

INCOME REDISTRIBUTION IN URBAN CHINA BY SOCIAL SECURITY SYSTEM – AN EMPIRICAL ANALYSIS BASED ON ANNUAL AND LIFETIME INCOME

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This study investigates the redistributive effect of social security reform in urban China using the nationally representative urban household surveys of 1995 and 2002. The main findings are as follows. First, public pension is the main income for the elderly in urban China. The majority of people aged 60 and over (72% in 1995 and 82% in 2002) receive a pension. Second, the social security system in urban China has increased the income of low-income and older age groups and reduced the relative poverty rate. However, the redistributive effect did not offset the expanding income inequality, which resulted in the Gini coefficient of redistributed income in 2002 being higher than that in 1995. Third, during 1995 and 2002, both low-income and high-income groups received a positive net benefit from the social security system, but the net benefit increased with income. The Chinese social security system lacks progressivity in contribution, and does not favor the poor in terms of benefits. Fourth, assuming that the reformed policy was applied to public sector employees, the long-term redistributive effect of the pension system for the working population, calculated using their lifetime income, is larger. (JEL D31, H55, I38)

I. INTRODUCTION

Following 30 years of economic growth since 1978, China has made significant progress in raising the living standards of urban and rural residents and decreasing the number of people living below the poverty line. The poverty rate declined from 53% in 1981 to 8% in 2001 (Ravallion and Chen 2007).¹ On the other

hand, a dramatic widening of the income gap occurred over this period. According to the World Bank (2003), the Gini coefficient in China rose from 0.3 in the 1980s to 0.42 in 1993, which was the most rapid among developing countries.² Moreover, several studies estimated measures of long-term income inequality in China and found an upward trend (Ravallion and Chen 2007; Meng et al. 2010). Li and Luo

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1. For studies on urban and rural poverty in China (Chen and Ravallion 2004, 2007, 2008; Chen, Ravallion, and Wang

2006; Luo 2010; Ravallion and Chen 2007; Xia, Song, and Simon 2007).

2. The estimation of income inequality depends on the definition of income. Ravallion and Chen (2007) adjust for cost-of-living differences to obtain a lower Gini coefficient. Before the adjustment, the coefficient is 0.42 and 0.447 in 1993 and 2001, respectively. After adjustment, it is 0.367 and 0.395, respectively. Li and Luo (2007) included implicit income from all kinds of social security programs and adjust for the cost-of-living difference between urban and rural areas and obtain a Gini coefficient of 0.44 in 2002.

ABBREVIATIONS

BMI: Basic Medical Insurance
 CHIP: China Households Income Project
 GDP: Gross Domestic Product
 NBS: National Bureau of Statistics
 OECD: Organization for Economic Cooperation and Development
 PAYG: Pay-As-You-Go
 RCRI: Ratio of Contribution to the Redistributed Income
 RNBC: Ratio of Net Benefit to Contribution

(2011) used the latest household survey data to correct the potential biases caused by problems such as the difference in living costs between urban and rural areas, under-representation by high-income households in the sample, and a Gini coefficient as high as 0.485. Chen, Ravallion, and Wang (2006) found that certain subgroups have been adversely affected or have been unable to participate in the new economic opportunities because of their lack of skills, long-term illness, or disability. Some of the “left behind” households were poor at the start of this study and some became poor, even though aggregate poverty rates have tended to fall over time. As a redistributive policy, the effect of the social security system in China today is an important topic for scholars and policymakers.

Social security systems generally include a social insurance system, a social assistance system, and a social welfare system. Social insurance requires the insured persons to pay certain insurance premiums or taxes to be eligible for benefit which is generally not for the purpose of income redistribution. For some social insurance plans, however, benefits received have little to do with contribution and the benefits may not depend completely on the amount paid. Thus social insurance plans also contribute to income redistribution to a certain extent. Funded by public finance, social assistance, and social welfare, on the other hand, are direct income redistribution plans. If the social security system in one country mainly provides social insurance, it has smaller income distribution effects; if social assistance and social welfare, funded by public finance, constitute the major part of the social security system, the system has relatively strong income distribution effects. In addition, the proportion of the population covered by social security and the extent of protection provided by social security also have direct impacts on its income distribution effects. Therefore, the role that the social security system plays in income distribution depends on the composition and specific designs of the system. Its effect on the income distribution of social security is an empirical issue.

Generally speaking, there are two perspectives to test regarding the redistributive role of social security. One is to investigate the effect of certain programs in the system. The other is to estimate the overall effects of income transfers made by all kinds of programs in the system. Annual household or individual data is always used. However, annual data might not reflect the

real economic situation of the household or the individual (Rosen and Gayer 2007). When evaluating the redistributive effect of public pension plans in particular, life cycle data are needed to compare the total contribution and benefit. During the working age period, one contributes to the pension system and hence the net benefit is negative in each year in this period of the life cycle. In contrast, one acquires positive net benefits after retirement if based on annual income. Therefore, we have to predict and estimate the contribution and benefit and obtain the net benefit over the life cycle. Nelissen (1998) compared the differences between contribution and benefit using detailed annual income and life cycle income data. There are several studies that evaluate the redistributive effects of public pensions using life cycle income data for various countries, for instance, Nelissen (2000) for Italy, Coronado, Fullerton, and Glass (2000, 2002) and Liebman (2002) for the United States, and Oshio (2002, 2005) for Japan. For developing countries, Barrientos (2007) concluded that emergent tax-financed social security has the potential to have an impact on global poverty and vulnerability. Kaseke (2010) argued that the role of social security in South Africa is to prevent and reduce poverty and to promote reintegration. The social security system needs to be strengthened to enhance effectiveness. For the Chinese system, He (2004) investigated regional and occupational disparities in pension benefits. Wei and Gustafsson (2005) found inequality in medical expenses between urban and rural residents and among China’s eastern, middle, and western regions. Ren et al. (2004) conducted a macro-data study on the intergenerational imbalance of the pension system using generational accounting. He (2008) utilized 1 year’s micro-data to examine differences in the income-transfer effects of public pension plans. However, these studies addressed only one program within the social security system and were based on data from 1 year. They did not examine the overall redistributive effect of the social security system.

He and Sato (2008) preliminarily estimated the redistributive effect of social security. However, there are biases in the estimation of income and more discussion is needed to justify the redistributive function of the Chinese social security system. This article will redefine income by taking tax and private and public transfers into consideration. The database used is drawn from the micro-data obtained between the

1995 and 2002 urban household surveys (China Households Income Project—CHIP) by the Institute of Economics at the Chinese Academy of Social Sciences. First, we use annual data to estimate the transfers under a variety of programs including public pension and minimum living allowance, and investigate the redistributive effect on various income groups and age groups. Secondly, we forecast life cycle income to estimate the income redistributive effect of the public pension program and compare its effect on improving income inequality under the different schemes.

This article proceeds as follows. Section II introduces the institutional context and the data used; moreover, we capitalize on the official survey macro- and micro-data to consider the role of the social security system on income distribution in urban China. After introducing relevant concepts and empirical methodologies, Section III presents the social security system's redistributive effect based on individual income in a certain year. Section IV estimates the redistributive effects of the public pension system using life cycle income and compares the income redistributive effects of various pension plans. Section V concludes this study.

II. BACKGROUND AND DATA DESCRIPTION

A. Institutional Context

In 1951, China issued the *Insurance Provisions of Republic of China*, which included pension, medical, and work-related accident insurance provisions. This document became the embryonic form of the social security system during China's planned economy era. Prior to the economic reforms, social security for urban employees in the public sector³ and enterprises was provided through work units (*danwei*). The benefits, including pension, medical care, housing, and other income subsidies, were financed by enterprises or fiscal budgets. Employees were not required to pay for their benefits.

With China's transition to a market economy, the original social security system no longer met the demands of rapid economic development. China started to reform its original social security policies after the 1980s. In the late 1990s, the urban employees' pension

3. The public sector refers to institutions and state organizations that are mainly financed by fiscal spending, such as the government, education, health sectors, and so forth.

system, medical insurance, and other social security policies, among others, were adjusted substantially. Till date, the urban social security system has been operating, consisting of social insurance (public pensions, medical care, and unemployment insurance) and minimum living allowances.

The most important pension reform was introduced in 1995 and was revised in July 1997, when the State Council issued a new document, No. 26, and established a new pension system for urban employees in enterprises, called Basic Pension Insurance.⁴ This system is available for all employees of all urban enterprises, including state-owned enterprises, collective enterprises, foreign-owned enterprises, and so forth.⁵ The new system has three pillars: a pooling account to redistribute contributions to all beneficiaries, compulsory individual accounts, and voluntary supplementary pensions provided via commercial insurance. The first pillar imposes a payroll tax of 17% (paid by employers) to ensure that employees who have worked more than 15 years have a replacement ratio of 20%. The second pillar (paid jointly by employers and employees) establishes an individual account for each employee. The contribution rate for this is 11% of an individual's wage, of which the employer contributes 3%–8%. After retirement, the employee receives a monthly benefit from this account amounting to the accumulated value divided by 120. However, a change was made in December 2005 to adjust the percentage that goes to the individual's account and the method of calculating and receiving pension payments. There were two changes in the 2005 reform. One is a decline in the contribution rate to individual accounts from 11% to 8%. The other adjustment is changes to the benefits obtained from the first pillar (basic pension) and the second pillar (individual account pension). Benefits from the first pillar depend on the amount and years of contribution, instead of using a uniform replacement rate for average income (20% in the 1997 version). The benefit from individual accounts has been changed to be more actuarial (Table A1).

4. The information on the pension system provided here is mainly based on Feng, He, and Sato (forthcoming). Drouin and Thompson (2006) provided a more detailed explanation of the social security system in China.

5. Some public institutions began to take part in the insurance system from 1999, but the percentage was very small. For insured staffs in public institutions, the percentage was 6.7% in 1999 and 9.8% in 2007 among all the participating employees (The China Statistical Yearbook 2008).

On the other hand, employees in public sectors experience no reform and the benefit is a percentage (75%–100%) of the wage just before retirement. It is worth noting that, in the Chinese pension system, the beneficiary is the contributor. There is no consideration for disabled workers and their families, for young children of a deceased worker, and for elderly spouses and surviving spouses, which is different from the case in some other countries, such as Japan and the United States.

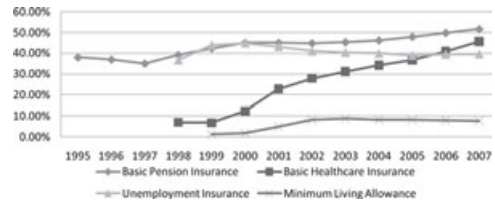
In December 1998, the State Council selected a new model for urban workers' health insurance, to be called the Basic Medical Insurance (BMI) System.⁶ The BMI program replaced the old health insurance system for urban workers and dependents and the Government Health Insurance System for civil servants and public workers. The implementation of BMI has begun in almost all areas of the country, but is not yet complete in that many of the employers that are supposed to be covered by the new system are still operating under one of the old systems. Moreover, medical insurance covers government employees, whereas pensions do not (Drouin and Thompson 2006). BMI is designed to rely on a combination of individual accounts to finance outpatient care and social pooling to finance inpatient care. The contribution rate of BMI for employees is 2%.

The reform of unemployment insurance started in 1998. The contribution rate was 1% of an employee's wage in order to be insured. Employees were not required to pay contributions until the unemployment reforms in 1998. In addition, the minimum living allowance sponsored by the Ministry of Finance was implemented in 1999.

We use official macro-data to show the coverage of the social security system after the reform (Figure 1). There has been a rapid expansion of the coverage, in which BMI increased the most rapidly from 7% in 1998 to 46% in 2007. Pension insurance coverage increased from 38% in 1995 to 51% in 2007. Unemployment insurance coverage fluctuated around 40%. Although the number of urban employees covered by the social insurance had increased in previous decades, half of them were not included until 2007.

6. The China Statistical Yearbook referred to this system as Basic Medical Insurance before 2007 and thereafter as Basic Medical Care Insurance. Following Drouin and Thompson (2006), this system is referred to as Basic Medical Insurance in this article.

FIGURE 1
Coverage of the Social Security System in China (Number of Participants/Number of Urban Employees), 1995–2007



Notes: Coverage of basic pension insurance = contributors of basic pension insurance/number of employed persons in urban areas \times 100.

Coverage of basic medical care insurance = contributors of basic medical care insurance/number of employed persons in urban areas \times 100.

Coverage of unemployment insurance = contributors of unemployment insurance/number of employed persons in urban areas \times 100.

Coverage of minimum living allowance = number of persons receiving minimum living allowance in urban areas/number of employed persons in urban areas \times 100.

Here, contributors indicate the number of employees that participated in the above insurance programs.

Source: China Labor Statistical Yearbook 2003, China Statistical Yearbook 2008, and China Civil Affairs' Statistical Yearbook 2008.

In general, the extension of the social security coverage will strengthen the income redistributive effect of social security, thereby narrowing income inequality. As mentioned above, however, individual contributions to the social security programs were low before the social security reforms in the late 1990s, because people could receive various subsidies from their work units and retirees could draw benefits equaling a percentage of their pre-retirement wages. It seems that during that period the net benefit of social security was always positive for high- and low-income groups. However, after the reforms an individual's contribution in social security has been increased, not only contributing to pension, medical insurance, but also other kinds of insurance. Furthermore, some workers did not receive their entitlement benefits because of various flaws in the system. For example, the original living allowance was replaced by a severance payment for laid-off workers. However, Xia, Song, and Simon (2007) found that only 18% of the laid-off workers' families received this subsidy in 2002. The research also indicated that only 11% of laid-off workers' families received unemployment benefits and only 8% of the laid-off workers' families enjoyed the minimum living standard guarantee. Moreover, Cai, Giles,

and Meng (2006) found that pension arrearages had emerged in some areas. Therefore, compared with the pre-reform system, the relationship between an individual's social security benefit and his/her contribution was uncertain after the reform. An empirical test is required to determine how the social security system improved income distribution in urban China using income transfers. We use the CHIP data to estimate the social security system's redistributive effect.

B. Data

The data used in this article are from the CHIP survey, which was conducted in 1996 and 2003 by the Institute of Economics at the Chinese Academy of Social Sciences. The samples of CHIP data were drawn from the large sample used by the National Bureau of Statistics (NBS) in its annual household survey.⁷ The NBS's sampling method is that the respondent households are selected using a two-stage stratified systematic random sampling scheme. In the first stage, cities and county towns are selected and in the second stage, households within the selected cities and county towns are chosen. The procedure for selecting cities and county towns is designed as follows. First, all cities and county towns are classified into five categories on the basis of their population size. At the second stage, the households are selected in each sample city by a multiphase sampling scheme. The above-sampling method yields about 35,000 households selected for the NBS annual household survey in 1995 and 45,000 in 2002. These samples represent total urban populations of approximately 350 and 450 million in the 2 years, respectively.

The 1995 and 2002 CHIP data cover 6,931 families (21,696 individuals) from 11 provinces and 6,835 families (20,632 individuals) from 12 provinces, respectively. Survey questions included individual characteristics, individual incomes, and family assets. Information about each respondent's age, sources of income, employment status, and industry and industry ownership of his/her employer are included. One of the advantages of CHIP data is that it has more categories of income, such as subsidies for laid-off employees, minimum living allowance, subsidies from enterprises, and in-kind transfers. The CHIP data were widely applied in research

on income distribution, and many relevant studies have been published. Recent works include Gustafsson, Li, and Sicular (2008), Khan and Riskin (2005), Sicular et al. (2007), and Yin, Li, and Deng (2006). These studies provided insights into changes in China's income distribution structure, urban-rural and regional income disparities, and mobility. For example, in their re-estimation of income disparity between urban and rural China, Li and Luo (2007) included all types of invisible income (e.g., social security transfers) in urban residents' total income. Xia, Song, and Simon (2007) analyzed the trend and pattern of Chinese urban poverty. We will quantitatively measure the redistributive effect of the social security reform in urban China, especially the degree of income inequality under pension reform, using these data sets.

Table 1 compares income-related statistics of surveys conducted in 1995 and 2002 with data from the China Statistical Yearbook. Table 1 shows that, based on the CHIP data, the results of the average wage, the household disposable income per capita, and the pension replacement rate were all very close to the ones based on the national statistics.

Figure 2 shows some basic information about the public pension and medical insurance system in urban China. The figures indicate that both in 1995 and 2002, the majority of people aged 60

TABLE 1
Annual Income and Pension Benefits

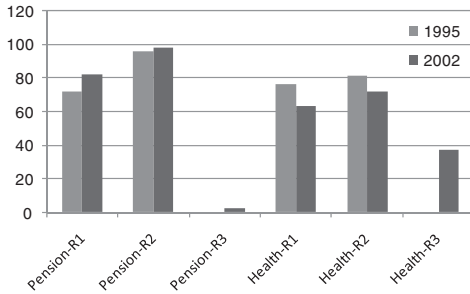
Data Type	National Statistics Data		Survey Data	
	1995	2002	1995	2002
Average annual wage of staff and workers (yuan)	5,500	12,422	5,616	12,123
Per capita annual disposable income of urban households (yuan)	4,288.1	8,177.4	4,745	8,230
Per capita annual pension benefits of retirees (yuan)	4,335	8,807	4,435	8,743
Pension replacement rate (%)	78.8	70.9	78.9	72.1

Notes: Pension replacement rate = per capita annual pension benefits of retirees/average annual wage of staff and workers \times 100. Average annual wage of staff and workers refer to wages of fully employed staff and workers, which do not include those of township and village and private enterprises.

Source: China Statistical Yearbook (2008), CHIP data (summary statistics are calculated using the entire sample of 21,696 individuals in 1995 and 20,632 individuals in 2002).

7. On the basis of Li et al. (2008); see the article for more details.

FIGURE 2
Recipients of Public Pension and Medical Benefits



Notes: Pension-R1 = number of people aged 60 and over, with pension benefits/number of people aged 60 and over $\times 100$.

Pension-R2 = number of retirees aged 60 and over, with pension benefits/number of retirees aged 60 and over $\times 100$.

Pension-R3 = number of retirees who did not receive pension benefits adequately in time/number of retirees $\times 100$.

Health-R1 = number of employees covered by public medical and health programs/number of employees $\times 100$.

Health-R2 = number of retirees covered by public medical and health programs/number of retirees $\times 100$.

Health-R3 = number of retirees who could not write off the medical expenses adequately in time/number of retirees $\times 100$.

Source: CHIP data in 1995 and 2002. Unless otherwise stated, the diagrams from here on are all based on the CHIP data.

and over could receive a pension. If we focus on the retirees aged 60 and over, in 1995, 95.95% of retirees aged 60 and over received pension payments, and in 2002, 98.07% received pension payments. Pension-R3 indicates that in 2002, 2.14% of retirees did not receive their pensions on the due date. This issue did not appear in the 1995 questionnaire because pensions were rarely in arrears in 1995. On the other hand, the percentage of people covered by public health insurance declined from 61.50% in 1995 to 47.16% in 2002. The decline of the percentage can be further separated according to employment status: for active employees the change is from 76.20% in 1995 to 63.09% in 2002, and for retirees, from 81.76% in 1995 to 71.88% in 2002. The numerator and denominator of Health-R1 and Health-R2 included all enterprise and public sector employees. Enterprise employees probably received public medical and health services in 1995 and did not participate in the new medical insurance system, leading to a decline in these two ratios. In addition, the CHIP data indicate that the percentage of unemployed or laid-off workers aged 16–59

rose from 2.68% in 1995 to 6.18% in 2002, but only 28.37% received unemployment insurance benefits or minimum living allowance. The main sources of income for the elderly are pension income, salary, and private transfers. The average ratio of these three items to total income for the retirees aged 60 and over was 85.39%, 6.05%, and 3.83%, respectively, in 1995 and 92.83%, 3.18%, and 1.75%, respectively, in 2002. Clearly, pensions were the major and increasing source of income for retirees in urban China and played an essential role in old age income security.

III. REDISTRIBUTIVE EFFECTS OF SOCIAL SECURITY ON DIFFERENT INCOME GROUPS

We employ the CHIP data to separate individuals into different income groups to estimate the income redistribution effects of China's social security system. First of all, it is necessary to discuss the measurement of income and social security benefits.

A. Relevant Concepts and Definitions

The main idea of estimating the redistributive effect is to compare the inequality of initial income and redistributed income. Initial income is an individual's total earnings prior to redistribution, which is derived from either labor or returns on assets, and includes income from wages, interest, commercial insurance, and income-in-kind, whereas redistributed income, in addition to including initial income net of taxes, also includes the individual's social security benefit. The social security benefit includes not only cash benefits such as pension payments, but also non-cash benefits such as medical treatment, education, and services. In China, subsidized public housing is considered an in-kind payment. The taxes mentioned include income tax, asset taxes, and social security payments (e.g., pension contributions and medical insurance payments). By comparing initial and redistributed incomes, we can observe the effects of redistribution policies.

Two indicators can be used to measure the redistributive effect. One is the MT index, which was generated by Musgrave and Thin (1948).⁸ The MT index can be expressed as:

$$MT = G - G^*$$

8. Coronado, Fullerton, and Glass (2000) derived a measurement from this index to estimate the effective progression of social security.

where G is the Gini coefficient of initial income and G^* is the Gini coefficient of redistributed income. It compares Gini coefficients before and after redistribution. If the Gini coefficient of initial income distribution is larger than that of the redistributive income distribution, the policy is said to improve the income inequalities and has a positive effect on income distribution. Otherwise, the policy makes income inequality worse and has negative effects on income distribution.

The other indicator is called the redistributive coefficient, which measures the relevant variation in income inequalities. The other indicator can be expressed as follows:

$$R = MT/G \times 100.$$

Because our study focuses on the redistributive effects affecting workers and retirees in urban China, we selected urban residents aged over 16 (4,024 individuals in 1995 and 3,378 individuals in 2002 were excluded), and eliminated samples classified as “currently a full-time student,” “awaiting job assignment or school admission” (1,207 in 1995 and 1,529 in 2002), and those whose income or current status information was missing (717 in 1995 and 34 in 2002).⁹ The sample size after the adjustment was 15,748 for 1995 and 15,691 for 2002.

The measurements of initial income and redistributed income are as follows:¹⁰

Initial income = salaries + net income of private businesses + property income
 + private insurance benefits + monetary value of in-kind income
 + other minor sources of income.

Redistributed income = initial income – personal income tax + social security benefits (pension benefits, social relief that includes the minimum living standard guarantee, unemployment insurance, medical expenses paid by public sources)
 – social security payments.

9. Considering that the income information of the unemployed might be missing, in order to retain the unemployed in the sample, for these samples with current status being unemployed and no income information recorded, we change the income to zero.

10. It should be noted that the composition of the initial incomes used here is different from the “gross income” used in Atkinson, Rainwater, and Smeeding (1995). Our initial income does not include transferred income from public policy and social security. Private transfers such as alimony tend to respond to negative shocks experienced by the recipients (Cai, Giles, and Meng

2006) and would confound the redistributive effects of public transfers. The CHIP data identify two main sources of private transfer income: required cash transfers by relatives (alimony income) and cash voluntarily transferred by relatives (donated income). Both sources of income are likely to respond to income shocks (such as pension arrearages, layoffs, or unemployment); therefore, our analysis excludes them from initial income.

11. As the minimum living allowance program was not in effect in 1995, the share of households benefiting from the program cannot be used to measure poverty.

B. Social Security's Effects on Different Income Groups

Table 2 shows the summary statistics of initial income and redistributed income. Compared with 1995, in 2002, both social security benefits and social security contribution increased; however, social security benefits increased only by 74.31% while the contribution increased by 645%.

First, we examine social security's redistributive effects on reducing poverty. Adopting the approach of Cai, Giles, and Meng (2006), we calculated the proportion of families below the poverty line. The poverty line is based on the minimum living standard consumption per capita calculated by the Ministry of Labor and Social Security for each province's capital city. The average annual poverty line across the 12 capital cities of the CHIP provinces was 2,454 yuan per capita in 2002. Household per capita initial income below 2,454 yuan accounted for 17% of total households, but if measured by per capita redistributed income, the poverty households accounted for only 2%. Clearly, social security contributed enormously to reducing poverty.

We use the relative poverty rate in the absence of data on minimum living standard consumption per capita.¹¹ According to Förster and Mira D'Ercole (2005), the relative poverty

TABLE 2
Summary Statistics of the Total and the Components of Initial-Redistributed Income

	Initial Income		Redistributed Income	
	1995	2002	1995	2002
Salary	5,127.810	7,575.550	—	—
Net income of private businesses	72.465	314.219	—	—
Property income	94.967	68.132	—	—
Private insurance benefits	NA	6.149	—	—
Others income	126.042	234.476	—	—
Personal income tax	—	—	4.633	33.120
Social security benefits	—	—	1,263.838	2,203.015
Social security payments	—	—	43.394	323.361
Total of initial (redistributed) income	5,523.452	8,198.525	6,613.222	9,938.591

Note: Per capita annual income (yuan) at 2002 prices is used. NA indicates that the kind of classification did not exist in 1995.

Source: CHIP data in 1995 and 2002.

rate is defined as¹²:

$$PR = N_p / N \times 100$$

where N is the total population and N_p is the population that earns less than half the median income.

In 1995, the median initial income was 4,876 yuan, and 18.2% of households reported that income was less than half the median total household income, whereas the percentage of households receiving redistributed income of less than 2,438 yuan decreased to 3.2%, a decline of 82.4%. Similarly, we calculated that the relative poverty rate based on initial income was 23.6% in 2002, yet the relative poverty rate based on redistributed income was only 6.6%, a decrease of 72%. However, the 2002 PR indexes for both initial and redistributed income increased relative to the 1995 indexes, indicating that the number of individuals in the lowest-income group had increased.

Using initial income per capita and redistributed income per capita, we divide individuals into quintile groups according to initial income and redistributed income, respectively, to examine the income distribution of initial income and net benefit distribution of social security. Table 3 reports the mean age and sample sizes in each income group.

Table 4 shows the distribution of initial and redistributed incomes as a percentage share of the total income in 1995 and 2002. The first two rows display each quintile's percentage share

(initial and redistributed incomes) in 1995. The middle two rows display each quintile's percentage share (initial and redistributed incomes) in 2002. For both 1995 and 2002, note that the redistributed income of different quintiles has a more equal distribution because of benefits from social security. In particular, the lowest quintile's share of total income increased by 9.48 percentage points in 1995 and 10.22 percentage points in 2002 (see Change 1 in Table 4). Furthermore, compared with initial income, the redistributed incomes of groups above the middle quintile accounted for a smaller share of the total income, and the higher the income, the larger is the proportionate decline. Therefore, social security has a greater effect on increasing the income of lower income groups measured by annual income.

Note that the groups ranking below the middle quintile showed a decrease in percentage share between 1995 and 2002, whether measured by changes in initial income (Change 2-I) or redistributed income (Change 2-R). Furthermore, the percentage share increased for the fourth fifth and the highest fifth. As measured by initial income, the lowest quintile's share of total income declined from 4.12% in 1995 to 2.80% in 2002, but the highest quintile's share rose from 40.16% in 1995 to 45.21% in 2002. This is also the trend for redistributed income. The lowest-income quintile's share declined in 2002 compared with that of 1995, but the trend for highest-income groups was the opposite. This demonstrates that the inequality of income redistribution in urban China was growing, as the Gini coefficient in the rightmost column of

12. They use this method to analyze income distribution in 27 OECD countries.

TABLE 3
Sample Size and Mean Age of Quintile Groups

Income Group	Initial Income Quintile				Redistributed Income Quintile			
	Mean Age		Sample		Mean Age		Sample	
	1995	2002	1995	2002	1995	2002	1995	2002
Lowest fifth	51.94	54.38	3,150	3,140	42.51	44.73	3,153	3,139
Second fifth	41.01	45.04	3,150	3,139	42.47	45.60	3,147	3,138
Middle fifth	39.80	43.00	3,150	3,137	42.51	45.71	3,151	3,139
Fourth fifth	40.09	42.62	3,149	3,137	43.31	45.22	3,149	3,138
Highest fifth	40.97	42.25	3,149	3,138	43.02	46.05	3,148	3,137
Total	42.76	45.46	15,748	15,691	42.76	45.46	15,748	15,691

TABLE 4
Distribution of Initial Income and Redistributed Income

Item	Percentage Share					Gini Coefficients
	Lowest Fifth	Second Fifth	Middle Fifth	Fourth Fifth	Highest Fifth	
Initial income_1995 (A)	4.12	12.82	18.38	24.52	40.16	0.3576
Redistributed income_1995 (B)	13.61	13.38	16.97	21.60	34.46	0.2635
Initial income_2002 (C)	2.80	10.43	16.80	24.76	45.21	0.4240
Redistributed income_2002 (D)	13.02	12.41	15.85	21.74	36.98	0.3165
Change 1_1995	9.48	0.56	-1.41	-2.93	-5.71	-0.0941
Change 1_2002	10.22	1.98	-0.95	-3.02	-8.23	-0.1074
Change 2_initial	-1.32	-2.39	-1.58	0.24	5.05	0.0664
Change 2_redistributed	-0.58	-0.97	-1.11	0.14	2.52	0.0531
Redistributive coefficient_1995 (%)				26.31		
Redistributive coefficient_2002 (%)				25.34		

Note: Change 1_1995 = B-A; Change 1_2002 = D-C; Change 2_initial = C-A; Change 2_redistributed = D-B. R is the redistributive coefficient. $\text{Redistributive coefficient}_{1995} = (A-B)/A \times 100$; $\text{redistributive coefficient}_{2002} = (C-D)/C \times 100$.

Table 4 illustrates that the Gini coefficient in 2002 is larger than that in 1995 for both initial and redistributed incomes.

Moreover, the redistributive coefficient R (the last two rows of Table 4), representing the relative change in the degree of inequality, was essentially identical in 1995 and 2002, but the Gini coefficient in 2002 is higher than the coefficient for 1995. Social security income transfers reduced inequality by raising income among low-income groups, but not enough to offset the expanding inequality in initial income.

Besides the possible changes in the redistributive effect of the policy rules in the social security system, this result can be explained from two aspects: first, income shocks (such as being laid off or unemployment) faced by individuals in 2002 exacerbated the degree of income inequality. Since 1996, China's labor market reforms have led to a large number of

laid-off workers. The number of laid-off workers increased rapidly from 8,916,337 in 1996 to 14,352,155 in 1997 and to 19,771,986 in 1998. From 1999 to 2001, more than 200 million people were laid off every year, and the number of laid-off workers accounted for about 19% of the total workers in post. The number of laid-off workers in 2002 was slightly lower at 19,594,870 people, accounting for 18.56% of the total urban workers in post.¹³ Furthermore, Xia, Song, and Simon (2007), using the CHIP database, found that the percentage of families with laid-off members had increased from 5.55% in 1995 to 20% in 2002. These laid-off workers were supposed to receive a severance payment for being laid off, but only 18% of the laid-off workers' families were eligible for this payment in 2002. The average yearly income

13. Source: China Labor Statistical Yearbook, 1997-2003.

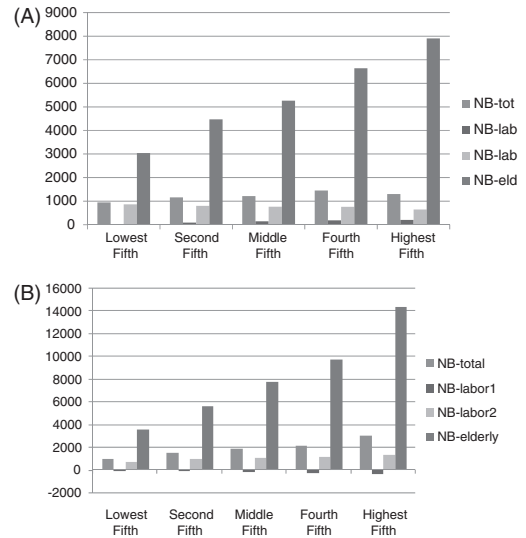
of these (laid-off or unemployed) people was only 29% of that of working or employed people. These income shocks have undoubtedly increased the inequality of the initial income distribution.

On the other hand, although the social security system in urban China, including the pension insurance system, medical insurance system, and other kinds of insurance, was thoroughly reformed in the late 1990s. Figure 1 shows that the coverage of urban employees by social security was still low in 2002, and that the maximum coverage of pension insurance was less than 50%. Furthermore, because the government promised to take responsibility for social security of laid offs and require them to end the contract with their original units, the living subsidy provided by work units had reached an extreme low level in 2002. In fact, Xia, Song, and Simon (2007) found that only 11% of laid-off workers' families enjoyed unemployment benefits while only 8% enjoyed the minimum living standard guarantee. Moreover, Cai, Giles, and Meng (2006) found that pension arrears had emerged in some areas. Therefore, the income transfers of social security reduced the degree of income inequality, but this kind of improvement was limited.

We also compute the Gini coefficients of initial income and redistributed income for the working age group (males aged 16–59 and females aged 16–54) and the elderly group (males aged 60 and over and females aged 55 and over). The results show the Gini coefficients were larger in 2002 than in 1995 either in terms of initial income or redistributed income. However, the redistribution coefficient in the elderly group is much larger than that of the working age group, which was 55.9% and 11.83%, respectively, in 1995, and 51.63% and 13.53%, respectively, in 2002. Therefore, the redistributive effect of social security in China is mainly demonstrated in the elderly group and its effect on the income of the working age group is not significant.

Figure 3 shows the net benefit of social security for each income group and divides the sample into age groups within the income group. Except for those younger than 40, the age pattern of net benefits is the same in all income groups. In both periods of time, all income groups have positive net benefits. The net benefit increases with income, and in each income group the elderly benefit most from the system.

FIGURE 3
Net Benefits of Social Security for
Redistributed Income Groups (A) 1995 and
(B) 2002



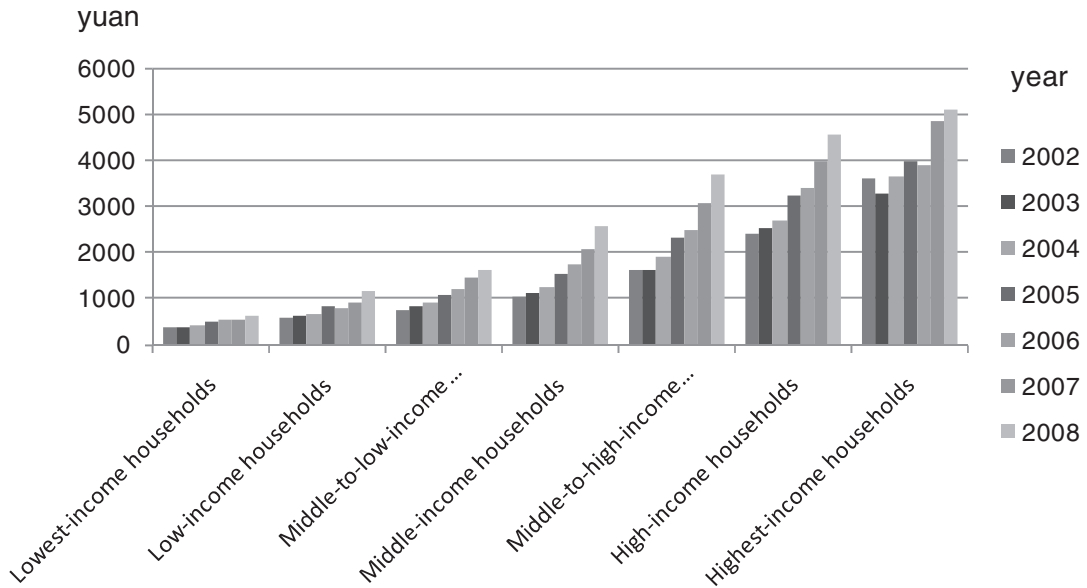
Notes: NB = benefit of social security—contribution of social insurance (RMB yuan, 2002 price). Labor 1: 16–39 working age samples; Labor 2: 40 and over working age samples; elderly: males aged 60 and over and females aged 55 and over based on the retirement age in China.

Generally speaking, social security involves a positive transfer of income. Various studies based on Organization for Economic Cooperation and Development (OECD) countries show that social security systems in these countries redistribute income from higher to lower income groups. However, the redistributive effect in China is intergenerational rather than between income groups. Although the elderly receive a positive transfer, the elderly in higher income groups gain more. Overall, the net benefit of the highest-income group is 1.4 and 3.2 times as much as that of the lowest-income group in 1995 and in 2002, respectively. The net benefit of the elderly in the highest-income group is 2.6 and 4 times as much as that of the elderly in the lowest-income group in 1995 and 2002, respectively. This outcome implies that the adverse income transfer of social security is increasing over time.

We obtain the same results using aggregate data from statistical yearbooks. Using the annual income of households, Figure 4 shows that the households that benefit most from the social

FIGURE 4

Net Benefits of Social Security in Urban Households of Different Income Groups (2002–2008)



Note: Urban households are categorized according to disposable income per capita, and labeled as lowest-income households (bottom 10%), low-income households (next 10%), middle- to low-income groups (next 20%), middle-income groups (next 20%), middle- to high-income groups (next 20%), high-income groups (next 10%), and highest-income groups (top 10%), altogether seven income groups.

Sources: Survey on China's Price and the Income and Expenditure of Urban Residents 2002–2003, Yearbook of China's Cities 2004, 2005, and China Urban Life and Price Yearbook 2006–2009.

security system are not the lower income households but the higher income households. During 2002–2008, in each year, the net benefit has been increasing with the income of the households. The net benefit of the highest-income households is 7.4–9.3 times as much as that of the lowest-income households. From 2002 to 2008, the net benefit of the lowest-income households increased by a small margin that was much smaller than that of the highest-income households.

We also computed the ratio of contribution to the redistributed income (RCRI) and found that there is no significant difference across various income groups in 2002. They are 3.61%, 3.56%, and 3.63% for the lowest-, middle-, and highest-quintile groups, respectively. For the elderly group, there is a somewhat negative relationship with income: 1.61%, 1.43%, 1.34%, 1.5%, and 1.37%, respectively, from the lowest to the highest quintile. In the *Labor 1* group, from lower income to higher income, RCRI is 3.4%, 3.45%, 3.61%, 3.62%, and 3.78%, respectively. RCRI is increasing with income

only slightly (less than 1% change by income group). In contrast, Förster and Mira D'Ercole (2005) show that the RCRI of the lowest fifth and highest fifth were 7% and 16%, respectively, in Germany; 18% and 50%, respectively, in Sweden; and 1% and 32%, respectively, in the United States. Therefore, compared with OECD countries, China's social security system lacks any progressive effect, which is one of the reasons for the adverse income transfer.

On the other hand, according to the ratio of net benefit to contribution (RNBC), we find that for the elderly group, it is less in the lower income group. For the lowest-, middle-, and highest-quintile groups, it is 84.2, 369.4, and 619.4, respectively. The propensity is reversed in the young generation group: 26.6, 28.7, and 25.6, respectively, for the *Labor 1* group with no significant difference across the income groups. On the basis of these results, we could conclude that in the Chinese social security system there is no progressivity of contribution, and it does not favor the poor in terms of benefits. Thus if we want to improve the

redistribution effect of the social security system, it is necessary to increase the progressivity of the contribution and to increase the RNBC of the low-income groups.

However, the above analysis is based on annual income. For particular social security programs, such as public pension, estimation of the redistributive effects requires an evaluation based on life cycle income as discussed in Section I.

IV. REDISTRIBUTIVE EFFECTS OF DIFFERENT PENSION DESIGNS BASED ON LIFETIME INCOME

As noted earlier, the cost and benefit of the pension system changes at different stages of the life cycle. Therefore, it takes a lifelong process to uncover its overall effect. It is thus necessary to investigate it from a lifelong perspective. From a theoretical stance, redistribution through the pension system can be understood as follows. The individual earns the right to receive a pension during his/her retirement by participating in the public pension system, thus accumulating pension assets. However, under a pay-as-you-go (PAYG) system, the level of pension one receives and the contributions one pays are determined by the population growth rate and wage growth rate in each time period. As such, the actuarial present value of costs and the actuarial present value of benefits could be different. This margin is called the net benefit, which reflects the lifetime cost versus benefit, and therefore is the total redistribution transfer through the public pension system. Redistribution exists if the net benefit is not zero, and vice versa.

As described in Section II, the current public pension system is a partially funded system combining social pooling with individual accounts. The practical policy rules of benefits for each group are different. In addition, the pre-reform pension system prior to 1997 was applied to urban employees of the Chinese public sector, where pension benefits were calculated as a certain percentage of an individual's wages upon reaching retirement age. If provisions in the 2005 reform were applied to urban employees in the Chinese public sector, how would the pension system contribute to the equalizing effect? If the PAYG part of the system was replaced by a fully funded system, would the result reduce current inequalities? In this section, we estimate the redistributive effects of

various pension plans on the basis of lifetime income.

From a life cycle perspective, we need information on lifetime contributions and benefits. If the system has a long enough history, then there is complete life cycle data for individuals, from which it is possible to calculate the present value of lifetime contributions and benefits and obtain the net benefit. However, the partially funded system has been in effect in China only for about one decade, therefore there is no such life cycle data available. Even in countries with this data available, such as the United States, Italy, and Japan, sometimes it is impossible for the researcher to have access to the data. Therefore, in the literature, the lifetime net benefits are estimated according to cross-sectional data and based on certain assumptions.

We use CHIP data, first to calculate the abovementioned lifetime net benefits according to the policy rules of the Chinese pension program and then we derive the lifetime income distribution index (the Gini coefficient) under various pension program designs. Finally, we analyze the pension system's effect on inequality. The following discussion uses only the data for lifetime wage income and ignores income from all other sources. In short, our concept of lifetime income defines initial income as income from labor and defines redistributed income as initial income plus lifetime net benefits from pension payments.

The procedure for the computation is as follows. First, we use samples of males aged 20–59 and females aged 20–54 who have wage earnings included in the CHIP data of 1995 and 2002, and estimate a wage equation with individual characteristics such as age, education, occupation, and regional dummies as explanatory variables.¹⁴ Then, with the aid of the wage equation we predict annual income, hence, the individual's lifetime income distribution using an assumed wage growth rate and interest rate hypotheses. The last step is to derive contributions and net pension benefits according to the policy rules (see Appendix 2 for details). We consider three possible designs of the pension program. Design 1 represents the current pension plan, that is, pre-reform pension provision is applied to the public sector employees, which would be calculated as a certain proportion

14. The regression results refer to Table 1 in He (2008).

of the wage income when retired,¹⁵ yet other employees' would be calculated according to the policy rules of the 2005 plan in Table A1. Those who entered the labor market after 1997 are "new participants" and their pension benefits consist of a basic benefit and a benefit from their individual account. Those who started to work before 1997 and retired after 1997 are "in-between participants" and their pensions consist of a basic benefit, transitional benefit, and benefit from their individual account.¹⁶

Design 2 assumes that the 2005 reform is applicable to the whole sample, that is, the benefits and contributions of employees in both the public sector and other sectors are calculated using the same formula.

Design 3 represents the fully funded system and it is applicable to the whole sample, that is, pension benefits consist of only individual account pensions if the employee is a "new participant," whereas pension benefits consist of individual account pensions and transitional benefits if the employee is an "in-between participant."

We use three indicators to estimate the redistributive effects. The first is the ratio of redistributed income between public sector employees and employees of other sectors (A). The second is the ratio of redistributed income between the highest- and lowest-income groups (B), with groups divided into deciles on the basis of initial income levels. The third is a redistributive coefficient R . Table 5 shows the redistributive effect under the three designs.

The results illustrate that Design 2 has the largest effect on the redistribution of income and narrowing the income gap. Under Design 2, the ratio of redistributive income between public sector employees and employees of other sectors is 1.2992, which is smaller than those from Design 1 and Design 3, indicating that the distributed income gap among public sectors

15. The replacement ratio of pensions for employees in the public sector is determined by working experience, ranging from 75% to 100% with an average of 90%. We use the average replacement ratio.

16. In addition, those who retired before 1997 are old participants. In reality, because of various entry ages into the labor market and retirement ages, there is no fixed formula relating age with old, in-between, and new participants. For reference, if an individual enters into the labor market at the age of 20 and retires at 60, then those aged 65 and over in 2002 are called old participants, those aged 26–64 are in-between participants, and those aged under 25 are new participants. This study uses samples of individuals aged 20–59 in 2002, so most sample individuals are in-between participants and a few are new participants.

TABLE 5
Redistributive Effects of Different Pension Designs Based on Lifetime Income

	Design 1	Design 2	Design 3
Redistributed income (public sector/ others) (A)	1.3584	1.2992	1.3564
Redistributed income (the highest-decile group/the lowest-decile group) (B)	4.5481	4.3241	5.8381
Redistributive coefficient R (%)	11.5883	14.6168	3.1881

Notes: The sample consists of workers with labor income between the ages of 20–59 (20–54 for females) in 2002.

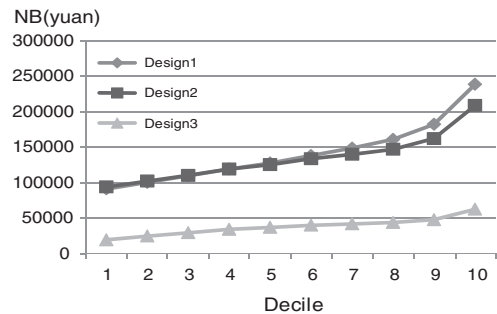
Redistributed income = initial income + net pension benefits.

Initial income = present value of personal lifetime labor income in 2002.

Net pension benefits = present value of personal lifetime net benefits from the pension system in 2002.

R = (the Gini index for initial income – the Gini index for redistributed income)/the Gini index for initial income \times 100.

FIGURE 5
Net Benefits of Different Pension Designs by Lifetime Initial Income Deciles



Note: NB = present value of personal lifetime net benefits from the pension system in 2002.

and others is smallest under Design 2, and the distributed income gap between the highest- and lowest-income groups is also smallest. The redistributive coefficient R again demonstrates that Design 2 has the strongest effect on narrowing the income gap.

We divide the sample into deciles ranked from lowest to highest on the basis of initial income. Figure 5 shows the net benefit of each income group under various designs. There is an obvious trend that net benefits increase with income, under all designs. The results imply that the adverse redistributive effects of Chinese

social security exist when evaluating based on lifetime income, especially under current policy rules, that is, Design 1.

To compare the annual and lifetime income-based effects, we utilize annual income from the same sample to calculate the Gini coefficient for both initial and redistributed incomes of 0.3417 and 0.3406, respectively. These results are lower than the lowest redistributive coefficient reported in Table 5. This implies the redistributive effect of the pension system could be negligible if measured by the annual income of current workers. However, the effect strengthens if measured using long-term income. This implies that the long-term redistributive effect is larger compared with its short-term effect for current workers.

V. FINDINGS AND POLICY IMPLICATIONS

We use the CHIP data to estimate the income redistributive effects of the Chinese urban social security system from several new perspectives. Our findings are as follows:

1. Public pension is the main income for the elderly in urban China. During both the pre-reform and post-reform period, the majority of people aged 60 and over (72% in 1995 and 82% in 2002) had pensions, comprising 80% to more than 90% of their total income. Moreover, compared with 1995, the share of the pension in total income was higher in 2002. Other income sources are salary and private transfers. In contrast, the percentage of employees covered by public health insurance programs declined from 76% in 1995 to 63% in 2002. Among the retirees, the coverage declined from 81% to 72%.

2. In urban China, social security greatly improved the income of low-income groups and helped to reduce poverty. The proportion of households that earned less than half the median income was reduced after social security transfer payments. Comparing 2002 with 1995, however, the inequality of the initial income of urban residents expanded and the relative poverty rate increased, indicating that the number of low-income groups had increased.¹⁷ Meanwhile, although the Gini coefficient and relative poverty rate declined in 2002 after

redistribution by social security, they remained higher than those in 1995. As the increase in initial income inequality could also affect the Gini coefficient based on redistributed income, without controlling for changes in initial income between 1995 and 2002, it is difficult to conclude that the Gini coefficient of redistributed income in 2002 was actually higher than that in 1995 because of the weakened redistributive effect of social security. However, we can conclude that the effectiveness of social security in reducing inequality did not offset the increase in initial income inequality from 1995 to 2002, although income inequality decreased through income transfers provided by social security and hence the Gini coefficient of redistribution income in 2002 was higher than in 1995.

3. The redistributive effect of the Chinese social security system has demonstrated an inter-generational transfer rather than a transfer from high- to low-income individuals. During 1995 and 2002, both low- and high-income groups obtain a positive benefit from the social security system, but the net benefit increases with income. Overall, the net benefit of the highest-income group is 1.4 times and 3.2 times larger than the lowest-income groups in 1995 and in 2002, respectively. This outcome implies that the adverse income transfer of social security was increasing over time. Aggregated data and estimation with lifetime income show the same tendency. On the other hand, the RCRI exhibits no significant difference across various income groups (3.61%, 3.56%, and 3.63% for the lowest-, middle-, and highest-quintile groups, respectively, in 2002), while in the elderly group, it exhibits almost a negative relationship with income. Thus, the Chinese social security system lacks progressivity in contribution, and does not favor the poor in terms of benefits.

4. We use lifetime income to evaluate the redistributive effect of the pension program among current workers and we find that a combination of the funded system and a PAYG system has a larger effect in improving income inequality. Furthermore, if the current policy is extended to all employees including those in the public sectors, the income gap between employees in the public sectors and other sectors declines more, as does the gap between incomes in the highest- and lowest-income groups. In addition, we find that the equalizing effect is

17. This is consistent with the finding of Xia, Song, and Simon (2007) that the rate of relative poverty was increasing.

significantly larger than the short-term effect calculated using 1 year's income, when measured by lifetime income. China is now discussing how to reform public sector pensions. If the government expects social security to play a bigger role in income redistribution, differences in the long- and short-term effects of pensions should be considered.

In summary, from 1995 to 2002, the social security system in urban China raised the income of low-income and old age groups and narrowed the income gap. The redistributive effect of the social security system did not offset the rising income inequality. The 2002 Gini coefficient of redistributed income was higher than that in 1995, public medical insurance

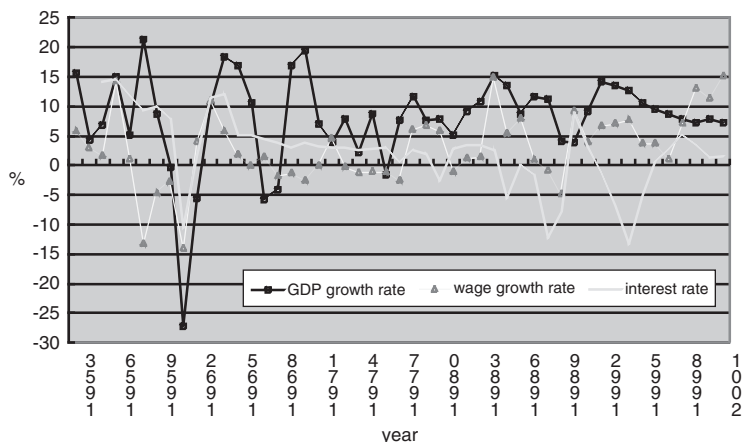
protection was weakened, and the adverse income transfer of social security was increasing over time. If the government wishes to improve income redistribution, it can strengthen the equalizing effect of social security by improving the public medical insurance system, increasing the progressivity of the contribution of the social security system to reduce adverse income transfers, adjusting the proportion of basic pensions and individual account pensions in the pension system, and instituting a unified pension system for the entire urban labor market. In addition to these changes in the social security system, inequality in income distribution should be addressed using other policies.

APPENDIX 1

TABLE A1
Contribution and Benefit Structure in Pension Plans in 1997 and 2005

Item		Old Participants	In-Between Participants	New Participants
Definition		Personnel retired before 1997 reform	Personnel retired after 1997 reform but started working before 1997 reform	Personnel started working after 1997 reform
Contribution	Pension plan 1997	N/A	28% of wage (contributed jointly by employee and employer), 11% of which is reserved in individual account	Same as the in-between group
	Pension plan 2005	N/A	28% of wage (contributed jointly by employee and employer), 8% of which is reserved in individual account	Same as the in-between group
Benefit	Pension plan 1997	Same as the pre-reform terms, which is $x\%$ of the individual standard retirement wage	Basic pension (20% of last year's average monthly wage of local employees) + individual account pension (the amount of individual account savings/120) + transitional pension (average indexed monthly earnings) \times modulus \times years without an individual account	Basic pension (20% of last year's average monthly wage of local employees) + individual account pension (the amount of individual account savings/120)
	Pension plan 2005	Same as the pre-reform terms, which is $x\%$ of the individual standard retirement wage	Basic pension (years of contribution) $\times 1\% \times 0.5$ (average indexed monthly earnings + last year's average monthly wage of local employees) + individual account pension (the amount of individual account savings)/months of payment scheduled (depends on average life expectancy of urban population at the time of retirement & age of retirement) + transitional pension (average indexed monthly earnings) \times modulus \times years without an individual account	Basic pension (years of contribution) $\times 1\% \times 0.5$ (average indexed monthly earnings + last year's average monthly wage of local employees) + individual account pension (the amount of individual account savings)/months of payment scheduled (depends on average life expectancy of urban population at the time of retirement and age of retirement)

FIGURE A1
Major Economic Indicators (1953–2001)



Note: All of the indicators are real values and the interest rate is the 1-year saving interest rate.

Source: China Statistical Yearbook 1990, 1993, 2002, and 2003; China Financial Yearbook 1997, 2000, and 2003.

APPENDIX 2: ESTIMATING LIFETIME INITIAL INCOME AND LIFETIME REDISTRIBUTED INCOME

As described in Section IV, when estimating the redistributive effects of the social security system, the initial income is the individual's lifetime income while the redistributed income is the sum of initial income and the net benefit of social security during the life cycle. Lifetime earnings are defined as the sum of the present value of wage earnings from the first year of an individual's working life to the year prior to retirement. Gross lifetime pension benefit is defined as the sum of the present value of the pension benefit from retirement to the end of life. Lifetime contribution is defined as the sum of the present value of contributions during an individual's working life. Hence, the net benefit is the present value of gross lifetime benefit minus lifetime contribution.

The method of estimating lifetime wages and lifetime net pension benefits follows He (2008) and Feng, He, and Sato (forthcoming). First, we use samples of males aged 20–59 and females aged 20–54 who have wage earnings in the CHIP data for 1995 and 2002 to be used in the estimation of a wage equation. Log wage is the dependent variable with individual characteristics such as age, education, occupation, and regional dummies as explanatory variables. Then, with the aid of the wage equation, we predict annual income, and hence, the individual's lifetime income distribution for a given wage growth rate and interest rate hypotheses (Equation (A1)).

$$(A1) \quad LTW_i = \sum_{s=a_0}^{R-1} \left\{ \frac{[\hat{w}_{i(s)} \cdot (1 + g_s)^{(s-a)}]}{(1 + r_s)^{(s-a)}} \right\},$$

where LTW_i is the discounted present value of a worker's lifetime wage income in 2002, accumulated from the beginning of his/her working life at age a_0 to the year before retirement at $(R-1)$ years of age. $\hat{w}_{i(s)}$ is the predicted labor income of worker i when he/she is s years old. " a " represents worker i 's age in the year of the survey, and R is the

retirement age (60 for men and 55 for women).¹⁸ g_s is the real growth rate of the mean social wage when worker i is s years old. r_s is the discount rate. In our estimation, for years preceding 2002, we use the national growth rate of the real wage, g_s , and the real 1-year saving interest rate, r_s . After 2002, we assumed equal wage growth rates and discount rates.¹⁹

For reference, Figure A1 provides the real wage growth rate, real 1-year saving interest rate, and real gross domestic product (GDP) growth rates for 1953–2001.

According to the policy rules of contributions and benefits listed in Table A1 of the Appendix we derive lifetime pension benefits and contributions for each individual.

Design 1

The pension for public sector employees is calculated as a certain proportion of the wage income when retired and there is no contribution. The calculation method of the pension is the same as in Feng, He, and Sato (forthcoming), that is:

$$(A2) \quad LPold_i = \sum_{s=R}^D \left\{ \hat{w}_{i(R-1)} \times x \times (1 + g_s)^{(s-R)} / (1 + r_s)^{(s-a)} \right\},$$

where $LPold_i$ is the present value of the sum of pension benefits from retirement age R to death age D of individual i . $\hat{w}_{i(R-1)}$ is projected earnings in the year before retirement, x is the replacement ratio (90%); D is life expectancy

18. The mandatory retirement age is 60 for males and 55 for females.

19. This assumption is meaningful because it matches the condition for the government's reform to achieve a target replacement rate of 58.5%. The assumption is a baseline scenario for evaluating the income redistribution effect of the social security system in China. We are going to do sensitivity analysis in future work.

TABLE A2
Lifetime Income and Lifetime Pension Benefits

Schemes	Age Group	Lifetime Income	Lifetime Benefits	Lifetime Net Benefits	Lifetime Contribution	Sample
Design 1	20–29	361,550	160,159	132,055	28,104	1,140
	30–39	319,421	152,221	135,716	16,504	2,818
	40–49	260,235	155,746	143,806	11,940	3,516
	50–59	236,182	164,096	157,448	6,648	1,346
Design 2	20–29	361,550	153,874	116,236	37,638	1,140
	30–39	319,421	146,518	120,642	25,876	2,818
	40–49	260,235	158,016	140,346	17,670	3,516
	50–59	236,182	173,360	162,889	10,471	1,346
Design 3	20–29	361,550	53,507	15,869	37,638	1,140
	30–39	319,421	52,690	26,814	25,876	2,818
	40–49	260,235	61,503	43,833	17,670	3,516
	50–59	236,182	76,553	66,082	10,471	1,346
Total sample		—	—	—	—	8,820

at the current age and data on life expectancy at each age are from the World Bank's life tables for China for 2003 (Sin 2005; Table 1). (Other symbols have the same meanings as before.)

For employees in other sectors, contributions and benefits are calculated according to the policy rules of 2005 in Table A1. Individuals contribute 8% of their wage to individual accounts. The real rate of return on individual accounts is 3%.²⁰ For new participants, we calculate the basic pension benefit and benefit from individual accounts. For in-between participants, we calculate the basic benefit, transitional benefit, and benefit from the individual accounts. LTC_i is the current contribution for individual i of age a , which is:

$$(A3) \quad LTC_i = \sum_{s=a_1}^{R-1} \left\{ [\hat{w}_{i(s)} \times (1 + g_s)^{(s-a)} \times 0.08] / (1 + r_s)^{(s-a)} \right\}.$$

a_1 is the age at which the individual's account was established.

$LTBB_i$ is the current basic pension benefit for individual i of age a , which is:

$$(A4) \quad LTBB_i = \sum_{s=R}^D \left\{ \bar{w}_{m(i,R-1)} \times (1 + Q_i) / 2 \times Y_{insu(i)} \times 1\% \times (1 + g_s)^{(s-R)} / (1 + r_s)^{(s-a)} \right\}.$$

$\bar{w}_{m(i,R-1)}$ is the predicted average wage at the time when individual i is age $R - 1$. Q_i is the wage index of individual i , which is the individual wage relative to the regional average wage. $Y_{insu(i)}$ is the accumulated contribution years of individual i .

20. We make this assumption because there is no explicit arrangement for undertaking investment in individual accounts and because, according to Document No. 26, funds should accumulate in individual accounts at a rate equal to the annual interest rate. In fact, most of the individual accounts are empty because of the transition costs of the reform. Thus we set the real rate of return at 2%–3%.

$LTPB_i$ is the present value of pension wealth from the individual account:

$$(A5) \quad LTPB_i = \sum_{t=R}^D \left\{ \sum_{s=a_1}^{R-1} \hat{w}_{i(s)} \times (1 + g_s)^{(s-a)} \times 0.08 \times (1 + Ir)^{(R-1-s)} / (1 + r_s)^{(s-a)} \right\} \times 1 / (Y_{rem(i)}) \times (1 / 1 + r_s)^{(t-1)}$$

where Ir is the real rate of return on the individual's account. $Y_{rem(i)}$ is the life expectancy in the city where individual i retired. Data of life expectancy is from World Bank's life tables for China.

$LTTB_i$ is the present value of transitional pension wealth, the calculation method for which is the same as in Feng, He, and Sato (forthcoming), that is:

$$(A6) \quad LTTB_i = \sum_{s=R}^D TB_{i(s)} (1 / 1 + r_s)^{(s-a)}$$

where the formula $TB_i = 1.3\% \times L_i \times \bar{w}_{m(i,R-1)} \times Q_i$ is implied by the policy. This coefficient is 1.3% for most regions. L_i denotes work experience gained up to 1997.

Design 2

The 2005 reform is applicable to the whole sample, that is, the benefits and contributions of employees in both the public sectors and other sectors are calculated using Equations (A3)–(A6).

Design 3

A fully funded system, lifetime contributions are calculated according to Equation (A3), and gross pension benefits are according to Equations (A5) and (A6) for all samples.

According to Equations (A1)–(A6), we compute life time income and benefit under three designs. Table A2 demonstrates the mean value of each age group.

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