Intergenerational Transfers and China's Social Security Reform

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Abstract

Most of the studies examining the implications of social security reforms in China use overlapping generations models and abstract from the role of family support. However, in China, family support plays a prominent role in the well-being of the elderly and often substitutes for the lack of government-provided old-age support systems. In this paper, we investigate the impact of social security reform in China in a model with two-sided altruism as well as a pure life-cycle model. We show that the quantitative implications of social security reform are very different across the two models.

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1 Introduction

Since the 1990s, China has introduced a series of social security reforms aimed at increasing pension coverage, providing poverty relief, and redistributing income for its growing elderly population. However, changes in demographics and the implications of the one-child policy pose significant challenges to the government's ability to deliver sufficient old-age support. Sin (2005) provides an extensive study of the old age insurance system in China where the old age dependency rate is expected to rise to 80.3% by 2050 compared to 37.2% in 2010. Song, Storesletten, Wang, and Zilibotti (2014) also discuss some of these challenges and argue that the current social security system does not seem to be sustainable and will require a significant adjustment in either contributions or benefits.

Most of the studies examining the implications of social security reforms in China use overlapping generations models and abstract from the role of family support. However, in China, family support plays a prominent role in the well-being of the elderly and often substitute for the lack of government-provided old-age support systems. For example, in the 2005 Census, 57% of adults between 45 and 60 indicate that they rely on family support while only 25% of them point to pension wealth and income for old-age support. Also, children in China provide substantial levels of support, both in-kind and financial for their parents. For example, 45% of the elderly (60+) in urban households report living with their adult children where positive net transfers from adult children to parents occur in 65% of households.[1] Changes in demographics and the social security program, however, are likely to impact the balance between family support and government-provided support.

In this paper, we examine the implications of social security reform in two model economies. In the pure life-cycle model, individuals obtain utility from their lifetime consumption and leisure and they do not care about their descendants and predecessors. In the dynastic model, the decision-making unit is the household consisting of a parent and children. Agents derive utility from their own lifetime consumption and from the felicity of their predecessors and descendants.[2] In both models, agents face idiosyncratic labor income risk and a realistic pension system. However, in the dynastic model, since parents care about the utility of their descendants, they save to insure them against the labor income risk. Since children are altruistic toward their parents, they support them during retirement. Institutional details and changes in demographics influence the size of these inter vivos transfers and saving rates. In the life-cycle model, agents save to insure themselves against income risk and to support themselves during retirement.

Bohn (2006) shows that the impact of population aging on capital-accumulation and interest rates differs across life-cycle and dynastic models because of their different assump-

[1] See Choukhmane, Coeurdacier, and Jin (2013) for more detail.
[2] Similar to Fuster, İmrohoroğlu, and İmrohoroğlu (2003 and 2007) and Laitner (1992).

tions about bequests. In a life-cycle model, population aging gives rise to an increase in the saving rate as individuals expect to live longer. In a dynastic model, on the other hand, fewer births imply a lower weight in dynastic preferences for future generations and results in lower saving rates. In addition, while public pensions reduce savings unambiguously in a life-cycle model, their impact is subdued in a dynastic model due to an increase in bequests.

In order to tease out the quantitative implications of the changes in demographics and the pension system in China, we calibrate both models to the Chinese economy in the late 2000s. Next, we investigate the implications of a series of social security reforms on tax rates, saving rate, capital stock, and GDP in both models. We do so by comparing the benchmark economy with counterfactual economies with different policy reforms in each model economy.

The initial steady state represents an economy with a social security replacement rate of 15%, a social security tax rate of 3.9%, and an old-age dependency ratio of 37%. From this initial state, we first examine the implications of the expected change in demographics without changing anything else. We find that the aging of the Chinese population, everything held constant, will have significant implications on the saving rate, tax rates, capital stock, and output. In both models, to keep the social security system as it is, the payroll tax rate increases from 3.9% to 7.9% while lower fertility results in a decrease in the labor supply by 23%. Capital per person implied by the two models, however, is strikingly different. In the life-cycle model, increased longevity results in an increase in the capital per person of about 4%. In the dynastic model, on the other hand, consistent with the discussion in Bohn (2006), capital per person declines. Consequently, output per person is significantly lower in the dynastic model (21%) as opposed to the life-cycle model (11%).

Next, we examine the implications of social security reform in each model. We consider three different reforms. In Reform 1, we consider an increase in the social security replacement rate from 15% to 30%. In the second reform, we increase the retirement age from 60 to 65, and in the last reform we change both the replacement rate and the retirement age at the same time. We compare the implications of these reforms on capital accumulation and output across the two models.

We find that quantitative implications of social security reform are indeed quite different across the two models. For example, an increase in the social security replacement rate reduces capital per-person by 19% in the life-cycle model and 10% in the dynastic model. Similarly, the decline in output implied by the life-cycle model is twice as high as the decline implied by the dynastic model. Implications of the third reform where we increase the retirement age and the replacement rate at the same time, are also significantly different across the two models. The life-cycle model results in a 1% decline in output per-person while the dynastic model results in a 7.6% increase in output per person.

Given the prevalence of family support in China, we suspect the quantitative findings using the dynastic model might provide a better approximation for the Chinese economy. According to these results, changes in demographics together with the changes in social security that are examined in this paper yield a long-term decline in output per-person between 15% to 25%.

The remainder of the paper is organized as follows. Section 2 presents the model used in the paper and Section 3 its calibration. The quantitative findings are presented in Section 4, and Section 5 presents the concluding remarks.

2 Two Models

We start by summarizing the features of the economy that are common between the dynastic and the pure life-cycle models.

2.1 Technology

There is a representative firm that produces a single good using a Cobb-Douglas production function $Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}$ where α is the output share of capital, K_t and L_t are the capital and labor input at time t, and A_t is the total factor productivity at time t. The growth rate of the TFP factor is $\gamma_t - 1$, where $\gamma_t = (\frac{A_{t+1}}{A_t})^{1/(1-\alpha)}$. Capital depreciates at a constant rate $\delta \in (0, 1)$. The representative firm maximizes profits such that the rental rate of capital, r_t, and the wage rate w_t, are given by:

$$r_t = \alpha A_t (K_t/N_t)^{\alpha-1} - \delta \quad and \quad w_t = (1-\alpha) A_t (K_t/N_t)^{\alpha}. \tag{1}$$

2.2 Government

The government taxes both capital and labor income at rates τ_k and τ_e, respectively, and uses the revenues to finance an exogenously given amount of government consumption expenditures G. A transfer that is distributed back to the individuals helps balance the government budget. In addition, the government runs a pay-as-you-go social security program that is financed by a payroll tax τ_{ss}.[3]

2.3 Demographics

Each period t, a generation of individuals is born who become parents at age T+1. There is a mandatory retirement age R, after which individuals face random lives and can live up to 2T periods. Depending on survival, an individual's life overlaps with his parent's life in the first T periods and with the life of his children in the last T periods. A household, that lasts for T periods, consists of a parent and the children living together. At age T +1,

[3]Both budget constraints are provided in Section 2.6.

each child becomes a parent in the next-generation household of the dynasty. At the steady state, the size of the population evolves over time exogenously at the rate $g - 1$, and the population growth rate satisfies $g = n^{1/T}$, where n is the fertility rate.

Labor income of the working age individuals is determined by three components. First, a shock z at birth determines the permanent lifetime labor ability of an individual: high (H) or low (L). Labor ability of the children, z', is linked to the parent's labor ability, z by a two-state Markov process with the transition probability matrix $\Pi(z', z)$. In addition, labor income of both ability types have a deterministic component ε_j representing the age-efficiency profile and a stochastic component, μ_j, faced by individuals up to age T.[4]

2.4 Dynastic Model

The model economy consists of overlapping generations of households with two-sided altruism as in İmrohoroğlu and Zhao (2015). Labor income of a family is composed of the income of the children and the income of the father. The income of the children is given by $w\varepsilon_j\mu_j z_s n$ where w is the economy-wide wage rate, ε_j is labor productivity at age j, and μ_j is the stochastic component of labor income. Before retirement, the father, whose children are j years old, receives $w\varepsilon_{j+T}z_f$ as labor income. Once retired, the father faces an uncertain lifespan where $d = 1$ indicates a father who is alive and $d = 0$ indicates a deceased father. The transition matrix for d is given by $\Lambda_{j+T}(d', d)$ with $\Lambda_{j+T}(0, 0) = 1$, and $\Lambda_{j+T}(1, 1)$ represents the survival probabilities of the father of age $j + T$. If alive, a retired father receives social security income, SS_j. All children in the household split the remaining assets (bequests) equally when they form new households at time $T+1$. Earnings, e_j, of the household with age-j children is given by:

$$e_j = \begin{cases} w\varepsilon_j\mu_j z_s n + w\varepsilon_{j+T}z_f & \text{if} \quad j + T < R \\ \\ w\varepsilon_j\mu_j z_s n + dSS & \text{if} \quad j + T > R \end{cases} \tag{2}$$

where $j = 1, 2, ...T$ is the age of the youngest member.

The budget constraint facing the household with n children is given by:

$$a_{j+1} + nc_{sj} + dc_{fj} = e_j(1 - \tau_{ss} - \tau_e) + a_j[1 + r_t(1 - \tau_k)] \tag{3}$$

where c_{fj} and c_{sj} denote the consumption of the parent (father) and the children (sons)

[4]The logarithm of the labor income shock is assumed to follow an AR(1) process given by $log(\mu_j) = \Theta log(\mu_{j-1}) + \nu_j$. The disturbance term ν_j is distributed normally with mean zero and variance σ_ν^2 where $\Theta < 1$ captures the persistence of the shock. We discretize this process into a 3-state Markov chain using the method introduced in Tauchen (1986), and denote the corresponding transition matrix by $\Omega(\mu', \mu)$. In addition, the value of μ at birth is assumed to be determined by a random draw from an initial distribution $\overline{\Omega}(\mu)$.

respectively, and r is the before-tax interest rate, τ_e is the labor income tax rate, τ_{ss} is the payroll tax rate to finance the social security program, and τ_k is the capital income tax rate.

The father and the sons pool their resources and maximize a joint objective function by choosing a sequence of consumption and asset holdings given the set of prices and policy parameters. The state of the household consists of age j; assets a; permanent abilities of the parent and the children z_f and z_s, respectively; the realizations of the labor productivity shock μ; and mortality d states faced by the elderly.[5] Let $V_j(x)$ denote the maximized value of expected, discounted utility of age-j household with the state vector $x = (a, z_f, z_s, \mu, d)$ where β is the subjective time discount factor. The household's maximization problem is given by:

$$V_j(x) = \max_{c_s, c_f, a'} [nu(c_s) + du(c_f)] + \beta E[\tilde{V}_{j+1}(x')] \tag{4}$$

subject to equations 2-3, $a_j \geq 0, c_s \geq 0$ and $c_f \geq 0$, where

$$\tilde{V}_{j+1}(x') = \begin{cases} V_{j+1}(x') \text{ for } & j = 1, 2, ..., T-1 \\ nV_1(x') \text{ for } & j = T \end{cases} . \tag{5}$$

2.5 Pure Life-Cycle Model

Individuals in the pure life-cycle model obtain utility from their own lifetime consumption only and they do not care about their descendants and predecessors. They maximize

$$\sum_{i=j}^{2T} \beta^{i-j} \left[\prod_{k=j}^{i} \psi_k \right] u(c_i)$$

where ψ_k is the conditional probability of surviving to age $k+1$, subject to the budget constraint:

$$a_{j+1} + c_j = e_j(1 - \tau_{ss} - \tau_e) + a_j[1 + r_t(1 - \tau_k)] + \kappa e_j \tag{6}$$

where

$$e_j = \begin{cases} w\varepsilon_j \mu_j z_j & \text{if} \quad j < R \\ \\ SS & \text{if} \quad j > R. \end{cases} \tag{7}$$

The state vector x consists of assets a; ability z and the realizations of the labor productivity

[5]All children are born at the same time with the same labor ability and face identical labor income shocks.

shock μ and the household's maximization problem is given by:

$$V_j(x) = \max_{c,a'}[u(c_j)] + \beta E[\tilde{V}_{j+1}(x')]$$

subject to equations 6 and 7, $a_j \geq 0, c_j \geq 0$ and where

$$\tilde{V}_{j+1}(x') = \begin{cases} V_{j+1}(x') \text{ for } & j < 2T \\ 0 \text{ for } & j = 2T \end{cases} .$$

2.6 Equilibrium

Stationary recursive competitive equilibrium (steady state) for the dynastic model[6]: Given a fiscal policy $(G, \tau_e, \tau_k, \tau_{ss}, SS)$ and a fertility rate n, a stationary recursive competitive equilibrium is a set of value functions $\{V_j(x)\}_{j=1}^T$, households' decision rules $\{c_{j,s}(x), c_{j,f}(x), a_{j+1}(x)\}_{j=1}^T$, time-invariant measures of households $\{X_j(x)\}_{j=1}^T$ with the state vector $x = (a, z_f, z_s, \mu, d)$, and relative prices of labor and capital $\{w, r\}$, such that:

1. Given the fiscal policy and prices, households' decision rules solve households' decision problem in equation 4.

2. Factor prices solve the firm's profit maximization policy by satisfying equation 1.

3. Individual and aggregate behavior are consistent :

$$K = \sum_{j,x} a_j(x) X_j(x)$$

$$N = \sum_{j,x} [\varepsilon_j z_s n + \varepsilon_{j+T} z_f] X_j(x)$$

4. The measures of households satisfy:

$$X_{j+1}(a', z_f, z_s, \mu', d') = \frac{1}{n^{1/T}} \sum_{\{a,\mu,d:a'\}} \Omega(\mu', \mu) \Lambda(d', d) X_j(a, z_f, z_s, \mu, d), \text{for } j < T,$$

$$X_1(a', z_s, z'_s, \mu', 1) = n \sum_{\{a,\mu,d,z_f:a'\}} \overline{\Omega}(\mu') \Pi(z'_s, z_s) X_T(a, z_f, z_s, \mu, d)$$

where $a' = a_{j+1}(x)$ is the optimal assets in the next period.

5. The government's budget holds, that is, $G + \sum_{j,x} d\kappa X_j(x) = \tau_k r K + \tau_e w N$.

[6]The equilibrium concept for the pure life-cycle model is similar and therefore skipped.

6. The social security system is self-financing:

$$\sum_{j=R-T}^{T} \sum_{x} dSS_j X_j(x) = \tau_{ss} \sum_{j,x} e_j X_j(x).$$

Our computational strategy is to numerically compute the steady state of the benchmark economy that mimics the current Chinese economy, and then compute counterfactual economies with demographic changes and a series of social security reforms.

3 Calibration

We calibrate the two models so that the initial steady state matches the fertility rate and the old age dependency ratio in China in the late 2000s. The final steady state represents the economy in about year 2050, with a much older population.

3.1 Demographics

The model period is a year. Individuals enter the economy when they are 20 years old and live, at most, to 90 years old. They become a parent at age 55 (to children who are 20 years old) and face mandatory retirement at age 60. At age 55, the parent and his n children form a household. After retirement, the parent faces mortality risk. Table 1 summarizes the mortality risk at five-year age intervals, which are used to calibrate the transition matrix for d at the initial steady state.[7]

Table 1: Survival Probabilities:

Age	<60	60	65	70	75	80	85
Surv.	1	.9815	.9696	.9479	.9153	.8642	.7611

We calibrate the fertility rate (average number of children per parent) as 1.2, that is, $n = 1.2$. This amounts to 2.4 children per couple. The corresponding annual population growth rate is 0.5% (i.e., $n^{1/35} - 1 = 0.5\%$). This, together with the survival probabilities, results in an old-age dependency ratio of 37% at the initial steady state.[8]

China is expected to experience dramatic demographic changes over the next several decades as more and more one-child cohorts are entering the economy. According to Sin

[7] Data are taken from the 1999 World Health Organization data (Lopez et al., 2001). The survival probability is assumed to be the same within each five-year period and along the transition.

[8] Here, the old-age dependency ratio is defined as the retired population over the working population.

(2005), the old-age dependency ratio is expected to rise to 80.3% in 2050. The upcoming demographic changes in China are largely believed to be due to the one-child policy and the increasing life expectancies. Therefore, we simulate the final steady state by exogenously changing the fertility rate and the mortality risks. In the final steady state, we set the fertility rate to n = 0.65, the weighted average of rural and urban populations implied by the one-child policy. Then, we scale down the mortality risks to match the projected old-age dependency ratio in China in 2050, that is, 80.3%. The reduced mortality risks resulting from this exercise imply that the life expectancy will increase from 76.2 years in the initial steady state to 80.7 years in the final steady state, which is fairly consistent with the life expectancy projections provided by the United Nations (2015).[9]

3.2 Preferences and Technology

The utility function is assumed to take the following form: $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. The value of σ is set to 3, which is in the range of the values commonly used in the macroeconomics literature. The subjective time discount factor β is set to 0.99 in the dynastic model and 1.01 in the life-cycle model, which results in a capital output ratio of 1.6 for both models.[10]

Based on Bai, Hsieh, and Qian (2006) and Song, Storesletten, and Zilibotti (2011), the capital depreciation rate δ is set to 10% and the capital share α is set to 0.5. The total factor productivity A is chosen so that output per household is normalized to one. The growth rate of the TFP factor $\gamma - 1$ is set to 3.8%, which is the average growth rate of the TFP factor in China in the late 2000s.

3.3 Labor Income

Labor income of the agents in our framework is composed of a deterministic age-efficiency profile ε_j and a stochastic component (faced up to age 55) given by $log(\mu_j) = \Theta log(\mu_{j-1}) + \nu_j$ in both models. Based on the findings in Yu and Zhu (2013) and He, Ning, and Zhu (2015), we take $\theta = 0.86$ and the variance σ_ν^2 as 0.06.[11] We discretize this process into a 3-state Markov chain by using the Tauchen (1986) method. The resulting values for μ are $\{0.36; 1.0; 2.7\}$, and the transition matrix is given in Table 2.

We take the age-specific labor efficiencies, ε_j, from He, Ning, and Zhu (2015) who use

[9] According to the World Population Prospects from the United Nations, China's life expectancy is expected to increase from 76.0 years in 2015 to 83.0 years in 2050.

[10] Note that the implied time discount factor in the model is lower than the value of β as individuals also face mortality risk.

[11] Yu and Zhu (2013) replicate the exercises in Guvenen (2009) to estimate the stochastic process for household income using the China Health and Nutrition Survey (CHNS). We use their estimates for the persistent shock from the Restricted Income Processes (RIP) model (Table C) for the 1989-2009 period. He, Ning, and Zhu (2015) also provide very similar estimates.

Table 2: Income shock

$\Gamma_{\mu\mu'}$	$\mu' = 1$	$\mu' = 2$	$\mu' = 3$
$\mu = 1$	0.9259	0.0741	0
$\mu = 2$	0.235	0.953	0.0235
$\mu = 3$	0	0.0741	0.9259

the data in CHNS to estimate them. Permanent lifetime labor ability $z \in \{H, L\}$, where the high and low states represent high school graduates and non-high school graduates, respectively, is also calibrated using the CHNS according to which the average wage rate of high school graduates is approximately 1.79 times higher than that of high school dropouts. Therefore, the value of L is normalized to one and the value of H is set to 1.79. The values for the transition probabilities for z are calibrated to match the following two observations. First, the proportion of Chinese working-age population that are high school graduates is 46%. Second, the correlation between the income of parents and children is 0.63, according to the estimates by Gong, Leigh, and Meng (2012). These observations imply the transition probabilities for labor ability shock z shown in Table 3.

Table 3: Labor Ability Shock

$\pi_{zz'}$	$z' = L$	$z' = H$
$z = L$	0.83	0.17
$z = H$	0.2	0.8

3.4 Government Policies

Government expenditures were, on average, 14% of GDP in China from 1980 to 2011. Based on this information, we set the value of G so that it is 14% of output in the benchmark economy. We assume that labor income and capital income face the same tax rate and the rate is determined so that tax revenues exactly balance the government budget. The resulting value for the income tax rate is 16.9%.

Gu and Vlosky (2008) report that in 2002 and 2005, 40-50% of the elderly in cities and more than 90% of the elderly in rural areas did not have a pension.[12] According to Song, Storesletten, Wang, and Zilibotti (2014), the Chinese pension system provided a replacement rate of 60% to those retiring between 1997 and 2011 who were covered by the system.[13] As the urban population was approximately 40% of the Chinese population from 1980-2011, we assume that the pension coverage rate was 25% of the population. Therefore, we set the average social security replacement rate at 15% (i.e., 60% $\times$ 25% = 15%) for the whole

[12]See also He, Ning, and Zhu (2015) for a detailed account of the changes in the social security system in China.

[13]Sin (2005) also reports a 60% replacement rate.

Table 4: Calibration

Parameter	Description	Value
α	capital income share	0.5
δ	capital depreciation rate	0.1
σ	risk aversion parameter	3
A	TFP factor	0.46
$z \in \{H, L\}$	permanent life-time labor ability	$\{1.79, 1.0\}$
G	government expenditures	14% of GDP
SS	social security replacement rate	15%
τ_{ss}	social security payroll tax rate	3.9%
(τ_k, τ_e)	labor and capital income tax	16.5%
$\gamma^{1-\alpha} - 1$	TFP growth rate	3.8%

population. Note that the pension benefits are partially indexed to the wage growth in China. Here, we follow the same indexation as in Song, Storesletten, Wang, and Zilibotti (2014) when calculating the replacement rate. That is, 40% of pension benefits are indexed to wage growth.[14] We assume that the social security program is self-financing and that the social security payroll tax rate τ_{ss} is endogenously determined to balance the budget in each period.

Table 4 summarizes the calibration that is used in both the initial and the final steady states.

4 Results

We start this section by examining the properties of the initial and the final steady states in the dynastic model. The main difference between the two steady states lies in the assumption about the fertility and mortality rates. The benchmark represents the economy in the 2000s, and the "No Reform" represents the economy with its demographic structure in 2050. Next, we present the same experiments for the pure life-cycle economy.

4.1 Dynastic Model

In this section, we present results for a series of social security reforms that aim to cope with the challenges from the upcoming demographic changes in the dynastic model. We consider three reforms: (1) an increase in the social security replacement rate from 15% to 30%, (2) an increase in the retirement age from age 60 to age 65 where the social security

[14] In other words, we approximate the pension benefit by a linear combination of the average past earnings of the retirees and the average earnings of current workers, with weights of 60% and 40%. That is, $SS_j = 0.6 \times e_j^{past} + 0.4 \times e^{current}$. Here, e_j^{past} represents the average past earnings of the retirees with age $T + j$, and $e^{current}$ is the average earnings of current workers. For simplicity, we obtain e_j^{past} by discounting the average earnings of current workers l years back using the growth rate of TFP factor, γ, that is, $e_j^{past} = e^{current} \times \frac{1}{\gamma^l}$. Here, l represents the number of years from the time of their retirement, i.e., $l = j - 5$.

replacement rate is kept at 15%, and (3) increases in both the retirement age (from 60 to 65) and the social security replacement rate (from 15% to 30%). The results from these policy experiments are presented in Table 5 under the "Reform 1," "Reform 2," and "Reform 3" columns. The column labeled "No Reform" represents the steady state in 2050 in the absence of any changes in pensions but with the change in demographics.

Table 5: Demographic Changes and Social Security Reform-Dynastic Model

	Benc	No Reform	Reform 1	Reform 2	Reform 3
			(2050 demographics)		
Output per person	100	79	75	88	85
Capital per person	100	81	73	88	81
Labor per person	100	77	77	88	88
Return to capital (r)	22%	21%	23%	22%	23%
Wage (w)	0.161	0.165	0.157	0.162	0.155
Average replacement rate	15%	15%	30%	15%	30%
SS payroll tax (τ_{ss})	3.9%	7.9%	15.8%	5.8%	11.5%
Old-age dependency ratio	37%	81%	81%	56%	56%

According to our results, if there are no reforms, aging of the society alone results in a decrease in capital per person by 19% (from 100 to 81) and a 21% decline in output per person. Old age dependency ratio increases to 81%, and these changes require the social security tax rate to increase from 3.9% to 7.9%. Reform 1 in which the social security replacement rate is doubled results in a further decline in savings and thus in capital per person. Output per person declines another 5% (from 79 to 75). An increase in the retirement age alone (Reform 2) results in an increase in the labor per person and leads to an increase in capital and output per-person relative to the "No Reform" case. If both of these changes (social security replacement rate and the retirement age) take place at the same time as in Reform 3, the resulting economy displays an 8% increase in output per person relative to the "No Reform" case. Of course, relative to the economy in 2000s ("Benc"), we observe a 15% decline in output per-person in Reform 3.

4.2 Social Security Reforms in the Pure Life-Cycle Economy

In this section, we present the same set of experiments discussed in the dynastic model for the pure life-cycle economy. In this case, aging of the population alone results in a 4% increase in the capital per-person and a 11% decline in output per-person. Reform 1 where the social security replacement rate is increased leads to a 19% reduction (from 104 to 84) in capital per-person and a 10% reduction in output per-person relative to the "No Reform" case. An increase in the retirement age (Reform 2) alone results in an increase in the labor per person and leads to an increase in output per-person relative to the "No Reform" case.

If both of these changes (social security replacement rate and the retirement age) take place at the same time as in Reform 3, the resulting economy displays a 1% decrease in output per person relative to the "No Reform" case. Of course, relative to the economy in the 2000s, we observe a 12% decline in output per-person in Reform 3.

Table 6: Demographic Changes and Social Security Reform-Life-Cycle Model

	Benc	No Reform	Reform 1	Reform 2	Reform 3
		(2050 demographics)			
Output per person	100	89	80	95	88
Capital per person	100	104	84	103	88
Labor per person	100	77	77	88	88
Return to capital (r)	22%	18%	21%	20%	22%
Wage (w)	0.161	0.187	0.168	0.173	0.160
Average rep. rate	15%	15%	30%	15%	30%
SS payroll tax (τ_{ss})	3.9%	7.9%	15.8%	5.8%	11.5%
Old-age dep. ratio	37%	81%	81%	56%	56%

5 Differences Between the Two Models

In this section, we first examine the impact of aging and social security reforms in the dynastic versus life-cycle models separately. Next, we summarize the differences between the two models when both demographics and the social security reforms take place at the same time.

5.1 Impact of Aging in Different Models

There are some noticeable differences between the results presented in Table 5 and Table 6. First, the impact of aging on capital accumulation is very different between the two models. As Bohn (2006) discusses, fewer births imply a reduced weight on future generations and a reduced need to endow them with capital in the dynastic model. The "No Reform" case in the dynastic model indeed results in a lower capital per person (a decline from 100 to 81). In the life-cycle model, the opposite happens. Longer lives result in higher capital accumulation (an increase from 100 to 104).

To observe these results more clearly, we present a summary of the differences between the initial benchmark and the "No Reform" case in each model in Table 7. Aging of the society results in a 23% decline in labor in both models since that is tied to the exogenous changes in fertility and mortality rates. However, capital per-person declines by 19% in the dynastic model while it increases by 4% in the life-cycle model. Consequently, output per-person declines by 21% in the dynastic model and 11% in the life-cycle model. Of course, the implications of the two models in the return to capital and the wage rate are also dramatically different.

Table 7: Demographic Changes in Two Models

	Dynastic	Life-Cycle
	% change in	
Output per person	-21	-11
Capital per person	-19	4
Labor per person	-23	-23
Return to capital (r)	-3.8	-20.6
Wage (w)	2.6	16.6

5.2 Impact of Social Security Reform in Different Models

Next, we examine the implications of the social security reforms in the two models. In Table 8, we compare the steady state with new demographics ("No Reform") to the steady state under "Reform 1" and "Reform 3." This allows us to isolate the impact of social security reforms in the two models. There are again large quantitative differences between the implications of the two models. Reform 1 results in a 5% decline in output per-person in the dynastic model. This is half the decline in output per-person implied by the life-cycle model. For Reform 3, the differences are even more dramatic. The dynastic model implies an increase in output per person by 8% while it declines by 1% in the life-cycle model. These differences are driven by what happens to capital accumulation in each model. In the life-cycle model, an increase in the social security replacement rate results in a large decline in the saving rate. In the dynastic model, however, the decline in the saving rate is muted since bequests increase. Parents realize that their children will face higher taxes and compensate them.

Table 8: SS Reform in Two Models

	Dynastic	Life-Cycle	Dynastic	Life-Cycle
	Reform 1		Reform 3	
Output per person	-5	-10	8	-1
Capital per person	-10	-19	0	-15
Labor per person	0	0	14	14
Return to capital (r)	7.2	17.5	10.1	26.2
Wage (w)	-4.7	-10.2	-6.4	-14.3

The comparisons we have summarized in Table 7 and Table 8 demonstrate the quantitative differences between the implications of the two models faced with changes in demographics or social security reforms.

5.3 Impact of Demographics and Social Security Reform

If we are interested in understanding the changes that might take place in China from the late 2000s to 2050, then we need to compare the implications of the two models under the different reforms relative to the benchmark economy that represents the late 2000s. The economy in 2050 is expected to undergo both the changes in demographics and the social security coverage we examined so far. As we have documented, these changes have opposing effects on capital accumulation in dynastic versus life-cycle models. Aging implies an increase in capital per-person in the life cycle model and a decrease in the dynastic model. Increases in social security coverage, on the other hand, imply a much larger decline in capital per-person in the life-cycle model compared to the dynastic model.

In Table 9, we compare the results in the initial benchmark (2000s) to the results in "Reform 1" and "Reform 3" (which incorporate the new demographics). This comparison compounds the two effects together (change in demographics and social security reform). As a result of the opposing forces present in these two effects, the differences between the two models, though still substantial, seem smaller in Table 9. For example, reform 1 results in a 27% decline in capital per-person in the dynastic model and 16% decline in the life-cycle model. The decline in output is 25% in the dynastic case and 20% in the life-cycle case.

Table 9: SS Reform in Two Models

	Dynastic	Life-Cycle	Dynastic	Life-Cycle
	Reform 1		Reform 3	
Output per person	-25	-20	-15	-12
Capital per person	-27	-16	-19	-12
Labor per person	-23	-23	-12	12
Return to capital (r)	3.1	-6.5	5.9	0.2
Wage (w)	-2.1	4.7	-3.9	-0.1

6 Sensitivity Analysis

6.1 Social Security Reforms Without Demographic Changes

In our main results, we compared the implications of social security reform in economies with 2050 demographics. We found that the decline in output per-person due to an increase in the social security replacement rate ("Reform 1") was twice as high in the life-cycle model relative to the dynastic model. The differences between the two models in case of "Reform 3" were even larger. In this section, we examine if these results are sensitive to the assumed demographics. In Table 10, we compare the benchmark economy to the steady states under "Reform 1" and "Reform 3" where we use the demographics of the initial steady state that mimics the economy in the late 2000s. We again find substantial differences between the implications of the two models. However, the changes we find in capital per-person and output per-person are quantitatively smaller in both models compared to the results summarized in Table 8. Reform 1 results in a 2.8% decline in output per-person in the dynastic model, half the decline in output implied by the life-cycle model. For Reform 3, the dynastic model implies an increase in output per person by 4.7%, while it declines by 0.7% in the life-cycle model. Similar to our earlier findings, these differences are driven by what happens to capital accumulation in each model.

Table 10: SS Reform in Two Models Without Demographic Changes

	Dynastic	Life-Cycle	Dynastic	Life-Cycle
	Reform 1		Reform 3	
Output per person	-2.8	-5.6	4.7	-0.7
Capital per person	-5.5	-10.8	-0.4	-10.4
Labor per person	0.0	0.0	10.0	10.0
Return to capital (r)	4.3	8.2	7.2	15.2
Wage (w)	-2.9	-5.3	-4.8	-9.5

6.2 Decomposing the Impact of Demographic Changes

In our benchmark case, we model China's upcoming demographic changes as a combination of two changes, i.e., reduced fertility and increased life expectancies. We found that the combination of reduced fertility and increased life expectancies results in a decrease in capital per person by 19% and a 21% decline in output per person. Old age dependency ratio increases to 81%. In addition, these changes require the social security tax rate to increase from 3.9% to 7.9%.

In this section, we decompose the impact of the two types of demographic changes. Specifically, we repeat the main reform experiments with only one of the two types of demographic changes, respectively. We only do so in the dynastic model here as it is believed to be a better representation of the Chinese economy. The results with only reduced fertility are summarized in Table 11, and the results with only increased life expectancies are reported in Table 12.

Table 11: Decomposition of the Impact of Demographic Changes: Reduced Fertility

	Benc	No Reform	Reform 1	Reform 2	Reform 3
			(2050 demographics)		
Output per person	100	90	86	100	96
Capital per person	100	95	86	102	94
Labor per person	100	86	86	98	98
Return to capital (r)	22%	21%	22%	21%	23%
Wage (w)	0.161	0.169	0.161	0.164	0.158
Average replacement rate	15%	15%	30%	15%	30%
SS payroll tax (τ_{ss})	3.9%	6.4%	12.8%	4.3%	8.7%
Old-age dependency ratio	37%	62%	62%	40%	40%

Table 12: Decomposition of the Impact of Demographic Changes: Increased Life Expectancies

	Benc	No Reform	Reform 1	Reform 2	Reform 3
			(2050 demographics)		
Output per person	100	92	90	99	97
Capital per person	100	91	86	95	91
Labor per person	100	94	94	103	103
Return to capital (r)	22%	23%	24%	23%	24%
Wage (w)	0.161	0.159	0.154	0.155	0.151
Average replacement rate	15%	15%	30%	15%	30%
SS payroll tax (τ_{ss})	3.9%	4.6%	9.3%	3.3%	6.7%
Old-age dependency ratio	37%	46%	46%	32%	32%

6.3 Alternative Future Fertility Rates

In this section, we explore the consequences of different fertility rates on our projections. We consider two alternative cases: (1) number of children per couple equal to 2 (which represents the replacement rate of fertility) and (2) number of children per couple equal to 1.8 (the estimated fertility rate under the relaxed one-child policy as in Bairoliya, Canning, Miller, and Saxena (2016)). In the model, these correspond to fertility rates per parent of 0.9 and 1 ($n = 0.9$ and $n = 1$). The results from these cases for the dynastic model are summarized in Tables 14 to 15 where the second column represents the benchmark economy that mimics China in the late 2000s and the third column represents China in 2050 where the number of children per couple is equal to 1.3 ($n = 0.65$). The two last columns represent the Chinese economy under the two new fertility rate assumptions. Old age dependency ratio for these cases range from 81% (under $n = 0.65$ as predicted by Sin (2005)) to 54% (under $n = 1$).

Table 13 summarizes the results for the impact of the demographic changes under the three different fertility rates in 2050. This comparison does not incorporate any changes related to social security. The decline in the labor per person from the initial benchmark is smaller the higher the fertility rate is. The same is true for capital per person. Overall, output per-person is projected to decline by 21% if $n = 0.9$ and by 11% if $n = 1$.

Table 13: Demographic Changes - Dynastic Model

		Fertility Rate in 2050 (n)		
	Benc	0.65	0.9	1
Output per person	100	79	86	89
Capital per person	100	81	87	88
Labor per person	100	77	86	89
Return to capital (r)	22%	21%	22%	22%
Wage (w)	0.161	0.165	0.161	0.160
Average replacement rate	15%	15%	15%	15%
SS payroll tax (τ_{ss})	3.9%	7.9%	6.0%	5.5%
Old-age dependency ratio	37%	81%	60%	54%%

Effects of social security reform is also different under the three alternative fertility rate assumptions. In "Reform 1" where only the social security replacement rate is increased, capital per person declines between 15% ($n = 1$) and 27% ($n = 0.65$). But even under the optimistic scenario of $n = 1$, output per person declines by 15%.

Table 14: Social Security Reform 1

		Fertility Rate in 2050 (n)		
	Benc	0.65	0.9	1
Output per person	100	75	83	85
Capital per person	100	73	80	82
Labor per person	100	77	86	89
Return to capital (r)	22%	23%	23%	23%
Wage (w)	0.161	0.157	0.155	0.155
Average replacement rate	15%	30%	30%	30%
SS payroll tax (τ_{ss})	3.9%	15.8%	12.0%	10.9%
Old-age dependency ratio	37%	81%	60%	54%

Table 15 summarizes the results for "Reform 3" where both the social security replacement rate and the retirement age are changed at the same time. This reform in general generates better macro economic results. The decline in output ranges between 7% for $n = 1$ and 15% for $n = 0.65$ cases.

Table 15: Social Security Reform 3

		Fertility Rate in 2050 (n)		
	Benc	0.65	0.9	1
Output per person	100	85	91	93
Capital per person	100	81	86	88
Labor per person	100	88	97	99
Return to capital (r)	22%	23%	24%	24%
Wage (w)	0.161	0.155	0.152	0.152
Average replacement rate	15%	30%	30%	30%
SS payroll tax (τ_{ss})	3.9%	11.5%	8.7%	7.9%
Old-age dependency ratio	37%	56%	41%	37%

7 Conclusion

In this paper, we examine the implications of the expected changes in demographics and social security reforms in China using two different models. We find significant differences between the quantitative implications of the two models. The dynastic model, which is likely to provide a better description of the Chinese economy, results in a 21% decline in output per-person due to the aging of the society and in the absence of any changes in social security. If the Chinese government extends the social security benefits from 15% to 30% without any changes in the retirement age, output per-person in the new steady state is reduced by 25%. If the retirement age is increased at the same time, the reduction in output per-person is less, around 15%.

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