WPS 1607

POLICY RESEARCH WORKING PAPER 1607

Population Aging and Pension Systems

Reform Options for China

As China's population ages, China must address macroeconomic issues affecting its old-age social security system, not just the design and management of pension funds

F. Desmond McCarthy
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Summary findings

Using an integrated simulation model, McCarthy and Zheng estimate the scope and speed of population-aging in China, the cost of supporting the old, and the impact of different reform options and pension arrangements. Among their conclusions:

The scope and speed of population-aging in China make the present pension system financially unsustainable, even assuming that GDP grows steadily in the long term. Moving the retirement age back would provide a temporary fix for the current pay-as-you-go pension system but would be politically viable only where there is great demand for labor.

Pension funds could be made more sustainable by increasing GDP growth, raising contribution rates, or gradually reducing benefit rates. But the financial costs and social obstacles of those reform options must be carefully assessed. Fully funded, privately managed pension schemes might be feasible, but require a sound regulatory framework and institutional infrastructure, including financial markets that provide adequate savings instruments and insurance options.

Pension reform is a long-term, multidimensional problem involving economic, social, political, and cultural factors. Governments should not focus only on taxes and transfers to redistribute income to and among the elderly.

Real income growth is needed to cope with poverty among the elderly, especially in developing countries. To establish an adequate, efficient, and equitable social security system, China must maintain long-term socioeconomic stability and sustainable growth.

China could improve the labor market by removing management rigidities, facilitating human resource development, making labor markets more competitive, improving the household registration system, improving incentives, and rewarding hard and innovative work. To reduce unemployment, China can create more job opportunities in nontraditional sectors, especially its underdeveloped service industries. To shift jobs to the nonagricultural sector, it can develop medium-size cities. And to cushion the impact of demographic shocks, China should preserve traditional values and maintain family-community support.

Drawing on experience in Europe and Latin America, China should move toward a transparent and decentralized system with (1) a fully funded, portable, defined-benefit pension plan, designed to meet basic needs, and (2) occupational pension plans or personal savings accounts to satisfy demand for maintaining or improving living standards.

This paper — a product of the Office of the Senior Vice President, Development Economics — is part of a larger effort to study strategic and policy issues for socially sustainable development in developing countries. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Mila Divino, room N6-056, telephone 202-473-3739, fax 202-522-1157, Internet address mdivino@worldbank.org. May 1996. (47 pages)

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Population Aging and Pension Systems

I. Introduction

While being proud of its civilization as one of the world's oldest, China, though relatively youthful at present, is getting older rapidly and massively. Strict family planning practice has sharply reduced fertility since early 1980s. Better living conditions and medical services have cut down mortality and extended life expectancy in both urban and rural areas. Consequently, the percentage of older persons in the total population increases continuously, and the median age of the population rises steadily. Moreover, the aging process is expected to accelerate in the coming decades as the baby boomers born between early 60s and mid-70s, currently numbering more than 250 million (twice Japan's present total population), approach retirement age around 2030. By then as many as 22 percent of Chinese nationals will be more than 60 years old, jumping from 9.7 percent in 1995. During the same period, the ratio of working-age persons to the aged is estimated to be halved from 9.7:1 to 4.2:1. Without a properly designed social security system and strategically formulated policy responses, it would be very difficult for China to cope with this coming old-age challenge.

The pressure generated from these demographic dynamics for China in the 2030s share some similarities with those facing Western developed countries and Japan in the next decade. However, China is a low-income country, with per capita income of US$ 490 in 1993 being less than 2 percent of that in the United States at the current market exchange rate, or close to 10 percent when measured at purchasing power parity[1]. Apparently, China's quick population aging process and lower level of development mean that income resources available to support non-productive aged people will be far less

[1] The World Bank's World Development Report 1995 , page 220, presents a cross country comparison of PPP estimates of GNP. Here China's per capita GNP in 1993 is estimated at US2,330 as compared with that of India at US$1,220.

than in the developed world. Even with the Confucian tradition of filial piety and respect for the elderly, China with relatively fewer young will soon find itself in difficulties to provide adequate support to its rapidly increasing old-age population.

Faced by these serious challenges for harmonizing economic growth with social sustainability, the Chinese government has begun to take measures to reform its currently fragmented social security system. Policy options on pension system reforms have been studied, and several experiments for social security decentralization have been carried out at provincial and municipal levels. State and collective enterprises began pooling pension funds in order to ease uneven burden of retirement costs. However, many long-term strategic issues on the interdependence between demographic transition and economic growth remain to be systematically investigated. For instance, what is the real financial burden the population aging process creates, given the fact that both the income growth rate and the average private savings rate in China rank among the world's highest in recent years and will probably continue to be so in the near future? What are the macroeconomic implications if the current pay-as-as-go type of pension scheme were not reformed? How to deal with the insolvency of pension funds associated with state-owned enterprises? What roles shall individual workers, enterprises, and different levels of governments play to establish sufficient, efficient, and equitable social security systems? How can pension funds be most effectively managed, privately or publicly? How are different schemes socially and financially sustainable? What are the political implications associated with pension system reforms since any adjustments on this front will inevitably necessitate inter-generational transfers and intra-generational redistribution among different income groups? How much can China learn from experiences of both developed and developing countries?

This paper seeks to make a contribution to policy thinking on these important questions. The theme of the paper is that issues around the old-age social security system in most developing countries, such as China, need to be addressed in a broader macroeconomic sense rather than over-stressing on design and management of the pension

funds pe se. The ultimate means to endure and improve living standards for the old population is to maintain long-term stability and promote sustainable income growth, while reforming micro-incentive structure to encourage private savings. Workers, pensioners, enterprises, and different levels of governments need to cooperate to improve labor productivity, create new job opportunities, preserve traditional and family values, liberalize and develop financial markets, and rationalize government interventions in the social security system.

There exist extensive discussions, as cited in World Bank (1994), on pension schemes and social security systems. However, only a few are directly concerned with policy applications in China[2]. Using a simple simulation model similar to that of Schieber and Shoven (1994) and the World Bank's population forecasting for China (World Bank 1995), this paper attempts to quantitatively illustrate: (a) the scope and the speed of population aging and its associated cost of supporting the old in the future, (b) whether a typical pay-as-you-go system is sustainable and how large the cost if no reforms were conducted, and (c) system sensitivities with respect to alternative policy choices. Although other kinds of benefits and compensations, such as health insurance and disability benefits, are integral parts of the social security system, the focus here is maintained on pensions for retired persons.

The rest of the paper is organized as follows. Section II analyzes major challenges China will face during its demographic and socio-economic transition. Section III presents a simple model built around a pay-as-you-go system which integrates demand for old age supports with supply of funds available from workers' contribution. Section IV focuses on the sustainability sensitivities of different policy alternatives. Section V concludes this paper with some remarks and suggests directions for further policy studies.

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[2] A partial list of studies on pension system reform in China includes Ahmad and Hussian (1991), Barkan (1990), Dixion and Macarov (1992), Hu (1994), Hussain (1993,1994), Hussian and Li (1989), Lee (1993), Tian (1995), World Bank (1990, 1994), and Yue (1985).

II. Challenges Ahead

Living on about 7 percent of the arable land of the earth, China's population of 1.2 billion accounts for about 21 percent of the world's total and surpasses that of India, the second largest in the world, by more than 30 percent. Significant socio-economic progresses, as shown by the indicators in Table 1 in terms of both development dynamics and international comparison, have been made in the past decades. These achievements are especially apparent within the past 15 years, when market reforms and integration into the world trade and finance systems resulted in noticeable improvement in production efficiency and income growth. Within the period between 1980 and 1994, real GDP grew at a rate close to 10 percent per annum on average, the number of persons living in absolute poverty was halved, and the international trade volume rose by five to six times to more than US$200 billion. This remarkable growth was largely financed by domestic savings, although foreign financial assistance through investment and lending also played an important role. As exemplified in the 1992 Development Diamond presented in Figure 1, China compares favorably with most low-income economies in all four dimensions.

While fundamental transformation and economic growth will probably continue at a fast pace in the first decades of the twenty first century, a number of concerns for long term sustainability are emerging. The old-age security system is one of more pressing. Out of many social, political, and economic factors that can generate significant impact on the social security system in the near future, the following four intertwined factors are central for policy formation to avert a potential old age crisis:

(a) how to promote growth while preserving traditional values?

(b) how to adjust population policies to cope with the demographic development?

(c) how to divert labor force concentration from agriculture to industries and services while maintaining rural-urban balances? and

(d) how to mitigate the social cost during the transition from a central planning regime towards a competitive market economy?

Table 1

Basic Indicators of Social and Economic Development

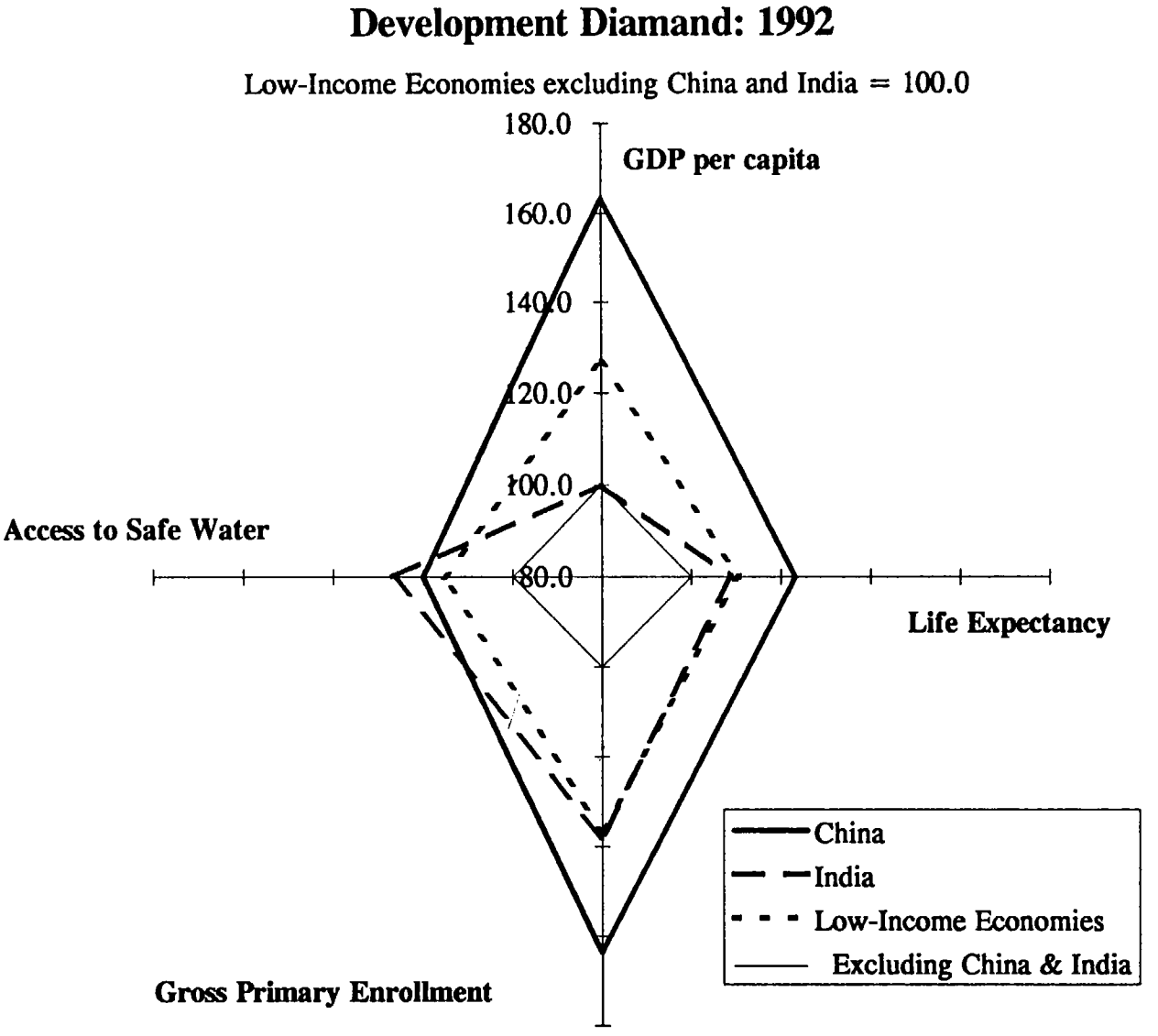
(1993 unless otherwise stated)

		China	*India*	*Other Low-Income Economies*[1/]	*Middle-Income Economies*	*World*
Population	million	1178	898	1015	1597	5501
Urban	%	29	26	27	60	37
Growth Rate (80-93)	%	1.4	2.0	2.5	1.7	1.7
Total Fertility Rate		2.0	3.7	5.5	3.0	3.2
Life Expectancy	years	69	61	56	68	66
Adult Illiteracy	%	27	52	49	17	33
Primary Net Enrollment	%	96		57		
Access to Safe Water	%	71	75			
GNP per capita	US$	490	300	300	2480	4420
GDP Growth Rate (80-93)	%	9.6	5.2	2.9	2.1	2.9
Avg. Inflation Rate (80-93)	%	7.0	8.7	27.1	90.1	19.6
Exports	US$ bil.	91.7	21.5	43.2	648.2	3701.5
Growth Rate (80-93)	%	11.5	7.0	1.4		
Imports	US$ bil.	103.1	22.8	62.9	724.6	3778.7
As Share of GNP						
Gross Domestic Investment	%	41	24	17	23	22
Gross Domestic Savings	%	40	24	10	22	22
Agriculture	%	19	31	37		
Industry	%	48	27	22		
Service	%	33	41	42		

Source: World Bank (1995): World Development Report 1995: Workers in an Integrated World

1/ excluding China and India.

Figure 1


Development Diamand: 1992
Low-Income Economies excluding China and India = 100.0
180.0
GDP per capita
160.0
140.0
120.0
100.0
80.0
Access to Safe Water
Life Expectancy
Gross Primary Enrollment
China
India
Low-Income Economies
Excluding China & India

Traditional Values

For thousands of years, ***traditional values*** in China have placed strong emphasis on the role of the family as a unit of production and consumption in general, and as a basis for raising the young and supporting the old in particular. Three or four generations usually live under the same roof to pool resources and share risks. When grandparents in ordinary families become too old to generate income directly from working outside, they stay at home not only to just rest but to take care of young grandchildren and do housework in order to reduce burdens of the middle generation. This system worked quite well, often in the absence of any formal market work arrangements. The virtues of diligence, frugality and thrift are glorified. Accumulation of social experience and financial wealth, largely bequest-motivated, by the old through their life-long hard work wins them respect from the society. Thus the welfare of older members has been an essential responsibility of families, as a reward to the altruistic spirit of the older generation. This traditional natural harmony between generations within the family and among members of a community is now being disrupted as the economy modernizes and opens to external influences. The families themselves are getting smaller, especially in urban areas because of housing problems. While a higher percentage of family members are living longer, traditional extended family living arrangements are being stressed by the need for some members to become more mobile to respond to new economic incentives. Understandably in an increasingly secular society more activities are valued through market interactions, and there is often more emphasis on self gratification and less on communal responsibilities.

In China, significant importance needs to be attached to preserving the tradition of respecting and supporting the old on family and community basis. Currently, China's big population is mostly rural with low income. About 10 percent of the population are still living in absolute poverty with an income less than half a dollar a day. In addition, 27 percent of adults are illiterate. For persons 60 years or older, about one in ten women and two in ten men can actually read and write. Socialized old-age security systems through operations of pension funds and insurance arrangements are unlikely to play a major role until later in the next century, because of China's current development level of economy

and infrastructure. Nursery homes, if built to house China's 360 million old persons in the 2030s, would be very costly and labor-intensive, and may not necessarily provide better services to the elderly than within a family atmosphere. Hence, how to preserve and promote traditional family values shall be a key policy issue in designing old-age security systems in China.

Demographic Transition and Population Policy

Another challenge comes from ***the inertia of the demographic transition***. China's population, unevenly distributed across regions, is projected to grow at an average annual rate of less than 0.9 percent between 1995 and 2030. This growth rate is only a half of the 1.8 percent rate between 1970 and 1980 and substantially lower than 1.4 percent rate between 1980 and 1993. But the size of the incremental population is enormous because of the much larger population base. Close to a net of 430 million people will be added to China's population within the next 35 years, which is equivalent to five times of the current total population in Germany. More than half of this increase can be attributed to extension of life expectancy, which is forecast to advance from 69 years at birth in 1995 to 75 years in 2030. By 2030, close to 30 percent of the world's incremental old-age population, as compared with that in 1990, will be accumulated in China. The normal population aging process seen in most countries has been particularly rapid in China during a long period of steady growth, when overall economic conditions improve and access to better health facilities becomes wider. In France, 140 years elapsed before the proportion of the population over 60 doubled to 18 percent in 1976. It will take China just 34 years. The old-age dependency ratio will rise from 15 in 1995 to 38 in 2030, while the average age of the population increases by 8.3 years from 29.4 in 1995 to 37.7 in 2030. Table 2 below summarizes some trends of the demographic development in China. Figures 2 to 5 plot some indicative demographic trends of China based on the population projections of the World Bank.

Table 2

Basic Indicators of Demographic Development

		China	*India*	*Other Low-Income Economies*	*Middle-Income Economies*	*World*
Annual Population Growth						
1970-1980	%	1.8	2.2	2.5	1.9	1.8
1980-1993	%	1.4	2.0	2.5	1.7	1.7
1993-2000	%	0.9	1.8	2.9	1.4	1.5
Labor Force: 1993						
As % of total population	%	60.0	38.0	37.9		
Participation Rate	%	91.5	67.4	83.9		
Engaged in Agriculture	%	61.0	63.2			
Infant Mortality Rate						
1970	0/00	69	137	135	74	1272
1993	0/00	30	80	89	39	42
Total Fertility Rate						
1970	0/00	5.8	5.5	6.5	4.5	4.8
1993	0/00	2.0	3.7	5.5	3.0	3.2
2000	0/00	1.9	3.2	4.9	2.7	2.9
Crude Birth Rate						
1970	0/00	33	39	45	31	32
1993	0/00	19	29	40	23	25
Age Dependency Ratio: 1993		52	77	121	81	73
Urban Population Growth						
1970-1980	%	3.0	3.7	4.2	3.3	2.6
1980-1993	%	4.3	3.0	4.2	2.8	2.6

Source: World Bank (1995): World Development Report 1995: Workers in an Integrated World

Figure 2

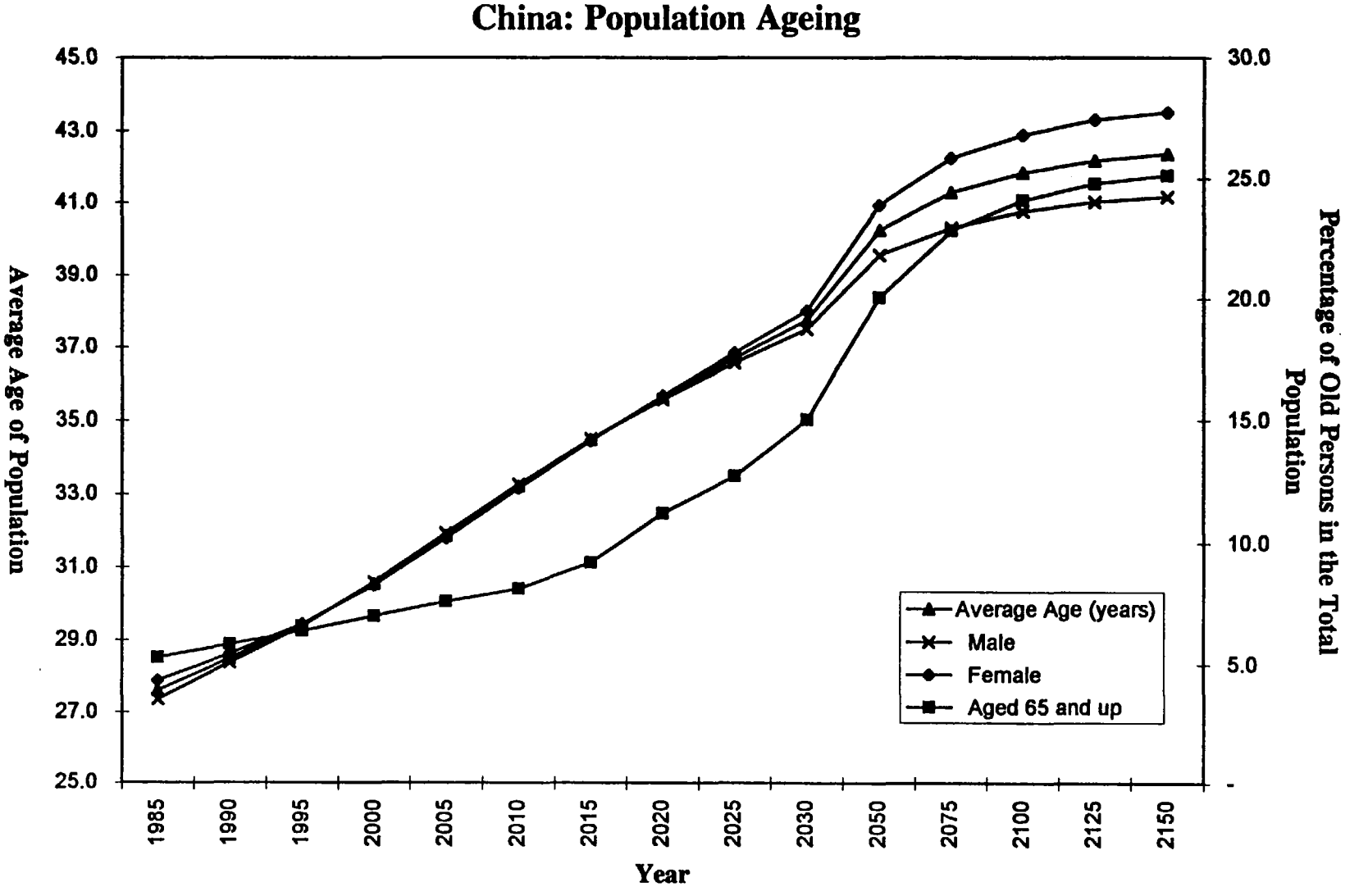
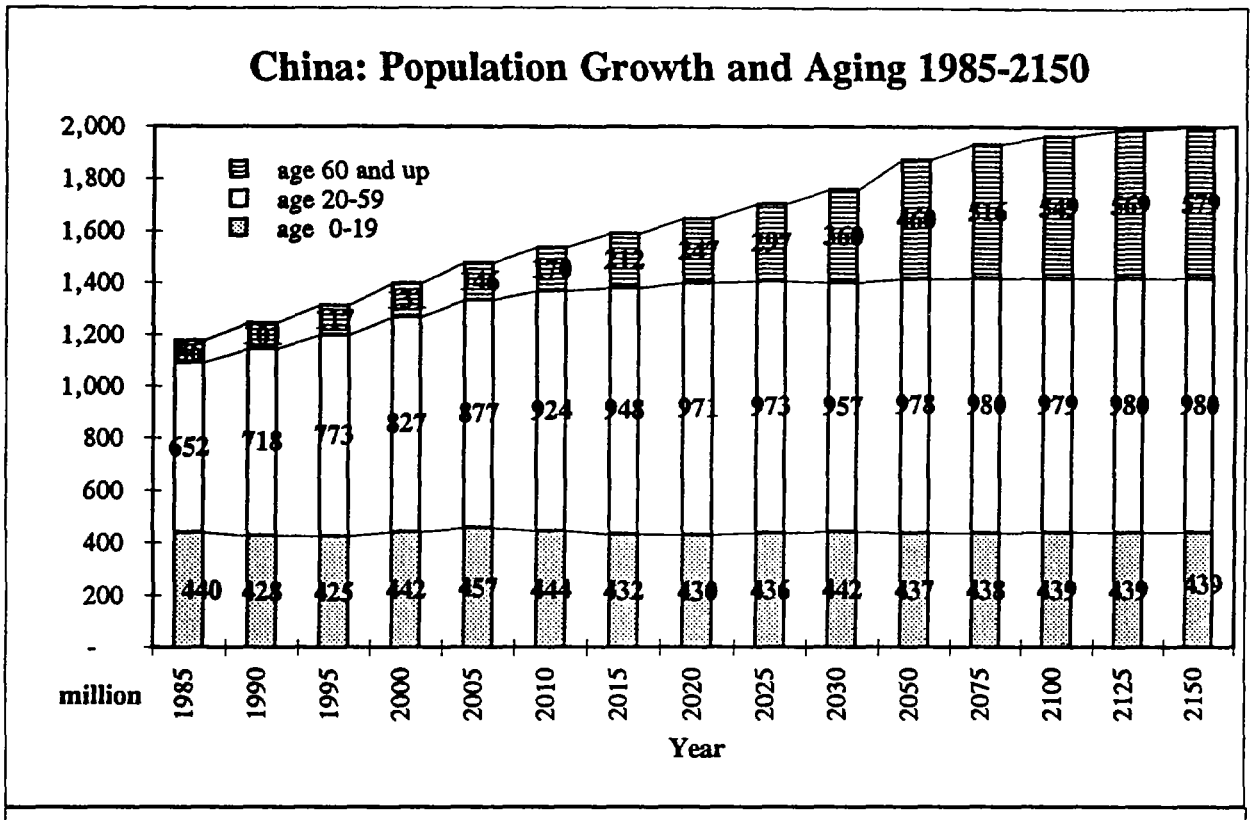

China: Population Ageing
Average Age of Population
Percentage of Old Persons in the Total Population
Year
45.0
43.0
41.0
39.0
37.0
35.0
33.0
31.0
29.0
27.0
25.0
30.0
25.0
20.0
15.0
10.0
5.0
-
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2050
2075
2100
2125
2150
Average Age (years)
Male
Female
Aged 65 and up

Figure 3


China: Population Growth and Aging 1985-2150
age 60 and up
age 20-59
age 0-19
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-
million
652
718
773
827
877
924
948
971
973
957
978
980
979
980
980
440
428
425
442
457
444
432
430
436
442
437
438
439
439
439
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2050
2075
2100
2125
2150
Year

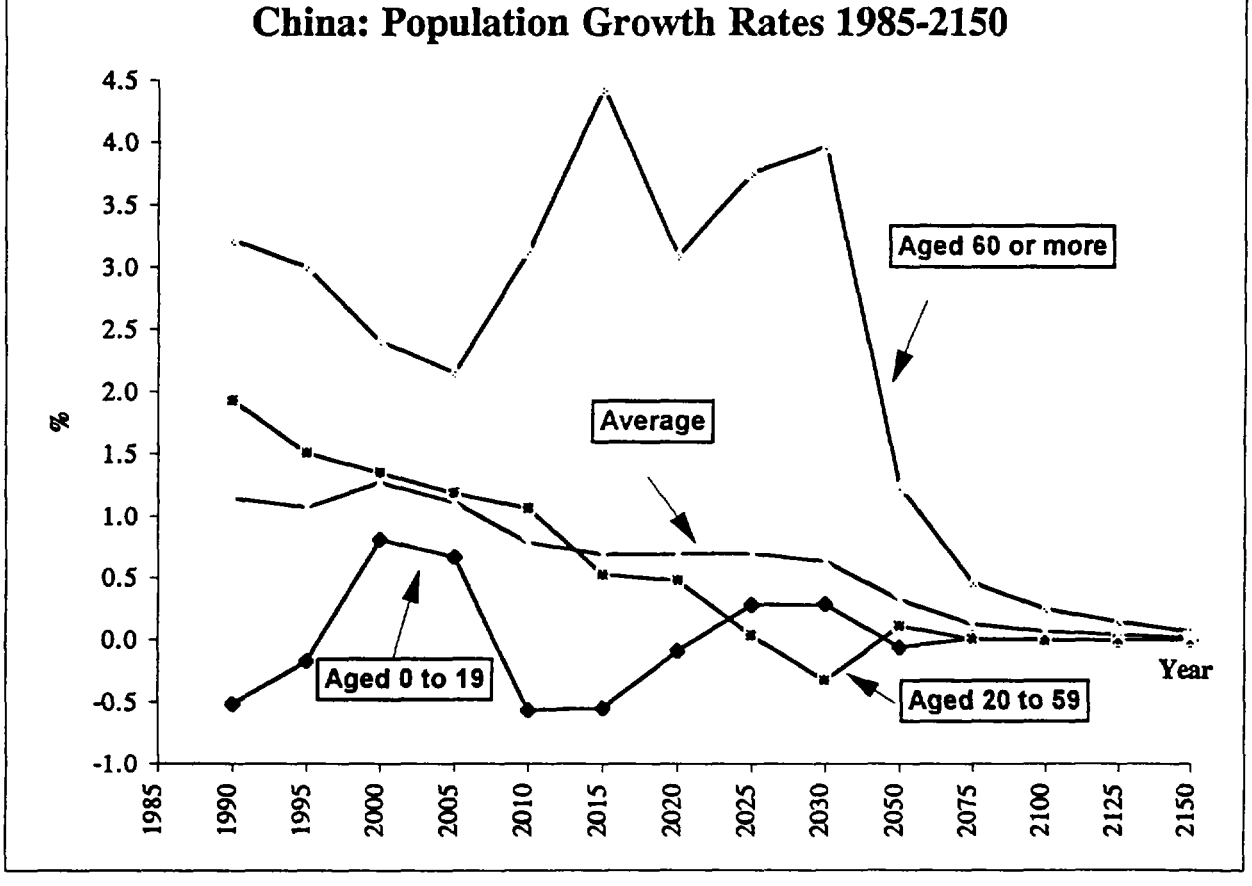

China: Population Growth Rates 1985-2150
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
%
Aged 60 or more
Average
Aged 0 to 19
Aged 20 to 59
Year
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030
2050
2075
2100
2125
2150

Figure 4

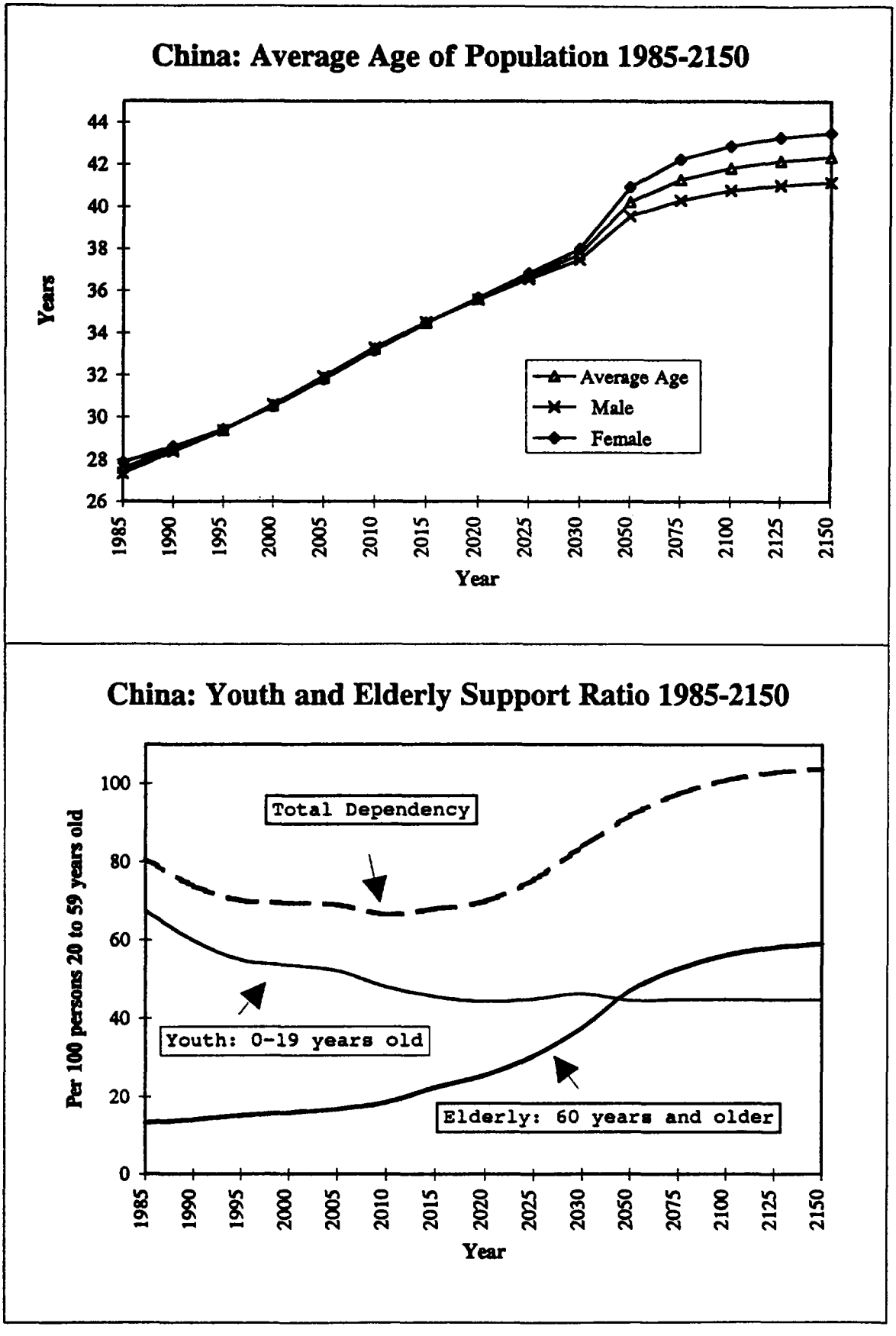
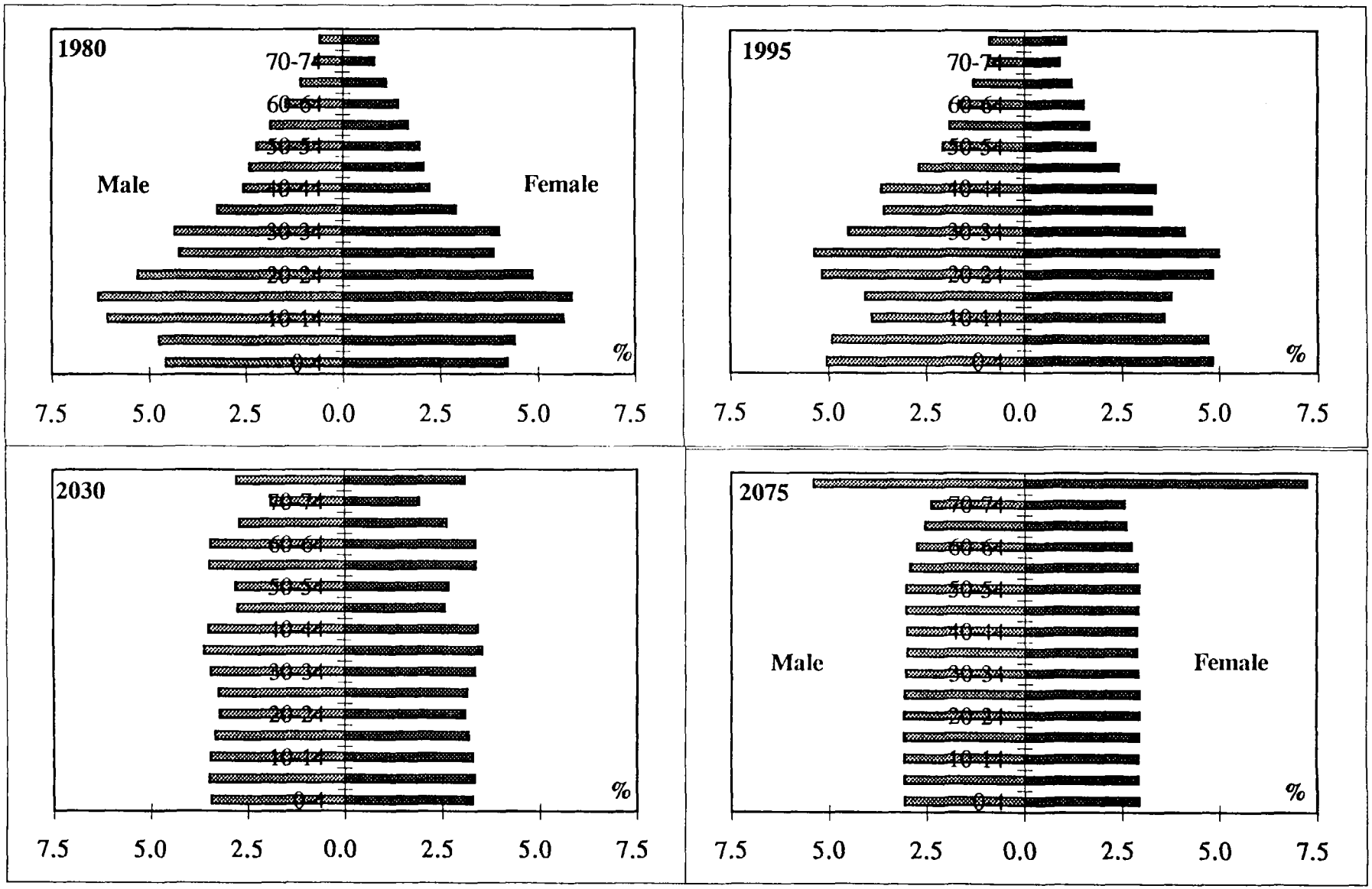

China: Average Age of Population 1985-2150
Years
Year
Average Age
Male
Female
China: Youth and Elderly Support Ratio 1985-2150
Per 100 persons 20 to 59 years old
Total Dependency
Youth: 0-19 years old
Elderly: 60 years and older
Year

Figure 5

China: Evolution of Age Structure



This accelerated aging process has also been heavily influenced by very aggressive birth control policies. Especially the "one couple-one child" policy has been carried out since the late 1970s in response to the baby boom from 1960s to early 1970s, and in order to move rapidly to a balanced simple reproduction level. Admittedly, this "one-child" policy has been successful to reduce the number of the new born, as evidenced by a sharp decline of the total fertility rate from 5.8 per woman in 1970 to 2.0 in 1993 and of the crude birth rate from 33 in 1970 to 19 in 1993. However, it creates irregular waves of population cohorts and imposes pressures for frequent adjustments in education systems, employment settlements, and pension systems for retirees. In the worst case, when persons born under the "one-child" policy reach the age of child-bearing, they may enter into a 1-2-4 structure, i.e., the middle-aged couple have to support their young child as well as four old grandparents. Unfortunately, the population age structure may reflect past irregularities for several generations before these echo effects disappear. Trade-offs between short-term benefits and long-term costs have to be taken into consideration when population policies are adjusted.

Structural Adjustment and Rural-Urban Balance

Rural-urban balance is another important aspect of the old-age security system evolution in China. As in most countries, the share of the population living in urban areas increases during the course of industrial development and economic growth. Driven primarily by youthful migration from the countryside to big cities, urbanization changes socio-economic profiles of the work force as workers shift from predominantly self-sufficient agricultural engagement to highly mobile industrial pursuits and services. Old persons, especially old women, in urban areas usually have relative disadvantages in competing with better educated and more flexible younger workers in income generation, and thus tend to have a decreased participation in the labor force and a greater need for support. After a fast growth rate of 3.0 percent per annum during 1970s, urban population in China increased at an accelerated rate of 4.3 percent per annum during the period from 1980 to 1993. This rate is more than three times the overall national population growth rate of 1.4 percent in the same period and significantly

higher than the corresponding world average of 2.6 percent. Consequently, the share of urban population in the national total rose sharply from 17 percent in 1970 to 29 percent in 1993. However, the current level of urbanization in China is still very low as compared with that of 60 percent in middle-income countries and 78 percent in high-income countries in 1993.

Urbanization stimulates changes in the family structure and kinship networks with both beneficial and adverse impact for the well-being of the elderly. These changes have particular implications for old age security arrangements in China. On one hand, young family members living in urban areas may not be able to provide immediate and direct care for their parents and grandparents who may remain in rural areas. The delivery of services to the rural elderly is often logistically difficult and costly when socialized institutions and the basic infrastructure are not yet in place. On the other hand, the younger generation in urban areas with better job opportunities may have enhanced financial capacities to support their parents and can afford to pay for higher quality services, such as old age health care. Given China's current low level of urbanization, one approach to addressing this rural-urban balance might be to use economic incentives to reduce population concentration in large cities with a population more than one million but develop small and medium cities with a population between 100 to 500 thousands. The elderly can thus live together with or within a short distance from the younger members of the family. Policy efforts have to be formulated well in advance since the magnitude and the speed will be unprecedented in history: To absorb a half of about 400 million incremental population between 1995 and 2030 and reach an urbanization level of 35 percent, China needs to build up around 1,000 cities with an average size of 200,000 persons within just 35 years!

Sustainability of Socio-economic Transition

Bottlenecks for establishing a well-functioning old age security system in China can also present themselves in terms of **social and political sustainability of economic transition**. As the economy experiences systemic transformations and becomes more market oriented and more open to the outside world, it undergoes various social, political, and institutional changes as well. Economic growth together with pension reforms will change the

original pattern of income distribution among different interest groups. People's expectations and decisions on consumption and savings, on labor supply and wage demand, and on inter- and intra- generational income redistribution have to be reshaped to better reflect the economic and social realities. To minimize disruption associated with the transitional distortions, governments have to formulate strategies and policies to deepen reforms and mitigate the potential social costs of reforms. Legal and regulatory frameworks have to be set up to govern design and management of pension and social security systems and to specify the sharing of responsibilities for financing retirement pensions among state, enterprises, and individual employees. The labor market needs to be more flexible and labor more mobile. Financial markets need to be developed to stimulate efficient resource allocation. Incentives are needed to ensure adequate national savings and capital accumulation. Administrative interventions of governments in supporting the elderly needs to be rationalized. Without socially sustainable economic growth, social security reforms are unlikely to be successful.

Meanwhile, an appropriate old age support system can be supportive to a desirable growth process, generating a number of positive externalities. These include stimulating capital formation and labor mobility, and encouraging productive investments. One of the most pressing issues in China at present is to integrate pension reforms with restructuring of state-owned enterprises (SOEs). As in many other historically socialist countries, SOEs in China directly provide their employees with housing, pension, child care, health care, and other benefits to cover nearly all living needs throughout their lifetime "from cradle to grave". In some of the older enterprises, the pensioner-employee ratio has reached a level of one-to-one. In a planned regime, profits were taken away and resources were allocated according to plan, hence the pension burden on individual enterprises was not a serious concern. With marketization, individual enterprises have hard budget constraints imposed and become directly responsible for profits and losses. Pension expenditure turns out to be a big burden too heavy to carry forward for many SOEs. Even when the core business of an enterprise is profitable, it may show losses because of its large pension outflows; and thus its capacity to operate, borrow, and expand suffers. A large number of pensioners have not been able to get what was promised to them just because of the accident of their

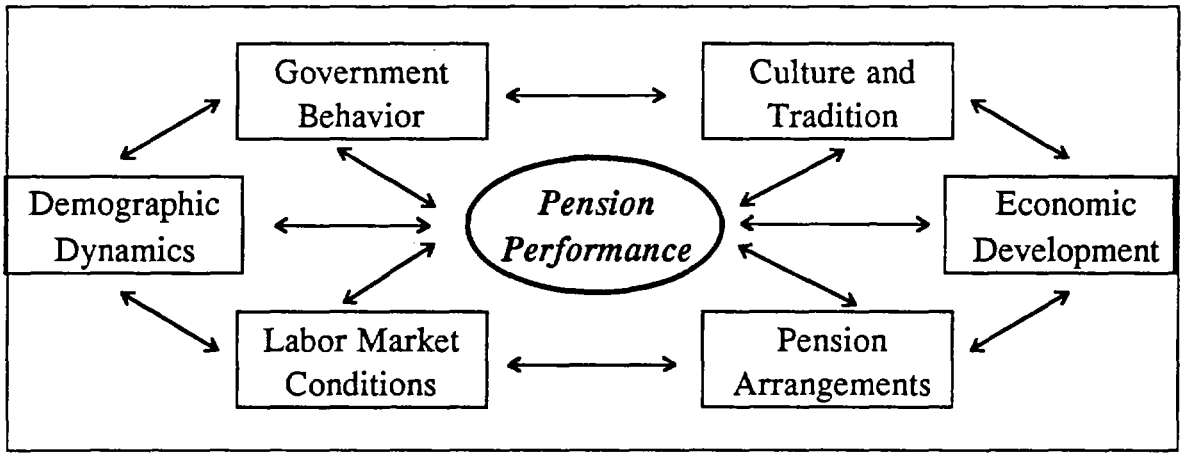
being assigned in the past to an enterprise that is not making enough money now. This system, insufficient in some cases and unfair in other cases, seriously impedes labor mobility and productivity and leads to delays for enterprise reforms. Bankruptcy of an SOE raises difficult issues of how to honor the pension commitments and other social welfare obligations to its retirees. Therefore, it is very important and urgent to formulate and implement a strategy to develop a market-based pension system and a robust social safety net, freeing enterprises of direct welfare responsibilities and thereby helping reform the enterprise system. In order to de-link the enterprise from provision of all retirement income and to share the costs of retirement programs among enterprises, the central government has recently encouraged local governments to experiment in setting up pension pools. This to a certain degree has relieved some enterprises of full direct responsibility for their worker's retirement pensions since resources and risks are pooled among enterprises. However, governments need to accelerate their programs to widen pension, unemployment and health insurance pools and improve financial linkages between contributions and benefits. Meanwhile, the pooled pension schemes need to enlarge their coverage, especially to include employees in collective (township and village) enterprises, foreign joint ventures, and individual private enterprises, who are becoming increasingly more numerous in number and more important in economic contributions.

These four areas of concerns are closely intertwined with the overall issue of how best to address the old age income security in China, when its population is aging at a remarkable pace. The key point here is that a social security system shall not be viewed as a purely accounting or even economic matter. Pension reforms need to take into consideration the cultural background, respect traditional values, formulate long-term visions on demographic trends and economic growth, and adjust macroeconomic policies to smooth this social transition.

III. A Simple Simulation Model for Pension Reforms

To quantitatively analyze policy implication of pension reforms, a mathematical model is a necessary though not sufficient tool. Ideally, a comprehensive dynamic general equilibrium model might be better to reflect interdependence of economic factors in policy reforms. However, such a model would impose more data and resource requirements. This section describes a simple simulation model, which is composed of four blocks illustrating interrelations among (a) a representative pension fund, (b) demographic trends, (c) development of the economy and labor market, and (d) government behavior under different pension arrangements. Figure 6 below presents key inter-links among these factors.

Figure 6 Links Among Pension Performance and Socio-Economic Development



Like the RMSM-X model used in the World Bank for medium term projections and policy consistency check, the model proposed here is useful to examine the financial sustainability of pension funds and to show impacts of external changes and policy alteration. The model, however, has not explicitly endogenalized linkages between the pension accounts and the affecting factors, such as savings through pension schemes and

GDP growth, and between labor supply and wage-pension setting. In addition, the treatment of uncertainty is done indirectly, though evaluating the effectiveness of pension reform options encounters numerous uncertainties. To a certain extent, both demographic dynamics and economic development are stochastic processes affected by many unpredictable factors. With some information on prior probability distributions of these random factors, the basic structure of the model can be used to generate bounds of confidence intervals, such as in the scenario analysis through defining "the best" and "the worst" possible situations. Another approach of addressing these uncertainties is through stochastic numeric simulations (e.g. using Monte Calro techniques).

Political economy of pension reforms is also difficult to model. Since pension reforms necessarily redistribute income among different generations and among different income groups within one generation. Pareto optimality is difficult to achieve during the reform period. These may have serious implications for social stability and longer-term sustainable income growth

The Pension Fund Balance

During the planning period $t \in \{t_0, t_0+1, t_0+2,.., t_0+T\}$, the balance of a representative pension fund in a specific region at time t, denoted by B_t, can be written as

$$B_t = (1+r_t)B_{t-1} + I_t - O_t - AE_t, \quad \text{for given } B_{t-1}$$

where the increment is the difference between the current income (as the sum of the investment returns on the previous balance B_{t-1} at rate r_t and the contribution inflow I_t) and the current expenditure (as the sum of total pension payments O_t and the administrative expenses AE_t). This increment can be negative when the income cannot fully cover the expenditure, and thus the fund decumulates. Let $s \in \{M, F\}$ be sex index for male and female, respectively. Given A_1^s for the average first time working age and A_2^s for the retirement age, the total contribution to the fund can be calculated as

$$I_t = \sum_{s\in\{M,F\}} \sum_{a=A_1^s}^{A_2^s} c_t W_t^{a,s} N_t^{a,s}$$

where c_t is the pension-related payroll tax rate, $W_t^{a,s}$ is the nominal average wage for workers at age a and $N_t^{a,s}$ is the number of workers covered by the pension scheme. The summations are conducted over both age and sex. Meanwhile the total pension payments can be calculated as

$$O_t = \sum_{s\in\{M,F\}} \sum_{a=A_2^s+1}^{A_3^s} \theta_t H_t^{a,s} N_t^{a,s}$$

where A_3^s is the maximum age and $H_t^{a,s}$ is a basis for pension calculation, which can be linked to the pensioners' personal wage history, past contributions to the fund, the wage profile of current workers, inflation, or some other social or policy factors. The replacement rate, θ_t, specifies the benefit a pensioner will receive as a portion of the pension basis. Thus, in a functional form,

$$H_t^{a,s} = a_t^{a,s}(w, i, \ldots)$$

where w and i are wage and inflation matrices. In some cases, H can be zero if the person is not eligible for pension benefits. The administrative cost is affected by many factors, including the fund balance (portfolio management, cash flows, and some fixed cost. For simplicity, , the administrative cost in our simulation is taken as a portion of the average of the total income and total payments of the fund balance, i.e.,

$$AE_t = e_t \frac{I_t + O_t}{2}$$

where e_t captures the cost effectiveness of the fund management.

Demographic Dynamics and Labor Market

At time t, the magnitude and age structure of the population can be presented as a simple first order Markov chain,

$$P_t^{a,s} = (1 - m_t^{a,s}) P_{t-1}^{a-1,s} + NI_t^{a,s}, \text{ for } a \in \text{int}(0, A_3^s]$$

where $P_t^{a,s}$ is the population of sex s at age a, $m_t^{a,s}$ is the mortality rate, and $NI_t^{a,s}$ is the net immigrants into the region.

$$P_t^{0,s} = (1 - m_t^{0,s}) \sum_{a=20}^{49} f_t^a P_t^{a,s}$$

where $m_t^{0,s}$ is the infant mortality rate for the first year after birth, and f_t^a is the fertility rate of a woman at age a, which depends critically on the population policy, social custom, and current and expected economic conditions including the cost of raising a child. The old-age dependence ratio, d, is defined as

$$d = \frac{\sum_{s \in \{M,F\}} \sum_{a=A_2^s}^{A_3^s} P_t^{a,s}}{\sum_{s \in \{M,F\}} \sum_{a=A_1^s}^{A_2^s - 1} P_t^{a,s}}$$

The size of the labor force can be written as

$$L_t^{a,s} = l_t^{a,s} P_t^{a,s}$$

where $l_t^{a,s}$ is the labor participation rate across ages and sexes. Here, the participation rates for the young and the old are set to zero, namely, $l_t^{a,m} = l_t^{a,f} = 0$ for $a \in \text{int}[0, A_1^s)$ and $a \in \text{int}[A_2^s, A_3^s]$. The total employment $E_t^{a,s}$ is the product of the labor force and the employment rate, $1-u_t^{a,s}$, namely,

$$E_t^{a,s} = (1 - u_t^{a,s}) L_t^{a,s} \quad \text{for } a \in \text{int}[A_1^s, A_2^s)$$

The pension scheme coverage can be presented by

$$N_t^{a,s} = \begin{cases} \sigma_t^{a,s} E_t^{a,s}, & for \quad A_1^s \le a < A_2^s \\ (1 - m_t^{a,s}) N_{t-1}^{a-1,s}, & for \quad A_2^s \le a \le A_3^s \end{cases}$$

where $\sigma_t^{a,s}$ is the contribution coverage ratio.

Economic and Wage Growth

The economy is assumed to follow a growth pattern, which is affected by a number of factors including population growth, labor productivity improvement, technological and management innovations, and government policies. For simplicity, we only emphasize the linkage between the increase of real wage, $w_t^{a,s}$, with the growth of per capita output, g_t, i.e.,

$$\frac{\Delta w_t^{a,s}}{w_{t-1}^{a-1,s}} = w(g_t),$$

where w( ) is a functional form and the real wage in the base year is set to be 1. For given price level in the base year P_0 and a path of inflation rates, π_t, the nominal wage then can be calculated as

$$W_t^{a,s} = w_t^{a,s} P_0 \prod_{\tau=1}^{t} (1 + \pi_\tau)$$

Government Behavior under Different Pension Arrangements

The government may have multiple objectives in pension design and reforms. The simplest approach is to assume that the government attempts to maximize a well-defined social welfare function, which takes into consideration (indirect) utility functions of all individuals in the society. Hence generally, the government's behavior shall be derived from the following maximization framework

$$\text{Max SWF} = \text{SWF}(V^j, j \in P)$$

subject to all the relevant constraints. Here P is the union of all categories of people in the society and V^j is the expected life-time indirect utility of an individual j, which mainly depends on the individual's income stream (wages when he/she works and pension benefit after he/she retires), variations of price levels, his/her own time preference parameters, and probability distributions on future uncertainties. Namely,

$$V^j = E\{v^j[(W_t^j, \theta_t H_t^j); \pi_t]\}$$

Policy instruments available to the government vary with different kinds of pension arrangements. Four out of many commonly adopted pension schemes, namely a Pay-as-you-go scheme, a defined benefit scheme, a defined contribution scheme, and a private fund-type scheme, are discussed here. Through some aggregation, policy implications of reforming to a multi-pillar system as advocated by the World Bank can also be simulated. For the purpose of policy simulations here, uniformity is assumed across individuals so that the whole society can be treated as a unit. When the policy focus turns from the solvency of pension funds to income redistribution, the model needs considerable modification.

Pay-As-You-Go Scheme

Strictly speaking, this scheme requires that the pension fund be balanced in each and every single year during the whole planning period. In practice, pensions are usually indexed to wages and financed by a pay-roll tax. In this case, $B_t = 0$ for all t, i.e.,

$$I_t = O_t + AE_t$$

where the total income of the pension scheme cover exactly the sum of the total pension payments and the administrative cost at each period t. Given the demographic dynamics, the pension-wage linkage, and the administrative efficiency, the behavior of the government can be derived as

$$\underset{[c^{\min},c^{\max}]}{Min}\ c_t = \frac{1+\frac{e_t}{2}\sum_{s\in\{M,F\}}\sum_{a=A_2^s+1}^{A_3^s}\theta_t H_t^s N_t^{a,s}}{1-\frac{e_t}{2}\sum_{s\in\{M,F\}}\sum_{a=A_1^s}^{A_2^s} W_t^{a,s} N_t^{a,s}} \quad \text{for all t,}$$

where $[c^{min}, c^{max}]$ is the feasible region for the contribution rate. Under the Pay-As-You-Go system, there will be no explicit or implicit debts generated from pension fund insolvency accumulating through time. But the required minimum contribution rate changes from year to year, and could increase to a level socially unbearable when the population ages.

Defined Contribution System

Within the defined contribution system, the contribution rate is usually fixed at a certain level $c=c_t$. The government can choose to set a uniform replacement rate ($\theta=\theta_t$) to the highest possible while the pension fund is maintained with positive balances during the planning period. This translates into

$$\underset{[\theta^{\min},\theta^{\max}]}{Max}\ \{\theta\},$$

where $[\theta^{min}, \theta^{max}]$ is the feasible region for the benefit rate. This maximization is subject to $B_t \geq 0$ and that all other relations specified above hold. The disadvantage of this kind of pension system is that when the ratio between the numbers of the pensioners and workers becomes larger over time, the benefit received by the pensioners will decline significantly.

Defined Benefit System

A defined benefit pension system specifies the pension path a retiree will receive during the period after he or she retires. The government minimizes the required contribution rate, which can be assumed uniform through time for simplicity, because doing so increases the disposable income of the workers without scarifying pensioners' welfare. Therefore, policy simulations can be based on all the accounting and economic relations specified above and the following optimization framework:

$$\underset{[c^{\min}, c^{\max}]}{Min}\{c\}, \qquad \text{subject to } B_t \geq 0,$$

where $[c^{min}, c^{max}]$ is the feasible region for the contribution rate. The potential problem with this system is that even with a very moderate replacement rate, the burden for the contributing workers could be too heavy as the population ages.

Private Pension Fund Accounts System

One critical argument for publicly managed social security system is rooted in paternalistic concerns—the belief that many individuals, if left to themselves, could be myopic in their consumption-savings behavior and thus would not save enough to sustain their living standards after retirement. Therefore, everyone in the society needs to be mandated to save at least a minimum portion of his or her income before the retirement age. A private account can be established to record the savings. Within this system a worker pays a certain percentage of his wage to the fund when he works and receive a pension after he retires according to the amount of his total savings and investment returns.

Let c be the portion of wage a worker sets aside for his retirement, then his life time savings values at the time of retirement, A_2^*, will be

$$B_{A_2^*} = \sum_{t=A_1^*}^{A_2^*} \left[(cW_t - AE_t) \prod_{\tau=t}^{A_2^*} (1 + r_\tau) \right]$$

where AE_τ is the personal transaction cost of maintaining the account and r_τ is the interest rate. If the possibility of receiving and giving bequest is ignored, namely,

$$B_{A_3^s} = 0$$

and the pension he derives from his personal fund is an annuity fully indexed with the inflation, then

$$B_t = (1+r_t)B_{t-1} - O\prod_{\tau=A_2^s+1}^{t}(1+\pi_\tau) \quad \text{for t} \in \text{int}[A_2^s+1,\ A_3^s].$$

where O is the real annuity valued at time of retirement. The worker's problem is then to find an appropriate c for a given O or to derive an acceptable O for a given c. The government can affect individual workers choice through its macroeconomic policies which exercise direct impact on wage levels, interest rates, real and expected levels of inflation, and the transaction cost of maintaining private pension funds.

A Multi-pillar Pension System

Recent work by the World Bank (1994) suggests that a combination of multiple pillars of old age income support may be most suitable. There should be some minimum pension guaranteed by the state to all pensioners. This would then be complemented by a second leg which would allow for each person to contribute to an individual account. The idea is that the former would help to protect the poorer members of society but also those who are not able or choose not to save for retirement. The latter would allow for each person to save with appropriate safeguards and achieve certain living standards for their old age. In order to meet these needs, various individual pension options warrant careful consideration but it is also important to weigh the overall implications. This might be done in the context of the four options noted above.

IV. Pension System Reform in China

This section turns to analyze policy options for pension system reforms in China. First, some aspects of the evolution of the Chinese pension systems since 1978 are reviewed. This helps to calibrate parameters essential for simulating policy reforms based on the simulation model presented in the last section. A benchmark case is then worked out to show that the current pension arrangements are unlikely to remain financially sustainable for more than forty years if no reforms are undertaken. Then some policy simulations are conducted to numerically illustrate implications of different reform options.

The Current Pension System in China

Out of a total labor force of more than 600 million, existing pension schemes cover about 150 million, mostly employees of state enterprises, government staff, plus a portion of urban collectives. These schemes, many of which are not financially healthy at present, leave uncovered about 75 percent of labor force, mainly rural peasants, urban contract workers, and employees of individual firms. Permanent workers' pensions are publicly managed and basically financed by payroll taxes on a pay-as-you-go basis. Enterprises share a part of the financial burden through contributing a portion of permanent employee's current wage to the pension pool. Retirement age is relatively young, 60 for men and 55 for women. Many workers retire early for health reasons or disability, in most cases receiving full benefits. Contribution rates vary across regions and sectors and may apply to different bases. Financial and actuarial linkages between contributions and benefits are not always clear. Pension funds are usually deposited in local bank accounts that are often less-than-fully indexed with inflation. Local interest in keeping financial resources within the localities do not always lead to investments with highest possible returns. Over time, the aging of China's population means that pension expenditures as currently structured will increase dramatically from 12.7% of the total wages in 1987 to almost 20% by 1997, to 25% by 2010 and to over 48% by 2030. Table 3 below presents some statistics that quantitatively summarize development of China's formal pension systems between 1978 and 1993.

Table 3

China: Pension and Wage Statistics 1978-1993

	Pensioners		Employees		Employee	Average Pension			Average Wage			Pension Wage Ratio		GNP	CPI
	Number	Growth	Number	Growth	Pensioner	Nominal	Real 78	Growth	Nominal	Real 78	Growth	Average	Total	Growth	Change
	million	%	million	%	Ratio	Yuan		%	Yaun		%			%	%
1978	3.1		95.0		30.3	551.0	551.0		615.0	615.0		89.6	3.0	11.7	0.7
1979	6.0	89.8	99.7	4.9	16.7	714.0	700.0	27.0	668.0	654.9	6.5	106.9	6.4	7.6	2.0
1980	8.2	36.9	104.4	4.8	12.8	714.0	660.4	(5.7)	762.0	704.8	7.6	93.7	7.3	7.9	6.0
1981	9.5	16.4	109.4	4.7	11.5	706.0	637.7	(3.4)	772.0	697.3	(1.1)	91.5	7.9	4.4	2.4
1982	11.1	17.2	112.8	3.1	10.1	709.0	628.4	(1.4)	798.0	707.3	1.4	88.8	8.8	8.8	1.9
1983	12.9	16.1	115.2	2.1	8.9	726.0	634.0	0.9	826.0	721.3	2.0	87.9	9.9	10.4	1.5
1984	14.8	14.4	118.9	3.3	8.0	766.0	650.7	2.6	974.0	827.4	14.7	78.6	9.8	14.7	2.8
1985	16.4	10.8	123.6	3.9	7.5	935.0	730.0	12.2	1,148.0	896.3	8.3	81.4	10.8	12.8	8.8
1986	18.1	10.3	128.1	3.6	7.1	983.0	724.1	(0.8)	1,329.0	978.9	9.2	74.0	10.4	8.1	6.0
1987	19.7	9.0	132.1	3.2	6.7	1083.0	743.5	2.7	1,459.0	1,001.6	2.3	74.2	11.1	10.9	7.3
1988	21.2	7.7	136.1	3.0	6.4	1322.0	765.8	3.0	1,747.0	1,012.0	1.0	75.7	11.8	11.0	18.5
1989	22.0	3.8	137.4	1.0	6.2	1450.0	713.1	(6.9)	1,935.0	951.6	(6.0)	74.9	12.0	4.0	17.8
1990	23.0	4.5	140.6	2.3	6.1	1726.0	831.3	16.6	2,140.0	1,030.7	8.3	80.7	13.2	5.8	2.1
1991	24.3	5.7	145.1	3.2	6.0	1936.0	906.2	9.0	2,340.0	1,095.3	6.3	82.7	13.9	6.1	2.9
1992	26.0	6.8	147.9	2.0	5.7	2260.0	1003.7	10.8	2,711.0	1,204.0	9.9	83.4	14.6	13.6	5.4
1993	27.8	7.0	148.5	0.4	5.3	2779.0	1090.2	8.6	3,371.0	1,322.5	9.8	82.4	15.4	13.4	13.2

Source: Chinese Statistics Press -- Yearbook of Labor Statistics of China 1994

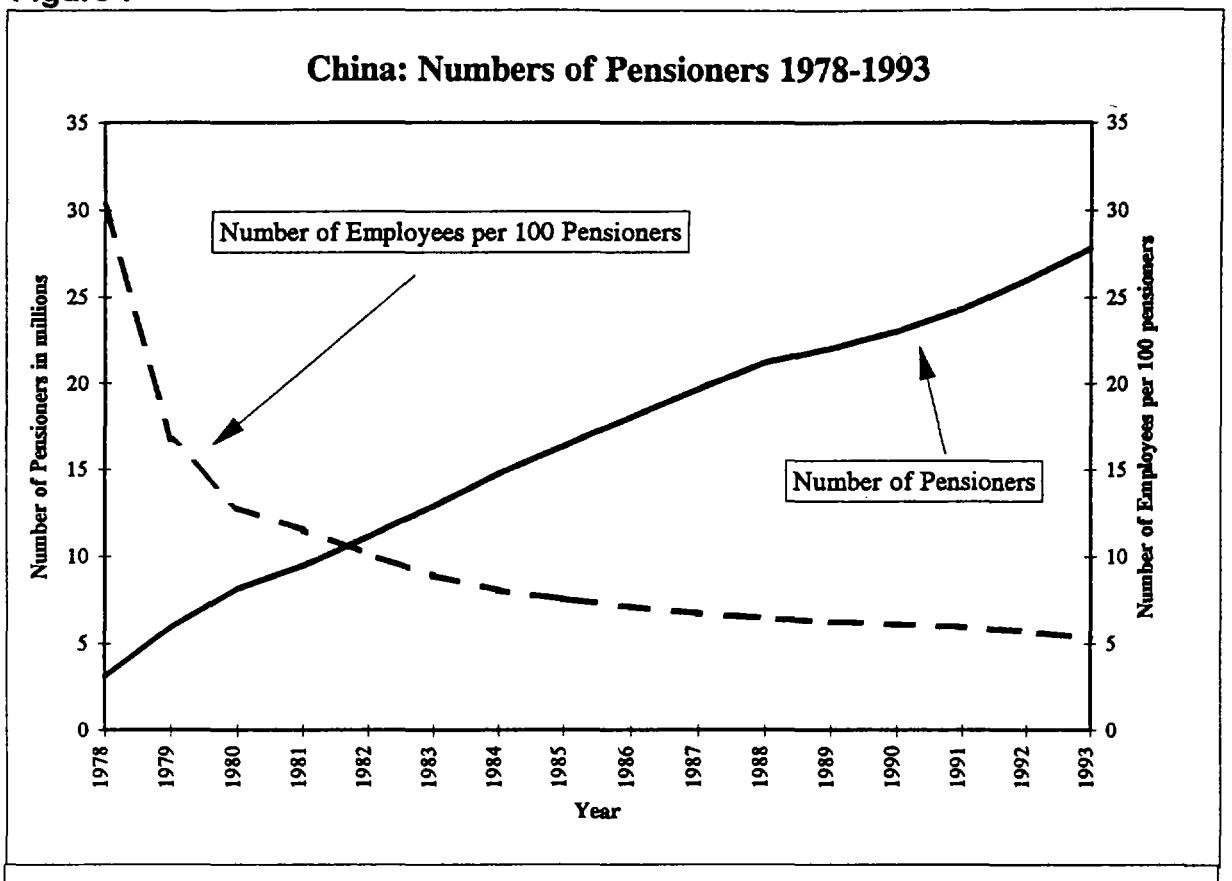
During these sixteen years between 1978 and 1993, pension-covered employment grew by 56.3 percent while the retirees supported by the pension systems increased by close to eight times, leading the employee-pensioner ratio declining dramatically from 30.3 in 1978 to only 5.3 in 1993. This ratio will continue to decline when more people who joined the labor force in 1950s and early 1960s reach the retirement age. While the pension-wage ratio on average remained relatively stable around 80 percent in recent years, the total pension expenditure increased remarkably from 3.0 percent of the total wage bill in 1978 to 10.8 percent in 1985, and then to 15.4 percent in 1993. This occurred because the pension scheme was of a defined-benefit type and the number of pensioners increased sharply from 3.1 million in 1978 to 16.4 million in 1985, and then to 27.8 million in 1993. People outside of the public pension coverage rely mainly on private savings and family supports for their old age income security. This explains, at least partially, why China's gross domestic savings (GDS) rate can be as high as 35 to 40 percent.

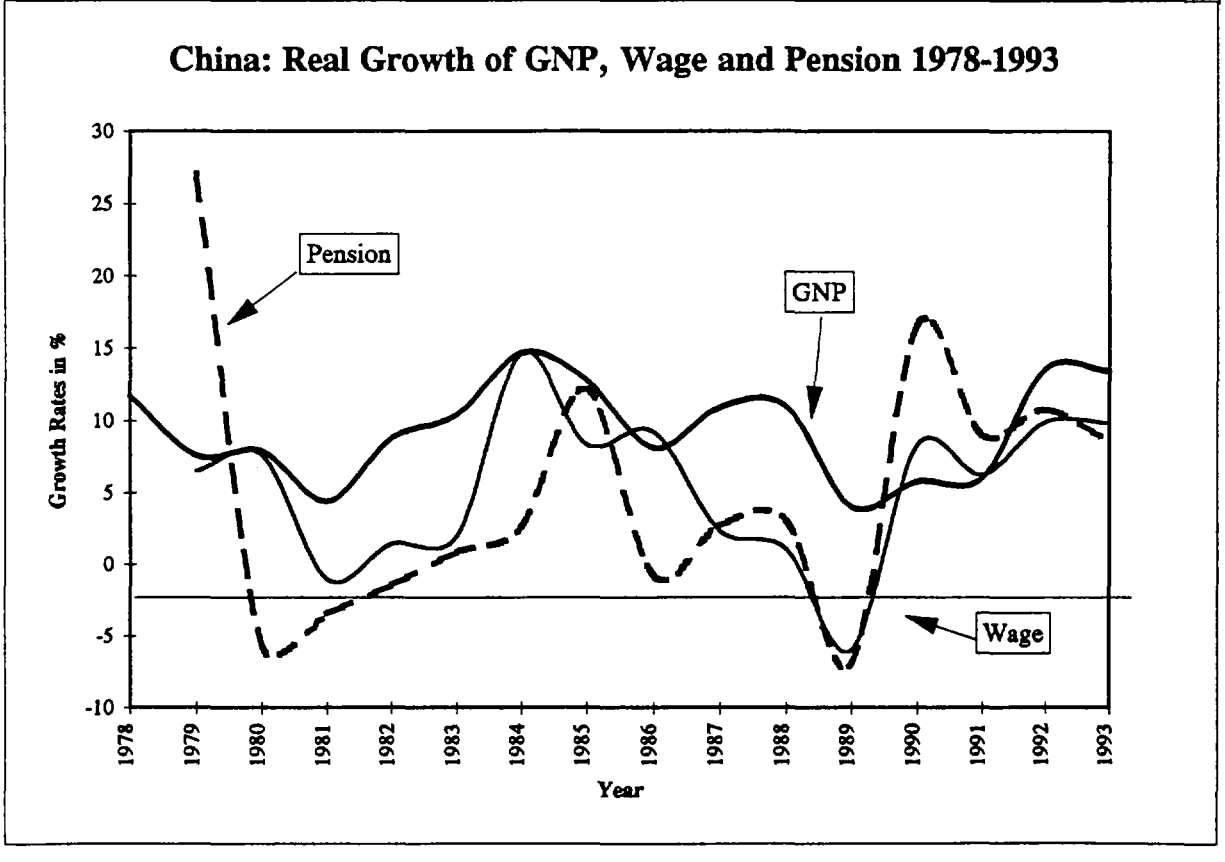
Real growth of GNP per capita, average wage, and average pension were not closely correlated. In 1988 and 1989, when GNP grew by 11.0 percent and 4.0 percent, respectively, the real average wage rose by only 1.0 percent in 1988 and actually declined by 6.0 percent in 1989. High inflation -- 18.5 percent in 1988 and 17.8 percent in 1989 -- completely eroded moderate gains in nominal wage. Correspondingly, the real average pension rose slightly by 3.0 percent in 1988 and dropped by 6.9 percent in 1989. This may be one of the reasons leading to social unrest in many regions in 1989. To investigate how real wage growth is linked to GDP growth and inflation rate, we run a regression using data presented in Table 3 and get the following result:

$$\frac{\Delta w_t}{w_{t-1}} = \underset{(5.94)}{0.8786 g_t} - \underset{(-2.383)}{0.4060 \pi_t}, \quad R^2 = 0.525, F = 7.183$$

where the numbers in brackets are t-statistics, showing that the regression is significant at level α=5%. Hence, the real wage gains about 0.88 percent if GDP grows by one more percent, while an increase in inflation of one percent is associated with a 0.4 percent erosion of the workers' gain. Figure 7 shows historical paths of GDP growth, pension and wage movements, and changes in numbers of contributors and pensioners, respectively.

Figure 7


China: Numbers of Pensioners 1978-1993
Number of Employees per 100 Pensioners
Number of Pensioners
Number of Pensioners in millions
Number of Employees per 100 pensioners
Year
0
5
10
15
20
25
30
35
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993


China: Real Growth of GNP, Wage and Pension 1978-1993
Pension
GNP
Wage
Growth Rates in %
Year
-10
-5
0
5
10
15
20
25
30
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993

The Need for Pension Reforms: The Benchmark Case

The model specified above is utilized to simulate policy sensitivities of reforming pension systems in China for 80 years between 1995 and 2075. The basic demographic information is extracted from the World Bank Population Projections (World Bank, 1995). Key parameters are calibrated using historical data published by Chinese authroties. Essential assumptions are spelt out based on reasonable judgment of Chinese economic outlook in the next century. For simplicity, many indicators are kept uniform through time, but these can be changed as deemed appropriate.

Base Year Parameters

In the base year 1995, the initial balance of all pension funds in urban areas, which are treated as a single fund hereafter, remains in the neighborhood of 100 billion Yuan or 1.8 percent of the total GDP. The average annual wages for a male and a female worker in 1995 are estimated to be around five thousand Yuan. A simple replacement ratio between the average pension and the average wage is used, which stands at 75 percent in 1995. Thus the average pensions for a male, who retires at age of 60, and a female pensioner, who retires at 55, in 1995 are estimated to be around 3.75 thousand Yuan.

Key Assumptions

Table 4 summarizes some key assumptions for the simulation exercises. Real GDP is assumed to grow at an average rate of 10 percent per annum until 2000 and then at a lower rate of 7.5 percent between 2001 and 2049. Since 2050, GDP growth stablizes at 5% per annum. The annual inflation rate declines from 10 percent during 1996-2000 to 7.5 percent between 2001 to 2049 and then to 5 percent starting from 2050. The growth of real wage depends on the GDP growth and inflation path, according to the formula specified in the regression equation presented in the last section. Nominal wages are fully indexed to inflation

Table 4

China: Major Assumptions for Public Pension System Analysis

(The Base Case)

	1995	1996	1997	1998	1999	2000	2010	2025	2050	2075
GDP Growth (%)	10	10	10	10	10	10	7.5	7.5	5	5
Inflation Rate (%)	10	10	10	10	10	10	5	5	3.5	3.5
Real Wage Growth (%)	4.7	4.7	4.7	4.7	4.7	4.7	4.6	4.6	3.0	3.0
Contribution Rate (%)	27	27	27	27	27	27	27	27	27	27
Replacement Rate (%)	75	75	75	75	75	75	75	75	75	75
Administrative Cost Ratio (%)	3	3	3	3	3	3	3	3	3	3
Real Rate of Returns on Fund Reserves	2	2	2	2	2	2	2	2	2	2
Price Index	1	1.10	1.21	1.33	1.46	1.61	2.62	5.45	13.85	32.73
Real Wage (Yuan '000)	5.0	5.2	5.5	5.7	6.0	6.3	9.8	19.2	43.1	89.6
Nominal Wage (Yuan '000)	5.0	5.8	6.6	7.6	8.8	10.1	25.8	104.7	597.0	2,934.0
Real GDP (Y. trillion)	5.5	6.1	6.7	7.3	8.1	8.9	18.3	54.0	205.8	696.8
Nominal GDP (Y. trillion)	5.5	6.7	8.1	9.7	11.8	14.3	47.9	294.6	2,849.8	22,806.4

During the next 80 years, the replacement rate is averaged at 75 percent, while the contribution rate is averaged 27 percent under the selected pension arrangements. The administrative cost is assumed to be 3 percent of the average of pension fund receipts and payments. The real rate of returns from investment of the pension fund balance is assumed to be 2 percent across time.

The urbanization speed is taken to be 0.3 percent per annum, leading the urban population as a share in the total national population increasing gradually from 29.6 percent in 1995 to 38.4 percent in 2030 and to 50 percent in 2075. This compares with 54 percent in low-middle-income economies on average in 1993. The urban labor participation rate averages 90 percent, and the unemployment rate is kept around 3 percent.

Pressure from Population Aging

Under these assumptions for the benchmark case, the pressure from population aging is apparent. Table 5 below presents a projected population structure and pension coverage for China from 1995 to 2075. The population dependency rate, in terms of the number of persons older than the retirement age per 100 working age persons, increases from about 21 in 1995 to 44 around 2025 and then rises again to nearly 70 in 2075. The system dependency ratio, in terms of the number of pensioners per 100 contributors, decreases initially from 21 in 1995 to 15 around 2000 when the pension coverage rate for the working age population extends from 25 percent to 38.5 percent, as projected. This implies more contributors will join the pension pool in the near future. However, this system dependency rate quickly rebounds to 35.1 in 2025 and approaches the population dependence rate in 2075, as the population structure and the pension system mature. If the young dependents are also taken into consideration, the total dependency rate will be in the neighborhood of 100 around 2025.

Table 5

China: Projection of Population Structure and Public Pension System Coverage
(The Base Case)

	1995	1996	1997	1998	1999	2000	2010	2025	2050	2075
Population (Thousand)	1,218,134	1,230,499	1,244,183	1,259,230	1,275,670	1,293,548	1,420,314	1,597,166	1,763,793	1,821,789
Young (below age 20)	424,807	427,741	430,939	434,418	438,185	442,255	444,272	436,160	436,950	438,226
Working	656,096	662,532	669,943	678,345	687,760	698,218	766,834	807,431	810,387	814,603
System Covered	164,025	186,701	208,267	228,990	249,105	268,813	416,853	507,362	527,935	532,052
Not Covered	492,071	475,831	461,676	449,355	438,655	429,404	349,981	300,069	282,453	282,551
Old	137,231	140,224	143,301	146,467	149,725	153,076	209,208	353,575	516,455	568,960
System Covered	34,308	35,057	36,092	37,388	38,924	40,678	75,676	178,327	312,402	360,693
Not Covered	102,923	105,169	107,209	109,079	110,801	112,398	133,532	175,248	204,053	208,267
As Percentage of Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Young	34.9	34.8	34.6	34.5	34.3	34.2	31.3	27.3	24.8	24.1
Working	53.9	53.8	53.8	53.9	53.9	54.0	54.0	50.6	45.9	44.7
Covered	13.5	15.2	16.7	18.2	19.5	20.8	29.3	31.8	29.9	29.2
Not Covered	40.4	38.7	37.1	35.7	34.4	33.2	24.6	18.8	16.0	15.5
Old	11.3	11.4	11.5	11.6	11.7	11.8	14.7	22.1	29.3	31.2
Covered	2.8	2.8	2.9	3.0	3.1	3.1	5.3	11.2	17.7	19.8
Not Covered	8.4	8.5	8.6	8.7	8.7	8.7	9.4	11.0	11.6	11.4
System Coverage Rate (%)										
Young	25.0	28.2	31.1	33.8	36.2	38.5	54.4	62.8	65.1	65.3
Old	25.0	25.0	25.2	25.5	26.0	26.6	36.2	50.4	60.5	63.4
Dependency Rates (%)										
Population	20.9	21.2	21.4	21.6	21.8	21.9	27.3	43.8	63.7	69.8
System	20.9	18.8	17.3	16.3	15.6	15.1	18.2	35.1	59.2	67.8
Young	64.7	64.6	64.3	64.0	63.7	63.3	57.9	54.0	53.9	53.8
Total	85.7	85.7	85.7	85.6	85.5	85.3	85.2	97.8	117.6	123.6

Source: Word Bank Population Projections and authors' estimates.

The Base Case Scenario

In the current pay-as-you-go pension system continues in to future without any reform measures being undertaken, China's pension system will not be financially sustainable. Table 6 below presents simulation results, with four indicators suggests the insolvency of the simulated pension fund. First, the fund's current balance turns negative in 2025, meaning that total receipts of the fund are not sufficient to cover the due payments and administrative cost. Second, the accumulated balance of the fund, which may peak at more than 30 percent of current GDP around 2010 when baby boomers are the backbone of the working force and the pension coverage expands quickly, becomes negative before 2050. Third, on a counter-factual basis, the pension cost rate is defined as the contribution rate required to obtain zero current balance for a given total pension payment. This cost rate in China rises from 12 percent in 2000 to 28 percent in 2025 and then to 54 percent in 2075, doubling the assumed contribution rate. A pension contribution rate higher than 30 percent is not likely to be socially acceptable. Finally, the affordable replacement rate can maintain above the assumed benefit rate until 2025. After that the affordable benefit rate drops to 32.7 percent, about a half the assumed benefit rate.

Clearly, financial sustainability is only one out of many demands for reforming the pension system in China. However, the strength of this demand is remarkably strong. Since pension policies impact over a long period, small incremental changes on annual basis can accumulate into enormous effects across time. As shown in Table 6, if the pension system were not modified, the negative accumulative balance of the pension fund in 2075 can reach an unbearable level of 41 percent of current GDP. Or alternatively, China can only afford to support half of its pensioners, who in fact have contributed to the pension fund throughout their working life.

Table 6

China: Pension Fund Accounts under Pay-As-You-Go Scheme

(The Base Case)

	1995	1996	1997	1998	1999	2000	2010	2025	2050	2075
With Reserves (Y. Billion)										
Revenue Collection	221.4	290.4	373.1	472.6	592.2	736.2	2,904.6	14,345.2	85,098.9	421,487.9
Pension Payments	128.7	151.4	179.6	214.3	257.1	309.5	1,464.7	14,005.7	139,879.8	793,718.1
Administrative Cost	5.3	6.6	8.3	10.3	12.7	15.7	65.5	425.3	3,374.7	18,228.1
Current Balance	88	132	185	248	322	411	1,374	(86)	(58,156)	(390,458)
As % of GDP	1.6	2.0	2.3	2.5	2.7	2.9	2.9	(0.0)	(2.0)	(1.7)
Investment Returns		12	29	55	91	141	895	5,355	(20,208)	(465,750)
Accumulative Balance	100	244	459	762	1,176	1,728	15,059	81,763	(445,787)	(9,324,392)
As % of GDP	1.8	3.7	5.7	7.8	10.0	12.1	31.4	27.8	(15.6)	(40.9)
NPV	100	222	379	572	803	1,073	5,740	14,992	(32,187)	(284,880)
With Zero Current Balance										
Cost Rate (%)	16.17	14.95	13.80	13.00	12.44	12.05	14.46	27.99	47.13	53.99
Affordable Benefit Rate (%)	125.3	139.5	151.2	160.5	167.7	173.2	144.3	74.5	44.3	38.7
Supportable Coverage Rate for the Old	41.8	46.5	50.8	54.6	58.1	61.4	69.6	50.1	35.7	32.7
Needed Coverage Rate for the Working Age	15.0	15.1	15.4	15.8	16.2	16.7	28.2	63.2	110.3	126.7
No. of Supportable Pensioners	57,304	65,226	72,760	80,000	87,027	93,912	145,632	177,252	184,439	185,877
No. of Needed Contributors	98,203	100,346	103,309	107,019	111,415	116,436	216,613	510,440	894,213	1,032,440
As Compared with Benchmark in %										
Contribution Rate	59.9	55.4	51.1	48.2	46.1	44.6	53.5	103.7	174.5	200.0
Benefit Rate	167.0	186.1	201.6	214.0	223.6	230.9	192.4	99.4	59.0	51.5
In 1995 Yuan										
Real Wage	5.00	5.24	5.48	5.74	6.01	6.30	9.84	19.20	43.11	89.64
Real Pension	3.75	3.93	4.11	4.31	4.51	4.72	7.38	14.40	32.33	67.23
As % of 1995										
Real Wage	100.00	104.73	109.68	114.86	120.29	125.97	196.75	384.03	862.11	1,792.83
Real Pension	100.00	104.73	109.68	114.86	120.29	125.97	196.75	384.03	862.11	1,792.83

Policy Simulations for Reform Options

Apparently, pension reforms cannot be avoided in China. The issues turn to what to do and when. This subsection simulates implications of various reform options for pension systems. With the simulation model, policies in four broader areas can be simulated:

(a) macroeconomic development, such as real GDP growth, inflation, and unemployment;

(b) labor market condition, including labor participation, real wage growth, and change of retirement age;

(c) demographic dynamics, mainly changes of mortality rates, migration, urbanization, and life expectancy; and

(d) pension fund management, such as effective coverage rate, contribution rate, compliance rate, eligibility conditions, changes of benefits in nominal and real terms, real returns from investment of fund surplus, administration costs, adjustment of linkage between real wage and real pension, and inflation indexing mechanism.

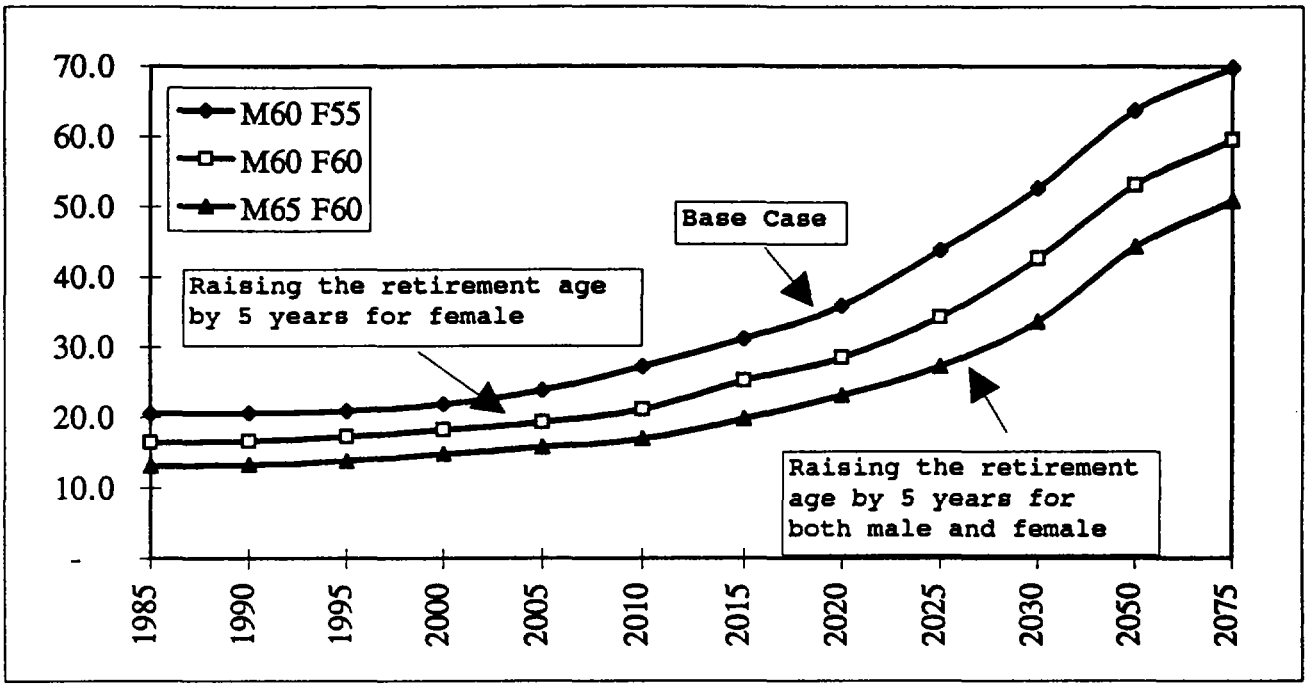
Out of many possible combinations of policy options, the impact of three changes are illustrated. The first simulation shows the effects of delaying retirement age. The second shows the possible consequences of different GDP growth paths. The last simulation compares trade-offs between raising contribution rates and lowing benefit rates.

Delaying Retirement Age

The most direct impact of delaying the retirement age is to change the system dependency rate of the pension system through enlarging the labor participation rate for old people. The impact can be dramatic, since the effect is doubled when the number of pensioners is reduced while the number of contributors is increased. Thus old age problem is converted into the (un)employment problem with pressures on real wage growth. Without endogenalizing the relationships among GDP growth, labor demand and supply, and real wage changes, it is difficult to predict the potential outcome. Here, only population dependence rates are plotted in Figure 8 for three sets of retirement age.

Figure 8

Population Dependency Rate With Different Sets Retirement Age



The key policy issue here is how the society as a whole absorbs this segment of old age labor. For China, the unemployment and under-employment in the urban areas are becoming more apparent. Transition in agriculture is releasing a large amount of surplus labor, close to 100 million in recent years. The government needs to weigh the cost against the benefit of dealing with either the pension problem or the unemployment problem. The latter may be more politically sensitive and more uncertain in financial terms. Without excess demand in the labor market, it would not be a desirable option to increase the retirement age.

Change of GDP Growth Path

Promoting GDP growth enlarges the pie to be shared by the old and the young. Without long run stable income growth, neither pensioners nor contributors can expect to improve their living standards steadily. Better growth performance means higher real wage, leads to larger contribution revenue for the pension fund, and leaves some leeway for adjustment of benefit rate. Table 7 compares three cases with the base case, for different GDP growth paths and pension-wage indexation. The first thing to notice here is that, as shown in the last line of Table 7, one percentage point change (faster or slower) in the real GDP growth rate can double or half the real wage and pension, as compared to that in the base case scenario. The magnitude of this effect depends on the length of pension planning period (80 years here). Even allowing the pensioners' benefit rate to shrink over time, as shown in the last column of Table 7, their welfare measured in real pension income is significantly improved when the GDP grows faster than in the base case. Secondly, it is noticeable that even a combination of faster growth and less than full wage indexation will not necessarily makes the pension fund financially solvent. Higher growth leads to higher wage, and thus higher pension. However, this combination delays the first year for the current and accumulative balance of the pension fund to be negative by 4 years and 9 years, respectively. Finally, it is worthwhile to look at the break-even contribution and benefit rates of the pension funds, which are assumed to be uniform across years and to be required to achieve a zero accumulative balance at the end of the

Table 7

China: Impact of GDP Growth on Pension Fund Solvency

	Base Case	GDP Growth		
		Slower by 1%	Faster by 1%	
Wage Indexation	100%	100%	100%	90%
Break-even Contribution Rate	39.6	37.5	41.5	31.8
As % of the Assumed	146.8	138.9	153.7	117.8
Break-even Replacement Rate	51.1	54.0	48.7	63.7
As % of the Assumed	68.1	72.0	65.0	84.9
The First Year for				
Negative Current Balance	2025	2025	2025	2029
Negative Fund Reserves	2041	2043	2039	2052
Fund Reserve as % of Current GDP				
2030	18.1	22.7	14.4	21.8
2050	-15.6	-13.7	-16.3	1
2075	-40.9	-47.9	-34.5	-11.4
Real Wage/Pension as % of 1995				Real Pension
2030	479.9	357.2	643.2	536.3
2050	646.6	546.2	1,369.4	1060.1
2075	1,792.8	907.5	3,521.7	2480.4

planning period. One percent faster GDP growth plus 90 percent wage indexation reduces the break-even contribution rate from 40 to 32 percent, and increases the break-even replacement rate from 51 to 64 percent.

Changing the Contribution Rate and the Replacement Rate

Another commonly recommended policy option is to raise the contribution rate or to reduce the replacement rate, or both. While knowing that this option is politically difficult, we conduct a numerical simulation to examine the financial implication of the policy recommendation. The outcome is presented as a sensitivity trade-off table, shown in Table 8. Starting from the base case point where the contribution rate is 27 percent and the replacement rate is 75 percent. Raising the contribution rate to 35 percent or reducing the replacement rate to 60 percent alone will reduce the negative pension balance level as percentage of current GDP at the end of 2075 from 41 percent to around 15 percent. Moving towards the lower left corner is the direction for pension solvency, but objections from both pensioners (for a lower replacement rate) and the contributors (for a higher contribution rate). To achieve a near-zero balance at the end of the planning period, one needs to set the contribution rate at 32 percent and the replacement rate at 60 percent, or the contribution rate at 33 percent and the replacement rate at 62.5 percent.

Fully Funded Individual Accounts

The individual pension accounts specified in the model are fully funded by definition. They are self-balanced if the uncertainties on investment returns and life expectancy are carefully handled, through pooling, for instance. The relevant policy issues here are the positive linkage between the contribution rate and the benefit rate. The government needs to make sure most people in the society save sufficient for their own old age expenditure. For China, the private savings rate is usually around 35 percent. Therefore, establishing personal notional pension accounts can be a feasible and effective reform option in China.

Table 8

Sensitivity of the Pension Fund Balance with respect to Changes of Contribution Rate and Replacement Rate

(in % of Current GDP as of the end of 2075)

Contribution Rate	Replacement Rate										
	60.0	62.5	65.0	67.5	70.0	72.5	75.0	77.5	80.0	82.5	85.0
21	-34.6	-38.9	-43.2	-47.5	-51.7	-56.0	-60.3	-64.6	-68.8	-73.1	-77.4
22	-31.4	-35.7	-40.0	-44.2	-48.5	-52.8	-57.1	-61.3	-65.6	-69.9	-74.1
23	-28.2	-32.4	-36.7	-41.0	-45.3	-49.5	-53.8	-58.1	-62.4	-66.6	-70.9
24	-24.9	-29.2	-33.5	-37.8	-42.0	-46.3	-50.6	-54.9	-59.1	-63.4	-67.7
25	-21.7	-26.0	-30.3	-34.5	-38.8	-43.1	-47.4	-51.6	-55.9	-60.2	-64.5
26	-18.5	-22.7	-27.0	-31.3	-35.6	-39.8	-44.1	-48.4	-52.7	-56.9	-61.2
27	-15.2	-19.5	-23.8	-28.1	-32.3	-36.6	-40.9	-45.2	-49.4	-53.7	-58.0
28	-12.0	-16.3	-20.6	-24.8	-29.1	-33.4	-37.7	-41.9	-46.2	-50.5	-54.8
29	-8.8	-13.0	-17.3	-21.6	-25.9	-30.1	-34.4	-38.7	-43.0	-47.2	-51.5
30	-5.5	-9.8	-14.1	-18.4	-22.6	-26.9	-31.2	-35.5	-39.7	-44.0	-48.3
31	-2.3	-6.6	-10.9	-15.1	-19.4	-23.7	-28.0	-32.2	-36.5	-40.8	-45.1
32	0.9	-3.3	-7.6	-11.9	-16.2	-20.4	-24.7	-29.0	-33.3	-37.5	-41.8
33	4.2	-0.1	-4.4	-8.7	-12.9	-17.2	-21.5	-25.8	-30.0	-34.3	-38.6
34	7.4	3.1	-1.2	-5.4	-9.7	-14.0	-18.3	-22.5	-26.8	-31.1	-35.4
35	10.6	6.4	2.1	-2.2	-6.5	-10.7	-15.0	-19.3	-23.6	-27.8	-32.1

V. Preliminary Conclusions

Population aging and pension system reforms are serious challenges to both developed and developing countries in the coming decades. Theoretical thinking and policy debates in recent years, including Arrau and Schmidt-Hebbel (1994), Diamond (1995), Iyer (1994), Rein (1994), Sayeed (1984), the World Bank (1994), have contributed significant insights in finding sustainable solutions for providing income support to the increasingly number of elderly. This paper proposes an integrated framework linking pension reforms to macroeconomic development, demographic dynamics, and labor market conditions. With basic assumptions on the future development trends, the model specified in the paper can be utilized to simulate potential impact of different reform options under different pension arrangements. These simulations give decision-makers some quantitative indication on possible outcomes a policy package can generate.

Based on the World Bank's population projection for China, numerical results from the simulation exercises conducted in the paper suggest some important policy messages. Notably, the scope and speed of population aging in China makes the present pension system financially unsustainable, even though the GDP is assumed to grow steadily over a long period. Pension reforms are inevitable. For the current pay-as-you-go pension system, increasing retirement age would provide a temporary fix and would only be politically viable when there is excess labor demand. Pension fund sustainability can be improved by increasing GDP growth, raising contribution rates or gradually reducing benefit rates. But implementation of these reform options need careful assessment of financial costs and social obstacles. Establishing fully funded and privately managed pension schemes can be a feasible and effective alternative, but sound regulatory framework and institutional infrastructure need to be established to facilitate the transition.

More generally, the following considerations should be useful for formulating longer-term pension reform strategies.

First, pension system reform is a long-term problem of multi-dimension, involving not only economic, but also social, political, and cultural factors . The governments should not over-concentrate on the old age income security system pe se, relying exclusively on taxes and transfers to achieve the goals of inter-generational or intra-generational income redistribution. A more strategic approach with broader policy options needs to be explored. Country characteristics, mostly importantly the cultural and traditional values as well as expectations and reactions of different interest groups, have to be taken into consideration..

Second, real income growth is the ultimate means to cope with poverty among the old, especially in developing countries. An important policy objective in China for the next fifty to one hundred years should still be to maintain long-term socio-economic stability and sustainable growth. This is clearly a precondition toward establishing a sufficient, efficient, and equitable social security system in China.

Third, international experience should be studied to avoid repeating the same mistakes others made before. Countries in Europe and Latin America have experimented with different kinds of reform options to improve their pension systems. Their experiences show that in order to get out of the lurking population aging trap, China should move towards a system that combines two elements. One is a fully funded and portable, defined benefit pension plan designed to meet basic needs. The other is occupational pension plans or personal savings accounts to satisfy demand for maintaining or improving living standards.

Fourth, specific action plans need to be worked out for long-term targets of establishing a sustainable social security system. Real economic growth can be reinforced through improvement of the labor market; for instance by removing management rigidities,

facilitating human resource development, strengthening competitiveness in labor markets, reforming the household registration system, bettering the incentive structure, and rewarding hard and innovative work. More job opportunities can be created in non-traditional sectors, especially service industries which are still under-developed in China at present, so that the unemployment rate can be lowered. While rapid urbanization may create some troubles, development of medium-size cities can be a feasible way to convert some of rural population mainly engaged in agricultural activities to urban population less dependent on land. Preserving traditional values and maintaining family-community support -- the informal system for income security of the aged with no government and little market involvement -- will cushion some impact of demographic shocks. Financial markets should be liberalized and developed so that people can have adequate savings instruments and insurance options, and private savings can be stimulated and put into productive investment. With proper inflation control, workers can build up financial assets now to pay for expenditure later. Management of pension funds needs to be transparent and decentralized to reduce both corruption and administrative costs. The balance of pension funds should be invested efficiently to generate prudent returns.

However, many key issues need further exploration, including among others, the cost of switching from one pension system to another more desirable system, the endogenous choice of a worker with options to select from different pension arrangements, the linkage between pension systems and labor supply, and the interdependence among savings through pension arrangements and through other channels. The modeling technique needs improvement, for instance, in the direction of generational accounting (see Auerbach and Kotlikoff, 1985, Auerbach. Kotlikoff and Hagemann, 1989, Boll, Raffelhuschen and Walliser, 1994). Meanwhile empirical studies should be extended to cover regional disparities and sectoral differences.

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