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Implicit Pension Debt, Transition Cost, Options, and Impact of China's Pension Reform

A Computable General Equilibrium Analysis

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China's population is aging rapidly: the old-age dependency ratio will rise from 11 percent in 1999 to 25 percent in 2030 and 36 percent in 2050. Currently, three workers support one retiree; without reform, the system dependency ratio will climb to 69 percent in 2030 and 79 percent in 2050. The pension system has been in deficit, with an implicit pension debt in 2000 as high as 71 percent of GDP. The lack of an effective, sustainable pension system is a serious obstacle to Chinese economic reform.

Summary findings

The main problems with China's pension system—the heavy pension burdens of state enterprises and the aging of the population—have deepened in recent years.

Using a new computable general equilibrium model that differentiates between three types of enterprise ownership and 22 groups in the labor force, Wang, Xu, Wang, and Zhai estimate the effects of pension reform in China, comparing various options for financing the transition cost. They examine the impact that various reform options would have on the system's sustainability, on overall economic growth, and on income distribution. The results are promising.

The current pay-as-you-go system, with a notional individual account, remains unchanged in the first scenario examined. Simulations show this system to be unsustainable. Expanding coverage under this system would improve financial viability in the short run but weaken it in the long run.

Other scenarios assume that the transition cost will be financed by various taxes and that a new, fully funded individual account will be established in 2001. The authors compare the impact of a corporate tax, a value-added tax, a personal income tax, and a consumption tax. They estimate the annual transition cost to be about 0.6 percent of GDP between 2000 and 2010, declining to 0.3 percent by 2050. Using a personal income tax to finance the transition cost would best promote economic growth and reduce income inequality.

Levying a social security tax and injecting fiscal resources to finance the transition costs would help make the reformed public pillar sustainable. To finance a benefit of 20 percent of the average wage, a contribution rate of only 10 percent–12.5 percent would be enough to balance the basic pension pillar. Gradually increasing the retirement age would further reduce the contribution rate.

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Executive Summary

A serious obstacle to China's economic reform is the lack of an effective and sustainable pension system. Two major problems with China's current pension system, the short-run problem of the heavy pension burdens of State enterprises, and the longer-term problem arising from the rapid aging of the population, have only deepened over the past few years. Using a newly designed Computable General Equilibrium (CGE) model that differentiates among three types of enterprise ownership and 22 labor force groups, this study estimates the effects of China's pension reform and compares various options for financing the implicit pension debt and transition cost. The study examines the impacts various reform options would have on the sustainability of the system, on overall economic growth, and on income distribution. Results from simulations of the various options are promising:

- *The baseline scenario.* Because China's population is growing at a decreasing rate, the labor force will stop growing between 2015 and 2020 and will decline afterward, but the populations age 65 and over will continue to grow. Thus, the old age dependency ratio will rise steadily from 11 percent in 1999 to 25 percent in 2030 and 36 percent in 2050. The system dependency ratio, which is currently as high as 30 percent with three workers supporting one retiree, will rise rapidly to 69 percent in 2030 and 79 percent in 2050. The pension system will be in deficit from 2000 onward, and the implicit pension debt in 2000 will be as much as 71 percent of the average annual GDP.

- Scenario set 1 assumes that the current system— pay-as-you-go with a notional individual account— remains unchanged. Simulation results confirm that this system is not sustainable. Expanding coverage under the current system will improve the financial situation in the short run, but it will lead to a worsening of financial viability in the long run.

- The second set of scenarios assumes that the transition cost will be financed by various taxes, and a new fully funded individual account will be established as of 2001. Various options are considered: a corporate tax, a value-added tax (VAT), a personal income tax, and a final demand tax, and the impacts of these options are compared. The annual transition cost is estimated at around 0.6 percent of GDP between 2000 and 2010 and decline to 0.3 percent by 2050. Using personal income tax to finance the transition cost would best promote economic growth and reduce income inequality.

- Effects of the abovementioned reforms and levying a social security tax are shown in Scenario set 3. After injecting fiscal resources to finance the transition cost, the reformed public pillar becomes financially sustainable. To finance a benefit of 20 percent of average wage, a contribution rate of only 10 to 12.5 percent is sufficient to balance the basic pension pillar annually. If the retirement age of female workers is increased gradually by five years, the balanced contribution rate would be reduced to around 9 percent. In addition, if a new social security tax is levied to replace the current pillar 1 contributions, the pension system would become nationally unified and financially sustainable.

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—A Computable General Equilibrium Analysis

China's population has been aging rapidly, and the burdens of supporting the elderly are distributed unevenly across regions and sectors. A serious obstacle to China's economic reform is the lack of an effective and sustainable national pension system. The World Bank's 1997 report *Old Age Security: Pension Reform in China* pointed to the two major problems with China's current pension system: the short-run problem of the pension burden of state-owned enterprises (SOEs), and the longer-term problem arising from the rapid aging of the population. Today these problems have become more severe than four years ago: for various reasons including slowing economic growth, many state enterprises have not been able to afford to pay payroll taxes and thus, pension funds in many municipalities are in deficit, which could threaten the fiscal stability of the central government as well as the local governments.[1] Reforming the current pension system is now a matter of urgency.

Building on previous studies, this paper addresses the most urgent issue in China's pension reform, namely, how to finance the unfunded pension liabilities, put another way, this study investigates ways to recapitalize the pension system, which is financially nonviable. Previous studies have analyzed the problems of China's urban- and enterprise-based pay-as-you-go system and recommended a multipillar system combining social pooling and funded individual accounts, and voluntary savings.[2] Some analyses including World Bank 1997 have used actuarial models to simulate the impacts of various pension reform options, is a partial equilibrium framework, however, and has some disadvantages as compared with a general equilibrium model.

Using a newly designed Computable General Equilibrium (CGE) model that differentiates three types of enterprise ownership and 22 labor force groups, this study estimates the effects of China's pension reform and compares various options for financing the implicit pension debt and transition cost. This study examines the impacts various reform design options would have on the sustainability of the system, on overall economic growth, and on income distribution.

Issues addressed by this paper have significant implications for China's fiscal stabilization and public sector reform and management, and for the alleviation of poverty and inequality. First, the unfunded pension liabilities represent a significant part of the direct and implicit (partly current and partly future) liabilities of the local and central governments.[3] The deficit in social pooling funds in

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1. Statistics from the Ministry of Labor and Social Security show that Chinese enterprises owed the government as much as RMB 38 billion (US$4.6 billion) in overdue pension contribution. Separately, it was reported that in 1999, the central government transferred more than RMB17 billion to 25 provinces for pension payments (People's Daily 1999).

2. On China's pension reform, see, for example, Ahmad and Hussain 1991; James 1997, and 1999; Hussain 1993; China RGSSS 1995; Zhou 1994; Friedman, James, Kane, and Queisser 1996;Wang 1997; World Bank 1997, and recently Fox 2000, and Dorfman and Sin 2000.

3. Government liabilities can be classified into four categories: explicit and direct (such as formal debt, budgeted expenditure), explicit and contingent (e.g., government guarantees and deposit insurance schemes), implicit and current (e.g., social insurance expenditure), and implicit and contingent (e.g., default of SOEs, banks, and social insurance funds). See Brixi 1998.

many localities has already become a threat to local government finance. If not monitored and checked carefully, it could threaten the central government's fiscal sustainability. Second, pension reform is closely linked to restructuring of the state sector and financial sectors. It is desirable to find some synergy between the transition problems of the pension system and the state sector, as shown by international experience. All reform options involving taxation and other forms of financing have benefits and costs; this study seeks to help making decision by comparing various reform options. Third, China's income inequality has been rising, from a Gini coefficient of 28 percent in the 1980s to 40 percent in 1998, a trend that should not be allowed to continue (World Bank 2000).[4] It is thus crucial to examine the impact of pension reform on poverty and inequality.

A major contribution of this research is combining the CGE model and population growth model into a recursive dynamic framework, which provides a new flexible tool to simulate various pension reform plans in a general equilibrium setting. Another contribution is differentiating production and employment by ownership type and organizing the demographic data in a matrix with four dimensions. Number of workers and worker income, two major variables of the pension system, have been organized in the model into a four-dimension matrix based on sector, age, sex, and ownership of the enterprise.[5]

Pension reform in China and around the world

Over the next 35 years, the proportion of the world's population that is over age 60 will nearly double from 9 percent to 16 percent. Because of rapid improvements in life expectancy and declining fertility rates, populations are aging faster in developing countries than they did in industrial countries (World Bank 1994b). In China the proportion of the population over age 60 will rise rapidly from 9 percent in 1990 to 22 percent in 2030 (World Bank 1997). Based on new base year data and our estimates, China's old age dependency ratio (population 65+ /15-64 year-olds) will rise from 11 percent in 1999 to 25 percent in 2030 and 36 percent in 2050. Population aging has put severe pressure on pension systems around the world. Many countries have undertaken major or minor reforms of their pension systems. A review of the various approaches to pension reform puts China's reform into context and provides rationales for our simulation design.

Box 1. Pension reform around the world

Three criteria can be used to classify pension systems around the world: how benefits are calculated (defined contribution or defined benefit) and whether they are guaranteed by the government; how benefits are financed, funded or unfunded; and whether management of the system is public or private. Most formal pension systems are publicly managed, pay defined benefits according to a formula, and are financed by payroll taxes on a pay-as-you-go basis, which 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, lost

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[4] Gini coefficients estimated by Chinese researchers seem to be higher, 45 percent in 1997, or 51 percent if the informal economy is included (S. Wang 2000).

5. The database would include, for example, the following information: the total number of female workers age 30-34 employed in state-owned enterprises in the machinery sector is 356,722, and their average annual salary is RMB5122 per year.

opportunity to generate long-term savings, unintended intergeneration transfers (often to higher income groups that live longer), and the growth of a large implicit pension debt and financing gap in the face of aging population.[6]

To address the short-term and long-term fiscal viability problem as well as economic and distributive concerns, the World Bank (1994) has been recommending and many countries (including China) have been moving toward, multipillar systems that contain the following provision:

- 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 old age.

The multipillar pension system is defended by three main theoretical arguments that are supported by limited empirical evidence. First, it is often argued that the multipillar pension system will facilitate economic efficiency and growth, through removing labor market distortions and by providing better incentives, increased savings, and better allocation of resources (James 1999). 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, defined contribution pillar would reduce this distortion: following Chile pension reform, the share of informal employment actually dropped, unemployment fell and wages rose between 1980 and 1990. Evidence is not conclusive on whether pension reform leads to a rise in national saving. Haindl Rondonelli (1996) indicates that Chile pension reform accounts for 6.6 of the 9.9 percentage point increase in the national saving rate, from 16.7 percent of GDP in 1976-80 to 26.6 percent in 1990-94. However, the fiscal cost of financing the pension transition initially may have canceled out the positive effect on private saving (Agosin et al 1996, Holzmann 1996). On the other hand, there is strong evidence of the positive effects of a fully funded second pillar (individual accounts) on financial market development, and hence on resource allocation and growth. (See, for example, Holzmann 1997a, Schmidt-Hebbel 1998, Vittas and Iglesias 1992, Vittas 1995.)

Another argument for the multipillar system is that it enhances the financial sustainability of the pension system and thereby provides better long-term protection for the elderly. Further, a multipillar system has a redistributive impact and, in particular, could improve intergenerational equity (James 1999). In principle, the entire population should have access to some old age income, at a minimum 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 pay-as-you-go 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 intergeneration 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 major reformers, 10 countries are moving toward fully funded individual accounts (the Latin America model), three OECD countries are adopting an employer-sponsored, defined contribution system, and three countries (Latvia, Poland, and Sweden) are using notional defined contribution systems. Several other developing countries are moving in an opposite direction, from defined contribution provident funds to the PAYGO defined benefit system (Figure 1).

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[6] These problems were recognized and analyzed by many seminal work on pension systems, for example, Aaron 1977, Atkinson 1987, Auerback and kotlikoff 1987, Feldstein 1974, Feldstein and Samwick 1992, Seidman 1986, Arrau 1990, Kotilkoff 1995 and 1997, Holzmann 1988, James 1992 and 1994. See World Bank 1994 for a literature survey. See also Holzmann 1999 and other studies on *Pension Reform Primer* at www.worldbank.org/pensions.

Countries adopted differing pension reform paths based on their initial conditions and socio political situations. The pros and cons of various types of reform are discussed in detail in Schwarz and Demirguc-Kunt 1999 and James 1999. One of the factors influencing a country's choice of reform path was the size of implicit pension debt (IPD). A huge IPD forced some countries, such as Latvia, Poland, and Sweden, to adopt a notional defined contribution system (Disney 1999). Countries have used various options to finance the transition cost or IPD. These and other issues will be discussed later in the paper.

Figure 1. Classification of pension reforms/systems
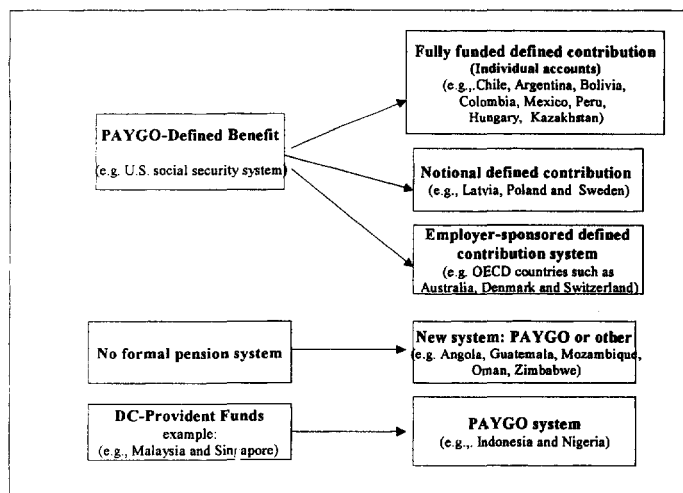
Source: Based on Schwarz and Demirguc-Kunt 1999, James 1999.

Pension reform in China

Past reforms. China used to have an urban- and enterprise-based PAYGO pension system covering only the state sector and some large collective enterprises. After some experimentation beginning in 1982, pension reform was formally begun in 1986 when State Council Document 77 encouraged pension pooling across state enterprises on a limited basis at the municipal level, which individual contribution was implemented for contractual workers only. State Council Document 33 of 1991 called for individual contributions by all workers and encouraged experimentation including a role for individual accounts. It also, for the first time, called for the establishment of three tiers in the pension system: a basic benefit, a supplementary benefit to be provided by enterprises in sound financial condition, and a benefit based on individual saving.

Reform of 1995

In 1995 State Council Document 6 proposed two plans for the basic pension tier. Municipal and prefecture governments were given the right to select a reform design and provincial governments the right to approve the choice. This led to a highly fragmented system in which provincial and local governments and line-ministries selected various combinations of the two plans. In collaboration with

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the State Planning Commission, a World Bank mission visited 8 Chinese cities and provinces in 1995, and pointed out several problems with the new system, including:

- Fragmentation caused by wide dispersion of authority over pension policy;
- Low and variable coverage;
- Inadequate pooling and portability;
- High contribution rates, ranging from 10 percent (in civil aviation sector) to 29 or 30 percent in several municipalities (World Bank 1997).

The World Bank study recommended a multipillar system, which would consist of a small pay-as-you-go component for redistribution and social insurance (pillar 1), a large mandatory fully funded individual accounts component (pillar 2), and a supplemental voluntary pension accounts component funded via commercial insurance (pillar 3). Based on simulations using an actuarial model, the report proposed that pillar 1 to be financed by 9 percent of payroll tax with expanded coverage and provincial-level pooling, and that it provides 24 percent replacement rate, based on average provincial wages (World Bank 1997, page 7). The study was optimistic, however, in its assumptions about expanding coverage to 50 percent of township and village enterprises and other enterprises, leading to an over estimation of funds accumulated in the first and second pillars. Moreover, it could not investigate the effects of using different taxes to finance pillar 1 and transition cost, due to a limitation of the actuarial model.

Current reform and implementation

State Council Document 26 of July 1997 defined more clearly the direction of pension reform: a multi-tier pension system combining social pooling with individual account was to be instituted by 2000. Funds were to be pooled at the provincial level, with contributions from enterprises (no more than 20 percent of payroll) and individual workers (4 percent of a worker's wages, and gradually increasing to 8 percent). Pillar 1 was to be financed entirely by enterprise contributions of 13 percent, and would provide 20 percent replacement based on average wage. Pillar 2 individual accounts would be financed by individual contributions plus 7 percent from enterprises. This document provides the starting point of our policy simulation. In March 1998, a new ministry, the Ministry of Labor and Social Security (MOLSS), was established to oversee policy making for pension and other social security benefits. This has unified policymaking on pension reform with the administrative system. Several State Council documents and MOLSS decrees have been issued since 1998 to implement provincial-level pooling, and to clarify and enforce regulation of various aspects of the pension system, such as the collection of contributions.[7]

But, China still has fragmented, municipality-based PAYGO system (plus notional individual accounts), that is publicly managed. This hybrid system is in the process of transition. Based on incomplete knowledge gained from interviews and seminars held with officials, China's current system has the following problems:

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[7] For example, State Council Notice [no. 28] on Related Issues on Implementing the Provincial Pooling of Enterprise Workers Basic Pension Insurance and Transferring Sector Pooling to Local Government's management (August 6, 1998); Provisional Regulation on Collection and Payment of Social Insurance Contributions (State Council Document 259); and MOLSS Decree no. 1 to 3 (March 1999).

- *The system is still fragmented.* By mid-1999, only 5 (the provincial level municipalities Beijing, Chongqing, Shanghai and Tianjin, plus Hainan province) of the 27, had achieved full pooling or unification. In 17 provinces small provincial adjustment funds were established using 1- 2 percent of total contributions sent from city pools. No such adjustment funds were possible for 5 provinces because of the lack of funds in municipal pools. It is reported that all 11 sectoral pools (existed until September 1998; see State Council Notice 28 of 1998) have been dissolved and are now participating in local social pooling. It is not clear, however, whether the accumulated reserves were transferred to the local pools.

- *Social pooling is incomplete.* In most localities, pension services are not socialized; that is, contributions and pension expenditure are not administered separately by different agencies. An enterprise submits a net amount to the municipal pool, which equals the total contribution minus the total pension payments to retirees of that enterprise. Contribution rates vary significantly across provinces and cities and in some cases even across different enterprises.

- *Coverage is narrow and uneven across regions.* By the end of 1998, the basic pension insurance system covered only 78.4 percent of workers in state-owned enterprises, 16.2 percent of workers in collective enterprises, and 5.4 percent of workers in other urban enterprises (Hang, 1999). There is no pension scheme for the urban self-employed or individual entrepreneurs. In some rural areas there is a pension scheme designed and managed by the Ministry of Civil Affairs, but the coverage is small, and will be incorporated or merged under the MOLSS system.

- *Individual accounts are largely notional.* Reserves accumulated in these accounts over the past five years have been used to pay current retirees, as the government has not made a clear decision on how to finance the transition cost.

- *The funding problem is acute.* Many local pension pools are financially bankrupt as compliance rates are low and declining and the issue of how to finance the transition cost is unresolved. According to MOLSS statistics, state enterprises owe the government RMB 38 billion in pension arrears. Local governments have been using the reserves in pillar 2 to pay pensions to current retirees, leading to notional or empty individual accounts. And where funding has still been inadequate, local tax revenue has been used. The Ministry of Finance data indicates, in 1999, the MOF also transferred RMB17 billion to 25 provinces to cover pension shortfalls in localities. The central government is in effect bailing out local pension pools, many of which are bankrupt. This trend, if unchecked, will become a threat to the fiscal sustainability of the central government.

Implicit Pension Debt and Transition Issues

Implicit pension debt (IPD) refers to the benefit promises a pension scheme makes to workers and pensioners and is measured by adding the present value of benefits that have to be paid to current pensioners plus the present value of pension rights that current workers have already earned and would have to be paid if the system were terminated today. IPD usually is calculated under the termination hypothesis that the unfunded system is to be terminated immediately and that all pensioners and workers must be compensated for their future pensions and accrued rights. IPD, a stock concept, represents the direct and implicit liabilities that a government can predict with certainty and must include in its fiscal plans. Unlike a government's contingent liabilities (such as bailing out state banks), IPD poses no unexpected demand for fiscal expenditure.

Transition cost arises from the financing gap (a flow concept) created when expenditures to pensioners and future retirees must continue even though part of the contributions have been diverted to funded individual accounts. Thus transition cost stems from the need to pay off, over some years, the debt of the old system. This financing gap stems from the IPD but it is not equal to the IPD, since some of the expenditures are for new obligations that accrue each day, and some of the current obligations are covered by ongoing contributions.

The size of IPD depends on many economic and demographic factors such as the age structure of covered workers and pensioners, pension system coverage, level of pension benefits, retirement age, replacement rates, indexation mechanism, and discount rates. World Bank (1997) estimated China's IPD at between 46 percent and 69 percent of 1994 GDP, based on a hypothesis that the system would be terminated in 1994. A recent estimate puts the IPD at 94 percent of the 1998 GDP (Dorfman and Sin 2000).

The Chinese government, reluctant to recognize explicitly the pension debt, has been looking at other options to reduce or finance the transition cost (see box 2). In fact, the government has tried to use a combination of three methods to reduce the IPD and finance the transition. First, China has kept a small PAYGO pillar, with a 13 percent of contribution and a 20 percent replacement rate (State Council document 26). About 4-percentage point of the contribution was designed to finance the transition.[8] Second, older workers were kept under the old system, which will reduce the IPD to some extent. Third, the government did not cut pension benefits, but had hoped that expanding pension coverage would provide some extra funding, as workers in the private sector and township and village enterprises are younger.

It is now evident that these methods have not provided sufficient funding to finance the transition cost. The funding problem is acute: In 1998, 22 provincial pension pools had deficits amounting to RMB4.2 billion, and the other 10 provinces had RMB2.7 billion in surplus (Hang, 1999).[9] By the end of 1998, total reserves in the basic pension system (pillars 1 and 2) amounted to RMB58.7 billion, which was distributed unevenly. Five coastal regions, Guangdong, Jiangsu, Shanghai and Zhejiang accounted for RMB26.7 billion; 21 provinces had only RMB31.1 billion; and five provinces had no reserves (Hang, 1999). In 1999 the situation worsened and the central government had to step in to provide funding for pension payments in 25 provinces. Obviously, extra funding resources must be found to finance the transition cost.

Based on international experience, several options can be considered by Chinese policymakers:
- Reduce IPD by downsizing the existing system and reducing benefits,
- Use asset-debt swaps during corporatization or privatization of SOEs,
- Use general tax revenue or issue debt.

A recent World Bank study further specified options to finance the transition costs which include (i) financing from general revenues or dedicated Social Security taxes; (ii) financing from central and/or

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[8] According to World Bank 1997, 9 percent of payroll tax/contribution is sufficient to finance a small PAYGO pillar with a benefit level of 24 percent of provincial average wage (replacement rate). In State Council document 26, the contribution rate of 13 percent is obviously more than enough for a modest 20 percent benefit. The extra 4 percentage points in payroll tax was designed to finance the transition cost.

[9] However, since there is no national pooling, the central government cannot use the surpluses in several provincial pools. These surplus pools are located in the coastal region.

local government debt issuances; (iii) using proceeds of selling SOE or other assets; and (iv) increasing in salary-linked contribution rates (p.3, Dorfman and Sin 2000).

In this paper, we focus on the option of using various taxes to finance the transition cost. But it is still feasible to use proceeds from corporatization or privatization: Chile used proceeds from privatization to finance its transition cost from pension reform. The Bolivia government use proceeds from the privatization of its six largest state enterprises to establish a flat minimum pension for everyone. Though the benefit is low, it reaches the poorest and most vulnerable group in the countries—the elderly poor who cannot save for retirement.

Policymakers worry that corporatization or privatization will cause asset stripping from the State. State assets, if sold at their market prices, will not decline in value but only change composition, from physical assets to cash or revenue. The state can decide how to use this privatization revenue, whether to reduce its debt or invest in other projects. Hungary, for example, used the proceeds from privatization to repay its foreign debt and the subsequent reduction of interest payments and upgrading of the country's sovereign ratings have benefited the entire population (Kornai 2000). China could still consider using some of the proceeds from corportization to repay its pension debt. This could be accomplished by taxing the IPO proceeds of those publicly listed companies, and using the revenue to set up a national pension adjustment fund, which could be either centrally managed or by private fund managers through competitive bidding (as in Bolivia). This topic, while extremely interesting, is beyond the scope of the present paper. [10]

Box 2. How to finance IPD: International experience

The size of IPD is affected by factors such as the pension system, pension benefit levels, retirement age, replacement rates, indexatior mechanism, and discount rates. It depends on the age distribution of the covered population and on a set of assumptions about economic and population growth, wages growth, vesting rules, and future rules of the pension system. In OECD countries IPD ranges from 100 percent to 200 percent of GDP (Table 1). The IPD estimated for Chile at the time of its reform (1981) was between 40 and 130 percent of GDP, depending on the discount rate used. In Hungary and Uruguay, which have high coverage, high system dependency ratios, and generous benefits, IPD was more than 200 percent of GDP.

Box Table 1 Implicit pension debt[a] and pension reform

Countries that have not reformed[b]	IPD as a percentage of GDP	Reforming countries[c]	IPD as a percentage of GDP	Size of new public pillar[d]
Senegal	27	El Salvador	35	LO
Mali	26	Peru	37	LO
Burkina Faso	15	Colombia	40	LO
Venezuela	30	Mexico	42	LO
Cameroon	44	Bolivia	48	LO

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[10] Readers interested in this topic may consult, among others, Dorfman, Lorch and Zhang 2000 "Linking Pension Reform and State Enterprise Reform in China", Alfonso C. Revollo, 2000 on the Bolivian experience..

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Congo	30	Argentina	86	MED
Brazil	187	Kazakhstan	88	LO
Turkey	72	Chile	100	LO
Albania	67	Australia[e]	115	MED
China-1994	46-69	United Kingdom[e]	184	MED
China-1998	94	Netherlands[e]	188	MED
Ukraine	141	Denmark[e]	189	MED
		Switzerland	189	MED
United States	113	Sweden	210	HI
Japan	162	Hungary	213	HI
Germany	157	Uruguay	214	HI
France	216	Poland	220	HI
Italy	242	Croatia	350	HI
Canada	121			

Note :
a. IPD is the present value of the accrued rights of pensioners and workers, under old system.
b. *Sources*: Kane and Palacios, Finance and Development, June 1996, p. 38.
   Robert Palacios for Albania, Cheikh Kane for Burkina Faso, Congo, Mali;
   Paul Van der Noord and Richard Herd, Pension Liabilities in the Seven Major Economies, OECD 1993 for OECD
   Countries. World Bank 1997 for China-1994; Dorfman and Sin 2000 for China-1998 estimates.
c. Estimates by James based on current public expenditure. Details available upon request.
   Hungary, Peru and Uruguay are taken from Kane and Palacios, Finance and Development, June 1996, p. 38.
d. LO: minimum pension guarantee, financed out of general revenues (except Bolivia).
e. MED: flat (or compressed) public pillar and means-testing, usually financed out of general revenues.
   HI: large earnings-related public pillar, financed out of payroll tax.
f. Old system featured universal benefits financed out of general revenues, not out of earmarked payroll taxes. Hence, the
   IPD owed as repayment of past contributions is less applicable.

There are three principle ways to finance transition: cutting the size of IPD, finding special assets, and using taxation or issuing debt.

Reduce the value of IPD:
- Downsize the old system by reducing benefits, raising retirement age,
- Recognize past service cautiously through a recognition bond to be cashed upon retirement. The face value of the bond can be reduced if workers have confidence in the new system and young workers will be better off even without compensation for their past contributions. Mexico gives workers the right to return to the old system at the time of their retirement, if this would improve their welfare.
- Make only a partial switch to the new defined contribution system. Keep some workers in the old system, thus reducing the financing gap.
- Retain a PAYGO public pillar in the new system.

Find special revenue sources:
- Use social security surplus, if there is a pre-existing reserve in the social security system. The U.S. social security trust fund can be used in this way.
- Use Asset-debt swaps. If public enterprises are being privatized, some of the proceeds can be used to pay off the pension debt. Bolivia, Peru and Poland, have used this strategy. Bolivia used proceeds from the

privatization of its six largest state enterprises to set up a pension fund and provide a flat pension for everyone. The fund is managed by two international fund managers selected through competitive bidding on administrative costs.

- Reduce evasion and increase coverage. This can only provide a temporary financing source, however.

Use general taxation and borrowing
- Cut other public expenditures to build a budget surplus, which can be used to cover the financing gap.
- Issue general treasure debt to cover the remaining cash gap in the short run.
- Pay off explicit pension debt through taxation.

Source: based on James 1999.

CGE framework and its advantages

There has been a great deal of academic interest in analyzing and evaluating pension reform policies quantitatively. M. Feldstein (1974) pioneered the use of mathematical tools for describing aggregate capital accumulation in a social security system. Thomas J. Sargent and his colleagues (1995) used a rational expectation model to examine the impact of pension fund system. Laurence Seidman (1986), Patricio Arrau (1990), Laurence Kotilkoff (1997) and many others have advanced significantly the study of pension systems in recent years. The World Bank has developed a user-friendly computer program to calculate the effects of pension fund collection based on an actuarial model (Pension Reform Options Simulation Toolkit, PROST). While their research has provided important theoretical guidelines in this area, there have been repeated calls for more quantitative studies on social security to assist in the design of reform strategies.

Many quantitative studies in the past have relied on partial equilibrium analysis. For example, prices and wages were assumed as fixed: changes in the pension system would have no effect on the price level of products and input materials, no effect on the wage level of workers, no effect on the labor supply and demand, no effect on the structure of the economy and so on. In addition, these studies did not investigate the substitution effects between products and factors, nor did they consider the subsequent intersectoral reactions.

The Computable General Equilibrium model (CGE), which incorporates the fundamental general equilibrium links among production structure, pattern of demand, and incomes of various groups of households, has been widely used for economic policy analysis. Recent literature indicates a rapidly growing interest in these models. For instance, CGE models have been used to analyze the effects of various trade policies (J. Shoven and Whalley 1992), tax and fiscal policies (J. Piggott 1985), energy policies (T. Kehoe, 1992), and so on. Ayse Imrohoroglu, S. Imrohoroglu, and Duglas Joines (1992) used the CGE model to conduct a life cycle analysis of the U.S. social security system.

Employing the CGE model to analyze the impact of pension reform has the following advantages: First, the CGE model offers theoretical consistency. It can be thought of an incorporating particular specifications of production and demand functions in the well-known Arrow-Debreu general equilibrium framework. An economy wide consistency check can be performed by means of Walras' Law. Second, CGE models impose accounting consistency. A CGE model usually builds on a closed accounting system such as a social accounting matrix, which details all the basic identities for the

modeled economy. Therefore, there can be no sources of supply other than domestic production, inventories, or imports, and no destination of demand other than consumption, investment, inventory accumulation, and exports. Third, CGE models can provide much more concrete welfare analysis than other methods. Since any policy change has welfare consequences, properly measuring changes in welfare is important for policy evaluation. A multisector, multihousehold apparatus is justified because it generates such measures. Since CGE models can provide estimates of welfare effects in such complicated situations, they have been used extensively over the past two decades to evaluate pension reform programs. See concluding remarks on weaknesses.

Actuarial models and CGE models are complementary to each other. Both can be useful in building a bridge between economists and decisionmakers, and in providing them with a basis for dialogue and policy analysis. When policymakers need to look at links between pension reform and macroeconomic variables, CGE models are required. For pension system design issues, actuarial models should be used. Clearly, in order to analyze pension reform in China, significant innovation in the CGE model is needed and this innovation is possible because of the structural flexibility of CGE models.

Structure of the CGE Model for Social Security Reform in China

Building on a long tradition of multisector CGE models used in analyzing trade and public policies (Dahl, Devarajan and Wijnbergen, 1986; de Melo and Tarr 1992; Beghin and others 1994; Garbaccio 1994; Wang and Slagle 1996; Wang 1997; Wang and Zhai 1998), our model is recursive dynamic and has the following features.[11] It differentiates production and employment among three types of ownership, divides labor inputs into 22 age and gender groups, and has a built-in module on population dynamics and labor supply. The model includes ten production sectors, eight representative households, and is specified and solved in levels.[12]

Firms' ownership structure and production

Assume that three types of firms[13] exist in each of the productive sectors: state-owned enterprise, private and individual-owned enterprises[14], and other non-state-owned[15]. Each firm produces only one

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[11] For a survey of the literature on the application of CGE models in public policy, see Pereia and Shoven 1988, for application in developing countries, see Robinson 1992; for application in on trade policies, see Garbaccio and Plummer 1997.

[12] The model is implemented using the General Algebraic Modeling System (GAMS; Brooke, Kendrick, and Meeraus, 1988). Because of space limitation, only a description of the major characteristics of the model is presented. A detailed algebraic specification is available from the authors upon requests.

[13] The Chinese economy is a mixed economy under transition. The state sector still plays an overwhelming role in production and employment, and the non-state sector is expanding rapidly, consisting of village and township enterprises, joint stock companies, foreign joint venture companies, and private enterprises, as well as farm households in agriculture. Since 1997, the non-state sector has accounted for 74.5 percent of China's total industrial output and 72.2 percent employment. However, to avoid serious disruption of the economy, the share of state sector will be reduced gradually. This means that the multi-ownership structure of enterprises will persist for quite some time. Corresponding to this ownership structure, China's old pension system covers only part of state-owned enterprises. Thus, effective analysis of pension system reform and alternative scenarios of financing transition cost in such an economy will require a model that differentiates production and employment by ownership types.

[14] These include private investment companies, urban individual workers, and farm households.

product. Production by each firm uses primary factors and other products (both domestic and imported) as variable inputs in a cost-minimizing way, and is characterized by a multilevel nesting of constant elasticity of substitution (CES) functions. At the first level, firms are assumed to use a composite of primary factors, i.e., value-added and an aggregate intermediate input according to a CES cost function. Technology in all sectors is assumed to exhibit constant returns to scale, implying constant average and long-run marginal costs. At the second level, the division of other intermediate demand is assumed to follow a Leontief specification; therefore, there is no substitution among other intermediate inputs. At the same level, the value-added bundle is divided between land-capital and aggregate labor bundles, which are further split into three age groups - old, middle-age and young labor. Agricultural land and physical capital inputs are at the third level. In the fourth and fifth nests, each aggregate labor age group is further divided into detailed age and gender groups[16]. All composite bundles in each nest are assumed to substitute smoothly in a CES cost function. The degree of substitutability among them depends on their base year share in production costs and on the elasticity of substitution, which is assumed to be constant. Each firm allocates its production output between domestic sales and exports to the world market to maximize profits, subject to imperfect transformation between the two alternatives. Domestic sales and exports produced by different types of firms are assumed to be imperfect substitutes, a CES aggregation function with relatively high substitution elasticity is used to capture this property. In other words, buyers in both domestic and world markets choose a product mix among goods produced by the three types of firms within the same sector to minimize their cost.

Agricultural land as a sector-specific factor is used only in agricultural production, physical capital is ownership-specific, but mobile between sectors, while labor force is not only mobile across sectors, but also free to move among different ownership firms.

Domestic and import demand

Agents are assumed to consider products from domestic supply and imports as imperfect substitutes (the Armington assumption). The eight representative households (low, middle-low, middle, middle-high, and high income households in urban areas and low, middle, and high income households in rural areas) are assumed to maximize a Stone-Geary utility function over the 10 composite (Armington) goods, subject to their budget constraints, which leads to an extended linear expenditure system of household demand functions. Household savings are treated as a demand for future consumption goods with zero subsistence quantity (Howe 1975). A household-specific, aggregate consumer price index is specified as the price of savings. It represents the opportunity cost of giving up current consumption in exchange for future consumption (Wang and Kinsey 1994). Other final demands, including public spending and investment demand, are based on constant share functions that fix their structure in real terms. The intermediate inputs for the firms, household consumption, and other final demands constitute the total demand for the same Armington composite of domestic products and imported goods from the rest of the world. A CES aggregation function is specified for each composite commodity. The total demand is divided between domestically produced

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[15] These include urban collective firms, rural collective enterprises, joint stock companies, and foreign joint venture companies.

[16] Workers aged 15 to 34 are classified as young labor, workers age 35 to 49 are classified as middle-age labor, and workers age 50 and over are classified as old labor.

and imported goods according to cost minimization. However, changes in stock are assumed as a demand for domestic products only.

Income distribution and government policy instruments

Production generates income, which is distributed to four major institutions, namely, enterprises (corporations), households, the government, and extra-budget public sectors. Corporate earnings equal a share of gross operating surplus, i.e., sum of capital remuneration across all sectors, minus corporate income taxes. A part of net company income is allocated to households as distributed profits based on fixed shares, which are the assumed shares of capital ownership by households. Another part of net company income is allocated to extra-budget public sectors as fee. Retained earnings, i.e., corporate savings for new investment and capital depreciation replacement, equals after-tax company income minus the distributed profits and fee.

Household income consists of labor earnings and the returns from land and capital the household owns. Additionally, households receive pension benefits, transfers and subsidies from the government, and remittances from the rest of the world. Household disposable income equals the sum of household income from different sources less various taxes.

The government derives revenues from direct corporate and household income taxes, import tariffs, and various types of indirect taxes. Subsidies and export tax rebates enter as negative receipts. There are three types of indirect taxes in the model. The value-added tax, which is the most important part of indirect tax in China after 1994 tax reform, is treated as a tax levied on production factors; its revenues equal total sector value-added multiplied by a tax rate. The value-added tax is also levied on imports while firms obtain rebates when they export. The second indirect tax, a sales tax, includes household consumption taxes and other final demand taxes. The tax rate constitutes the difference between the aggregate Armington prices and prices of various final demands. The other indirect tax, including various agricultural taxes, and business taxes on construction and services, is treated as a production tax levied on sectoral outputs.

All tax rates are taken as parameters in the model. However, they can be endogenized to meet government fiscal targets, in which case those adjustment parameters associated with each type of taxes become endogenous. They shift in or out to achieve government budget balance. Otherwise, the tax schedules are exogenous and the adjustment factors remain at their initial value of one. An adjustment factor on government transfers, similar to the adjustment factors on other taxes, provides another fiscal instrument to achieve a specified budget target.

Extra-budget public sectors collect fees from enterprise and households. Their income is allocated to consumption and saving. The spending by extra-budget public sectors and government constitutes public consumption, one type of the final demands.

Intra-period equilibrium and macroeconomic closure

Equilibrium is defined as a set of prices and quantities for goods and factors such that (a) demand equals supply for all goods and factors; (b) each industry earns zero profit; and (c) gross investment equals aggregate savings, which is the sum of domestic savings plus foreign capital inflows.

Macro closure in a CGE model involves both macroeconomic accounting balances and assumptions about adjustment behavior when imbalance induced by external shock.

There are three major macroeconomic balances in the model: (a) the government budget, (b) aggregate savings and investment, and (c) the balance of payments. In the benchmark equilibrium all these three accounting balances hold. The behavioral aspect of macro closure involves choosing a mechanism by which macroeconomic balances are brought back into equilibrium when exogenous shocks disrupt the benchmark during an experiment. Thus, a macroeconomic scenario is imposed on the CGE model, and then the sectoral implications of the assumed macroeconomic behavior can be traced out (Devarajan, Lewis, and Robinson 1990). Because such an adjustment is not based on intertemporal optimizing behavior by rational agents, different assumptions about the adjustment process may lead to different results.

Two government closure rules are implemented. Under the first rule, government savings is fixed at its baseline value and one of the taxes, or government transfers to households, is allowed to adjust to achieve the government fiscal target. Under the second closure rule, all tax levels and transfers are fixed, while real government savings is endogenous. This latter rule has significant impact on the level of investment because investment is driven by savings in the model. The total value of investment equals total resources allocated to the investment sector; it includes retained corporate earnings, total household savings, government savings, extra-budget savings, savings from pension funds and foreign capital inflows.

Given China's small trade share in the world, a small-country assumption is used for imports, i.e. we assume that the local consumption of imports does not affect the border price of imports. Exports are demanded by the rest of the world according to constant-elasticity demand curves, the price elasticity of which are high but less than infinite (Pomfret 1997). An exchange rate is specified to convert world prices into domestic prices. Either this exchange rate or the balance of payment can be fixed while the other is allowed to adjust, providing alternative closure rules.

Since the purpose of this paper is to estimate the implicit pension debt, and government options in financing the transition cost, we keep the domestic savings and investment gap constant in all the simulations conducted. This is achieved by keeping the balance of payments and real government spending; except pension expenditure, fixed as share of GDP. In such a way, macroeconomic rigidity is imposed on the model. If government pension expenditure changes from the baseline because of an increase in government pension payment, an increase in government tax earnings must be implemented or a government deficit will occur. By a macroeconomic identity, this closure implies that a constant sum of domestic savings and taxes in real terms is needed to finance both real investment and real government expenditures. Thus, any changes in real gross domestic product (GDP) are induced by changes in real absorption, i.e., household consumption plus other final demand, thus making it easy to compare the efficiency impacts of different simulations.

Inter-period linkage and recursive dynamics

The intra-period equilibrium is solved recursively from 1995 to 2050. Between each two periods, dynamic growth in the model originates from three sources: rate and demographic structure of labor force growth, accumulation of physical capital stocks, and improvement of total factor productivity.

A built-in population and labor supply projection submodel generates the labor force growth rate and its demographic structure. It also takes participation rates by age and gender into consideration. A detailed description of this submodel will be given in next section.

Capital stock in each simulation period equals last period's capital stock plus gross investment minus depreciation. No optimal behavior is assumed for investment and capital accumulation. All net investments in the previous period are assumed to become new production capital in the next period.

Accumulation patterns for capital stock depend upon the depreciation rate and gross investment rate, which is set exogenously as a percentage of GDP. However, household and corporate savings, government surplus (deficit), and foreign capital inflow (foreign savings) are assumed to be perfect substitutes and collectively constitute the sources of gross investment.

Household saving decisions are endogenous in the model. It represents future consumption goods for the household with zero subsistence quantity (by assuming intertemporal separable preferences, ELES demand system). Government saving (deficit) is fixed and growth is at the same rate as real GDP.

In calibrating the baseline scenario, two economy wide, ownership-specific (one for SOEs, and one for IPEs and NSEs) Hicks-neutral efficiency factors are determined endogenously to obtain a pre-specified growth path of real GDP and total employment in SOEs. When alternative scenarios are simulated, the two TFP growth rates are set exogenously, while the growth rate of real GDP and the total employment in SOEs are solved endogenously.

Population projection and labor force dynamics

The sustainability of a pension system is closely related to the demographic structure of the labor force, which depends largely on the dynamics of population growth. Correctly modeling the structure and trend of population and labor force growth is a necessary condition for any successful pension reform design and analysis. Therefore, a population dynamics and labor supply submodel is an indispensable component of the CGE model for China's pension reform.

Our population projection model is based on the deterministic difference equation model developed by Leslie (1945), which has been used widely in mathematical demography and population dynamics studies. In such a model, China's population is taken as a whole, all factors that influence population growth, such as fertility and motility rate, are defined in terms of statistical means. We assume that changes of time, birth, and death are the three major determinants of population growth. The influence of other social and economic factors is implicitly included in those three determinants. Economic growth is assumed to affect fertility rate and motility rate through exogenously specified total fertility rate and life expectancy changes. We do not consider migration as a determinant because the number of immigrants is very small compared with China's huge population.

Newborn population equals the number of women at their fertility age (age 15 to 49) multiplied by the corresponding fertility rate. The population in each age group equals previous year's population at the next younger age group multiplied by the corresponding motility rate. There will no people live longer than 100 years. Fertility and motility rates, proportion of each gender in the newborn population, and base year population demographic distribution can be obtained from population survey data.

Labor supply at each age (15-70) for a given year equals the population in that age group for that year multiplied by a labor participation rate, which is gender and age specific. These specified labor forces are then aggregated into the 22 groups of labor inputs specified earlier in the cost and labor demand functions. We assume that workers start to retire at age 40. The total new retirees in a given year is the sum of all surviving workers age 40 and over multiplied by a retirement rate that is gender and age-specific. The total retiree in a year is the sum of the surviving retirees from all previous

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years plus new retirees'. Retirees are differentiated by ownership type. This enables the pension system in the model to reflect the fact that pension coverage for workers differs among ownership types of firms in China.

Pension system and transitional cost

Pension system in the model consists of three different pension schemes that represent the actual pension institution in current China. The three pension schemes are provided only to SOEs and urban NSEs[17]. IPEs and rural NSEs are not covered by any pension system. The first two pension schemes are pillar 1 and pillar 2 of the social pooling PAYGO system, respectively. Pillar 1 is called the basic social pooling fund, which receives contributions from enterprises and provides a replacement rate of 20 percent of final wages. The contribution rate for pillar 1 is 13 percent of a worker's wage. Pillar 2 is a mandatory individual account funded through a combination of employee and employer contributions. 11 percent of a worker's wage goes toward the individual account. Given that the fund in individual accounts is managed publicly together with the pillar 1 fund, and most individual accounts are empty, the individual accounts of pillar 2 are notional. Furthermore, because this system has been implemented gradually and very recently, and most retirees in the near future will not have accumulation in their individual accounts, retirees' pension benefits under pillar 2 are not defined based on their contributions to the individual accounts. Thus, pillar 2 is also specified as a defined benefits PAYGO system with an assumed replacement rate of 40 percent[18]. Pension contribution in these two pillars is implemented through payroll tax. Payroll tax for employees is considered a wage tax, and is levied on employees' labor income, while payroll tax for employers is levied on the capital income of enterprises.

The third pension scheme is provided to retirees not covered by the social pooling pension system. It is assumed to be an enterprise-based PAYGO system. Pension benefits in this scheme are fixed at a base-year level, which is sector- and ownership-specific. The contribution to this scheme is endogenously equal to pension expenditure and is levied on the capital income of the enterprise. All pension benefits in the three pension schemes are indexed by an economy- wide consumer price index.

Pension fund savings or deficits in pillar 1 and pillar 2 is the difference between pension revenue and pension expenditure in each of the two pillars. Pension fund saving or deficit, government saving or deficits, and the savings or deficits of extra-budget public sectors make up the aggregate public saving or deficit. A variable for government transfers to pension funds is entered into the saving-deficit equation of pillar 2, which is fixed at zero. But it can be endogenous when the saving or deficit of pillar 2 is set exogenous. In such cases, government transfers to pension funds are adjustable to achieve the balance of pension funds in notional individual accounts.

The model traces the accumulation of pension fund savings and deficits, which constitutes pension fund reserves and debts. The interest income and payments of a pension fund reserve and debts are assumed to be the revenue of pillar 1. An initial interest rate of 5 percent is assumed for the base year. The change in the interest rate is determined by the change of the average return of capital.

This study uses two measures related to transition: implicit pension debt (IPD) and transition cost. IPD, a stock concept, is the present value of total implicit pension obligations to current pensioners and current contributors if the current PAYGO system have to be stopped. Different from

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[17] We assume a constant share of the urban NSE workers in total NSE workers.

[18] The final benefit received in individual accounts would depend on the length of work and amount of contribution to this system and on how the money is invested. Officials in China estimated that on average the accounts would provide a replacement rate of at least 38.5 percent of final wages.

other studies, transition cost in this paper focuses on the transition of pillar 2 from notional to fully funded individual accounts. We assume that starting in 2001, current notional individual accounts will be kept only for prereform pensioners and workers who have contributed to the notional individual accounts (middle men), and that it will be phased out as the prereform pensioners and middle men die. Fiscal resources will be injected to finance deficits in the transition accounts. Using this model the financial flows over the next 50 years could be traced and estimates can be made of the financial resources needed over time to pay the current pension and accrued pension rights of current workers.

The equilibrium data set of the model at base year is constructed around a Chinese social accounting matrix for social security reform estimated for 1995. It provides a consistent framework for organizing the relevant flow-of-value statistics for China's economy to satisfy the requirements of a benchmark data set for CGE modeling, as outlined in Whalley (1985). Data on production and exports are divided among three types of ownership. The sources and structure of the base year data set are described in annex 2. The key parameters used in the model, and their averages, are listed in annex 3.

Baseline Calibration and Simulation Design

Major assumptions in baseline calibration

To calibrate a baseline of the model, we introduce two economy-wide, ownership-specific (one for SOEs, and one for IPEs and NSEs) TFP variables into the model. These are solved endogenously in calibration to match a pre specified path of real GDP growth and the decline of employment in the state sector. The growth rate of real GDP is set to the actual growth rate during 1996-99. The growth rate then declines linearly from 7.5 percent in 2000 to 3 percent in 2050. There were 113 million workers in the state sector in 1995. This figure had decreased to about 95 million by 1999. It is assumed to decrease further by 5 million annually from 2000 to 2020, and to remain stable afterward.

Since life expectancy will increase with rising living standards as the economy grows, a gradually declining motility rates are calculated each year in the baseline according to exogenously specified life expectancy estimates from recent World Bank population projections (World Bank 1994). The total fertility rate for women of childbearing years is assumed to increase slightly between 2000 to 2050 because of China's relaxation of its 'one child' policy in the coming years.

As mentioned, the individual accounts in China's current pension system are largely notional, and thus essentially a PAYGO system. The government is responsible for both the pension expenditure in notional individual accounts and the contributions in the social pooling PAYGO system of pillar 1. Thus, we combine pillar 1 and pillar 2 in our baseline calibration and assume 60 percent replacement and 24 percent contribution rates. Detailed assumptions on macroeconomic closure, demographic parameters, and pension system characteristics used to calibrate the baseline are summarized in table 2. (The major results from the baseline calibration are presented in table 6.)

Table 2 Assumptions in baseline calibration

Category	Assumptions

Macroeconomic variables	- Real GDP is exogenous in the baseline
	- Labor force in state sector decreases to 51.7 million in 2020, is stable afterward
	- Ownership-specific TFP growth rate is endogenous
	   - Trade balance gradually declines to 0 in 2010
	   - Gross investment rate declines from 39.7 percent of GDP in 1995 to 32 percent of GDP in 2050
	- Ownership distribution of investment changes from state sector 54 percent, individual and private 13 percent and other non-state sector 33 percent in 1995 to state sector 20 percent, individual and private 20 percent and other non state sector 60 percent in 2050.

Demographic parameters	- Life expectancy and total fertility rate increase from 70.3 year and 1.9 percent, respectively, in 1996 to 76.9 years and 2.1 percent in 2050, based on World Bank projections. - Labor participation rates for people older than 45 increase 3 percentage points for males and 5 percentage points for females between 1995 and 2050.
Pension system Characters	- Pension system coverage in state-owned sector gradually increases to 1 between 1995 and 2000; coverage in other sectors is fixed at the base year level - Replacement rate declines to 60 percent (pillar 1 at 20 percent plus pillar 2 at 40 percent) in 2000, then remains constant - Contribution rate increases to official rate (24 percent) in 2000, then remains constant - Ratio of worker contribution to employer contribution gradually increases to official ratio in 2005, then remains constant - Compliance rate is 85 percent - Pension expenditure is financed by payroll tax and government saving/deficit
Government fiscal closure	- Government consumption, transfers and saving (excluding saving/deficits for pension) are exogenous - Corporate tax rate is endogenous to achieve government budget balance - All other tax rates are fixed at base year level.

Simulation scenario design

Three sets of policy simulations and eighteen experiments are conducted.

Simulation set 1: Limited changes in current pension system. Since results in the baseline show that the current pension system in China is not sustainable, the question arises: can we solve the problem simply by raising the retirement age (which would reduce the system dependency ratio) and expanding program coverage (which would increase the pool size of contribution funds) to all SOEs and urban nonstate sectors without any fundamental reform of the current system? The first set of policy simulation combines of one scenario of expending program coverage with three scenarios of increasing retirement age (Table3).

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Table 3 Policy simulations set 1: Limited changes in current pension system

Policy Areas	Retirement age		
PAYGO coverage	No change in retirement age	Increase retirement age for female workers by 5 years (1 year each year) between 2010 and 2015	Increase retirement age for female workers by five years (1 year each year between 2010 and 2015, then increase retirement age by five years (1 year each year) for all workers between 2020 and 2025
Urban nonstate and non-individual sector gradually increase to 100 percent between 1995 and 2005	Scenario 1.1	Scenario 1.2	Scenario 1.3
Major assumption change from baseline	TFP growth is exogenous at baseline rates, real GDP is endogenous; the corporate tax rate is exogenous at baseline rates; government saving is endogenous, all other assumption stay the same		

If results from the above simulations show that extending program pooling size and increasing retirement age will not make the current system financially sustainable, will a fully funded individual account help solve the pension fund crisis in China? Two closely related questions arise when considering this option, first, what is the cost of phasing out the notional accounts and what is the best way of financing the transition cost from the perspective of the Chinese government? Second, is the proposed new system financially superior to the current system? Simulation sets 2 and 3 are designed to provide insights into these two questions, respectively.

Simulation set 2: reform current pension system and finance the transition cost

Simulation set 2 assumes that the current PAYGO system will be phased out after 2001. It will be replaced by a new system with a smaller public pooling PAYGO account plus a fully funded individual account. Workers and retirees who participated in the PAYGO system before 2001 will be covered under the remained transitioning PAYGO system, while other workers and new employees will not pay the payroll tax to the old system and will not be paid out of the remaining transitional PAYGO system upon retirement. They will participate in a fully funded new system, such as the social security plus 401K program in the United States. A full evaluation of such a system is beyond the scope of our current study. The transitional PAYGO system will be financed by the payroll tax on the covered workers and by other taxes. The coverage of the current pension system and the retirement age will remain constant in this set of simulations. In other words, after establishing a new fully funded individual retirement account to replace the current notional individual account, and injecting fiscal resources from taxation and other financial means into the old pension system to finance the current deficit and transition cost, the pension debt crisis in China may be solved gradually during a transition period. This set of simulations also estimates what level of financing would be needed for the transition and considers which types of taxes or other financial means should be used to collect the necessary funds. Details of the assumptions used in simulations in set 2 are summarized in table 4.

Table 4. Policy simulation set 2: phasing out the notional individual account

Scenario	Assumption
	The current notional individual account will be phased out after 2001. All workers and retirees that participated in PAYGO system (pillar 1 plus pillar 2) in 2000 will be covered by pillar 1 and the remained transitional pillar 2, while new workers will be covered by pillar 1 and participate in a fully funded individual account. The remained transitional pillar 2 will be financed by payroll tax from the covered workers and other taxes.
Scenario 2.1	The pension deficit after 2001 will be financed by corporate tax.
Scenario 2.2	The pension deficit after 2001 will be financed by value-added tax.
Scenario 2.3	The pension deficit after 2001 will be financed by personal income tax.
Scenario 2.4	The pension deficit after 2001 will be financed by final demand tax.
Scenario 2.5	The pension deficit after 2001 will be financed by combination of different types of taxes. The share of burden: value-added tax 1/3, corporate tax 1/3, and personal consumption tax 1/3
Scenario 2.6	The pension deficit after 2001 will be financed by a combination of different types of taxes. The share of burden: value-added tax 1/4, corporate tax 1/4, personal consumption tax ¼, and final demand tax 1/4
Major assumption change from baseline	TFP growth is exogenous at baseline rates, and real GDP is endogenous; the corporate tax rate is exogenous at baseline rates and government saving is endogenous before 2001; government saving/deficit is fixed and government tax adjusts after 2001; all other assumptions stay the same

Simulation set 3: Examine the financial sustainability of the social pooling PAYGO system after proposed reform

This set of simulations assumes that pillar 2 – individual accounts – is fully funded and the government no longer has financial responsibility for it. The government will be responsible only for pillar 1 – the social pooling PAYGO system. Therefore, this set of simulations will not take into account the payroll tax, pen ion funds, and pension benefits for the fully funded second pillar, which is simply aggregated into the total private savings. The payroll tax for the first pillar will be paid by enterprises only. The replacement rate is 20 percent, according to State Council Document 26 (1997). Similarly to simulation set 1, a combination of two scenarios of expanding program coverage with three scenarios of increasing retirement age will be conducted. However, they will be conducted on a new base - scenario 2.5 (see table 4). In other words, we want to use this set of simulations to investigate whether the public pension system in China could become financially sustainable after injecting fiscal resources to finance the transition cost and to fully fund the individual account.

In addition, the government is considering a new social security Tax covering not only old age pensions but also other benefits. To provide a scientific basis for policymaking, we provide a set of simulations on the social security tax (considering the old age pension part only). Without knowing the details of the design, we assume, in scenarios 5.1 to 5.3, that the social security tax will be levied on all enterprises and workers in the formal sector, including all SOEs, rural and urban collective enterprises, and urban individual and private enterprises. The tax rate is 12 percent shared by enterprises and workers, rather than levied on enterprises alone; the tax burden is as 8 percent and 4 percent for employee and workers between 2000 and 2010, and 6 percent and 6 percent, respectively, afterward. The detailed simulation design is summarized in table 5.

Table 5. Summary of Policy Simulation Set 3 - The Sustainability of pillar 1 after proposed reform

Policy Area	Retirement age		
PAYGO coverage	No change in retirement age	Increase retirement age for female workers by 5 years (1 year each year) between 2010 and 2015	Increase retirement age for female workers by five years (1 year each year between 2010 and 2015, then increase retirement age by five years (1 year each year) for all workers between 2020 and 2025
Coverage of pillar 1 in urban non-state and non-individual sector gradually increase to 100 percent from 2000-2005	Scenario 3.1	Scenario 3.2	Scenario 3.3
Coverage of pillar 1 in rural collective enterprises gradually increases to 50 percent from 2005 to 2010	Scenario 4.1	Scenario 4.2	Scenario 4.3
Levy a social security tax, implemented gradually between 2001 and 2010, covering 100 percent of the state sector; and gradually increase the coverage of all collective (rural and urban) and private (urban) enterprises to 100 percent in 2010.	Scenario 5.1	Scenario 5.2	Scenario 5.3
Major assumption change from scenario 2.5	In scenarios 4.1-4.3 and 5.1-5.3, the rate of returns on pension investment is assumed to be zero to reflect the fact that China does not liberalize pension fund investment policy. All other assumptions stay the same.		

Note: All the simulations for set 3 are based on scenario 2.5, in which it is assumed that notional individual accounts will be phased out after 2001, and the transition cost is financed by value-added tax (1/3), corporate tax (1/3), and final demand tax (1/3).

Simulation results

Starting with assumptions consistent with State Council document 26, using a dynamic recursive CGE model we estimate the annual balance of the pension fund under the current system for the next 50 years. We then discuss the impacts of various reforms of the pension system on the macroeconomic variables.

Financial deficit of current pension system

Results from the baseline calibration are presented in table 6. There provide a general picture of China's economic and demographic trends over the next 50 years. Under the assumptions specified in table 2, this calibrated benchmark will serve as a basis of comparison for counterfactual simulation analysis presented later in this report. All the endogenously solved macroeconomic and demographic variables seem to fall into reasonable range. TFP - as a residual and as an adjusting mechanism in the model to match the prespecified real GDP growth rate and the gross investment rate, given the labor

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supply projected by the model - decline gradually from 2 percent a year in 2010 to 1.2 percent in 2050, which seems consistent with recent estimations of TFP growth in China.

The results from baseline calibration also show that with the population growing at a decreasing rate, the Chinese labor force stops growing between 2015 and 2020 and declines afterward; however, the age group 65 and over continues to grow. Thus, the old age dependency ratio will rise steadily from 11 percent to reach 25 percent in 2030 and 36 percent in 2050 (Figure 2). The system dependency ratio will remain as high as 30 percent today, meaning that three workers support one retiree, and will rise rapidly to 68 percent in 2030 and 79 percent in 2050. At the beginning, the PAYGO system has a tiny surplus of RMB 0.6 billion in 2000. The gap between pension fund revenue and expenditures will widen significantly. The accumulated reserve will become negative during the next few years and decreases RMB 1027 billion by 2050 (table 6). Obviously, this annual deficit will have to be financed by taxation or issuing debt, which threatens to fiscal stability and makes China's future economic development uncertain.

Table 6. Baseline calibration

	1995	1996-2000	2001-05	2006-10	2011-15	2016-20	2021-25	2026-30	2031-35	2036-40	2041-45	2046-50
Exogenous specified variables												
GDP		8.16	7.23	6.78	6.33	5.88	5.43	4.98	4.53	4.08	3.63	3.18
Life expectancy[a]		70.30	70.57	71.72	72.49	73.28	74.11	74.97	75.87	76.86	76.86	76.86
Total fertility Rate[a]		1.900	1.900	1.948	1.994	2.04	2.084	2.127	2.145	2.135	2.135	2.135
Replacement rate (percent)	65.8	60	60	60	60	60	60	60	60	60	60	60
Calibrated results – Macroeconomic trends Growth rate (percent)												
Total absorption		8.97	7.61	7.01	6.47	5.97	5.48	5.01	4.55	4.09	3.64	3.19
Investment		10.37	8.27	7.40	6.62	5.92	5.27	4.69	4.15	3.65	3.16	2.69
Private consumption		8.13	7.16	6.69	6.31	5.98	5.62	5.24	4.84	4.41	3.97	3.52
Government revenue		8.46	7.21	6.35	5.82	5.44	5.10	4.72	4.33	3.92	3.51	3.07
Government saving		- 7.62	0.51	2.45	8.83	7.82	6.34	5.51	4.76	3.61	2.79	2.18
Labor force		1.14	1.29	0.75	0.22	-0.02	-0.14	0.01	-0.14	-0.39	-0.36	-0.10
Capital stock		10.10	9.58	8.67	7.84	7.09	6.40	5.77	5.19	4.65	4.15	3.68
TFP		2.21	1.50	1.78	2.01	2.07	2.05	1.87	1.80	1.75	1.56	1.24
	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Ratio to GDP (percent)												
Investment	39.7	39.7	38.9	38.2	37.4	36.6	35.9	35.1	34.3	33.5	32.8	32.0
Private consumption	47.1	48.2	49.3	50.4	51.5	52.5	53.4	54.3	55.1	55.9	56.6	57.4
Government revenue	9.8	10.0	9.9	9.7	9.5	9.3	9.2	9.1	9.0	8.9	8.9	8.8
Government saving	1.5	1.4	1.0	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.0
Population and labor force												
Population (Million)	1211.2	1267.7	1310.1	1360.1	1407.5	1436.9	1459.2	1478.2	1498.7	1514.8	1516.5	1507.8
15-64 year old	806.9	858.5	929.6	955.3	975.8	970.3	981.2	974.4	942.6	925.7	924.7	915.8
65 and older	81.1	97.0	109.1	120.9	142.0	177.3	202.4	241.3	286.4	313.3	318.3	329.6
Old dependency ratio (%)	10.0	11.3	11.7	12.7	14.6	18.3	20.6	24.8	30.4	33.8	34.4	36.0
Share of old age people (65+) (%)	6.7	7.7	8.3	8.9	10.1	12.3	13.9	16.3	19.1	20.7	21.0	21.9
Labor force (Million)	633.9	671.0	715.4	742.8	751.1	750.4	745.2	745.5	740.3	725.9	712.9	709.3
Agriculture	330.2	328.2	317.6	290.9	258.7	225.4	194.4	166.0	147.1	129.1	112.7	98.4
State sector	113.7	103.8	90.8	77.7	64.7	51.7	51.7	51.7	51.7	51.7	51.7	51.7

	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Pension (RMB 10 billion, in 1995 yuan)												
Revenue	8.5	17.9	19.6	20.5	21.1	21.1	24.8	29.1	34.4	40.8	47.4	53.7
Expenditure	8.5	17.3	22.1	27.3	32.6	38.1	44.8	52.3	61.4	74.7	90.9	109.0
Annual balance	0.0	0.6	-2.5	-6.8	-11.5	-17.0	-20.0	-23.2	-27.1	-34.0	-43.5	-55.3
Accumulated reserve	0.0	3.3	0.6	-20.6	-63.7	-131.8	-222.0	-328.4	-451.2	-598.7	-787.1	-1027.3
Balanced contribution rate (%)	25.0	23.3	27.2	31.2	34.5	37.7	35.8	34.3	33.3	33.4	34.2	35.1
(with 85 percent compliance rate)												
System dependency ratio (%)	25.6	28.3	35.6	43.7	52.9	64.0	67.3	68.7	70.5	74.2	77.4	79.2
IPD (RMB 10 billion in 1995 yuan)	293.7	632.8	758.4	870.5	990.3	1111.8	1397.9	1731.4	2136.1	2616.6	3159.7	3713.9
IPD as share of GDP (%)	48.8	71.1	60.1	49.7	41.6	35.1	33.9	32.9	32.5	32.6	33.0	33.1

Source: Authors.
[a]. The source for these two variables is 1994-95 World Bank 1994b.

It is thus necessary to increase payroll tax rates to maintain the financial viability of the pension system. However, the balanced contribution rate would have to increase from 23.3 percent in 2000 to 37.7 percent in 2020. After this peak the contribution rate will decline but still remain as high as around 35 percent. There is no doubt that the high contribution rates for the pension system will seriously depress investment and reduce the economic growth rate. The results of the baseline calibration confirm that the current PAYGO system is not financially sustainable.

Based on a termination hypothesis and baseline assumptions, implicit pension debt (IPD) would be as high as 71 percent of annual GDP if the current system were terminated in 2000. That is, if pension coverage and benefit do not change over time, the stock of IPD will increase rapidly. However, because the wage growth rate is lower than the assumed GDP growth rate, IPD as a percent age of GDP declines even though its absolute value continues to increase and reaches a very high level (RMB 37,139 billion in 2050).

Policy changes under current pension system

If the current pension system in China is not sustainable, the question arises: Could we solve the problem by raising the retirement age (which would reduce the system dependency ratio) and expanding program coverage (which would increase the pooling size of contribution funds) to all SOEs and urban nonstate sectors – and without any fundamental reform of the current pension system?

Expanding pension system coverage. In experiment 1.1, the PAYGO coverage in all state-owned enterprises, the urban nonstate sectors and the non-individual sector gradually increase to 100 percent between 1995 and 2005. The pension fund annual balances in the baseline and in experiments 1.1-1.3 are shown in Figure 3. Because the base of the pension system is enlarged, the pension fund will show a surplus in its annual balance during the first few years. The financial situation of the pension system will improve compared with the baseline between 2000 and 2035. However, expanding program coverage worsens the financial situation in the long run, because of a rapidly aging. The annual balance of the pension declines and shows a deficit of as much as RMB766.2 billion by 2050 (exp 1.1). If the pension system is not reformed, it will become a huge direct financial liability for the government, affecting its fiscal sustainability.

Raising retirement age. The retirement age can be raised in a single move or gradually, in steps. In all the experiments we assume that the retirement age is raised one year every year for five years. First, the retirement age of female workers is raised by five years between 2010 and2015. In experiment 1.3, the retirement age of both male and female worker is increased by another five years, one year at a time, between 2020 and 2025. We find that raising the retirement age decreases system dependency ratio and is useful reducing the pension fund annual balance deficit (see Figure 3). For example, the deficit is reduced from RMB 38.4 billion to RMB 14.0 billion in 2015. But the shortage of funds in the pension system is still a serious problem, with the showing a pension fund deficit as high as RMB 536 billion in 2050. If the retirement age of all workers is increased to 65 in 2020 (Experiment 1.3), the pension system maintains a surplus.

. The feasibility of raising the retirement age is questionable, however, first, it took the U.S. social security system 12 years to increase the retirement age by just 2 years. Second, we have not considered whether additional labor supply can be absorbed into the economy. In our CGE model, each age group is assumed to have the same marginal productivity and all workers are assumed to be fully employed. It follows then that GDP would increase when the labor input is increased by raising the retirement age. In reality, if the retirement age increases significantly, the marginal productivity of some labor may decrease; moreover, a society that has significant surplus of labor may not provide enough jobs for old-age workers. Thus, it might not be realistic to reduce the pension system deficit by raising the retirement age dramatically.

Economywide impacts are shown in Figure 4. An increase in the retirement age of female worker from 55 to 60 between 2010 and 2015 increases the total number in the labor force, and may boost the GDP by 1 percent compared with the baseline in 2020. However, the push force on GDP will disappear later on due to changes in the demographic structure change of the society. The GDP remains at the same level as the baseline after 2030 (see Figure 4). The retirement age of all workers is increased significantly in experiment 1.3 and, by assumption, increases the GDP growth rate. The GDP may increase by 5 percent compared with the baseline in 2050. The effects on government revenue and private consumption are almost the same as on GDP.

The GINI coefficient increases continually if the retirement age of female worker remains at its current level (55 years), perhaps because of intergenerational transfers. When the retirement age of female workers increased to 60 between 2010 and 2015, the GINI coefficient is reduced, helping to relieve social inequality. If the retirement age of all workers is increased further, to 65 year between 2020 and 2025, social inequality is improved during the period 2020-2028, and maintains the same level as in the baseline thereafter.

From the above simulation, it is clear that the current PAYGO system is not financially sustainable even when the retirement age is increased and/or coverage is expanded to the urban nonstate sector. A more fundamental reform of the current pension system is necessary.

Reform current pension system and finance transition cost

The results of the above simulation show that expanding pension coverage and increasing the retirement age are not sufficient to make the current pension system financially sustainable. We then simulate the impact of a major reform in which the current notional individual account is phased out beginning in 2001. The new system consists of a smaller public pooling PAYGO pillar plus a fully

funded individual account.[19] Workers and retirees who participated in the current PAYGO system before 2001 are covered by a transitional account (notional account); new workers and new participants in the system are not get paid from the transitional account. The public pension system thus will be narrowed to one pillar for all workers (with a replacement rate of 20 percent). But prereform pensioners and active workers who contributed to the current system before be covered by both pillar 1 and the transitional account (with a total replacement rate of 60 percent). [20]

This option raises two closely related questions: First, what is the cost of phasing out the notional account and what is the best way to finance the transition cost from the perspective of the Chinese government? Second, is the proposed new system financially superior to the current system? We simulate a transition in which the pension deficit and the transition cost after 2001 are financed by various taxies. The pension deficit is financed by corporate tax in experiment 2.1, by value added tax in experiment 2.2, by personal income tax in experiment 2.3, and by final demand tax in Experiment 2.4.

To answer the first question, we estimate the transition cost of using the notional individual account as a transition mechanism and phasing them out gradually (table 7). The transition cost is found to be reasonable, ranging from 0.5 to 0.6 percent of GDP during 2000-35 to 0.3 percent of GDP in 2050. (See also Figure 5)

Table 7. Transition cost of using notional individual accounts as a transition mechanism and phasing them out gradually

Transition Cost	2005	2010	2015	2020	2025
Pension deficit	6.6167	10.6785	14.8966	19.5064	24.4834
Ratio to GDP (percent)	0.5237	0.6079	0.6231	0.6125	0.5897
	2030	2035	2040	2045	2050
Pension deficit[a]	29.9163	34.8267	38.2329	37.6058	33.1387
Ratio to GDP (%)	0.5648	0.5267	0.4732	0.3890	0.2927

a. Pension deficit of transitional pillar 2 which is to be financed by taxes (10 Bn yuan)

Source: The authors.

To explore the option of increasing taxation to cover the cost of phasing out the notional individual account, experiment 2.1-2.6 look at the required tax rate hikes (table 8). The results show that the additional taxes needed to finance the pension transition are reasonable, while it is impossible to avoid a tax rate increase, the required increase is quite small, indicating it is feasible to finance the transition cost using some type of general taxation. The question, then, which tax should the government choose?

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[19] Ideally, the new fully funded accounts for new workers should be managed by private commercial entities such as private pension funds, insurance companies and commercial banks. But that is beyond the scope of this paper. See Wang 1997.
[20] It is beyond the scope of this research to discuss whether and how the government should recognize its implicit pension debt, transform it into explicit debt, and implement the transition. Our aim is to point out the general direction policy reforms should take, and show the impact of proposed policy options.

Impacts of various taxes. The use of different taxes to finance the pension system deficit will have different impacts on the economy. The impact on *GDP growth* will differ depending on which tax is used (Figure 6). In general, use of the personal income tax to finance the pension system has the least effect on GDP growth, followed by the final demand tax, the value-added tax and the corporate income tax, in that order, as pointed out by H. Varian (1984), society can achieve a higher utility level from a personal income tax than from a commodity tax on producers, even if both generate the same level of tax revenue. If the government levies a tax on product, it changes the relative prices between goods and other inputs in the production process. It changes the slope of the producer's budget line. If the government taxes income while retaining the same amount of tax revenue, the budget line has the same slope as in the original case but is shifted downward and is parallel. According to the property of convex indifference curves, it is possible to achieve a higher level of utility if the budget line shifts in parallel, rather than changing its slope. Personal income taxes generally are preferred to commodity taxes because a low tax burden on enterprises improves efficiency, productivity, competitiveness, and finally, social welfare (Xu 1998). The impacts of various forms of taxation on investment are almost the same as the effects on GDP. Note that the cost of collecting personal income tax has not been considered in the simulation. For cultural and other social resources the cost of collecting personal income tax is much higher than it is for corporate income tax and other taxes. Therefore, pension reform and tax reform in China need to be considered.

It is expected that *private consumption* will decrease if new taxes are collected to finance the pension system. However, from dynamic simulations we find that the negative impact on private consumption persists for only a short period. In the short term, the negative impact from corporate income tax is not as great as that from other taxes. But in the long term, the results from our dynamic simulations show that use of the personal income tax better stimulates private consumption (Figure 7). Thus, considering the prospects for long-term economic development and private consumption, it is better that the transition cost be financed by the personal income tax.

For the same amount of pension funds collected, personal income tax will improve *income distribution* more than other taxes, since income tax is a progressive tax in the model. If the pension deficit is financed using a final demand tax, the GINI coefficient may rise during the first 10 years. From the point of view of reducing inequality, as measured by the GINI coefficient, use of personal income tax is best, followed by corporate income tax, and value-added tax, and final demand tax, in that order (Figure 8).

Single tax or mixed tax. A common theme in many State Council documents is that three parties should share the financial burden of the pension system: the government, enterprises, and individuals. There are many options for distributing the financial burden among the three parties. Our simulation shows the impact on the economy of using various mixes of taxation. In MIX1, the pension deficit after 2001 is financed by a combination of three different types of taxes: one-third by value-added tax, one-third by corporate income tax, and one-third by personal income tax. In MIX2, the pension deficit is financed by a combination of four taxes: one-quarter by value-added tax, one-quarter by corporate income tax, one-quarter by personal income tax, and one-quarter by final demand tax.

For *GDP growth* rate, financing the pension deficit using MIX2 is better than using MIX1 or VAT. It seems to be better to share the financial burden of the transition cost among government, enterprises, and individual households (Figure 9). No matter which form of taxation is used to finance the pension system, *private consumption* will be reduced in the short term. With economic growth,

however, the consumption level will rebound, and the negative effect on private consumption will disappear in 10 years. In the long term, with a view to enhancing economic development and improving living standards, mixed taxation, in which the financial burden of transition is shared by the government, enterprises, and individuals, is better than an approach that puts the financial burden solely on the government.

After-reform sustainability and levying a social security tax

Following the proposed reform of the pension system, the government is not financially responsible for the newly established fully funded individual accounts, but does retain responsibility for a smaller first pillar—the social pooling PAYGO system. Two sets of simulations examine the impacts of raising the retirement age and expanding pension coverage. In experiment set 3, pillar 1 coverage in the urban nonstate and non-individual sectors increases gradually to 100 percent between 2000 and 2005. The retirement age is 55 for all female workers in experiment 3.1, and it increases gradually to 60 between 2010 and 2015 in experiment 3.2; the retirement age for all workers increases gradually to 65 between 2020 and 2025 in experiment 3.3. Based on experiment 3, experiment set 4 expands coverage to rural enterprises between 2005 and 2010, gradually reaching to 50 percent. The retirement age is 55 for all female workers in experiment 4.1, it increases gradually to 60 between 2010 and 2015 in experiment 4.2; the retirement age for all workers increases gradually to 65 between 2020 and 2025 in experiment 4.3. The interest rate is assumed as zero in this set.

In experiment set 5, we assume that the government starts to collect a social security tax for the old age pension. Not knowing the design features being considered by the authorities, we assume the following:

- This will be a nationwide tax to replace the current contributions to pillar1, and it will be levied on all enterprises in the formal sector, including all rural and urban collective enterprises and urban individual or private enterprises. This will unify the national pension system and impose a single tax rate on all localities, alleviating fragmentation, improving funding, and allowing portability and mobility for workers.

- The tax rate will be 12 percent on the wage bill, to be shared equally by employers and workers, that is, 6 percent will be paid by employers and 6 percent by workers. We continue to assume that transition cost will be financed by additional taxes (as in experiment set 2).

The benefit level will remain modest, at 20 percent of the average provincial wage level, since the objective of pillar 1 is to ensure a living standard just above the poverty line. An overly generous pillar 1 would increase the government's burden and reduce the incentive to save in individual accounts, making a multipillar system impossible.

Table 9. Pension fund annual balance (RMB 10 billion)

Experiment	1995	2000	2005	2010	2015	2020
Base	0	0.61	-2.55	-6.82	-11.48	-17.01
Exp. 3.1	0	0.61	3.05	2.82	2.77	2.72
Exp. 3.2	0	0.61	3.05	2.91	3.71	4.62
Exp. 3.3	0	0.61	3.05	2.91	3.71	5.03
Exp. 4.1	0	0.50	2.54	2.77	2.66	2.81
Exp. 4.2	0	0.50	2.54	2.87	3.79	5.01
Exp. 4.3	0	0.50	2.54	2.87	3.79	5.53
Exp. 5.1	0	0.50	1.18	1.63	0.84	0.26
Exp. 5.2	0	0.50	1.18	1.77	2.43	3.61
Exp. 5.3	0	0.50	1.18	1.77	2.43	4.36

	2025	2030	2035	2040	2045	2050
Base	-20.00	-23.19	-27.06	-33.96	-43.48	-55.33
Exp. 3.1	4.59	7.22	10.29	12.47	13.89	14.58
Exp. 3.2	7.20	10.38	14.58	18.41	21.06	22.64
Exp. 3.3	11.60	18.71	26.93	36.28	45.88	54.28
Exp. 4.1	4.78	7.70	10.80	12.14	12.14	10.98
Exp. 4.2	7.68	11.09	15.41	18.52	19.50	18.73
Exp. 4.3	13.31	21.34	30.09	39.39	47.85	53.53
Exp. 5.1	0.96	3.22	5.60	4.98	2.51	-1.21
Exp. 5.2	5.62	9.03	13.81	16.58	16.31	13.89
Exp. 5.3	14.06	24.96	37.40	50.93	63.51	72.36

Source: The authors.

The results of our simulations (Table 9) show that following the proposed reform, the sustainability of the pension system is guaranteed. Pillar 1 remains in surplus without raising the retirement age (experiment3.1, 4.1 and 5.1), and the annual surplus increases when coverage is expanded or the retirement age is raised. Because the government will be responsible for only pillar 1 – a smaller social pooling PAYGO system with only 20 percent replacement - the financial burden to the pension system will be reduced significantly.

The balanced contribution rates for simulation set 3 are listed in Table 10 together with the balanced contribution rate from the first two sets of simulations for comparison. This shows that if the current PAYGO system remains unchanged, the balanced contribution rate will be as high as 25 to 35 percent of payroll, even after expanding coverage or raising the retirement age. In experiment 2.5, after structural reform and tax-based financing of the transition cost, the balanced contribution rate for pillar 1 remained rather low, ranging from 9 to 12.5 percent between 2005 and 2050. This implies that with an 11 to 12 percent payroll tax, the small PAYGO pillar 1 (20 percent benefit) can be financially balanced. In experiment 3.1, 4.1, and 5.1, the balanced contribution rates remained in the 10 percent to 12 percent range, largely consistent with our assumptions for the social security tax rate.

In the short or middle term (20 years), the new system will push *GDP growth* up whether coverage is expanded to rural areas or not. For example, GDP is 1.2 percent higher than the baseline in set 3, and 0.8 percent higher in set 4, in 2020 (Figure 10). It seems better to raise the retirement age if coverage is expanded to rural areas. If pension coverage is restricted to urban areas then the best option is to set the retirement age for female workers at 60. No others increases in the retirement age are

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required. Because all points on the GDP curve in set 3 are higher than in set 4, expanding the pension system to rural enterprises may slow down the GDP growth rate.

The proposed pension system reform may reduce the GINI coefficient and improve *income distribution*. Increasing the retirement age of female workers will keep the GINI coefficient at a lower level. However, expanding the pension system to rural collective enterprises may not improve income equality in the short run. This may be attributable to rural-to-urban income transfer since the urban population is aging faster than the rural population. In the long run, it does reduce GINI (Figure 11).

Expand coverage under proposed pension reform

We now focus on the impact of expanding coverage of pillar 1 under the proposed new pension system. In experiment 3.1, the coverage of pillar 1 will be expanded gradually to the urban nonstate and non-individual sector between 2000 and 2005; in experiment 4.1, pillar 1 coverage is expanded gradually between 2005 and 2010. As financial sustainability is no longer a problem, we can focus on the impact on the overall economy.

Simulation results show that expansion of pension coverage has a very limited impact during the first 20 years. However, expanding pillar 1 coverage will slow down *GDP growth* after 20 years (Figure 10, exp 4.1 compared with 3.1). Expanding pillar 1 coverage has no impact on investment during the first 20 years and reduces investment by 1 percent by 2050. The new pension system reduces *private consumption* in the short term by about 0.5 percent, regardless of whether pillar 1 coverage is expanded. But if pillar 1 coverage is expanded to rural collective enterprises, private consumption is increased in the period from 2010 to 2030. The impact on private consumption is not significant if pillar 1 coverage is expanded only to the urban nonstate sector.

In experiment set 2, we find that financing the transition cost by MIX1 improves income distribution and thus is beneficial for improving social equality. However, the positive effect may be lessened to some extent if the pillar 1 coverage has been expanded. It is clear that the GINI curve moves downward five years of the base year, then raises again if pillar 1 coverage has been expanded to the nonstate and non-individual sector (Figure 11). The GINI curve raise more sharply if pillar 1 coverage has been expanding to rural collective enterprises.

Gradually increase the retirement age

One of the proposed reforms is to increase the retirement age gradually. Setting aside questions concerning the feasibility and political difficulty of this approach, we assume that the retirement age can indeed be raised gradually. The interest rate for the pension fund is assumed to be zero in experiment 4.1-4.3 and 5.1-5.3. This represents a more pessimistic assumption about capital market development and investment returns for pillar 1. Female workers are assumed to retire at 55 and male whereas at 60 in experiment 4.1. In experiment 4.2 the retirement age of female workers is increased one year every year until it reaches 60 between 2010 and 2015. Building on experiment 4.2, in experiment 4.3, the retirement age of both male and female workers is gradually increased to 65 between 2020 and 2025 (one year every year).

The results of this set of simulations show that increasing the retirement age significantly improves the pension fund annual balance. The annual balance increases from RMB 26.5 billion in

2010 to RMB 37.9 billion in 2015 if the retirement age of female workers is increased gradually from 55 to 60 during that period (Figure 12). The pension fund annual balance increases further from RMB 47.8 billion in 2020 to RMB 133.1 billion in 2025 if the retirement age for all workers is increased gradually from 60 to 65 during that period.

Simulation results also show that increasing the retirement age will promote growth in GDP, investment, and private consumption (Figure 13). The effect on the GINI coefficient, however, is not significant after expanding coverage to rural areas and adjusting the retirement age gradually. This could be attributable to rural-to-urban income transfer in the initial years since the urban population is aging faster than the rural population. This might worsen income distribution since the rural population is much poorer than the urban population. Thus to maintain an equitable income distribution, it may not be advisable to expand pension coverage to rural enterprises too soon.

If a new social security tax is levied, the old fragmented system will become unified across the country, and the reformed pillar 1 will remain financially sustainable, even if the tax rate is lower than specified in State Council Document 26 (Figure 14). Here, raising the retirement age will improve the funding situation further, allowing some accumulation of reserve funds in pillar 1. Simulation results also show that increasing the retirement age will promote growth in GDP, investment, and private consumption (Figure 15).

Conclusions

This paper examines the impacts of various design options for pension system reform on the sustainability of the system and on overall economy growth. We are able to combine the CGE model and population growth model into a recursive dynamic framework, which provides a new flexible tool to simulate various pension reform plans in a general equilibrium setting. We differentiate production and employment by ownership type and organize the demographic data in a matrix with four dimensions. We then conduct three sets of simulations with 18 experiments, (1) limited changes within the current system (no structure reform), (2) a structural reform (phasing out notional individual account) and financing the transition cost by taxes, (3) various options after the proposed structural reform including levying a new social security tax. Results from simulations are promising and summarized in the executive summary.

Our simulation results provide useful insights for the design of Chinese pension system reform and illustrate how CGE models can be valuable tools for evaluating different pension policies. However, several important limitations need to be mentioned. First, few CGE models have been able to incorporate rational expectations into the behavior of agents (though there are perfect foresight models). In our recursive dynamic model, agents adjust their behavior according to information received in the last period. Thus, the existence of a future pension benefit will not affect agents' saving behavior today. Second, the model does not specify explicitly the different behavior rules of the various types of firms in China, but assumes that all operate to maximize profit. A third limitation is that the model may overestimate the impact of various pension reform policies on macroeconomic variables because it does not include an explicitly specified financial market. Gross national savings, including pension reserves, are assumed to become gross investment, implying a perfect capital market, which is far from the reality in China. It is assumed that pension funds can earn interest that is equal to the average return on capital, except that in experiment 4 and 5 interest rates are assumed as zero. To our knowledge, only one paper had attempted to incorporate financial market into a

multicountry CGE model (McKabin, 1999). It is our intention to do the same for this single-country model. Fourth, the simulation results may under- or overestimate the real effects of each tax financing policy because the model does not take tax collection costs into account. And finally, CGE models assume full employment. Increases in the labor supply resulting from raising the retirement age are assumed to be absorbed by labor demand, which is not realistic. Because data and time constraints, we could not separate pension systems for civil servants and for workers, and could not examine the impact of rural-urban migration. Therefore, the simulation results must be interpreted with caution and may be best understood as indicative rather than conclusive.

The next step in this work will be to conduct simulations regarding various designs for a social security tax, with different coverage and tax rates. We also will consider debt financing of transition cost. In the future, we hope to have the opportunity of examining the impact of a comprehensive plan combining tax reform, wage reform, and pension reform in China.

Table 8. Required increments of tax rates for experiments 2.1-2.6

		2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Exp. 2.1	Corporate tax	0	1.12	1.27	1.28	1.23	1.15	1.07	0.96	0.82	0.62	0.39
Exp. 2.2	Value-added tax	0	0.59	0.66	0.65	0.62	0.57	0.53	0.47	0.40	0.30	0.18
Exp. 2.3	Personal income tax	0	0.72	0.80	0.78	0.73	0.68	0.63	0.56	0.48	0.34	0.18
Exp. 2.4	Final demand tax rate	0	0.56	0.61	0.60	0.56	0.52	0.48	0.43	0.37	0.27	0.15
Exp. 2.5	Corporate tax	0	0.41	0.46	0.46	0.44	0.40	0.37	0.33	0.28	0.21	0.12
	income tax	0	0.27	0.31	0.31	0.29	0.27	0.26	0.24	0.20	0.15	0.09
	Value-added tax	0	0.15	0.17	0.17	0.16	0.14	0.13	0.12	0.10	0.07	0.05
Exp. 2.6	Corporate tax	0	0.30	0.34	0.34	0.32	0.30	0.28	0.25	0.21	0.15	0.09
	Income tax	0	0.20	0.23	0.23	0.22	0.20	0.19	0.17	0.15	0.11	0.07
	Value-added tax	0	0.12	0.13	0.12	0.12	0.11	0.10	0.09	0.07	0.06	0.04
	Final demand tax rate	0	0.14	0.16	0.16	0.15	0.14	0.13	0.12	0.10	0.07	0.04

Source: The authors.

Table 10. Balanced contribution rate

	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Baseline	25.0	23.3	27.2	31.2	34.5	37.7	35.8	34.3	33.3	33.4	34.2	35.1
Exp 1.1	25.0	22.1	23.0	25.3	27.2	29.2	29.4	29.6	30.1	31.5	33.2	34.7
Exp 1.2	25.0	22.1	23.0	25.1	25.4	26.3	26.5	27.0	27.2	28.3	30.1	31.9
Exp 1.3	25.0	22.1	23.0	25.1	25.4	25.6	20.8	18.8	17.9	17.7	18.2	19.5
Exp. 2.5	8.3	7.8	9.1	10.4	11.5	12.5	11.9	11.4	11.1	11.1	11.4	11.7
Exp. 3.1	8.3	7.8	10.0	11.1	11.7	12.2	11.5	11.0	10.7	10.9	11.2	11.6
Exp. 4.1	8.3	7.8	10.0	10.5	11.1	11.4	11.1	10.7	10.5	10.7	11.1	11.6
Exp. 5.1	8.3	7.8	10.6	10.7	11.5	11.9	11.7	11.3	11.1	11.4	11.8	12.1
Exp. 5.2	8.3	7.8	10.6	10.6	10.6	10.5	10.4	10.2	9.9	10.0	10.4	10.8
Exp. 5.3	8.3	7.8	10.6	10.6	10.6	10.2	8.1	6.9	6.3	6.0	6.0	6.2

Source: The authors.

Population dynamics

(Mn person)
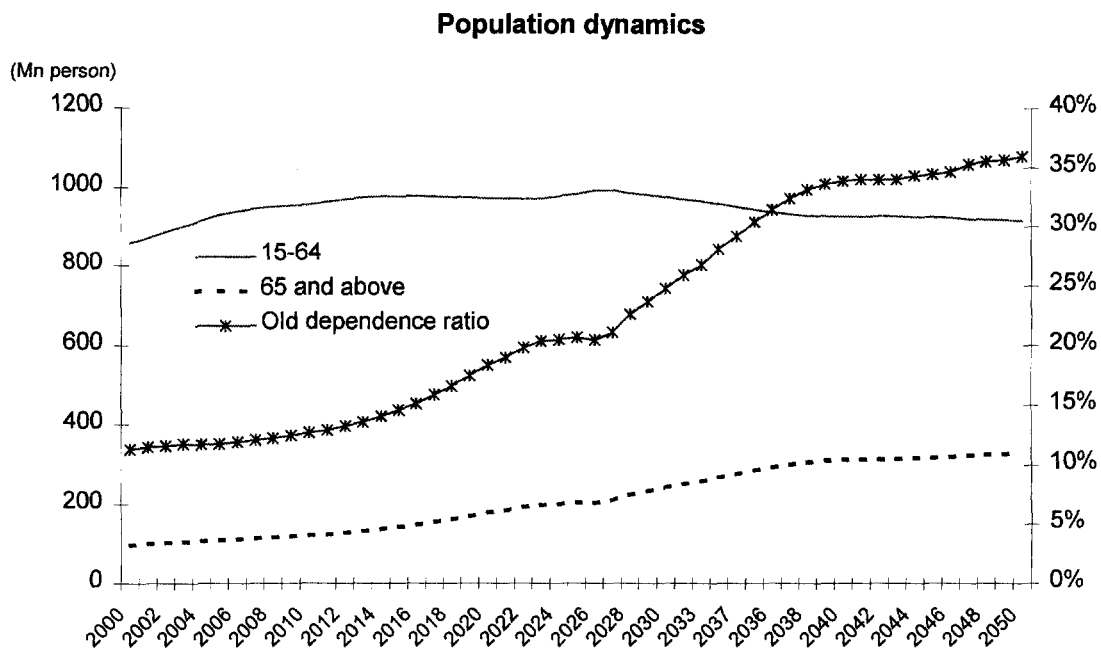
Figure 2. China's aging population

Pension fund annual balance 10bn yuan
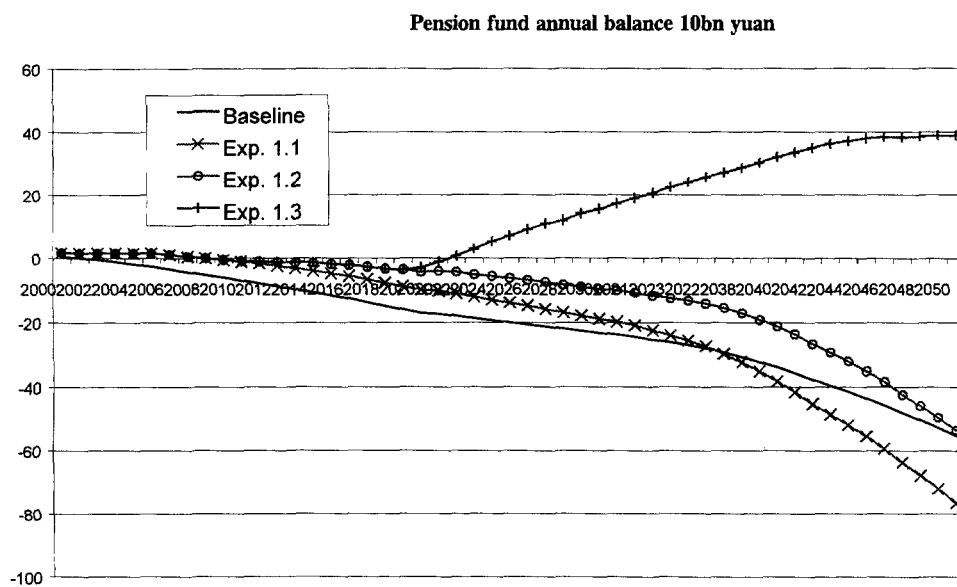
Figure 3. Pension fund annual balances, base line and experiments1.1-1.3

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Percentage change of GDP with baseline
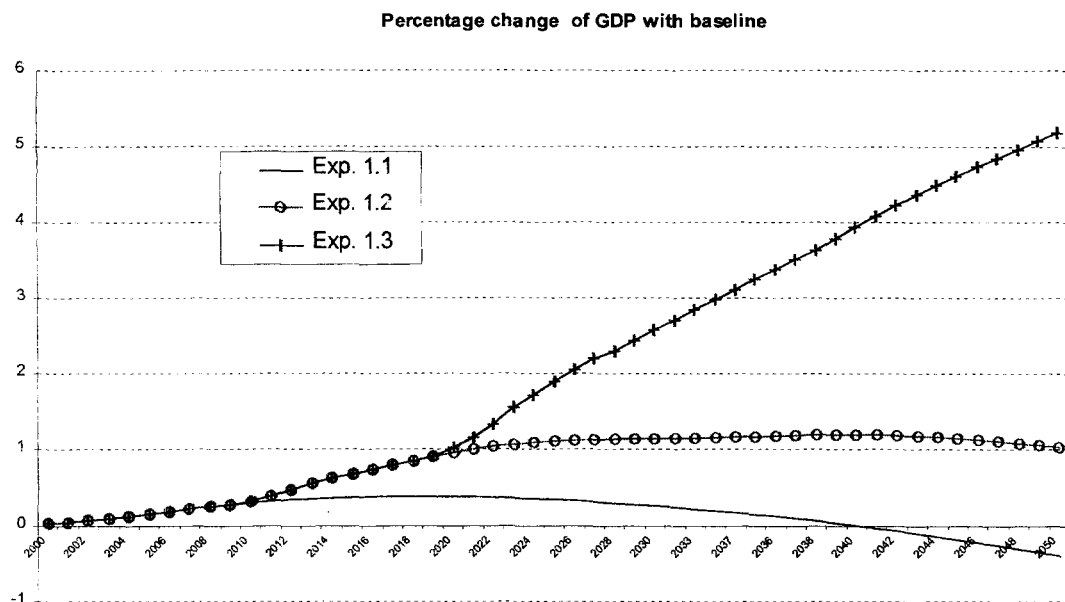
Figure 4. Change in GDP in experiment 1.1-1.3

Transitional cost of phasing out pillar 2 - Simulation result from Exp. 2.1
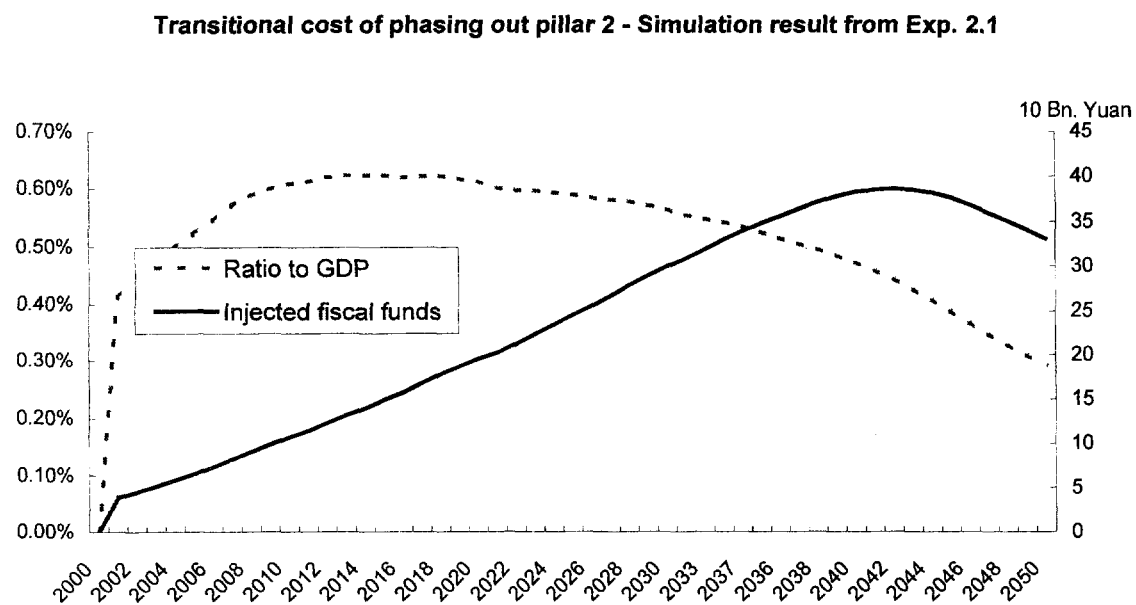
Figure 5. Transition cost of phasing out notional individual accounts

Percentage change of GDP with baseline
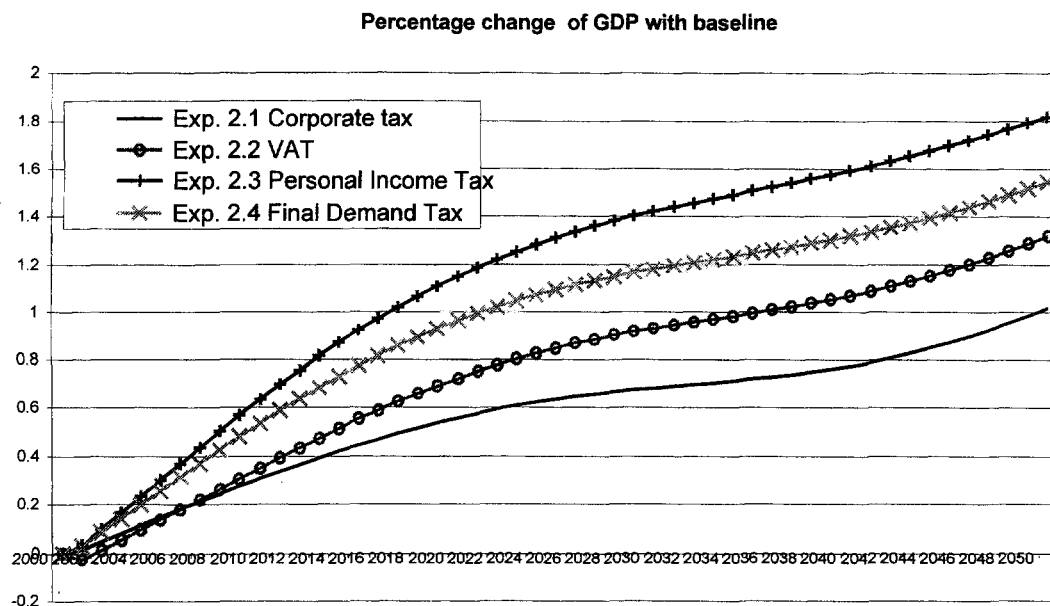
Figure 6. Change in GDP in experiment 2.1-2.4

Percentage change of private consumption with baseline
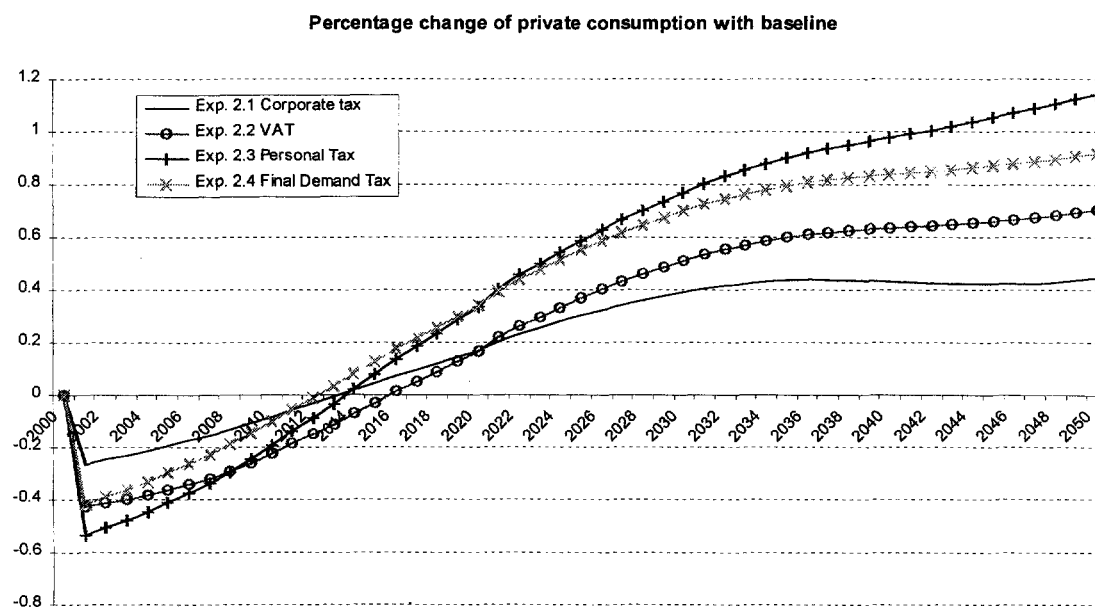
Figure 7. Change in consumption in experiment 2.1-2.4

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Change of Gini coefficient
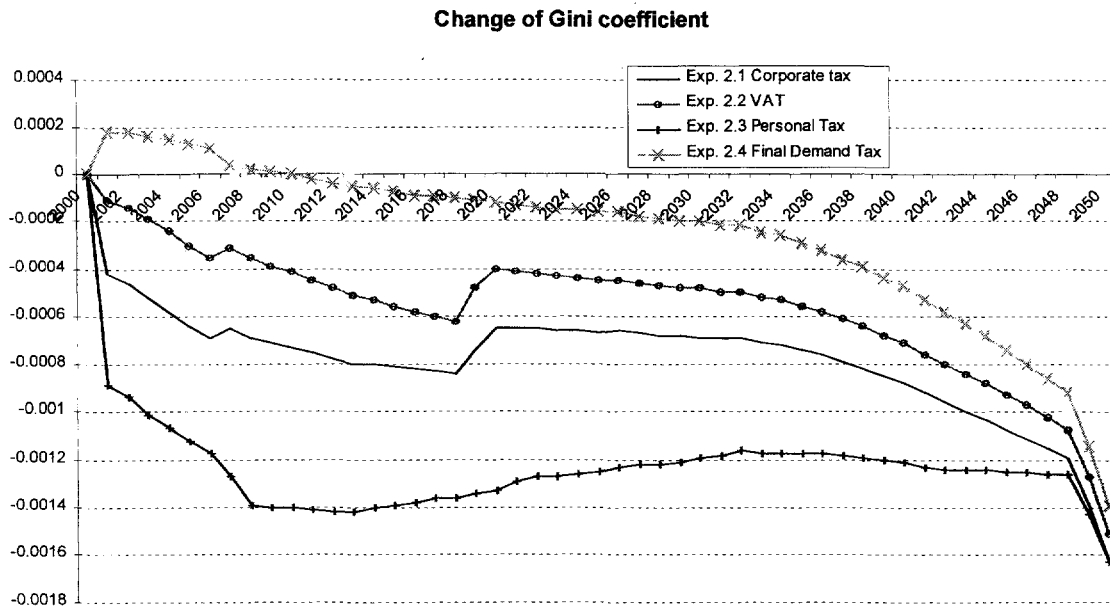
Figure 8. Change in GINI coefficient in experiment 2.1-2.4

Percentage change of GDP with baseline
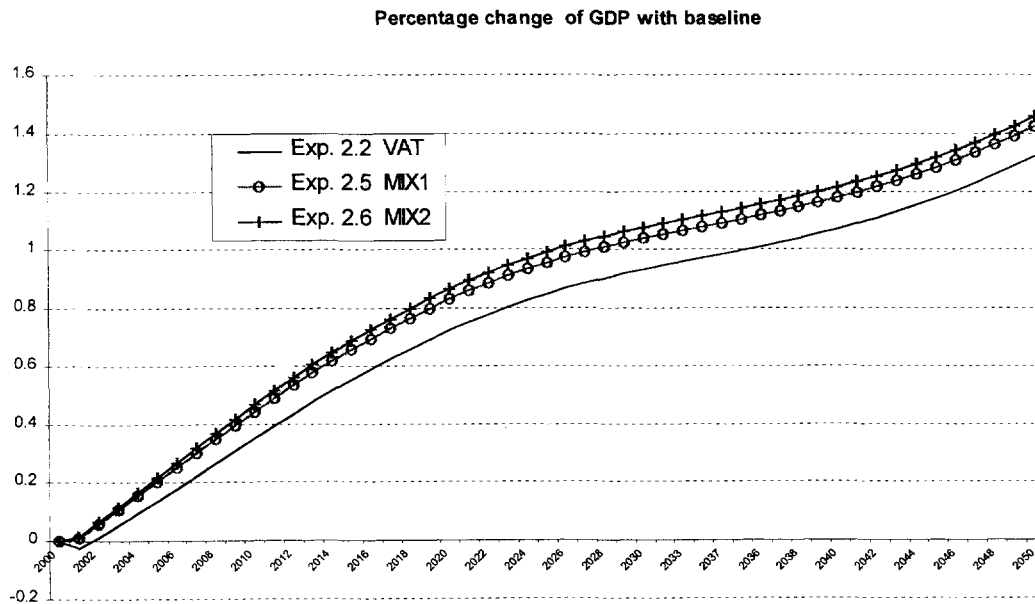
Figure 9. Change in GDP in experiment 2.2-2.6

Percentage change of GDP with baseline
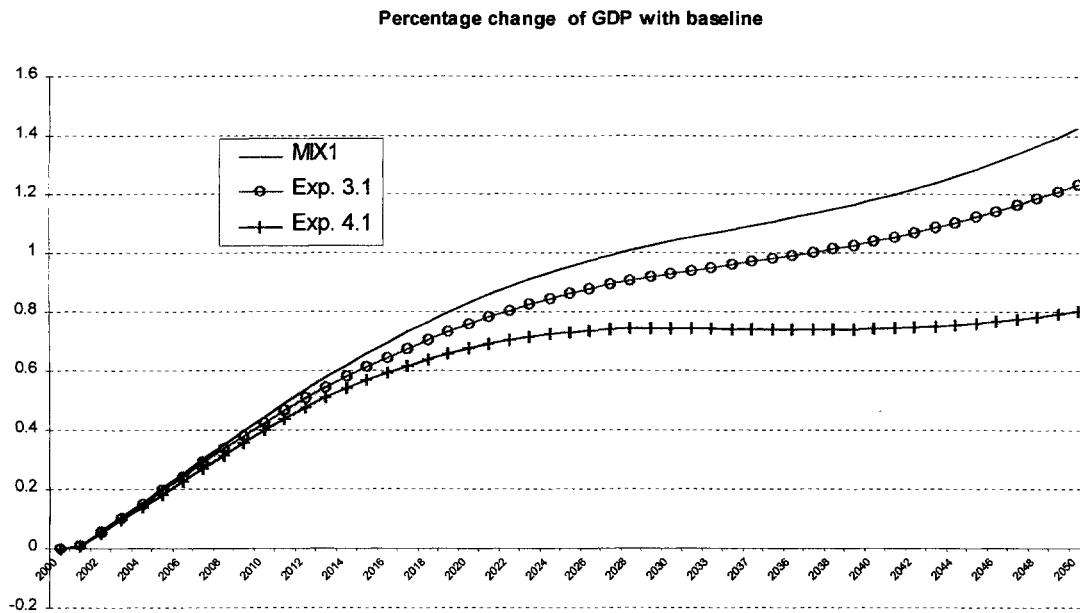
Figure 10. Change in GDP in experiment 2.5, 3.1, and 4.1

Change of Gini coefficient
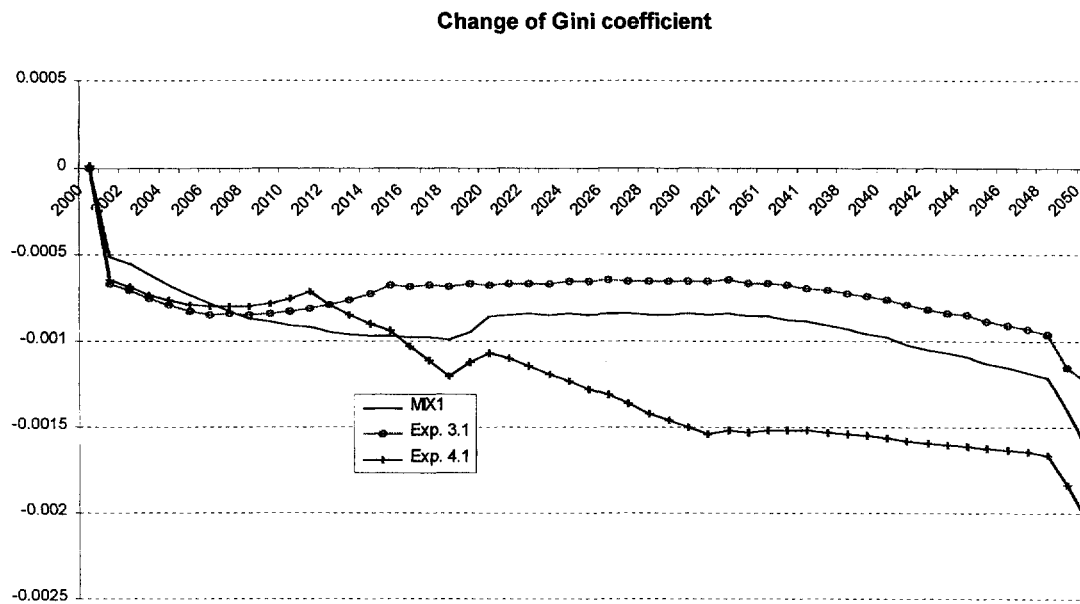
Figure 11. Change in Gini coefficient in experiments 2.5, 3.1, and 4.1

Pension Fund Annual Balance (10 bn. Yuan)
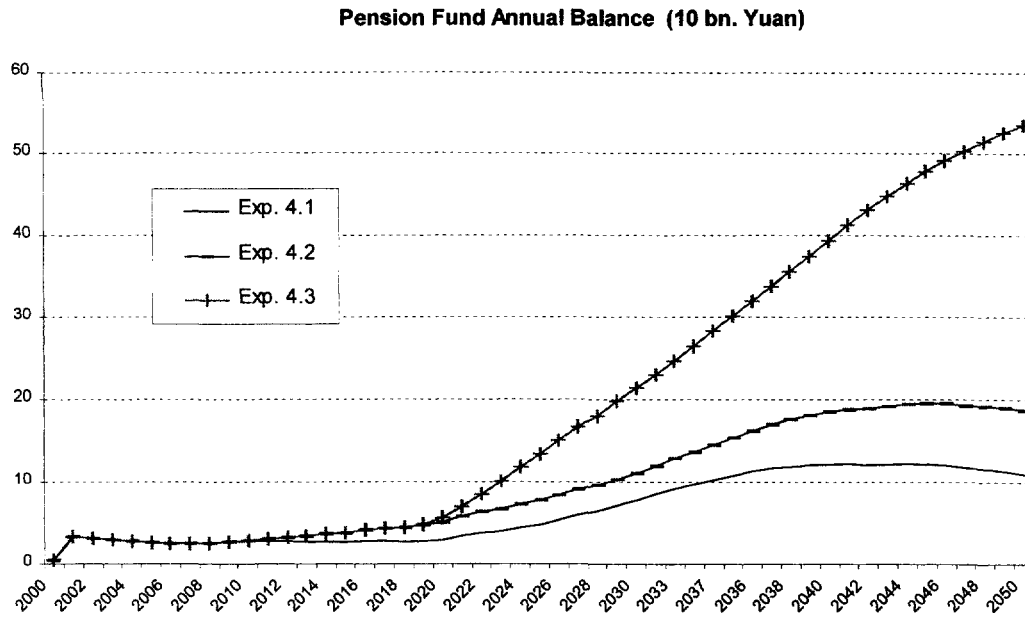
Figure 12. Pension fund annual balance in experiments 4.1 - 4.3

Percentage change of GDP with baseline
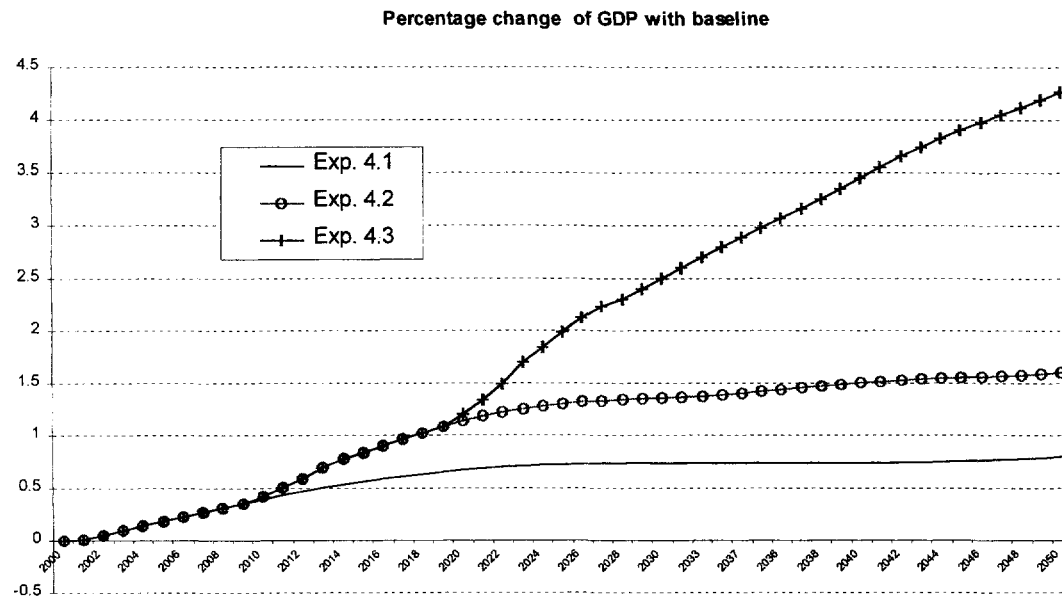
Figure 13. Change in GDP in experiments 4.1 - 4.3

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Pension Fund Annual Balance (10 bn. Yuan)
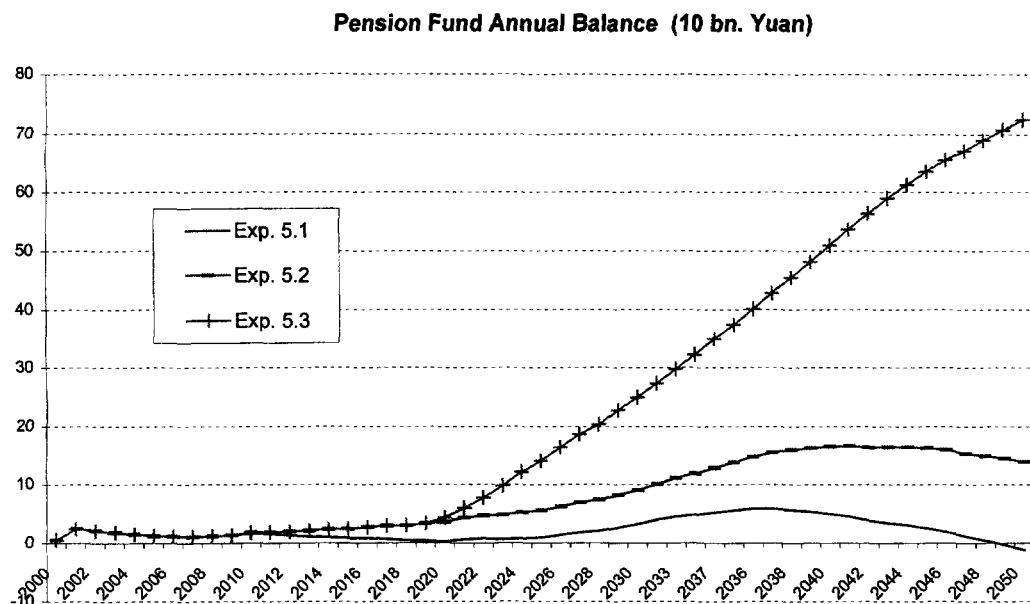
Figure 14. Pension fund annual balance in experiments 5.1 - 5.3

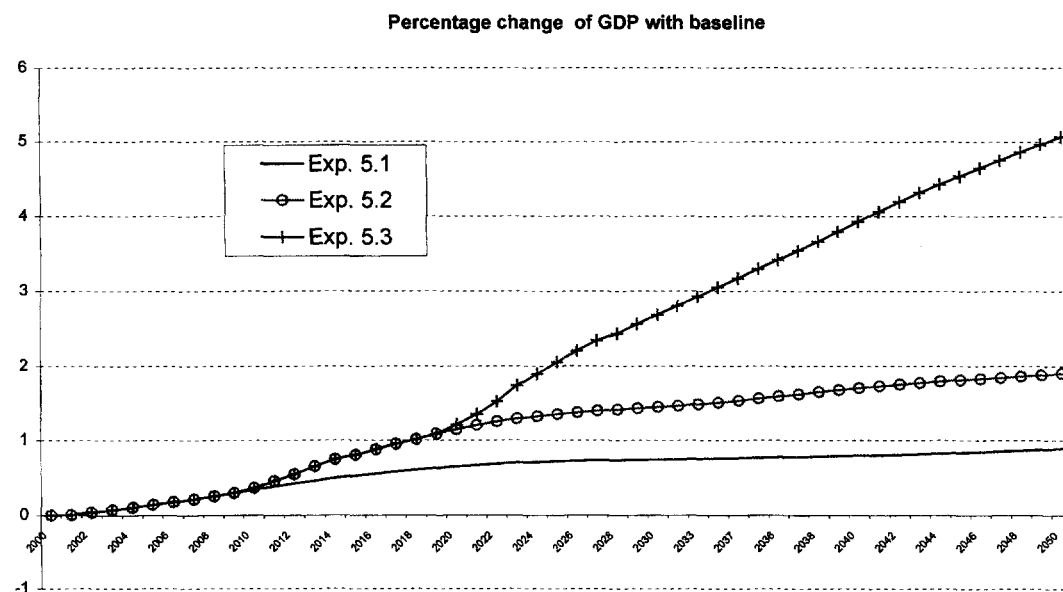**Percentage change of GDP with baseline**

Figure 15. Change in GDP in experiments 5.1 - 5.3

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