The Macroeconomic and Welfare Implications of China’s Rural Healthcare and Pension Reforms

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Abstract

In this paper we quantitatively assess the impact of healthcare and pension reform on macroeconomic outcomes and social welfare in a dynamic general equilibrium model calibrated to the Chinese economy. Mimicking recent reforms to rural health insurance and pay-as-you-go pension systems results in a decline in aggregate output and savings but increase in social welfare. Welfare gains are driven by rural health insurance providing direct relief from catastrophic medical expenditures as well as allowing for the favorable reallocation of consumption and leisure across agents and over the life-cycle. In contrast, the pay-as-you-go pension system results in a net welfare loss due to only mild redistributive benefits. Finally, despite an increase in required financing due to an aging population, the welfare impact of rural health insurance remains positive when incorporating the projected demographic structure for the year 2050. Likewise, the negative effects of the pension system are amplified due to the increased share of retirees.

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1 Introduction

In 2005, China’s Hu-Wen administration introduced a governing philosophy centered on social equality and the promotion of a harmonious society. In line with the new guiding principle, there has been a major restructuring of the social insurance systems across China in recent years. This has been most evident in the rural sector, where pension and health insurance schemes are being widely established for the first time in more than a generation. The new plans feature generous subsidies from both local and central government resulting in rapid coverage expansion despite voluntary participation. For instance, by 2011, enrollment exceeded 300 million for the newly introduced rural pension system. Likewise, rural health insurance was largely absent a decade ago and now boasts over 98% coverage rates (China, 2014). The primary goals of these new social insurance schemes are to lessen the healthcare disparities across socioeconomic status and between urban and rural sectors and to ease the growing financial burden of medical expenditures and old-age in rural China.

Along with the potential benefits of providing insurance coverage to hundreds of millions in rural China, the expansive scope of the new programs imply significant direct financing costs. Moreover, researchers have linked China’s substantial savings rates to the uncertainty of old-age and future medical expenditures (Chamon and Prasad, 2010). If the policies have measurable effects on savings or labor supply decisions, there could also be indirect macroeconomic implications. These concerns may be further compounded by the unprecedented aging of the Chinese population over the coming decades. As pension and healthcare spending is disproportionately concentrated among older individuals, the upcoming demographic change implies potentially large increases in the fiscal outlays of the programs. Moreover, changing demographics could have other general equilibrium effects that indirectly influence the long-term impact of the policies.

In this paper, we quantitatively assess the impact of the new pension and health insurance policies on macroeconomic outcomes and social welfare in a dynamic general equilibrium model calibrated to the modern Chinese economy. Our model employs a life-cycle structure within an overlapping generations framework. Individuals enter the economy as young adults and their earnings potential and health evolve stochastically with age. Each period agents face stochastic medical expenditures and choose how much to work, consume, and save. Current period health status affects medical expenditures, labor productivity, and mortality risk.

In addition to age, wealth, and health status, we allow for permanent heterogeneity across agents in terms of education and urban/rural sector. We model key differences in social insurance systems, labor productivity, and healthcare across the urban and rural sectors as they exist in reality. This gives us the required framework to understand the impact of rural social insurance policy changes in China.

The government is assumed to operate all pension and health insurance schemes in the model economy. From a welfare perspective, health insurance partially protects individuals against idiosyncratic medical expenditure uncertainty over the life-cycle.
Similarly, pensions serve as a partial insurance device against idiosyncratic labor productivity and medical expenditures. With the absence of annuity markets, the pension system also provides partial insurance against mortality risk.

Importantly, our model allows the rural and urban sectors to operate independent pension and health insurance programs that may be financed locally (at the sector level) or through the central government. Social insurance schemes are financed through a combination of proportional labor income and consumption taxes allowing for redistribution across agents. The presence of a central government allows for a further redistributive role for social insurance policies from one sector to the other. Thus, if equity is valued by society, the social insurance policies could contribute to social welfare through their redistributive effects.

We begin our quantitative analysis by calibrating our model to the Chinese economy circa 2000, prior to the rural social insurance reforms. We then compare our 2000 benchmark results with the stationary equilibrium produced using the same parameter values except for (a) health insurance benefits and/or (b) pension benefits.

Introducing rural pension and health insurance at current benefit levels results in an overall decrease in average hours worked, savings, consumption, aggregate output and an increase in interest rate and taxes. Nonetheless, the insurance schemes are welfare improving from a social perspective due to the redistribution of resources across agent types and over the life-cycle. Specifically, we find a 6.8% increase in expected welfare of an unborn agent (as measured by consumption equivalent variation). When decomposing the welfare effects by sector, the expected gain for an unborn rural agent is over 9%. In contrast, an unborn urban agent realizes nearly a 3% welfare loss due primarily to the increase in taxes required to finance the generous subsidization of the new rural insurance schemes.

We follow our joint analysis of current reforms by considering rural pension and health insurance programs individually in order to isolate the effects of each type of social insurance. Introducing healthcare benefits at anticipated future levels amplifies the favorable mechanisms of the current reform, resulting in an expected welfare gain of over 12%. The source of welfare improvement is the redistribution of consumption and hours supplied to the labor market in the rural sector—particularly on the basis of medical expenditures and labor productivity. In contrast, we find no net welfare benefits from the reallocation of resources when implementing only the pay-as-you-go pension system. Consequently, increasing rural pension benefits to match the current urban scheme results in a 2.9% decrease in the expected welfare of an unborn.

Lastly, in order to assess the effects of upcoming demographic change on our results, we conduct an analogous set of experiments but under an alternate demographic structure. Specifically, we alter the population growth rate to mimic the projected old-age dependency ratio for China in 2050, holding other parameters at the 2000 benchmark level. Despite an increase in required financing due to an aging population, the welfare effect of introducing rural health insurance remains positive. However, the demographic change implies even larger welfare losses from expanding the pay-as-you-go rural pension system beyond current levels due to the increased share of retirees.
Our model builds on the structure first proposed by Auerbach and Kotlikoff (1987) to study the effects of fiscal policy in a general equilibrium setting with overlapping generations. This class of models has been used extensively to analyze social security reform in the US as well as general pension reform in a variety of other contexts. More recently, the framework has been extended to analyze US healthcare reform. For example, Pashchenko and Porapakkarm (2013) model the effects of the Affordable Care Act on personal income while Attanasio et al. (2010) examine the economic effects of different methods of financing Medicare.

While primarily limited to the US and Europe, several papers have used computable general equilibrium (CGE) models to examine the impact of population aging on the pension system in China (Wang et al., 2001; Li and Mérette, 2005; Sun, 2007). In these papers, a primarily unfunded system is found to be unsustainable due to the increasing proportion of China’s retired population. A combination of funded individual accounts and a reduction in pay-as-you-go benefits are found to be sustainable solutions. While these papers provide quantitative insight into China’s urban pension scheme, they do not analyze the recent rural pension reforms and abstract from any healthcare considerations. Moreover, to the best of our knowledge, Chinese rural pension and healthcare reforms have not been studied within a general equilibrium framework, highlighting the major contribution of this paper.

The remainder of this paper is presented as follows. Section 2 begins by providing some additional discussion on social insurance schemes in China. Section 3 builds the economic framework of the model, and Section 4 describes our welfare measure. Section 5 details the calibration strategy and Section 6 presents the results of the quantitative analysis. Finally, Section 7 provides concluding remarks.

2 Social Insurance in China

2.1 Healthcare

Following the decentralization of China in the late 1970s, the major health insurance programs in urban areas remained intact until the late 1990s. These programs covered urban employees of state or collectively-owned enterprises and government agencies, as well as their dependents. In attempt to unify urban schemes and extend coverage to employees in the expanding private sector, the Urban Employee Basic Medical Insurance (UE-BMI) program was introduced in 1998 to provide basic medical coverage to all urban formal sector workers (Liu, 2002). As a result of the program, coverage rates remained relatively stable for employees and benefit levels continued to be high. However, the policy change no longer covered dependents, leading to the introduction of the Urban Residence Basic Medical Insurance (UR-BMI) program in 2007. The UR-

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BMI provides insurance for urban residents not covered by the UE-BMI—primarily children, students, and previously unemployed elderly (Liu and Zhao, 2012).

In contrast to urban programs, rural health insurance cooperatives were dissolved following decentralization and responsibility of social insurance schemes was shifted to local governments. As a result, health insurance coverage fell from nearly universal levels in 1978 to about 7% in 1999 (Barber and Yao, 2010). Facing rising public outcry over increasing healthcare inequalities along socioeconomic lines and between rural and urban areas, the central government introduced a new insurance scheme for the rural sector—the New Rural Cooperative Medical Scheme (NCMS). The program was piloted in several provinces in 2003 and quickly expanded over the next several years. Enrollment incentives included generous local and central government subsidies—roughly 80% of the individual premium on average. As a result, despite voluntary participation, rural health insurance coverage reached 90% by 2008 (Yip et al., 2012).

In order to expand coverage quickly, the NCMS was designed to initially provide relatively shallow benefits while maintaining low premiums. For example, taking into account co-payments, deductibles, and reimbursement ceilings, the average effective reimbursement rate for inpatient care was only 44% in 2010. However, with coverage rates now approaching universal levels, the central government aims to increase inpatient reimbursement rates to 70% over the coming years (Yip et al., 2012). This is near the rate already received by urban employees in the UE-BMI. Table 1 provides a summary of the current health insurance programs in China.

<table>
<thead>
<tr>
<th>Table 1: Summary of Health Insurance Programs</th>
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<tbody>
<tr>
<td><strong>Urban</strong></td>
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<tr>
<td><strong>UE-BMI</strong></td>
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<tr>
<td>Target Population</td>
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<tr>
<td>Enrollment (%)</td>
</tr>
<tr>
<td>Revenue Source</td>
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<tr>
<td>Central government</td>
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<tr>
<td>Local government</td>
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<tr>
<td>Individual</td>
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<tr>
<td>Inpatient reimbursement (%)</td>
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</table>

### 2.2 Pensions

The reforms of the 1970s not only brought significant changes to health insurance systems, they also affected urban pension schemes. A basic urban pension scheme was
first established in 1951—the Basic Old-Age Insurance System for Employees (BOISE). The system was characterized by generous benefits provided by individual state-owned enterprises using pay-as-go financing. A series of reforms in the 1980s and early 1990s increased the pooling base to the municipality level and extended coverage to more enterprises. However, high costs and increased competition of the post-reform era placed increased pressure on the system. Ultimately, the fully unfunded system proved unsustainable resulting in the move to a partially-funded system in 1997, though benefits continued be high (Feng et al., 2009).

In rural China, a pension system was only first attempted in 1992. The program emerged as a patchwork of schemes run by various levels of governments across the country. It relied heavily on individual and employer contributions leading to claims of inequitable access and benefits across rural populations. The lack of incentive for voluntary contributions resulted in low participation and the system eventually collapsed in 1999. Attempting to learn from the failed system of the nineties, a new pension scheme was launched in 2009. Dubbed the New Rural Social Pension Scheme (NRSPS), the program included more substantial government subsidies and minimum benefit standards nationwide (Vilela, 2013). As a result, voluntary enrollment exceeded 50% by 2011 (China, 2014).

In 2011, the Urban Social Pension Scheme (USPS) was introduced to extend pension coverage to adult urban residents not employed in the formal sector. The new program was merged with the existing NRSPS as it follows the same benefit and financing structure. By 2013, enrollment in the two programs reached nearly 500 million (China, 2014).

The current urban and rural pension systems consist of two fundamental components—a basic social pooling pension and an individual account. The individual account is funded primarily by individual contributions with a small contribution required from employers (BOISE) or local governments (NRSPS). The balance of funds in an individual account at retirement determines the pension annuity payment from this component of the system. In contrast, an additional basic pension is guaranteed to participants and is not tied to individual contributions. In the urban system (BOISE), financing the basic pension is achieved primarily through employer contributions. In contrast, financing the minimum basic pension is the responsibility of local governments under the NRSPS, though the central government provides heavy subsidization—100% in central and western regions and 50% in eastern regions (Vilela, 2013). In our model economy, we focus on the non-contributory basic pension, which is paid for with pay-as-you-go financing.\footnote{Note that this will likely underestimate the welfare benefits of the pension system as the annuity insurance is partially lost by excluding the individual account component.}

2.3 Eligibility

Eligibility for pension and health insurance programs in China is generally tied to an individual’s official urban or rural \textit{hukou} designation. However, substantial internal
migration from rural to urban areas has placed increased pressure on local governments, leading some cities to allow migrants to enroll in urban insurance programs regardless of hukou status. For example, some cities have included migrants in urban resident schemes such as the UR-BMI and USPS (Yip et al., 2012). Nonetheless, as primary eligibility criteria is crucial for evaluating the effects of social insurance programs, we calibrate our model to reflect heterogeneity based on urban/rural hukou, as opposed to current sector of residence. As later detailed, we estimate productivity and health within sectors by averaging over migrants and non-migrants, leaving the explicit modeling of internal migration for future work.

3 Economic Framework

3.1 Demographics and Health Status

Consider an economy populated by $J$ overlapping generations. Time is discrete ($t$) and in each period a new generation is born whose mass grows at rate $n$. Individuals are assumed to enter the economy with several exogenous characteristics that do not change over the life-cycle. Specifically, each individual is assumed to be of some education type $e \in E$ and belong to some sector $s \in S$. Let $\Pi^{es}(E, S)$ denote the invariant joint probability measure over education and sector types of an incoming generation.

In each period, individuals are characterized by health status $h \in \mathcal{H}$. Agents are assumed to enter the economy in the highest health state ($\bar{h}$). Health then evolves stochastically over the life-cycle. The stochastic process for health status follows a finite-state Markov chain with stationary transitions over time. The Markov process is assumed to differ by age, sector, and level of education, but is otherwise identical and independent across agents:

$$Q_{jests}^{h}(h, \mathcal{H}) = \text{Prob}(h' \in \mathcal{H} \mid h, j, e, s) = Q_{jes}^{h}(h, \mathcal{H}).$$

Agents of age $j$, education $e$, health status $h$, and sector $s$ survive to age $j + 1$ with
positive probability \( \psi_{jehs} \). At age \( J \), individuals die with probability one.

Each period agents realize an idiosyncratic medical expenditure shock \( x \in \mathcal{X} \). Medical expenditures are drawn from a stationary distribution that is conditional on current health status and sector:

\[
Prob(x \in \mathcal{X} | h, s) = Q^x_{hs}(\mathcal{X}).
\]

In this way the persistence of medical expenditures is realized through the persistence of health status. Moreover, the specification is flexible enough to allow for the large disparity in medical expenditures between the urban and rural sectors observed in the data. Let \( \Pi^x_{hs}(\mathcal{X}) \) denote the time invariant probability measure associated with \( Q^x_{hs} \).

### 3.2 Preferences and Labor Productivity

In each period, individuals are endowed with a unit of time that may be devoted to leisure or to earning wages in a competitive labor market. An individual’s productivity in the labor market has two components—a fixed age, education, health, and sector specific component \( (\epsilon_{jehs}) \) estimated directly from the data (see section 5 for details) and an idiosyncratic shock \( (\eta) \). The stochastic process for the labor productivity shock follows a finite-state Markov chain with stationary transitions over time and which is identical and independent across all agents:

\[
Q^n_{\eta}(\eta, \mathcal{E}) = Prob(\eta' \in \mathcal{E} | \eta) = Q^n(\eta, \mathcal{E}).
\]

Let \( \Pi^n(\mathcal{E}) \) denote the invariant probability measure associated with \( Q^n \). All individuals retire exogenously at age \( j_r \), at which point labor productivity is equal to zero \((\epsilon_{jehs} = 0 \forall j \geq j_r)\).

An agent’s preferences over consumption and leisure follow an additive time separable utility function given by:

\[
E \left\{ \sum_{j=1}^{J} \beta^{j-1} u(c_j, \ell_j) \right\}
\]

where \( \beta \) is a per-period discount factor, \( c \) consumption, and \( \ell \) hours worked. Expectations are taken with respect to stochastic processes for health status, medical expenditures, and labor productivity.

### 3.3 Market Structure

We assume individuals are unable to insure against idiosyncratic health and labor productivity risk by trading private insurance contracts. Furthermore, we assume there are no annuity markets to insure against mortality risk. Agents may self-insure by saving one-period risk-free bonds that earn interest rate \( r_t \). However, agents are not permitted to maintain a negative asset position between periods (i.e. borrowing
is not allowed). A non-negative asset limit ensures agents do not die in debt. Assets from the deceased are distributed evenly in a lump-sum fashion across all individuals entering the economy the following period. These unintended bequests are denoted by $T_{R_1}$.

### 3.4 Social Insurance

Government may operate two social insurance programs in our model. First, a pay-as-you-go pension system for each sector of the economy. This system is defined by a stream of fixed pension payment benefits $P_B_{st}$ for each retired individual in sector $s$. Pension benefits are determined by a replacement rate $b_{st}$ of current average wages. Second, the government may provide health insurance to cover stochastic medical expenditures. This program is characterized by healthcare reimbursement rates $RR_{st}$ for individuals in sector $s$, regardless of their medical expenditure history.

Social insurance programs may be financed by the central government and/or local (sector) governments. Denote the share of any program financed by local government as $\lambda_{st}$, with the remaining $(1 - \lambda_{st})$ to be financed by the central government. Central and local governments run a balanced budget each period. As a majority of public revenues in China are collected through direct or indirect consumption taxes, we assume local and central insurance programs are financed with a proportional tax on individual consumption. However, current urban pension and health insurance programs are primarily financed through payroll or labor income taxes. As such, we assume the urban share of financing in our model is collected with a proportional labor income tax. Local consumption tax rates are denoted by $\tau_{c_{st}}$, local labor tax rates $\tau_{\ell_{st}}$, and the central tax rate by $\tau_{ct}$.

Finally, we allow government to provide emergency relief in the event of catastrophic medical expenditures. Specifically, if an agent is unable to reach consumption floor $c$ in a given period, then it is provided to them by the local government. However, all assets and labor earnings are seized and the agent is required to supply $\bar{\ell}$ units of labor to the labor market. We view this as a succinct way of capturing emergency relief in the form of informal family and community transfers as well as formal government poverty transfer programs. Government shortfalls from this last-resort insurance is financed through a sector-specific lump-sum tax $Tx_{st}$.

### 3.5 Technology

Aggregate output ($Y_t$) is produced by a representative firm using the technology:

$$Y_t = \theta K_t^\alpha N_t^{1-\alpha} \quad \alpha \in (0, 1),$$

where $K_t$ and $N_t$ are the aggregate capital stock and labor inputs (measured in efficiency units) in period $t$, $\theta$ is total factor productivity, and $\alpha$ is the capital share.
Output can be consumed \((C)\), invested in physical capital \((I)\), or expended on healthcare \((E)\):

\[
Y_t = C_t + I_t + E_t.
\]

Finally, letting \(\delta\) equal per-period depreciation, the law of motion of capital is given by:

\[
K_{t+1} = (1 - \delta) K_t + I_t.
\]

### 3.6 Decision Problem

At any given time, an individual can be characterized by a vector of state variables \(\zeta = (a, \eta, j, e, h, x, s)\), where is a is current holdings of one-period, risk-free assets, \(\eta\) is a stochastic labor productivity shock, \(j\) is age, \(e\) is level of education, \(h\) is health status, \(x\) are stochastic medical expenditures, and \(s\) is the urban/rural sector of the economy. Given this state vector, an agent chooses consumption \(c\), labor supply \(\ell\), and next period assets \(a'\) to maximize expected lifetime utility. The decision problem facing an agent may be written:

\[
\nu_t (a, \eta, j, e, h, x, s) = \max_{c, \ell, a'} \left\{ u(c, \ell) + \beta \psi_{jehs} E_{\eta' h'x'} [\nu_{t+1} (a', \eta', j + 1, e, h', x', s)] \right\}
\]

subject to

\[
c(1 + \tau_c + \tau_{ct}) + a' = w_t \left(1 - \tau_{ct}\right) \epsilon_{jehs} \eta \ell + (1 + r_t) (a + Tr_t (j = 1)) - x (1 - RR_{st}) - Tx_{st} + PB_{st} (j \geq j_r),
\]

\[a' \geq 0, \quad c \geq 0, \quad 0 \leq \ell \leq 1\]

where value function \(\nu_t (.)\) is the expected discounted lifetime utility of arriving in a period of time with a given state vector. Note that expectations are taken with respect to stochastic processes for health status, medical expenditures, and labor productivity. The first constraint is the budget constraint while the final line gives the borrowing constraint followed by feasibility constraints on consumption and labor. Emergency relief is exogenously given when consumption \(c\) is unobtainable, in which case \(a' = 0\), \(c = \xi\), and \(\ell = \bar{\ell}\).

### 3.7 Definition of Competitive Equilibrium

Let \(\alpha \in A = \mathbb{R}_+, \ \eta \in \mathcal{E} = \{\eta_1, \eta_2, \ldots, \eta_n\}, \ j \in \mathcal{J} = \{1, 2, \ldots, J\}, \ e \in \mathcal{E} = \{e_1, e_2, \ldots, e_n\}, \ h \in \mathcal{H} = \{h_1, h_2, \ldots, h_n\}, \ x \in \mathcal{X} = \{x_1, x_2, \ldots, x_n\}, \ s \in \mathcal{S} = \{s_1, s_2, \ldots, s_n\}, \) and \(\mathcal{R} = \mathbb{R}_+ \times \mathcal{E} \times \mathcal{J} \times \mathcal{E} \times \mathcal{H} \times \mathcal{X} \times \mathcal{S} \). Let \(B (\mathbb{R}_+)\) be the Borel \(\sigma\)-algebra of \(\mathbb{R}_+\) and \(P (\mathcal{E}), P (\mathcal{J}), P (\mathcal{E}), P (\mathcal{H}), P (\mathcal{X}), P (\mathcal{S})\) the power sets of \(\mathcal{E}, \mathcal{J}, \mathcal{E}, \mathcal{H}, \mathcal{X}, \mathcal{S}\), respectively. Let \(\mathcal{M}\) be the set of all finite measures over the measurable space:

\[(\mathcal{R}, B (\mathbb{R}_+) \times P (\mathcal{E}) \times P (\mathcal{J}) \times P (\mathcal{E}) \times P (\mathcal{H}) \times P (\mathcal{X}) \times P (\mathcal{S})).\]
Definition 1. Given a sequence of pension replacement rates \( \{b_{st}\}_{t=1}^{\infty} \), healthcare reimbursement rates \( \{RR_{st}\}_{t=1}^{\infty} \), local government financing shares \( \{\lambda_{st}^p, \lambda_{st}^h\}_{t=1}^{\infty} \), and initial conditions \( K_1 \) and \( \Phi_1 \), a competitive equilibrium is a sequence of functions for individuals \( \{v_t, c_t, a_t', l_t\}_{t=1}^{\infty} \), production plans for the firm \( \{N_t, K_t\}_{t=1}^{\infty} \), prices \( \{r_t, w_t\}_{t=1}^{\infty} \), tax rates \( \{\tau_{st}, \tau_{ct}, Tx_{st}\}_{t=1}^{\infty} \), pension benefits \( \{PB_{st}\}_{t=1}^{\infty} \), transfers \( \{Tr_{t}\}_{t=1}^{\infty} \), and measures \( \{\Phi_t\}_{t=1}^{\infty}, \Phi_t \in M \) such that:

1. Given prices, tax rates, pension benefits, healthcare reimbursements, transfer rates, and initial conditions, for each \( t \), \( \nu_t \) solves the agent’s decision problem (with associated policy functions \( c_t, a_t', l_t \)).

2. Prices \( w_t \) and \( r_t \) satisfy:
   \[
   r_t = \theta \alpha \left( \frac{N_t}{K_t} \right)^{1-\alpha} - \delta \\
   w_t = \theta (1-\alpha) \left( \frac{K_t}{N_t} \right) .
   \]

3. Local government budgets are balanced\(^3\):
   \[
   \tau_{st}^\ell w_t N_{st} + \tau_{ct}^c \int c(\zeta) \Phi_t (d\zeta (s)) = \\
   \lambda_{st}^p PB_{st} \int \Phi_t (d\zeta (s, j \geq j_r)) + \lambda_{st}^h RR_{st} \int x(\zeta) \Phi_t (d\zeta (s)) ,
   \]
   \[
   Tx_{st} \int \Phi_t (d\zeta (s)) = \\
   \int \max \left\{ x - w_t \left( 1 - \tau_{st}^\ell \right) \epsilon_{jehs} \eta_{\ell} - (1 + r_t) (a + Tr_{t} (j = 1)) + x \left( 1 - RR_{st} \right) + Tx_{st} - PB_{st} (j \geq j_r) \right\} \Phi_t (d\zeta (s)) ,
   \]
   where
   \[
   PB_{st} = \frac{b_{st} w_t N_{st}}{\int \Phi_t (d\zeta (s, j < j_r))} .
   \]

4. Central government budget is balanced:
   \[
   \tau_{ct} \int c(\zeta) \Phi_t (d\zeta (s)) = \sum_s \left[ (1 - \lambda_{st}^p) PB_{st} \int \Phi_t (d\zeta (s, j \geq j_r)) + \left( 1 - \lambda_{st}^h \right) RR_{st} \int x(\zeta) \Phi_t (d\zeta (s)) \right] .
   \]

5. Transfers are given by:
   \[
   Tr_{t+1} = \frac{\int \left( 1 - \psi_{jeh} \right) a_t' (\zeta) \Phi_t (d\zeta)}{\int \Phi_{t+1} (d\zeta (j = 1))} .
   \]

\(^3\)\( \Phi(\zeta (s)) \) and \( \Phi(\zeta (s, j \geq j_r)) \) denote the total measure of agents and measure of retired agents in sector \( s \), respectively.
6. Markets clear:

\[
K_{t+1} = \int a'_t(\zeta) \Phi_t(d\zeta)
\]

\[
N_t = \int \epsilon_{jehs} \eta_{\ell_t}(\zeta) \Phi_t(d\zeta)
\]

\[
\int [c_t(\zeta) + x_t(\zeta)] \Phi_t(d\zeta) + K_{t+1} = \theta K_t^\alpha N_t^{1-\alpha} + (1-\delta) K_t.
\]

7. Law of motion:

\[
\Phi_{t+1} = f_t(\Phi_t).
\]

Denoting \( Z = \{A \times E \times J \times E \times H \times X \times S\} \), function \( f_t \) can be written explicitly as:

(a) For all \( J \) such that \( 1 \notin J \):

\[
\Phi_{t+1}(Z) = \int P_t(\zeta; Z) \Phi_t(d\zeta),
\]

where

\[
P_t(\zeta; Z) =
\begin{cases}
Q^y(\eta, E) Q^{h_s}_{jehs}(h, H) Q^x_{hs}(X) \psi_{jehs} & \text{if } a'_t(\zeta) \in A, j+1 \in J, e \in E, s \in S \\
0 & \text{ else}
\end{cases}
\]

(b) For all \( J = \{1\} \) :

\[
\Phi_{t+1}(A \times E \times \{1\} \times E \times H \times S) =
\begin{cases}
\Pi^y(E) \Pi^{es}(E, S) \Pi^x_{hs}(X) & \text{if } 0 \in A \bar{h} \in H \\
0 & \text{ else}
\end{cases}
\]

Definition 2. A stationary equilibrium is a competitive equilibrium where individual policy functions, prices, tax rate, and per capita transfers are constant over time and aggregate variables grow at the same constant rate as the population \((n)\).

4 Welfare Measure

In order to quantify the welfare effects of alternate policy scenarios we use a consumption equivalent variation measure to compare corresponding steady states. Our measure is akin to asking by what percentage expected consumption allocation must increase for an agent born into a benchmark steady state to achieve the same ex ante lifetime
utility as the alternate steady state, holding benchmark leisure allocation constant. Given our functional form for utility, the welfare impact of moving from benchmark consumption-labor allocation \((c_0, l_0)\) to an alternate allocation \((c_*, l_*)\) is given by:

\[
CEV = \left[ \frac{W(c_*, l_*)}{W(c_0, l_0)} \right]^{1/(\alpha(1-\gamma))} - 1,
\]

where \(W(c, l)\) is the expected lifetime utility of entering a given steady state with consumption-labor allocation \((c, l)\). Welfare may also be decomposed by sector by conditioning expected lifetime utility on entering the economy as an urban or rural agent. The measure is also convenient for dividing welfare into the effect stemming from changes in consumption versus leisure allocation. Moreover, the consumption effect can be decomposed into welfare gains from changes in average consumption and gains from the redistribution of consumption across types and over states of the world. An analogous decomposition is possible for leisure.\(^4\)

5 Calibration

We use a calibrated version of the model to quantitatively assess the impact of Chinese pension and healthcare reform on aggregate outcomes and welfare. We begin by choosing a model parametrization that matches key features of the Chinese economy and demographics circa 2000. We then compare our benchmark results with the stationary equilibrium produced using the same parameter values except for (a) health insurance benefits and/or (b) pension benefits. Next we conduct an analogous comparison under an alternate population growth rate, holding other parameters at the 2000 benchmark level. This analysis is meant to capture the effect of demographic changes on alternate policy scenarios for China in 2050.

5.1 Demographics and Preferences

Each model period is assumed to represent two years of life. Individuals enter the economy at real age 20 (model period \(j = 1\)) and die with probability one at real age 94 \((J = 38)\). The real retirement age is set at 60 \((j_r = 21)\) to match the current age of pension eligibility. The population growth rate for the initial steady state is set at 9.6% in order to match an old-age dependency ratio from 2000 of 11% (UN, 2013).\(^5\) For our alternate demographic scenario we target the projected dependency ratio for 2050 of 51%, implying a population growth rate of 0.5%.

We use data from the China Family Panel Studies (CFPS) for the exogenous distribution of new agents over education and sector types. The CFPS is a nationally

\(^4\)See Conesa et al. (2009) for details on decomposing the measure into consumption/leisure and level/redistribution effects.

\(^5\)The UN dependency ratio is of people older than 64 to those aged 20-64, though we calibrate to match the retired to working-age population in the model.
representative longitudinal survey of Chinese families and communities. The CFPS was chosen primarily for its ability to calibrate health transitions and medical expenditures, but we also use it here for consistency. We combine both available waves of the study—2010 and 2012—and include those 20 years and older. We use the official sector designation, or hukou, to classify each individual as urban or rural in the data. We choose this designation because eligibility for alternate social insurance systems is often tied to an individual’s hukou, as opposed to current sector of residence. We then group individuals into three educational attainment categories—no school, some primary school, and some high school or more. Incoming agents in the model economy are randomly assigned a sector and education type according to the distribution found in CFPS (see Table 3).

Preferences over consumption and leisure are assumed to follow a standard Cobb-Douglas utility function:

$$u(c_j, \ell_j) = \frac{c_j^\gamma (1 - \ell_j)^{1-\gamma} (1 - \sigma)\sigma}{1 - \sigma},$$

where $\sigma$ controls risk aversion and $\gamma$ determines the relative weight of consumption. We set $\sigma$ and $\gamma$ to target an intertemporal elasticity of substitution of 0.5 and average hours worked of one-third in our 2000 benchmark economy. Lastly, $\beta$ is set to match
an annual capital-output ratio in 2000 of 2.8 (Feenstra et al., 2015).

5.2 Health and Survival Transitions

We use both waves of the CFPS to estimate health transitions and survival probabilities. We begin by grouping respondents into two-year age intervals to map into the demographic structure of the model. We then assign individuals as good, fair, or poor health, based on their self-reported health status. Table 4 shows the share of individuals reporting each health status by education and sector designation in 2010. On average, the higher education groups reported to be in better health states. However, there were only mild differences between sectors, with the rural realizing higher percentages at the tails.

Table 4: Self-reported Health Status from 2010 Wave of CFPS (%)

<table>
<thead>
<tr>
<th>Health Status</th>
<th>Education</th>
<th></th>
<th></th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Middle</td>
<td>High</td>
<td>Urban</td>
</tr>
<tr>
<td>Good</td>
<td>35.6</td>
<td>48.7</td>
<td>53.5</td>
<td>44.5</td>
</tr>
<tr>
<td>Fair</td>
<td>34.2</td>
<td>37.4</td>
<td>38.0</td>
<td>42.3</td>
</tr>
<tr>
<td>Poor</td>
<td>30.3</td>
<td>14.0</td>
<td>8.6</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Health transitions are estimated by running an ordered probit of 2012 self-reported health status on education, urban/rural sector, 2010 health status, and a cubic function of age. Figure 1 shows select health transition probabilities for the high and low education groups in the urban/rural sector. The low education group is about 25% more likely to remain in the poor health state than the high education group, and 19% less likely to remain in the good health state. Analogous numbers for the rural compared to urban sector are much smaller at about 2% and 1%. The probability of remaining in good health falls sharply as individuals age regardless of education or sector. Conversely, the likelihood of falling from the good health to poor health increases.

As the CFPS also reports incidence of death between waves, we estimate mortality rates using a probit model analogous to the above health transitions. As expected, mortality rates increase with age and decrease with health status. Figure 2 plots the mortality rate by health status as well as mortality rate premiums for select characteristics. Mortality premiums reflect the change in probability of death between good/poor health, urban/rural sector, or high/low education. For example, the good

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6 We choose two-year periods because waves of the CFPS were collected two years apart.
7 2010 classification: Good=“healthy”, Fair=“fair”, Poor=“relatively unhealthy”, “unhealthy”, or “very unhealthy”. 2012 classification: Good=“excellent”, “very good”, or “good”, Fair=“fair”, Poor=“poor”.
8 Reported mortality rates are calculated holding other regressors at their overall mean.
health premium is the percentage point decrease in mortality rate of an individual in good health relative to a individual in poor health. All premiums are less than 1% at age twenty but increase quickly with age. The good health premium is the largest, reaching 7.3% by age eighty. Analogous numbers for urban and high education premiums at age eighty are 0.5% and 3.8%, respectively.

5.3 Medical Expenditures

Conditional on health status and sector, we assume medical expenditures can take one of two values. We estimate these values by first dividing individuals in the CFPS into percentiles based on reported medical expenditures.\footnote{Total expenditures computed by adding reported total cost of hospitalization and disease/injury in the 2012 wave.} As has been documented in other countries, the expenditure distribution is highly skewed with a thin right tail driven by a limited number of catastrophic events. As such, we calculate the mean expenditures among those in the bottom 90 percentiles of the expenditure distribution. Analogously we obtain the mean across the top 10 percentiles.

Table 5 shows the average reported total expenditures by health status, sector, and percentile range. On average, the healthy spend less than the unhealthy and the urban
sector spends more than the rural. Moreover, there are large differences in the value between low and high expenditure states. For example, the low expenditure value for a rural individual with poor health is about 7% of the value of the high expenditure estimate.

Table 5: Medical Expenditures (% of output per capita)

<table>
<thead>
<tr>
<th>Health Status</th>
<th>Urban 1-90</th>
<th>Urban 91-100</th>
<th>Rural 1-90</th>
<th>Rural 91-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>1.0</td>
<td>26.5</td>
<td>0.6</td>
<td>16.3</td>
</tr>
<tr>
<td>Fair</td>
<td>3.0</td>
<td>48.7</td>
<td>1.3</td>
<td>29.9</td>
</tr>
<tr>
<td>Poor</td>
<td>10.7</td>
<td>135.9</td>
<td>5.1</td>
<td>74.5</td>
</tr>
</tbody>
</table>

We set low/high values in the model such that our 2000 benchmark economy matches the reported mean expenditures in the data (as a share of output per capita). Correspondingly, the probability of realizing the low/high expenditure state each period is set at 0.90 and 0.10, respectively.

5.4 Labor Productivity

We estimate type-specific labor productivity $\epsilon_{jehs}$ from the CFPS by first regressing log of hourly income on age, age-squared, health status, and an individual fixed effect. We then regress the residual on our time invariant covariates (education and sector) in order to estimate productivity differences across all agent types. Combining our results, an agent from the high education group is estimated to have 119% higher wages than the low education group, holding other regressors at their overall mean. The analogous urban sector and good health premiums are smaller at 10% and 2%, respectively. The life-cycle productivity estimates for an individual in fair health by sector and high/low education are plotted in Figure 3. Productivity increases steadily until age fifty, at which point productivity begins to decline slowly until retirement.

For the stochastic component of productivity we assume an AR(1) process in logs:

$$\ln(\eta') = \rho \ln(\eta) + \epsilon_\eta, \quad \epsilon_\eta \sim N\left(0, \sigma_\eta^2\right).$$

We approximate this process with a Markov chain over four discrete values. Parameters governing the stochastic process are taken from the estimates of Fan et al. (2010). The authors estimate the parameters of the stochastic component of log-earnings using data from the 2002 Chinese Household Income Project (CHIP). Adjusting the estimates for a biannual time period results in values of $\rho = 0.939$ and $\sigma_\eta^2 = 0.118$. 

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5.5 Technology

We set \( \alpha \) to match the capital share of income for China in 2000 while the depreciation rate \( \delta \) is set to match an investment-output ratio of 0.31 (Feenstra et al., 2015). Total factor productivity \( \theta \) is normalized to one.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Target/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital share ( \alpha )</td>
<td>0.5</td>
<td>PWT 8.1</td>
</tr>
<tr>
<td>Period depreciation ( \delta )</td>
<td>0.12</td>
<td>I/Y = 0.31</td>
</tr>
<tr>
<td>Factor productivity ( \theta )</td>
<td>1</td>
<td>Normalization</td>
</tr>
</tbody>
</table>

5.6 Social Insurance

The pension replacement rate in the urban sector is set at 35%, the target rate for the social pooling component of the current system (OECD, 2010). Urban medical expenditure reimbursement rates are set to match the average inpatient rate of 70% (Yip et al. 2012). These rates are assumed to remain constant across all policy and demographic scenarios. Urban pension and health insurance schemes are funded through local payroll taxes and are unsubsidized by the central government.

We assume there is no rural pension or health insurance system in our baseline economy to approximate very low coverage circa 2000. In our first policy experiment, we set parameters to reflect the most currently available estimates of social insurance benefit levels. Specifically, we assume a pension replacement rate of 10% of average local earnings, which is the approximate rate funded from the social pooling pillar of the NRSPS. Rural healthcare reimbursement rates are set to the average inpatient rate in 2010 of 44% (Yip et al. 2012).

The largest source of government revenue in China is direct or indirect consumption taxes. Moreover, labor taxes are notoriously difficult to collect in rural areas dominated
by small local farms. As such, we assume all rural social insurance programs are financed though a combination of central and/or local proportional consumption taxes. In contrast to urban social insurance systems, China’s central government heavily subsidizes the newly implemented rural schemes. The social pooling pillar of the new pension system is fully subsidized by the central government in a majority of rural areas. As such, the central government is assumed to fully fund the rural pension scheme in our first experiment. Under the NCMS, individual health insurance premiums are subsidized roughly 40% by the central government. We assume the remaining 60% is financed by local government.\footnote{In practice, roughly 40% is subsidized by local government with the remaining 20% unsubsidized.}

We follow our joint analysis of current reforms by considering rural pension and health insurance programs individually in order to isolate the effects of each type of social insurance. In addition to considering each program in isolation, we also introduce more generous benefits in order to examine the effects of feasible increases in benefit levels in the future. As current benefits are comparatively small in the rural sector, we begin by comparing our baseline to an economy in which rural pension benefits equal those of the urban sector but rural health insurance continues to be unavailable. As this implies a relatively large increase in rural pension reimbursement rates, we adjust financing such that some of the burden is shifted to the local government. Specifically, we reduce the central government subsidy rate to 40% and assume the remaining 60% is financed through local consumption taxes.

In our final experiment, we drop the rural pension program and instead introduce increased rural health insurance benefits. Specifically, the healthcare reimbursement rate is increased to 70%, the stated target rate of Chinese policymakers and current rate under the urban scheme (Yip et al. 2012). Financing of the program is assume to remain a 40/60 split between the central and local government. For convenience, Table 7 summarizes all pension and health insurance parameters across policy experiments.

### Table 7: Pension and Health Insurance Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Urban</th>
<th>Baseline</th>
<th>Current Reform</th>
<th>Future Pension</th>
<th>Future Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare rate $RR$</td>
<td>0.70</td>
<td>0.00</td>
<td>0.44</td>
<td>0.00</td>
<td>0.70</td>
</tr>
<tr>
<td>Pension rate $b$</td>
<td>0.35</td>
<td>0.00</td>
<td>0.10</td>
<td>0.35</td>
<td>0.00</td>
</tr>
<tr>
<td>Local share of financing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health insurance $\lambda^h$</td>
<td>1.00</td>
<td>–</td>
<td>0.60</td>
<td>–</td>
<td>0.60</td>
</tr>
<tr>
<td>Pension insurance $\lambda^p$</td>
<td>1.00</td>
<td>–</td>
<td>0.00</td>
<td>0.60</td>
<td>–</td>
</tr>
</tbody>
</table>

We set the emergency relief consumption floor $c$ at 8% of output per capita in our baseline 2000 economy. This approximates the official rural food poverty line for China.
in 2000 (Zude, 2004). We then keep the value of $c$ constant for all other policy scenarios and under the 2050 demographic structure. This ensures that any endogenous change in output will not effect the real value of the consumption floor, allowing us to isolate the effects of other policy changes. Lastly, we set required labor for emergency relief $\ell$ at the average labor supply in our baseline of one-third. In sensitivity analysis we examine the welfare implications of adjusting these two parameters.

6 Results

6.1 Baseline Economies

We begin with a discussion of baseline results under our two alternate demographic structures. The first column of Table 8 provides baseline results with a growth rate set to match the 2000 dependency ratio. While baseline investment and hours worked were targeted during calibration, the remaining results are determined endogenously from the model. A biannual interest rate of 23% implies an annual rate of 11%. This is consistent with the results of Bai et al. (2006), who estimate the return to capital in China in 2000 in the 10-20% range, depending on their specification. Although not targeted during calibration, the model also does remarkably well in predicting aggregate medical expenditures from the data. Specifically, medical expenditures are 4.2% of output in the benchmark economy compared to 4.6% in the data for 2000 (World Bank Indicators). Similarly, fiscal outlays on healthcare are 1.11% in the baseline compared to 1.76% in the data.

Moving to the urban pension system, fiscal outlays are 0.76% of output for the 2000 benchmark economy. Official statistics for 2000 estimate revenue from the urban pension program closer to 2.7% of GDP (China, 2014). However, this includes both the basic pension and individual account components of the system. Moreover, prior to the reforms of mid-nineties the urban pension scheme was entirely unfunded. This resulted in a cohort of retirees depending on pay-as-you-go financing for the entirety of their pension payments. These so-called “legacy” pensions resulted in inflated spending on the system which is absent in the partially funded urban program currently in place and modeled in our benchmark economy.

Column five of Table 8 shows baseline results when moving to the 2050 demographic structure. As individuals tend to accumulate assets over the life-cycle, there is a sharp rise in per capita capital resulting from the aging of the population. This leads to nearly a 50% increase in per capita output compared to the 2000 baseline despite a smaller supply of labor. The increased capital holdings also lead to a significantly lower interest rate. As pension and healthcare spending is disproportionately concentrated among older individuals, the demographic change also results in increased per capita spending on baseline urban social insurance programs. Total per capita medical expenditures increase by 26%, though fiscal outlays on urban health insurance as a share of GDP slightly decreases due to the increase in output. In contrast, fiscal outlays on the urban
Table 8: Steady State Results

<table>
<thead>
<tr>
<th></th>
<th>Demographics: 2000 (n = 0.097)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Demographics: 2050 (n = 0.005)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Current Reform</td>
<td>Future Pension</td>
<td>Future Healthcare</td>
<td>Baseline</td>
<td>Current Reform</td>
<td>Future Pension</td>
<td>Future Healthcare</td>
<td></td>
</tr>
<tr>
<td>Output per capita</td>
<td>1.00</td>
<td>0.98</td>
<td>0.97</td>
<td>0.98</td>
<td>1.48</td>
<td>1.41</td>
<td>1.33</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>% change from baseline</td>
<td>-</td>
<td>-1.89</td>
<td>-2.71</td>
<td>-1.96</td>
<td>-</td>
<td>-4.20</td>
<td>-9.60</td>
<td>-2.38</td>
<td></td>
</tr>
<tr>
<td>Capital per capita</td>
<td>1.40</td>
<td>1.37</td>
<td>1.34</td>
<td>1.37</td>
<td>3.12</td>
<td>2.91</td>
<td>2.63</td>
<td>3.01</td>
<td></td>
</tr>
<tr>
<td>% change from baseline</td>
<td>-</td>
<td>-2.43</td>
<td>-4.47</td>
<td>-2.19</td>
<td>-</td>
<td>-6.65</td>
<td>-15.77</td>
<td>-3.59</td>
<td></td>
</tr>
<tr>
<td>Consumption per capita</td>
<td>0.65</td>
<td>0.64</td>
<td>0.64</td>
<td>0.64</td>
<td>1.02</td>
<td>0.99</td>
<td>0.94</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>% change from baseline</td>
<td>-</td>
<td>-1.95</td>
<td>-2.08</td>
<td>-2.26</td>
<td>-</td>
<td>-3.58</td>
<td>-8.32</td>
<td>-2.08</td>
<td></td>
</tr>
<tr>
<td>Health expenditure per capita</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Investment per capita</td>
<td>0.31</td>
<td>0.30</td>
<td>0.29</td>
<td>0.30</td>
<td>0.40</td>
<td>0.37</td>
<td>0.34</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>Average hours worked</td>
<td>0.33</td>
<td>0.31</td>
<td>0.33</td>
<td>0.31</td>
<td>0.27</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>% change from baseline</td>
<td>-</td>
<td>-4.87</td>
<td>-0.79</td>
<td>-7.36</td>
<td>-</td>
<td>-3.69</td>
<td>-4.15</td>
<td>-3.46</td>
<td></td>
</tr>
<tr>
<td>Wage rate</td>
<td>0.70</td>
<td>0.70</td>
<td>0.69</td>
<td>0.70</td>
<td>1.06</td>
<td>1.03</td>
<td>0.98</td>
<td>1.04</td>
<td></td>
</tr>
<tr>
<td>Interest rate (%)</td>
<td>23.35</td>
<td>23.55</td>
<td>24.01</td>
<td>23.44</td>
<td>11.35</td>
<td>11.97</td>
<td>13.08</td>
<td>11.65</td>
<td></td>
</tr>
<tr>
<td>Urban labor tax (%)</td>
<td>9.83</td>
<td>9.87</td>
<td>9.97</td>
<td>9.84</td>
<td>23.37</td>
<td>23.53</td>
<td>23.81</td>
<td>23.44</td>
<td></td>
</tr>
<tr>
<td>Rural consumption tax (%)</td>
<td>0.00</td>
<td>1.72</td>
<td>1.67</td>
<td>2.75</td>
<td>0.00</td>
<td>1.32</td>
<td>6.71</td>
<td>2.08</td>
<td></td>
</tr>
<tr>
<td>Central consumption tax (%)</td>
<td>0.00</td>
<td>1.23</td>
<td>0.70</td>
<td>1.16</td>
<td>0.00</td>
<td>2.69</td>
<td>2.92</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Fiscal outlays (% of GDP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare</td>
<td>1.11</td>
<td>2.31</td>
<td>1.14</td>
<td>3.01</td>
<td>0.97</td>
<td>2.02</td>
<td>1.07</td>
<td>2.57</td>
<td></td>
</tr>
<tr>
<td>Pension</td>
<td>0.76</td>
<td>1.09</td>
<td>1.91</td>
<td>0.77</td>
<td>3.46</td>
<td>4.97</td>
<td>8.64</td>
<td>3.49</td>
<td></td>
</tr>
<tr>
<td>Emergency relief (E.R.)</td>
<td>0.38</td>
<td>0.10</td>
<td>0.24</td>
<td>0.10</td>
<td>0.50</td>
<td>0.05</td>
<td>0.12</td>
<td>0.27</td>
<td></td>
</tr>
<tr>
<td>Accidental bequests (% of GDP)</td>
<td>2.57</td>
<td>2.55</td>
<td>2.51</td>
<td>2.56</td>
<td>4.57</td>
<td>4.46</td>
<td>4.18</td>
<td>4.55</td>
<td></td>
</tr>
<tr>
<td>Urban population on E.R. (%)</td>
<td>0.28</td>
<td>0.28</td>
<td>0.31</td>
<td>0.28</td>
<td>0.01</td>
<td>0.01</td>
<td>0.03</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Rural population on E.R. (%)</td>
<td>4.11</td>
<td>1.77</td>
<td>2.60</td>
<td>1.37</td>
<td>6.53</td>
<td>1.29</td>
<td>0.61</td>
<td>5.07</td>
<td></td>
</tr>
<tr>
<td>CEV (%)</td>
<td>-</td>
<td>6.80</td>
<td>-2.92</td>
<td>12.83</td>
<td>-</td>
<td>0.27</td>
<td>-12.13</td>
<td>3.78</td>
<td></td>
</tr>
</tbody>
</table>
pension system rise sharply to almost 3.5% of output, raising the urban labor tax to over 23%.

We further assess the fit of the model to the data by comparing 2000 benchmark results to several additional empirically observed outcomes not targeted during calibration. Figure 4 compares the life-cycle profile of labor earnings in the benchmark economy to empirical estimates from the National Transfer Accounts. Earnings are reported as a percentage of the total average income for all working age groups combined. There is a similar hump shape profile in both the benchmark economy and the data, though labor earnings in the model peak several years later. The model profile is primarily driven by our life-cycle productivity estimates which also peak close to age 50. Type-specific productivity estimates combined with idiosyncratic productivity shocks also serve as the primary determinants of wealth inequality in the model. The model somewhat over-predicts the amount of wealth inequality relative to empirical estimates, with a benchmark Gini coefficient of 0.77 compared to 0.55 in the data for the year 2000 (Davies et al., 2008).

Figure 4: Life Cycle Profile of Labor Earnings: Model vs Data

6.2 Policy Experiments

The first two columns of Table 8 provide a comparison between the 2000 baseline economy with no rural social insurance programs in place and the steady state produced under the current policy benefit levels, holding demographics constant. Introducing pension and health insurance results in new central and rural consumption taxes as well a small increase in the urban labor tax rate. As expected with the new insurance mechanisms in place, there is a significant drop in aggregate savings accompanied by an increase in the annual interest rate. Together, a reduction in aggregate labor supply and capital results in close to a 1.9% decrease in output and consumption. However, despite these declines in macroeconomic outcomes, there is an increase in aggregate welfare equivalent to a 6.8% increase in the consumption of an unborn agent. These
gains are decomposed in the following sub-sections but stem from the aggregate decline in hours worked and the redistribution of resources across agent types and over the life-cycle.

The third column of Table 8 shows results when implementing only the rural pension program at feasible “future” benefit levels. Similar to the current reform experiment, introducing the new pension benefits results in a decrease in aggregate capital, output, and consumption, as well as an increase in taxes. Though the proportional tax structure and central government subsidy implies some redistribution from the rural pension program, the reallocation of resources across agents is no longer able to counteract the negative macroeconomic effects, resulting in an estimated welfare loss of 2.9%. This result is consistent with much of the existing literature which finds positive long-run economic and welfare effects of eliminating pay-as-you-go pension systems in the presence of market imperfections.

In contrast to pensions, column four shows that further increasing rural healthcare benefits to anticipated future levels amplifies the estimated welfare gain to over 12%. In this case, welfare improvements from the redistribution of resources are not offset by the adverse general equilibrium effects of implementing the policy despite even higher taxes and lower aggregate capital and output. As detailed in the following sub-sections, health insurance involves a considerable redistribution of resources to agents that realize a high medical expenditure shock. Moreover, insurance against such potentially catastrophic expenditures in the future allows agents to significantly adjust behavior over their entire life-cycle in a welfare improving manner. As a result, the welfare gains from redistribution is much higher from health insurance as compared to the generous pay-as-you-go pension system.

Finally, the last four columns in Table 8 show the results from analogous experiments under the projected old-age dependency ratio for China in 2050. Overall, aggregate macroeconomic indicators move in a similar direction in response to the policy changes as under the 2000 demographics but are amplified in magnitude. Recall that average medical expenditures and fiscal outlays for pensions are considerably higher due to the increased share of older agents in the population. Comparing the percentage change from the baseline under alternate demographics shows that the reforms are much more costly to implement in a hypothetical economy with roughly a five times higher dependency ratio. Nonetheless, despite the considerable macroeconomic costs, the current reforms maintain a positive welfare gain equivalent to a 0.27% increase in the consumption of an unborn. Likewise, there continues to be a welfare loss from implementing higher future pension benefits under the 2050 demographic structure, while more generous future health insurance results in significantly higher estimated welfare gain relative to the current reforms.

6.3 Decomposition of Welfare Effects

As the policy affects the urban and rural sectors differently, we begin our decomposition exercise by conditioning our welfare measure on entering the economy as an urban
or rural agent. We then further decompose our measure based on the effects stemming from changes in consumption versus leisure allocation. Finally, these results are decomposed into gains from level changes in average consumption/leisure and gains from the redistribution across agent types and over the life-cycle.

The decomposition of estimated welfare effects from the current reform experiments are shown in Table 9. Despite a level decrease in average consumption in the rural sector, the increase in average leisure and the reallocation of both consumption and leisure across agents results in a net welfare gain of over 9% under the 2000 demographic structure. As detailed in the following sub-section, most of the redistribution gains stem from a more favorable allocation of leisure across ages and different states of the world.

In contrast to the rural sector, there are negative level and redistribution effects for consumption and leisure in the urban sector. This implies not only that urban agents are worse off due to aggregate declines, but the expected welfare loss in the urban sector is amplified by the unfavorable redistribution of consumption and labor supply across agents. From the perspective of an urban agent, the policy change induces higher taxes, lower wages, and higher returns to asset holdings. These changes result in an unequal consumption and labor supply response—the urban poor choose to consume less and work more relative to the urban rich. As a result, the urban poor bear a larger share of the welfare burden from subsidizing the new rural social insurance programs. Overall, the policy results in more than a 2.6% decrease in the expected welfare of an unborn urban agent.

When moving to the 2050 demographics, the welfare gains to an unborn rural agent are considerably smaller. This occurs primarily due to higher wages under the 2050 demographic structure resulting in lower hours worked in the baseline and leaving smaller potential gains from the reallocation of leisure. However, there is a more favorable redistribution of consumption induced by the policy change relative to the 2000 demographics. Nonetheless, on net the welfare gains are reduced to under 3%. In the urban sector, the expected welfare loss increases to over 6%, primarily due to
the larger decrease in average consumption induced by higher taxes and lower output from the policies.

Table 10 shows the results of a similar welfare decomposition exercise for the “future” pension and healthcare reforms under the 2000 demographic structure. The two policies produce similar declines in average consumption in the rural sector, but the increase in average leisure is significantly higher under healthcare reform. Moreover, introducing health insurance induces sizable welfare improvements from the redistribution of resources across agents. Specifically, and as detailed in the following sub-section, healthcare reform results in a relatively large reduction in labor supply for less productive agents (e.g. young, low education, or poor health) and for agents realizing high medical expenditures. Young rural agents and those with high medical expenditures also enjoy relatively more consumption.

In contrast to healthcare reform, the decline in hours worked from the subsidized pension system occurs as agents near the end of their working life as they choose to accumulate less assets for retirement. However, higher taxes and lower wages induce rural agents to increase labor supply early in the life-cycle when consumption is much lower. As a result, the welfare benefit of an average decline in hours worked from the pension system is more than offset by an unfavorable redistribution of leisure in the rural sector. All together, the expected welfare of an unborn rural agent increases 17.3% under the future healthcare reform compared to a decline of 2.8% from the generous pay-as-you-go pension system.

In the urban sector, the rural social insurance policies only impact agents through central consumption taxes and general equilibrium effects on interest rate, wages, and labor taxes. Though the central tax is somewhat higher under healthcare compared to pension reform, the general equilibrium effects are weaker resulting in a smaller expected welfare loss for a unborn urban agent.

<table>
<thead>
<tr>
<th>CEV (%)</th>
<th>Future Pension</th>
<th>Future Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban</td>
<td>Rural</td>
</tr>
<tr>
<td>Total</td>
<td>-3.39</td>
<td>-2.80</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
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<td>-2.41</td>
</tr>
<tr>
<td>Distribution</td>
<td>-1.22</td>
<td>-0.03</td>
</tr>
<tr>
<td>Leisure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td>-0.03</td>
<td>0.91</td>
</tr>
<tr>
<td>Distribution</td>
<td>-0.68</td>
<td>-1.23</td>
</tr>
</tbody>
</table>
6.4 Life-cycle Profiles

In order to further understand the implications of the policy experiments, this section presents average life-cycle profiles for asset holdings, labor supply, and consumption under alternate reform scenarios. Figure 5 begins with life-cycle profiles for the urban and rural sectors both before and after the “future pension” reform. On average, the pension program results in a decline in savings over the entire life-cycle of rural agents, as they require fewer asset holdings after retirement. As the urban sector effectively subsidizes the program through central taxes, rural retirees are able to consume somewhat higher amounts with the program in place. However, prior to retirement, rural agents consume less due to higher taxes and lower wages, though they do enjoy marginally higher leisure in the latter half of their working life.

![Life-Cycle Profiles for 2000 Demographics: Future Pension Benefits](image)

The average urban agent experiences a small increase in assets after retirement due to the general equilibrium effects of the pension reform resulting in higher interest rates. The higher asset holdings lead to a small increase in consumption after retirement, though increased taxes and lower wages result in an average decline in consumption over the entire life-cycle. The changes in interest rate, labor tax, and wages also lead to a very subtle shift in the labor supply of urban agents toward younger ages on average.

Figure 6a shows analogous life-cycle profiles before and after the “future healthcare” reform. The general equilibrium effects of the policy change are small for wages and urban labor tax, resulting in very little change in asset holdings and labor supply for urban agents over the life-cycle. However, there is still a small decline in urban consumption due to the new central consumption tax.

After introducing healthcare reform, rural agents save and consume less over their entire life-cycle on average, but enjoy a significant increase in leisure. Note that relative to the the rural pension program, the savings response is much smaller and labor supply response much larger as a result of introducing health insurance. Moreover, compared to older agents, younger individuals realize a significantly higher decline in labor supply and a relatively smaller decline in consumption. As younger individuals are less productive, they experience lower utility consumption/leisure allocations than older agents prior to the policy change. As a result, the pattern of reallocation across ages is welfare improving from the perspective a unborn rural agent. Thus despite the
Figure 6: Life-Cycle Profiles for 2000 Demographics: Future Healthcare Benefits

direct benefit of health insurance occurring disproportionately at old-ages, the utility gains are primarily realized during early stages of life.

As discussed in the previous sub-section, response to health insurance coverage is not the same for all types of rural agents. Rather, leisure and consumption are reallocated among rural types in a welfare improving manner. To illustrate this point, Figure 6b shows the same set of life-cycle profiles for rural agents conditional on realizing low or high medical expenditures. The policy change results in a small average increase in savings for the high expenditure group reflected in higher asset holdings. In contrast, there is reduction in the savings for those with low medical expenditures. Moreover, those with high medical expenditures are able to consume comparatively more at all points in the life-cycle as a result of the increased insurance coverage, though effects
are more pronounced in the years following retirement.

Of more importance quantitatively, both high and low medical expenditure groups reduce their labor supply in response to the policy. However, the welfare gains from the reduction in labor supply is considerably larger for the high expenditure group as they are working significantly more prior to the policy change. Moreover, there is also a welfare improving reallocation of labor supply evident across other rural agent types. For example, Figure 6c shows the labor supply profile of rural workers in good/poor health and of high/low education. Similar to young agents, individuals of poor health or low education are less productive and experience lower utility consumption/leisure allocations than other agents prior to the policy change. In response to the policy, the larger declines in labor supply for those of poor health or low education imply a welfare improving reallocation of resources across health and education groups.

6.5 Sensitivity Analysis

As our welfare results primarily stem from the reallocation of resources—particularly in favor of disadvantaged populations—this section investigates the sensitivity of our results to alternate parameter specifications for emergency relief and preferences over consumption and leisure. For each parameter change, we recalibrate our model to match the same empirical data targets as our benchmark specification.

We begin by exploring how changes in the generosity of emergency relief affects our welfare results (see Table 11). Recall that emergency relief in our model captures informal family and community transfers as well as formal government poverty transfer programs. More generous emergency relief decreases the precautionary savings motive and potentially limits the negative consequences of catastrophic medical expenditures and/or old-age on the poor. With a very generous consumption floor of 16% and no labor requirement, the estimated welfare effect of the rural insurance programs at current benefit levels falls considerably but remains positive at over 1%. The share of individuals on emergency relief in the baseline also increases to over 14% of the population. In contrast, when the consumption floor is cut to 2% and required labor set at two-thirds of the time endowment, welfare gains increase to over 13% while the share on emergency relief falls to less than 1%. Thus while the magnitude of welfare gains are somewhat sensitive to emergency relief parameters, the current reforms have net positive effects over a range of plausible values.

As policy reforms are found to have different impacts on consumption versus leisure, we next examine the sensitivity of results to preference parameter specification. Table 12 presents the percentage change from the baseline for select outcomes after introducing the current reforms under 2000 demographics for different preference parameter values. We begin by considering alternate values of \( \gamma \) while adjusting \( \sigma \) to maintain the benchmark intertemporal elasticity of substitution (IES) of 0.5. With a higher value of \( \gamma \) there is relatively more weight on consumption resulting in a smaller adjustment in labor supply in response to the social insurance policies. As a result, there are smaller aggregate declines in output and consumption. Nonetheless, our consumption
equivalent variation measure decreases somewhat with $\gamma$ as welfare gains are primarily occurring from reallocation along the leisure margin.

Lastly we examine sensitivity of results to changes in $\sigma$ while adjusting $\gamma$ to maintain the benchmark average hours worked of one-third. For comparison to our benchmark IES of 0.5, we choose alternate values of $\sigma$ such that the implied IES equals 0.3 and 0.8. The decline in output and consumption is slightly larger with the higher elasticity as labor supply is more responsive to the policy change. However, the larger decline in average hours worked results in a small net increase in welfare in comparison to the benchmark specification. In contrast, when elasticity is very low, agents choose to increase savings in response to the policy resulting in higher output and consumption. Combined with a similar decline in labor supply, the low IES leads to the highest estimated welfare gain across the range of elasticities.
7 Conclusions

In this paper we developed a model useful for understanding the general equilibrium effects of social insurance reforms in rural China. Importantly, we allow health to evolve stochastically over the life-cycle and influence mortality, productivity, and medical expenditures. We have also embedded important elements of existing Chinese policy including central and local tax structures and distinct urban and rural pension and health insurance schemes. However, the model is not without limitations. For example, we do not explicitly model insurance coverage for non-workers or internal migrants. We also do not include the individual account component of the Chinese pension systems, which effectively acts as an annuity purchase after retirement. A more realistic model may also allow for endogenous medical expenditures and consequently the partially endogenous evolution of health status. However, this poses considerable additional modeling challenges and increased computational burden. Addressing these limitations leaves scope for important additional research. However, we view this paper as an important step toward understanding the economic and welfare implications of China’s large and complex social insurance reforms.

References


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