends. The other variables are the additional pull or push variables.

[9] The sample countries are decided by the data availability, here the independent variables are not exactly the same for cross sectional and panel data analysis. The sample countries varies a bit.

There are some variables, which though thought to be important were not tested here due to the limited availability of data. For instance, indicators for the burden of the existing pension system, such as weight of pension expense or total social security expenditure as a percentage of government expenditure; and for the transition costs of reforming the pension system, e.g. the implicit debt. Further research is needed here when better data is available. Also countries in similar regions or countries with similar levels of wealth share more social and economic characteristics. It may be interesting to separate countries into groups, and conduct the tests separately, to find out the factors which drive the reforms in each group. This is also suggested for later research.

Chapter 6

CONCLUSION

This thesis studies the provision of public pension system through three different approaches: a simulation model, a theoretical analysis and an empirical test. It tries to address the following three questions:

1. What is the impact of the demographic change and the choice of public pension systems to China?

2. What is the optimal level of public pension benefit?

3. Why have some countries reformed away from the original PAYG pension system and some have not?

The provision of social security system is important to all societies. With the economic reforms and the one child policy, it is an even more challenging task for China. After a review of the pension system fundamentals, the thesis begins with a a survey about China's pension systems. It demonstrates why and how it changed from a purely PAYG enterprise contribution defined benefit system to a more complicated three-tier system [1] with higher coverage.

The reform has successfully established portability of pensions and relieved the heavy pension obligations of the SOEs. However, it has failed to overcome financial imbalance

[1] a mandatory publicly managed PAYG pillar, a mandatory fully funded defined contribution individual account and a voluntary fully funded pillar through personal savings or commercial insurance

in the system, which has resulted in repeated delays in paying pensions to retirees, and almost empty individual accounts. The second pillar individual account was originally designed to be fully funded. However, in practice it is behaving like a notional defined contribution system. It raises a question: 'is fully funded or the notional defined system better for China?'

Chapter 3 addresses this question, and it also investigates the impact of the demographic changes to individual choices and to the economy by applying a calibrated overlapping generations general equilibrium simulation model. The analysis is based on the model developed by Auerbach and Kotlikoff (1987). I change the model and the calibration of the parameters to adjust for Chinese characteristics for example high savings rate, inflexible labour market, fox example, including technological progress and bequest and fixing the individual labour supply to be constant.

The results show that the demographic structural change underway in China has severe effects to the individual and the economy. Without technological progress, the societal saving rate will become negative by 2025 and later cohorts will have lower life time utility. Otherwise, these problems are hidden by the production efficiency improvement. The interest, wage and tax rates might still be expected to change significantly as the demographic structure changes. When population ages, interest rates decrease, wage rates increase and the payroll tax rate has be increased to very high levels. Although the individuals enjoy smoother levels of consumption and wealth over the time under the notional defined contribution system, society is better off by choosing fully funded individual accounts, as all cohorts enjoy higher utility and a more reasonable payroll tax rate.

Results of all calibrated simulation models are sensitive to the choice of the parameters. For making the calibration more accurate, this research can be extended by estimating the parameters based on China's historical data. However, the sensitivity test results show that changing the parameters to a large extent doesn't affect the key feature and conclusion of the simulation. Another avenue for extend the research to model the transitional phase

of the Chinese pension system.

Chapter 4 addresses the second question: What is the optimal level of public pension benefit? After reviewing the important literatures in this field, we derive the optimal pension benefit level in a two period overlapping generations economy, by considering the welfare loss imposed by saving and labour supply distortion.

I extend previous work by introducing an elastic labour supply and by starting with a derivation of the optimal level of the payroll tax rate in a economy in which individuals have perfect foresight. This establishes the general framework and provides a standard of reference for evaluating the effect of myopia. With no restrictions on borrowing and no consideration about the cost associating with either borrowing or managing pension systems, the level of the optimal public pension payroll tax is shown to be only related to the relative return provided by the PAYG pension system (γ) and the interest rate earns by the savings (ρ). When the pension system provides higher return, social welfare is highest when $\theta = 1$. The pension system acts like a 'pyramid scheme'. Although it doesn't generate real capital, the consistent population and wage growth rate support its sustainability. When the returns are the same, society is indifferent as to whether has a pension system or not. When the return provided by the pension system is lower, it's better not to have a pension system.

Following this, myopia and elastic labour supply are introduced. By applying a log linear utility function, the optimal public pension payroll tax is calculated. The result shows that the optimal level pension contribution rate θ^* is unique and satisfies $0 < \theta^* < 1$. The result shows that θ^* satisfies $0 < \theta^* < 1$ when $\beta > 0$ and $\theta^* = 0$, when the pension system can not provide higher return than savings ($\beta \leq 0$). This is consistent with other work, and taken with the introduction of an endogenous labour supply, suggests that public pensions are even less desirable.

The limitation of this model is that doesn't deal with policy against myopia if there is no restriction on savings. Without it, at $\theta = \theta^*$ individuals would dis-save, the constraint is

binding at $s^* = 0$. The calculated optimal level of pension contribution is purely a function of the weight on the consumption for the retirement period set by the government, and θ^* increases with it. The purpose of the study rather than deriving practical parameters, it's for understanding how different factors influence the optimal level of a public PAYG pension system.

China is a not alone, aging population and pension reforms are global phenomenons in the past few decades. Why have some countries reformed away from the original PAYG pension system and some have not? Chapter 5 addresses this third question. It examines the social, economic and political factors which affect the probability of adopting different pension systems.

It began with a brief comparison of PAYG and a funded pension system as well as a review about the pension reforms in developed, Latin American and Central and Eastern European countries to find out what the main motivations for the past reforms were. Independent variables were selected based on the importance of their impact and also data availability. In the binary logistic test (0 for PAYG system, 1 for systems with funded element), the result shows the age dependency ratio and the politically free dummy variable have significant impact and both of their coefficient are negative. The higher the age dependency ratio, the less likely for a country to have a funded element in their public pension system. Countries with more political freedom and civil rights are facing more obstacle when they want to reform the pension system away from the traditional PAYG one. Although the sample size is not large for the multinomial and ordered logistic test, the result is mostly consistent with the binary logistic test. Also the GINI index appears to be significant. The higher the GINI index, the more likely to choose a funded pension system, especially a fully funded system.

For the panel data analysis, as it enjoys a bigger sample size and also captures the changes of variables over 24 years, more variables are shown to be significant. The same result was achieved from the cross sectional study: age dependency ratio is significant

and also has the greatest impact. GNI per capital, the GINI index and Domestic Private Credit as a Percentage of the GDP which represents the development of a financial market is significant with positive coefficients. Indicators for the political freedom and savings level don't appear to be significant.

All these result are highly consistent to the situation in China. It has an rapidly aging population provide enough incentive for the government to reform away from the original PAYG. Also the unique single party controlled political structure, make the implementation easier. Although it is nothing the government want, China's GINI index increased significantly over the past decades. People are starting to get used to the income equality, which makes the adoption of a funded system relatively easier.

Chapter 5 searches for the general factors affecting the choice of the pension systems across the globe. The age dependency ratio appears to be the most significant among all the tests, with notably different samples [2]. Countries may have reformed pension systems due to one particular reason or event or another, for example, the financial crisis in Latin American countries, the collapse of the Soviet Union, or perhaps the assistance of the World Bank. Also, much literature has spoken about the advantages of a funded system over a PAYG one. These advantages include higher returns, the encouragement of savings, and a reduction of the distortion to the labour supply. The results shows that the fundamental motivation for countries to reform their pension system boils down to demographic trends. The other variables are the additional pull or push variables.

There are some variables, which though thought to be important were not tested here due to the limited availability of data. For instance, indicators for the burden of the existing pension system, such as weight of pension expense or total social security expenditure as a percentage of government expenditure; and for the transition costs of reforming the pension system, e.g. the implicit debt. Further research is needed here when better data is available. Also countries in similar regions or countries with similar

[2] The sample countries are decided by the data availability, here the independent variables are not exactly the same for cross sectional and panel data analysis. The sample countries varies a bit.

levels of wealth share more social and economic characteristics. It may be interesting to separate countries into groups, and conduct the tests separately, to find out the factors which drive the reforms in each group. This is also suggested for later research.

Finally, these three different approaches all reach the same conclusion: that the demographic structure change has a significant impact on the economy, to the sustainability of a countries pension system and to the choice of that system. All of the other factors, which have been widely discussed throughout this thesis exhibit themselves as secondary contributing factors.

BIBLIOGRAPHY

Arza, C. and Johnson, P.: 2004, The development of public pensions from 1889 to the 1990s, SAGE Discussion Paper No.20.

Auerbanch, A. J. and Kotlikoff, L. J.: 1987, *Dynamic Fiscal Policy*, Cambridge University Press, Cambridge UK.

Baer, W.: 1994, Privatisation in latin america, *The World Economy* (17), 509–528.

Brooks, S. and James, E.: 1999, The political economy of pension reform, A presentation at World Bank Research Conference 14-15 September.

Brooks, S. M.: 2001, The diffusion of pension privatization over time and space, American Political Science Association Conference, San Francisco.

Cass, D.: 1965, Optimum growth in an aggregate model of capital accumulation, *Review of Economic Studies* (32), 233–240.

Chow, G. C.: 1993, Capital formation and economic growth in china, *Quarterly Journal of Economics* (108), 809–842.

Chow, G. C. and Li, K.-W.: 2002, China's economic growth:1952-2010, *Economic Development and Cultural Change* **51**, 247–56.

Corsetti, G. and Schmidt-Hebbel, K.: 1997, Pension reform and growth, published in The Economics of Pension: Principles, Policies and International Experience edited by S. Valdes-Prieto Cambridge University Press.

Davis, E.: 1995, *Pension Funds: Retirement-Income Security and Capital Markets-An International Perspective*, Clarendon Press, Oxford.

Diamond, P. A. and Mirrlees, J. A.: 1978, A model of social insurance with variable retirement, *Journal of Public Economics* (10), 295–336.

Diamond, P. A. and Mirrlees, J. A.: 1986, Payroll-tax financed social insurance with variable retirement, *Scandinavian Journal of Economics* (88), 25–50.

Diamond, P. A. and Mirrlees, J. A.: 2002, Social insurance with variable retirement and private savings, *Journal of Public Economics* .

Drouin, A. and Thompson, L. H.: 2006, Perspectives on the social security system of china, *ESS Paper 25*, International Labour Office, Geneva.

Feldstein, M.: 1974, Social security, induced retirement, and aggregate capital accumulation, *Journal of Political Economy* (82), 905–926.

Feldstein, M.: 1985, The optimal level of social security benefits, *The Quarterly Journal of Economics* **100(2)**, 303–20.

Feldstein, M. (ed.): 1998, *Privatizing Social Security*, The University of Chicago Press, London.

Feldstein, M. S.: 1987, Should social security benefits be means tested?, *The Journal of Political Economy* **95**(3), 468–484.

G.D.Hansen: 1993, The cyclical and secular behaviour of the labour input: Comparing efficiency units and hours worked, *Journal of Applied Econometrics* **8**(1), 71–80.

Hall, R.: 1980, Intertemporal substitution in consumption, *NBER Working Paper* (720).

Hansen, P. and Singleton, K.: 1983, Stochastic consumption, risk aversion and the temporal behaviour of asset returns, *Journal of Political Economy* **91**(2).

Hurd, M.: 1989, Mortality risks and bequests, *Econometrica* **57**, 779–813.

James, E.: 1999, New models for old age security and how can they be applied in china?, Paper presented at the WBI and MOLSS workshop Beijing.

Long, J.: 1997, *Regression Models for Categorical and Limited Dependent Variables*, SAGE Publications Inc.

Madrid, R. L.: 2000, *Understanding the Wave of Pension Reforms*, Oxford: Blackwell.

Mankiw, G.: 1985, Consumer durables and the real interest rate, *Review of Economics and Statistics* **67**(3).

Miles, D.: 1997, A household level study of the determinants of incomes and consumption, *Economic Journal* **107**(440), 1–26.

Miles, D.: 1999, Modelling the impact of demographic change upon the economy, *The Economic Journal* **109**(452), 1–36.

Min: 2001, *Yanglao Baoxian(in Chinese), old age insurance.*

Muller, K.: 2003, *Privatising Old-Age Security: Latin-America and Eastern Europe Compared*, Edward Elgar Publishing Limited.

N. Gregory Mankiw, D. R. and Weil, D. N.: 1992, A contribution to the empirics of economic growth, *The Quarterly Journal of Economics* **107**(2), 407–437.

Orszag, P. R. and Stilitz, J. E.: 1999, Rethinking pension reform: Ten myths abour social security systems, Presented at the conference on "New Ideas About Old Age Security".

P.D.Allison: 1995, *Survival Analysis Using the SAS System*, SAS Press.

Quarterly Superannuation Performance: 2007.

Rondanelli, E. H.: 1996, Chilean pension fund reform and its impact on saving, Discussion Paper.

Samuelson, P. A.: 1958, An exact consumption-loan model of interest with or without the social contrivance of money, *Journal of Political Economy* (66), 467–82.

Schwarz, A. M. and Demirguc-Kunt, A.: 1999, Taking stock of pension reforms around the world, *The World Bank working paper* (9917).

Shanggen Fan, X. Z. and Robinson, S.: 1999, Past and future sources of growth for china, *EPTD Discussion Paper* (53).

Social Security Programs Throughout the World: 2007, SSA Publication No. 13-11803. Social Security Programs Throughout the World is the product of a cooperative effort between the Social Security Administration (SSA) and the International Social Security Association (ISSA).

Sta: 1991, *A Decision on Reforming Pension System of Enterprise Workers.*

Sta: 1995, *A Circular on Deepening Enterprise Pension System Reform.*

Sta: 1997a, *China Labour Statistical Yearbook*, Vol. 1996, China Statistical Publishing House, Beijing.

Sta: 1997b, *A Decision on Establishing a Unified Basic Pension System for Enterprise Workers.*

Wang, L. and Davis, O. A.: 2003, Freedom and other variables in the choice of public pension systems, *Public Choice* **114**, 361–385.

Wigger, B. U.: 2001, Productivity growth and the political economy of social security, *Public Choice* (106), 53–76.

World-Bank: 1994, *Averting the Old Age Crisis: Policits to Protect the Old and Promote Growth*, World Bank and Oxford University Press, Washington, D.C.

World-Bank: 1997, *Old Age Security: Pension Reform in China*, The World Bank, Washington, D.C. USA.

World-Bank: 2001, Penison online-knowledge and information: Statistics, http://www.worldbank.org/pensions.

World Labour Report 2000: 2000, International Labour Office, Geneva.

Yao, X.: 2005, *Fertility Data of China (in Chinese)*, China Population Publishing House, Beijing.

Zhao, Y. and Xu, J.: 2002, China's urban pension system, *Cato Journal* **21**(3).