# Social Security and Female Labor Supply in China

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**Abstract**

This paper studies how a potential policy change that raises women's social security eligibility age from 50 to 60 would affect women's employment, human capital, and earnings in China. I develop a dynamic model of female labor supply, featuring voluntary retirement; occupational choice; human capital accumulation contingent on occupation, age, and employment status; and child care using time inputs from parents, grandparents, and formal child care from the market. I estimate the model parameters by matching moments on employment, wages, and the time allocation of child care from micro data in China. The policy counterfactual raising women's social security eligibility age yields two main findings. First, the policy change leads to only a moderate increase in aggregate labor supply because it affects the employment of old and young women in opposite directions. The reduction in social security insurance encourages women above the age of 50 to supply more labor. Yet low-skilled young women with children reduce their labor supply in response to the children's grandmothers working more and providing less child care. Second, since human capital accumulation is faster on the earlier career path rather than later, the reduction in early career employment leads to persistent losses in human capital and earnings for low-skilled women.

*Keywords:* China; Social security; Female labor supply; Child care; Human capital; Life cycle

*JEL Classification:* D15, J13, J22, H55

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# 1 Introduction

Under the current Chinese social security policy, women are entitled to withdraw social security benefits as early as age 50, while men are entitled to do so at age 60.[1,2] To maintain fiscal sustainability in the presence of an aging population, the Chinese government plans to raise women's social security eligibility age to 60. This paper studies how this policy change would affect Chinese women's employment, human capital, and earnings.

The current social security policy is an important factor affecting Chinese women's labor supply. Figure 1 plots the employment rates by age of urban Chinese women between ages 24 and 60 using data from the Urban Household Survey of China (UHS).[3] Before age 50, around 80% of Chinese women are employed. Once eligible for social security benefits at age 50, Chinese women drop out of the labor force very quickly. After the policy change, women between ages 50 and 60 would no longer be eligible for social security. The reduction in social security insurance will incentivize women to work more years and accumulate more human capital.

However, this policy change may bring about unintended effects to the labor supply of younger women, because women between age 50 and 60 are very likely to have young grandchildren and provide a substantial amount of child care to them under the current policy, which enables the children's mothers to stay in the labor market.[4] According to the 2008 wave of the China Time Use Survey (CTUS), around 30% of the grandparents between ages 50 and 64 provide positive child care hours, and they take care of children as a primary activity for 13 hours per week on average, conditional on provision.[5] The

[1]Technically speaking, only female workers are eligible at age 50, while civil servants are eligible at age 55. Fang and Feng (2018) document that around 93% women are eligible at age 50 in practice.

[2]A common practice in many countries–especially in developing countries– is to assign women a younger social security eligibility age than men. See https://en.wikipedia.org/wiki/Retirement_age#cite_note-72 for retirement ages across the world. One potential explanation is that, historically, old women are physically disadvantaged as factory labor workers.

[3]I exclude self-employed workers because they are enrolled in social security on a voluntary basis. Maurer-Fazio et al. (2011) document a similar pattern for labor force participation using the Population Census of China.

[4]See Figure 3 in Section 2.

[5]As a comparison, Rupert and Zanella (2018) document that only 13% of American grandparents in the same age group provide positive child care hours and spend 11 hours per week conditional on the provision using the Health and Retirement Survey (HRS) of the United States.

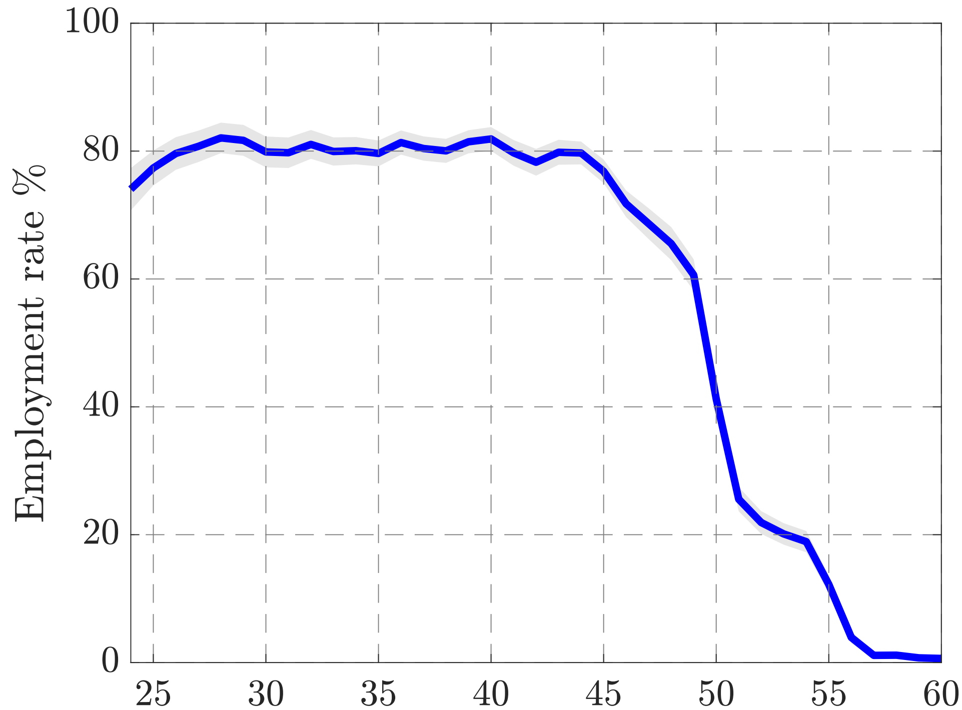


Figure 1: Employment rate of Chinese urban women by age

Source: Urban Household Survey of China 2007–2009. The employment rate is defined as employed workers as a share of total population, excluding self-employed workers, students, and the disabled. See Appendix A for more details about the construction procedure.

employment rate of young women with children under 7 is on average 26 percentage points higher in households that include children's grandparents relative to those without.[6] This may also contribute to the distinction between the patterns of young women's employment in China and other countries. In China, the employment rate of young women is around 80%, whereas in many other countries, the presence of children significantly lowers the employment rate of women in their early careers compared with those in their later careers (see Attanasio, Low, and Sánchez-Marcos (2008) for the United States and Adda, Dustmann, and Stevens (2017) for Germany).[7] Under the new policy, when grandmothers supply more labor and reduce child care hours to their grandchildren, the younger women have to either provide child care themselves or purchase formal child care services from the market. Additionally,

[6] I don't distinguish between women's parents and in-laws and simply refer to them as grandparents hereafter.

[7] This is not a consequence of women adjusting the intensive margin of labor supply. In Appendix A, I document that part-time jobs account for a very small fraction of employment.

early career employment is critical for human capital accumulation and will have dynamic effects on women's human capital and earnings later on the career path. The question of how much younger women will adjust their labor supply is important for understanding the overall policy impact.

In this paper, I develop a dynamic overlapping generations (OLG) model to address those issues and look at policy impacts on employment and human capital for both young and old women. The model features voluntary retirement; occupational choice; human capital accumulation contingent on occupation, age, and employment status; and child care using time inputs. In the model, young and old generations form households and jointly decide on consumption, savings, employment, and child care time allocation. Households with children need to spend a minimum amount of time with children. I allow for three types of child care providers: parents, grandparents and formal care from the market. The time that parents and grandparents spend time with children directly affects their time available for leisure and work. Formal care from the market is purchased with monetary resources. To better understand the career costs of children on women's employment and human capital, I introduce occupational choice and state-contingent dynamic human capital accumulation. More specifically, human capital accumulates in periods on the job and depreciates in periods of non-employment. The speed of human capital accumulation is a function that varies across occupations and changes linearly by women's age. With this setup, the opportunity cost of non-employment varies by age, which allows me to precisely estimate how much the reduction in early career employment affects human capital and earnings over the life cycle.

I estimate the model using the method of simulated moments (MSM). The internal parameters of the model are estimated with moments on employment and wages from the UHS and child care time from the CTUS. I classify occupations in the UHS as either high- or low-skilled occupations according to their task intensities and estimate the human capital accumulation functions by matching moments on wage growth by groups of occupation, age, and employment history. I find that human capital accumulates at a faster speed for women employed in high-skilled occupations and at younger ages. I also use the employment share of occupations to estimate the parameters of the occupational choice problem and use moments on child care hours by both young and old to estimate the parameters of preference for child care.

The model provides a good fit with the aggregate female employment rate by age. The model captures the elasticity of retirement to the social security entitlement and can thus replicate the drastic decrease in women's labor supply at age 50. Two features of the model allow younger women with children to supply labor, enabling me to match the employment rate of around 80% in their early careers. First, intergenerational time transfer allows the old women to retire and provide child care, which relaxes the time constraint of young women. Second, the human capital growth rate is declining in age, implying a higher opportunity cost of non-employment at the earlier career stage. The model matches the movement of high-skilled labor as a fraction of employment over the life cycle by capturing the labor supply incentives with respect to having children for women employed in different occupations. The model can generate similar patterns of child care provision in both the extensive and intensive margins. It also matches women's child care provision by their employment status. I validate the model by showing that the model reproduces the marginal effect of the presence of the old generation on young women's employment. This evidence indicates that my model correctly captures the role of intergenerational time transfer in determining young women's labor supply.

I use the model to conduct a counterfactual policy experiment to raise the social security entitlement age from 50 to 60 and then evaluate the changes in economic variables in a new steady state. Women under the new policy are not eligible for social security between ages 50 and 60, and the extra social security revenue will be reimbursed to the whole working population via income taxes. Under the new policy, the probability of choosing high-skilled occupation increases from 25% to 32% because of the reduction in the present discounted value (PDV) of social security programs. Overall welfare evaluated on a consumption-equivalent basis shows a negative change of –0.1%.

The policy counterfactual yields two main findings. First, although the policy change removes social insurance for 10 years, it leads to only a moderate increase in lifetime labor supply up to around 3 years. The policy change stimulates the labor supply of women above age 50 from 20% in the benchmark to around 65% in the counterfactual. However, the employment rate of low-skilled young women decreases. After the policy change, children's mothers act strategically in response to the reduction in grandparental child care support. The higher wages of high-skilled women enables them to purchase child care services from the market as a substitution, whereas the lower wages of low-skilled women prompt them to stay at home. Second, early career employment is critical for human capital accumulation and has dynamic effects on the periods that follow. A reduction in early career employment leads to persistent loss of human capital and earnings for low-skilled women. These results are robust in alternative setups of population aging and the elastic supply of formal care in the market.

The paper provides several contributions. First, motivated by unique data features of Chinese women, I incorporate features of intergenerational time transfer and dynamic human capital accumulation into a unified dynamic quantitative model of female labor supply and calibrate model parameters using rich micro data. Second, within this framework, the endogeneity due to the simultaneity nature of labor supply decisions of young and old generations, which is challenging for identification in the empirical literature, is addressed through a household model in which the young and old generations jointly make decisions on employment and child care time allocation. This framework thus provides a valid benchmark suitable for evaluating policy impacts over the life cycle. Third, the novel features of intergenerational time transfer and human capital dynamics turn out to be key in matching employment and wage growth of Chinese women under the current policy environment as well as understanding the policy impacts of delaying retirement policy.

**Related literature** This paper is primarily related to the literature on social security reform in China. Song et al. (2015) study the optimal social security policy design along the transition path of declining wage growth. İmrohoroğlu and Zhao (2018) investigate the role of intergenerational monetary transfer across young and old generations in evaluating effects of policy reform. He, Ning, and Zhu (2019) study the impact of the reduction in social security benefits on household savings and labor supply. Deng et al. (2021) evaluate several scenarios of delaying retirement age and reducing benefits and highlight the importance of health expenditures. Following the literature that highlights role of policy in characterizing female labor supply, such as Guner, Kaygusuz, and Ventura (2011, 2020), Bick and Fuchs-Schündeln (2018), and Borella, De Nardi, and Yang (2021), this paper focuses on policy impacts on employment and human capital of women.

Accessibility to informal child care, in particular grandparental child care, has been found to be an important factor that affects young women's labor supply. Maurer-Fazio et al. (2011) and Li (2017) provide evidence that in China, the presence of old household members is associated with a higher employment rate for young women in the household, especially in households with young children. Compton and Pollak (2014), Bratti, Frattini, and Scervini (2018), and Garcia-Moran and Kuehn (2017) find similar positive correlations in the United States, Italy, and Germany, respectively. Havnes and Mogstad (2011) and Bick (2016) argue that the substitution between informal and market formal care plays an important role in understanding policy effects of child care subsidies.

Looking through the other side of time transfer, a related literature studies the impact of grandchildren on the elderly's labor supply and retirement behavior. Feng and Zhang (2018) show that retirement is associated with an increase in the provision of child care in both the extensive and intensive margins. Rupert and Zanella (2018) and Frimmel et al. (2020) find evidence in the United States and Austria that becoming a grandparent increases the probability of quitting the labor market.

This paper is also related to a large literature that highlights the role of human capital accumulation in life cycle decisions and policy design such as Keane and Wolpin (2007, 2010), Blundell et al. (2016), Adda, Dustmann, and Stevens (2017), and Eckstein, Keane, and Lifshitz (2019). My results also echo the findings in Müller and Wrohlich (2020) that expansion of subsidized child care in Germany mainly affects mothers with a medium level of education but has no impact on highly-educated mothers' employment.

**Outline** The rest of the paper is organized as follows. Section 2 presents empirical facts about Chinese women's employment and wage dynamics by occupation as well as their time use on child care.

Section 3 lays out an OLG model with endogenous labor supply/retirement and child care decisions. Section 4 presents my calibration choices of the model and model fit. In Section 5, I conduct policy experiments that raise women's social security eligibility age to 60 and explore the policy impact on various labor market outcomes. Section 6 checks the robustness of the results. Section 7 concludes.

# 2 Labor supply and child care of young and old Chinese women

As shown in Figure 1, the current social security policy clearly shapes the employment rate of Chinese women over the life cycle. In this section, I further provide facts on unique features of employment and child care time allocation of Chinese women. I first use the first wave of CTUS in 2008 to document time use of young and old Chinese women. I also use the UHS between 2002 and 2009 to document employment and wage dynamics by occupation.

## 2.1 Time use

**Data source** The first wave of CTUS is conducted by the NBS of China in May 2008. The CTUS surveys respondents about time diary on two days in a week – one between Monday and Friday and another between Saturday and Sunday– each recorded into a weekday and a weekend module accordingly. I construct the total child care hours from the weighted average of time spent on child care as the primary activity in two modules.

The CTUS also contains information about individuals' age, relationship to the head, marital status, education, and employment status, which allows me to explore the distribution of child care hours provided by parents and grandparents. For the sake of space, I only present the novel data features of grandparental child care in this section. The interested readers are referred to Appendix A for more a detailed description of the survey design and additional results such as child care hours from parents.

**Grandparental child care** The CTUS does not provide information on the relationship between the children and the respondent who conducts child care activity. I assume that child care hours committed by individuals above age 50 are all grandparental care.[8] Table 1 documents intensive and extensive margins of primary child care hours for old men and women by their employment status.

Table 1: Extensive and intensive margin of grandparental child care, by employment status

| | Men | | Women | |
|---|---|---|---|---|
| Age | Employed | Retired | Employed | Retired |
| *Panel A: weekly child care hours* | | | | |
| 50 – 54 | 6.56 | – | 8.01 | 17.84 |
| 55 – 59 | 8.29 | – | 7.67 | 15.00 |
| 60 – 64 | – | 11.01 | – | 13.26 |
| 65 – 70 | – | 8.36 | – | 9.71 |
| *Panel B: fraction of child care provision* | | | | |
| 50 – 54 | 0.14 | – | 0.22 | 0.39 |
| 55 – 59 | 0.21 | – | 0.23 | 0.41 |
| 60 – 64 | – | 0.38 | – | 0.30 |
| 65 – 70 | – | 0.23 | – | 0.20 |

Chinese women typically retire between 50 and 55, while men tend to retire at around 60. I thus only report statistics for groups with sufficient amount of observations, i.e. men and women employed before age 60, women retired before age 60, and men and women retired after age 60. The main findings of Table 1 are as follows. First, compared with the retired, the employed women provide less grandparental child care in terms of both extensive and intensive margins. Second, contingent on employment status and age group, men and women do not show significant difference in terms of both the intensive and extensive margin of grandparental child care.

**Age profile of grandchildren** In Figure 3, I present the number and age distribution of grandchildren for grandparents by age with a fourth-order polynomial in age using data from CHARLS in year 2011.

[8] Bounds of imputation errors are reported in Appendix A.

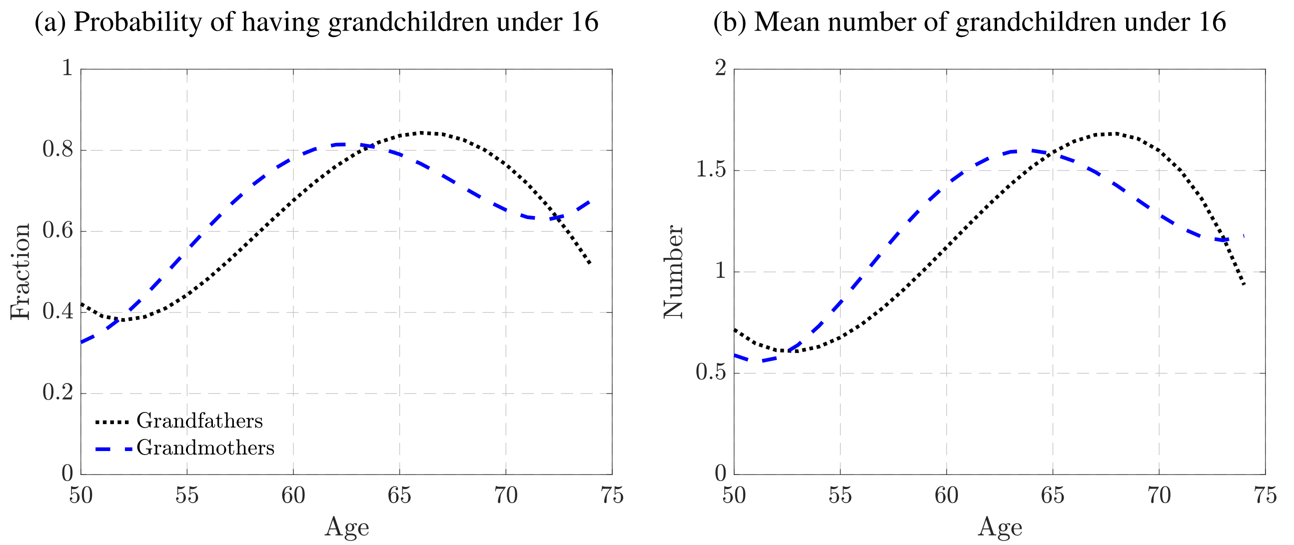


Figure 3: Age profile of grandchildren in urban China

Figure 3(a) documents the age profile of the probability of having at least one grandchildren under 16 and Figure 3(b) documents the age profile of the mean amount of grandchildren under 16. One average, men are two years old to have grandchildren. The figures clearly show that the amount of grandchildren under age 16 increase sharply for the population between age 50 and 65, which implies that delaying retirement change may have a sizable impact on the provision of grandparental child care.

## 2.2 Employment, occupations, and wages

Following Autor, Levy, and Murnane (2003), I classify the original occupational codes in the UHS into low- and high-skilled occupations based on tasks involved at work. Low-skilled occupations include those that involve more intensively the routine and manual tasks and high-skilled occupations include those that involve more intensively abstract task.[9] There are two advantages of using occupation over education under the context of Chinese economy. First, before 1990s, the college enrollment rate was less than 10% due to very limited high education resources. Since then, China went through rapid expansion of college enrollment, which makes degrees granted in different years potentially not

[9] High-skilled occupations include mangers, officials, engineers, professional workers, technical workers, artists, and teachers. Low-skilled occupations include clerical works, sales workers, production workers and operators.

comparable. Second, a large fraction of people continue to obtain more advanced degrees while they are on the job, among whom many even fulfill courses as part of their job requirements. For these reasons, I focus on the occupation as the key dimension to document human capital differences.

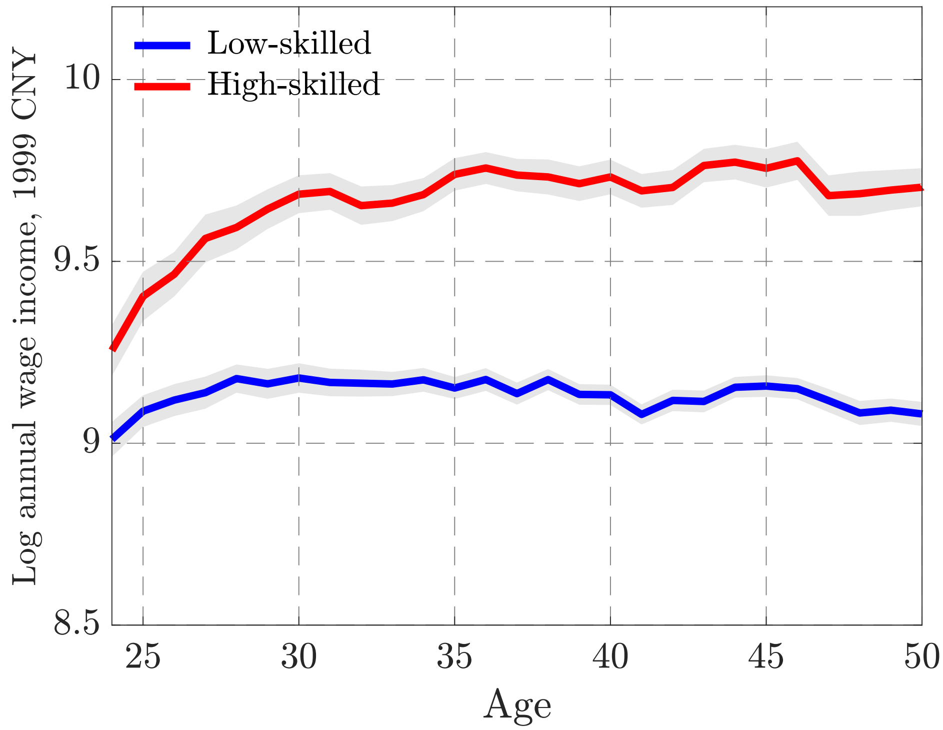


Figure 4: Mean wage by occupation over the life cycle

Source: Urban Household Survey of China 2007–2009.

Figure 4 presents the mean wage over the life cycle for two skill types. As is clear in Figure 4, wage premium of the high-skilled occupation is around 0.25 log points at age 24, and it keeps widening in later years. Figure 4 also shows that the majority of wage growth occurs on early career path. For both skilled types, wage growth is close to 0 beyond age 35. These facts have important policy implications. First, choosing a certain occupation implies a particular path of lifetime earnings thus occupational choice is potentially an important channel for women to act in response to the policy change. For example, if the incentive to develop human capital dominates when women expect to have a longer career, they may be more likely to select into the high-skilled occupation. Second, ages with faster wage growth coincides with ages with the presence of young children at home. As documented in the previous subsection, Chinese grandmothers provide large amount of childcare hours to their grandchildren. If women anticipate that they will reduce labor supply on early career path due to the reduction in grandparental child care under delaying retirement policy, the expected return of choosing high-skilled occupation is lower due to the reduction in human capital accumulation. Table 2 further presents descriptive statistics of employment share and wage growth rates by occupation.

Table 2: Descriptive statistics by occupation

| | Low-skilled | High-skilled | All |
|---|---|---|---|
| Share in employment, age $\in [24, 30]$ | 72.9 % | 27.1% | 100% |
| Share in employment, age $\in [24, 60]$ | 76.0 % | 24.0% | 100% |
| Log wage at age 24 | 9.03 | 9.24 | 9.07 |
| | (0.69) | (0.67) | (0.69) |
| Log wage at age 50 | 9.24 | 9.75 | 9.37 |
| | (0.75) | (0.63) | (0.76) |
| Average yearly wage growth, age $\in [25, 35]$ | 5.0% | 3.4% | 3.7% |
| | (0.199) | (0.194) | (0.197) |
| Average yearly wage growth, age $\in [40, 50]$ | 0.6% | 0.2% | 0.3% |
| | (0.173) | (0.185) | (0.182) |

*Note:* (1) Employment share is defined as the fraction of employed women in a given occupation in total employment. (2) Wage growth is evaluated for population continuously employed in consecutive years.

# 3 Model

In this section, I develop a quantitative framework of female labor supply. The key features of the model include intergenerational time transfer in the form of grandparental child care and dynamic human capital accumulation.

### 3.1 Setting

Time is discrete. The economy is populated by an infinitely lived government and overlapping generations of individuals. The size of cohort grows at rate $g$. In the economy, there are two genders—male and female, and two generations—young and old. I do not model child explicitly as a generation. Rather, as will become clear in the child care section, children are manifested as time costs to households. Individuals enter the economy at a common age of 22 and live consecutively through the young and the old stage, each lasting for 24 years. Since I use two years as a model period, a life stage is also equivalent to $T = 12$ model periods. A household consists of two overlapped successive generations of two genders, i.e. household members $i \in \mathcal{I} = \{\texttt{yf}, \texttt{ym}, \texttt{of}, \texttt{om}\}$, each referring to young female, young male, old female, and old male, respectively.

To simplify the problem, I abstract away from the marriage decision and assume all individuals are married in all periods.[10] Young women give birth to children stochastically. Old individuals in the same household are subject to a common mortality shock. Within a household, the measure of the young generation is normalized to 1 and the measure of the old generation is denoted as $m^o$. Before the mortality shock hits the household, $m^o$ is equal to $g^{-T}$, a constant that takes the value of the ratio of population of the young generation to the old generation in the same household. $m^o$ is 0 after the mortality shock. At the end of period-$T$, a new household is formed and individuals' household member identities evolves accordingly: any living old generation in the current household leaves the economy, the young generation in the current household becomes the old generation in the new household, and the young generation in the new household enter the economy.

Alive household members jointly make decisions to maximize the unitary household utility objective. The household maximization problem can be formulated into a recursive problem, with value function for period $j$ denoted as $V_j$.

[10]The marriage rate of Chinese urban population between age 24 and 50 is around 88% in 2007.

## 3.2 States, choices, and preference

**States** Households are heterogenous in states $\mathbf{x} \equiv (a, \pi, \mathbf{s})$, which include assets $a$, children type $\pi$, and a set of income-related state variables $\mathbf{s} \equiv \{s^i\}_{i \in \mathcal{I}}$. Children type $\pi$ determines time costs of child care. $\pi$ evolves according to a certain law of motion which will be specified in the section of calibration. $s^i$ refers to household member $i$'s income-related variables, which includes occupation $k^i$, human capital $h^i$, income shock $\epsilon^i$ that determine the wage income, and retirement status $r^i$ and average lifetime earnings $z^i$ that determine the social security income.[11]

**Choices** The household jointly choose $\mathbf{d} = \{k^{\text{yf}}, r^{\text{of}},\ \mathbf{n},\ \mathbf{l},\ \mathbf{q},\ q^n,\ a',\ \mathbf{c}\}$, each referring to :

- occupation of young women: $k^{\text{yf}} \in \{1, ..., K\}$
- retirement of old women: $r^{\text{of}} \in \{0, 1\}$
- working hours: $\mathbf{n} = \{n^i\}_{i \in \mathcal{I}}$
- leisure: $\mathbf{l} = \{l^i\}_{i \in \mathcal{I}}$
- household members' child care hours: $\mathbf{q} = \{q^i\}_{i \in \mathcal{I}}$
- market formal child care hours: $q^n$
- asset in the next period: $a'$
- consumption of the young and the old generation: $\mathbf{c} = \{c^y, c^o\}$

Also note that some of the choices may only apply to certain periods and are potentially subject to the current states. For example, the occupational choice is only made once at the beginning of period 1 and the retirement decision only applies to households in which the old women are not yet retired. This will become more clear when I introduce the corresponding elements in the following sections.

[11] Note that this formulation easily nests the case where the old generation is not present in the household with state variables of the old generation set to 0.

**Preferences** Preferences are assumed to be time-separable, with a constant discount factor $\beta$. Extending the framework of Ribar (1995) and Kimmel and Connelly (2007) to a dynastic household environment with multiple generations and multiple members, I assume that households derive utility from private consumption, private leisure, and child care hours of household members. I denote the period utility function as $u(\mathbf{c}, \mathbf{l}, \mathbf{q})$, which will be specified in the calibration section.

### 3.3 Government policies

Government taxes wage incomes to finance an exogenous public expenditures $G$ and the socials security expenditures to retired workers. $G$ works as a residual to balance government budget in the benchmark and is invariant to the changes in policy environment. Wage income tax is proportional to personal before-tax wage income, and the tax rate is denoted as $\tau$.

Retired workers receive social security incomes at the amount of $b(z)$, which is a function of individuals' average lifetime earnings $z$. Social security incomes are not taxable. Retirement is an absorbing state and there is no rehiring after retirement.[12] In the benchmark, social security eligibility age is 50 for women and 60 for men. Government budget balance is achieved when

$$\tau \sum_i w^i \mathbb{1}_{\{n^i=\bar{n}\}} - \sum_i b(z^i) \mathbb{1}_{\{r^i=1\}} - G = 0. \tag{1}$$

### 3.4 Monetary and time endowments

Households receive both asset incomes and labor incomes. Household members pool labor incomes from each household member and share a common savings account.

**Savings** Assets are used to finance periods out of the labor force, fluctuations in household earnings due to productivity shocks, and costs associated with children and retirement. $a_j$ denotes the household

[12]In UHS, 7.91% of the retired workers (and 8.75% retired female workers) are rehired, see Table A1 of the Appendix A. I thus do not allow for rehiring in the model.

savings account shared by parents and grandparents, which accumulates at a constant return $r$ each period. Allowing for savings is important to understand how policy change affects individuals' dynamic labor supply incentives. Household savings rate is as high as 22% in 2015, suggesting the important role of private savings in smoothing consumption for periods of retirement. A shared savings account allows for costless transferring of monetary resources across the young and the old generation.[13]

**Labor income** Household after-tax labor income $y_j$ is simply the sum of after-tax labor income from each household member:

$$y_j(s, \{n^i\}_{i \in \mathcal{I}}; \mathcal{T}) = \sum_i m^i y_j^i(s, n^i; \mathcal{T})$$

where individual $i$'s after-tax labor income $y_j^i$ includes wage and social security incomes

$$y_j^i(s^i, n^i; \mathcal{T}) = \mathbb{1}_{\{n_j^i = \bar{n}\}} w_j^i(o_j^i, h_j^i, \epsilon_j^i)(1 - \tau) + \mathbb{1}_{\{r_j^i = 1\}} b(z_j^i).$$

**Budget constraint** Households receive labor and asset incomes and choose private consumption goods $c^y$ and $c^o$, market formal child care $q^n$ given price $p^n$, and assets for next period $a'$:

$$c^y + c^o m^o + a' + p^n q^n = (1 + r)a + y_j(s, \{n^i\}_{i \in \mathcal{I}}; \mathcal{T}).$$

[13]The assumption of perfect risk sharing may seem extreme, however, İmrohoroğlu and Zhao (2018) documents that this setup can predict the right direction of transfers between parents and grandparents by age.

**Time endowment** Every individual is endowed with $1$ unit of time each period, which can be allocated across three types of activities : working $n$, child care $q$, and leisure $l$:

$$l^i + q^i + n^i \leq 1, \quad l^i \geq 0, \quad q^i \geq 0 \qquad \forall\, i \in \mathcal{I}$$

$$\text{where} \quad n^i \begin{cases} = 0 & \text{if } r^i = 1 \\ \in \{0, \bar{n}\} & \text{if } r^i = 0 \;\&\; i \in \{\text{yf}, \text{of}\} \\ = \bar{n} & \text{if } r^i = 0 \;\&\; i \in \{\text{ym}, \text{om}\}. \end{cases}$$

$q$ and $l$ are continuous choices and $n$ takes value of $\bar{n}$ if employed and $0$ otherwise. With this individual time allocation constraint, I assume explicitly that each activity can only be conducted separately. Retired individuals supply 0 market hours. Non-retired women (yf or of) make period-by-period decision on whether to work, while non-retired men (ym or om) supply $\bar{n}$ hours inelastically.

## 3.5 Children and child care

Child in the model is best interpreted as time costs of children. The state of children age $\pi$ evolves according to the fertility process and aging of children.

**Fertility process** Households are heterogeneous in the age of giving birth to children. The fertility rate in period $j$ is given by $\delta_j^c$. The assumption of stochastic fertility leads to different levels of average child care time costs for women at different ages. To simplify the problem, I assume that women give birth only once in their life and all women have children by age 40. In the benchmark, I further assume that women will give birth to a boy and a girl at a time, who will become the young male and female household members in the successive household.

**Child care time cost** A household with children at age $\pi$ needs child care for $\kappa_\pi$ hours. To capture the channel of intergenerational time transfer, I allow both the young and old generation to be child care providers. Additionally, households can also purchase formal child care service from the market. Following Ribar (1995) and Bick (2016), I assume that child care hours by different sources are perfectly substitutes. The *child care time constraint* faced by the household is thus given as

$$\sum_{i\in\mathcal{I}} q^i + q^n \geq \kappa_\pi.$$

Since all household members are faced with a common child care time constraint, when the old woman provides more child care hours, it relaxes individual time constraint for the young woman, enabling the young woman to provide more working hours. Children need child care up till age 16. Before age 6, households can only purchase formal care from the market at price $p^n$. After age 7, children attend compulsory public education for a fixed amount of $q^{\text{school}}$ hours. $q^n$ for children above 7 will be the sum of $q^{\text{school}}$ and the purchased formal care hours. To engage in formal care, the household must make a minimum amount of $\underline{q^n}$ hours purchase. Formal care unit price is denoted as $p^n$, which potentially vary according to children's age.

**Formal child care supply** Market formal child care is produced with labor. As child care only accounts for a small fraction of aggregate labor, I do not attempt to have a full specification of market child care production technology. Rather, I specify a flexible formal child care supply function Equation (2) to allow for the potential impact of policy change on formal care supply and formal care prices:

$$p^n = \xi_0 + \xi_1 Q^n. \tag{2}$$

$Q^n$ is the amount of aggregate supply of formal child care. $\xi_1 > 0$ refers to the case where child care supply is elastic with supply elasticity $\frac{1}{\xi_1}$ to formal care price. When $\xi_1 = 0$, the economy features perfectly elastic supply of formal child care.

## 3.6 Occupations, human capital and wages

Occupations differ in the costs upon entry and the expected income flows over the life. Modeling occupational choice allows me to capture differences in labor market attachment and wage growth across occupations to obtain precise estimates of policy impacts.

**Occupational choice** At the beginning of period 1, households choose occupations for young women, subject to occupational-specific training costs $\psi^k$ and unobserved labor market shocks $\varepsilon^k$ to occupations:[14]

$$k^{\text{yf}} = \underset{k \in \{1,\ldots,K\}}{\arg\max} \{V_1(a - \psi_k, \pi, \mathbf{s}) + \varepsilon_k\}.$$

The variance of the unobserved shock controls the importance of other unobservable factors relative to the expected returns in determining women's occupational choice, thus allows for the flexibility of the elasticity of occupational choice probability to the policy change.[15]

In the benchmark, I assume that occupation will be fixed for an individual all lifetime once the choice is made. The employment share of occupations will vary by age because different occupations have different levels of labor market attachment. To simplify the problem, I assume that occupational choice only applies to women while men are employed in one occupation.

**Wage income** The logged wage is simply additive in the wage premium of occupation $\alpha_k$, human capital $h$, and incomes shocks $\zeta$:

$$\ln w_j = \alpha_k + h_j + \zeta_j$$

[14] This captures all unobserved characteristics that affect the decision of initial occupation choice, including factors like regional or time variation in working opportunities, or any pre-labor market opportunities that may affect the decision of occupational choice. An alternative but more complicated way to introduce an occupational choice problem will involve educational choices and human capital formation before the labor market. I leave this direction for future research.

[15] An extreme case is that when the variance is infinitely large, the choice probability will be completely independent of labor market returns to occupations.

Agents will thus choose a career based on the fixed occupational wage premium and expectation of human capital growth along the career path.

**Human capital** Human capital $h$ is normalized to be 1 for all women entering the labor market. Human capital of young women evolves following:

$$h_{j+1} = (1 + \rho(k, n, j))h_j$$

where human capital growth $\rho$ is a function of women's occupation $k$, age $j$, and employment status $n$:

$$\rho(k, n, j) = \begin{cases} e^{\rho_{k,1} + j\rho_{k,2}} & \text{if } n_j = \bar{n} \\ \rho_{k,0} & \text{if } n_j = 0 \end{cases}$$

When a woman of age $j$ is employed, her human capital stock grows by $e^{\rho_{k,1}+j\rho_{k,2}}$. Occupations differ in both the intrinsic learning speed $\rho_{k,1}$ and the age slope of learning speed $\rho_{k,2}$. Occupations with a faster learning speed are expected to have higher wage returns with the same length of employment duration. When $\rho_{k,2}$ is negative, human capital accumulation is faster at younger ages thus non-employment in early career is more costly. Additionally, human capital depreciation rate of non-employment $\rho_{k,0}$ is also different across occupations. Instead of modeling human capital growth as a function of experience as in the previous literature, such as Eckstein and Lifshitz (2011), Adda, Dustmann, and Stevens (2017), and Sánchez-Marcos and Bethencourt (2018), I directly link human capital growth to age. This allows for the policy to affect human capital accumulation not only through length of career but also through the learning difference by age.[16] This model setup thus nests a special case in which there is a single occupation and another special case in which human capital growth is constant over the life cycle.

[16] A human capital accumulation function that features decreasing returns to experience is likely to underestimate the human capital loss over the life cycle to a reduction in early career employment when human capital growth is actually a function of age.

## 3.7 Recursive formulation

Given period $j$, states $\mathbf{x} = (a, \pi, \mathbf{s})$, household members jointly choose $\mathbf{d} \equiv \{k^{\text{yf}}, r^{\text{of}}, \mathbf{n}, \mathbf{l}, \mathbf{q}, q^n, a', \mathbf{c}\}$, subject to the household monetary budget constraint, each household member's individual time budget constraint, child care time allocation constraint, and the household borrowing constraint. The value function can thus be formulated recursively as

$$
\begin{aligned}
V_j(\mathbf{x}) &= \max_{\mathbf{d}}\{u(\mathbf{c}, \mathbf{l}, \mathbf{q}) + \beta \mathbb{E}[\hat{V}_{j+1}(\mathbf{x}')]\} \\
s.t. \quad & c^y + c^o + p^n q^n + a' = (1+r)a + y_j(\mathbf{s}, \{n^i\}_{i \in \mathcal{I}}; \mathcal{T}) \\
& l^i + q^i + n^i \leq 1, \quad l^i \geq 0, \quad q^i \geq 0, \quad n^i \in \{0, \bar{n}\} \qquad \forall\, i \in \mathcal{I} \\
& \sum_{i \in \mathcal{I}} q^i + q^n \geq \kappa_\pi \\
& a' > \underline{a}
\end{aligned}
\tag{3}
$$

The expectation is taken over exogenous processes of income, mortality, and the age of children, and

$$
\hat{V}_{j+1}(\mathbf{x}') = \begin{cases} V_{j+1}(\mathbf{x}') & \text{for } j = 1, ..., 11 \\ \max_{k^{\text{yf}} \in \{1,...,K\}}\{V_1(a - \psi_k, \pi, \mathbf{s}) + \varepsilon_k\} & \text{for } j = 12 \end{cases}
$$

The final period $T = 12$ differs from other periods in two main aspects. First, state variables evolve as the household structure and household member identities change. Second, the household makes the occupational choice for the young woman.

## 3.8 Definition of steady state equilibrium

Let $\Lambda = (j, a, \pi, \mathbf{s})$ denote the vector of household states and $\mu(\Lambda)$ denote the distribution of households over the state space. Given interest rate $r$, child care supply function, and a set of government policies $\{\tau, R_1, R_2, \tau_b\}$, a stationary recursive competitive equilibrium for this economy is a collection of (i) value function $V_j(a, \pi, \mathbf{s})$, (ii) formal child care price $q^n$, and (iii) policy functions $\mathbf{d}_j(a, \pi, \mathbf{s})$ such that:[17]

1. given prices and the government policies, the policy functions solve the problem described in Equation (3) and $V_j(a, \pi, \mathrm{s})$ is the associated value function;

2. formal care market clears with $Q^{n,S} = Q^{n,D}$;

3. government budget is balanced every period;

4. the distribution of households is stationary.

### 3.9 Role of social security entitlement age

In this model, the social security program insures households against stochastic shocks such as productivity shocks, fertility shocks and uncertain length of lives. Why would changing social security entitlement age affect women's employment and human capital accumulation? In this subsection, I summarize the channels through which the policy works and provide qualitative prediction on the policy effects. To set the idea, I consider a specific form of implementation that removes social security benefits completely for women between age 50 and 60 and reimburses the extra government revenue to households via proportional wage tax cuts.

**Wealth effect** Removing benefits for 10 years in general will reduce the present discounted value of social security incomes. Women between age 50 and 60 will work longer due to the reduction in insurance. In anticipation of collecting wage earnings for longer year, they may want to work high-skilled occupations and accumulate more human capital.

**Intergenerational time transfer effect** When women with grandchildren return to work, they will reduce the amount of child care transfer to children's mothers. Younger women will act strategically

[17]Detailed equilibrium definition is given in Appendix B.

in response to the reduction in grandparental child care support by either taking care of children by themselves or purchasing child care service from the market. Apparently, this effect will depend on the price of child care relative to young women's wage since this determines how easily young women can make the substitution between grandparental care and market formal care. Additionally, this channel may have dynamic effects due to its interaction with human capital accumulation process. If human capital accumulation is significantly faster at early career, non-employment in early career may lead to persistent losses in human capital and earnings in later life.

**Substitution effect** Government runs a social security surplus under the same tax rate when women have a longer average working year. When government reimburses revenue via a proportional tax cut, women are encouraged to supply more labor and accumulate more human capital.

As can be seen from the above analysis, although the policy change only targets women between 50 and 60, it may have an impact on women at younger ages as well through the channels of dynamic human capital accumulation and intergenerational time transfer. Meanwhile, these channels affect the incentive to supply labor and accumulate human capital in opposite directions, making the overall effect ambiguous. The quantitative importance of each incentive can only be justified with the numerical experiments.

# 4 Calibration

In this section, I describe the procedure how I parameterize the model. I take some parameters externally and estimate the others using the method of simulated moments(MSM). The MSM allows me to combine information on employment, wages, and time use from different data sources. I solve the model by backward induction of value functions and simulate the economy with 50,000 household dynasties until convergence of distributions as an approximation of the model steady state. The simulated data provides a panel data set to construct moments that can be matched to moments constructed from data.[18] After calibrating the model, I check the performance of the model by comparing the non-targeted moments with the data.

## 4.1 Functional specification

Following Fuster, İmrohoroğlu, and İmrohoroğlu (2007), I assume that household's period utility $u$ is separable in utility of young and old generations $\tilde{u}$. To be more specific, for each generation, period utility is derived from pooled consumption and each member's private leisure and child care hours:

$$u(\mathbf{c}, \mathbf{l}, \mathbf{q}; m^o) = \tilde{u}(c^y, l^{yf}, l^{ym}, q^{yf}, q^{ym}) + m^o \tilde{u}(c^o, l^{of}, l^{om}, q^{of}, q^{om}) \tag{4}$$

The instantaneous utility function $\tilde{u}$ is defined for a generation with two genders $m$ and $f$:

$$\tilde{u}(c, l^f, l^y, q^f, q^m) = \frac{(c^{1-\nu}(H^f)^{\frac{\nu}{2}}(H^m)^{\frac{\nu}{2}})^{1-\gamma}}{1-\gamma}$$

where $c$ is the pooled consumption of this generation, $H$ is a linear transformation which aggregates leisure and child care of an individual. I assume that individuals in the same generation have the same utility weight on child care, but individuals in different generations weight child care differently. To be more specific, young male (ym) and young female (yf) have utility weight $\omega^y$ and old male (om) and old female (of) have utility weight $\omega^o$, i.e.

$$H^i = \begin{cases} l^i + \omega^y q^i & \text{if } i \in \{\text{ym}, \text{yf}\} \\ l^i + \omega^o q^i & \text{if } i \in \{\text{om}, \text{of}\}. \end{cases}$$

Child care time $q$ not only directly affects utility but also enters as an input to relax the child care time constraint. I also assume $\omega < 1$ to guarantee there is a solution.[19] A higher utility weight for the

[18] See Appendix B for a description about the numerical solution of the model.
[19] See Appendix B for algebra.

young generation would imply more child care hours and less working time for young women relative to old women. Varying the preference parameters $\omega^y$ and $\omega^o$ allows me to match the child care hours allocation.

With this setup, young male and young female have the same preference over child care hours. However, young males have higher wages and inelastically supply labor, while young females have lower wages and can choose non-employment. These modeling assumptions attributes to the gender difference in childcare hours.

## 4.2 External parameters

In this section, I present my parameterization of the preference, government policies, hours allocation, child care processes and other external parameters. I restrict my analysis to the urban population to build a more clear mapping between the model and data.[20] Table 3 summarizes the external parameters.

**Environment and preference** A model period is equivalent to two years. An individual starts life at age 22 and live through the young and the old generations, each lasting for 24 years. I set the discount factor $\beta = 0.90$ and a fixed interest rate $r = 8\%$ on a two-year basis. I take a standard value of 2.0 for the coefficient of risk aversion $\gamma$. I take the fertility rates and mortality rates directly from the 2000 China National Population Census.[21]

**Government policy** In the benchmark economy, I set the wage income tax to be $28\%$ and the exogenous public expenditure to be $5.38$, which is the value that balances the government budget at the steady state when other moments are matched. I set the women's social security eligibility age to 50 and men's social security eligibility age to 60. The average replace ratio of social security for the urban

[20]The rural population mostly work in agriculture sector, whose labor supply displays a significantly different pattern from those who work in other sectors. In addition, the rural population receive much lower amount of social security income.

[21]For the fertility rate, I adjust the values in the beginning and the ending period of the potential fertile periods to simplify the computation. More details on the demographic process can be found in Appendix A.

Table 3: External parameters

| | Parameter | Description | Value |
|---|---|---|---|
| **Environment** | $A$ | Age turning adulthood | 22 |
| | $n$ | Model periods | 2 |
| | $T$ | Periods of young/old generation | 12 |
| | $r$ | Interest rate | 0.08 |
| | $g$ | Population growth | 0 |
| **Government** | $\tau$ | Social security tax rate | 0.28 |
| | $R_1$ | Social security eligibility age of women: 50 | 2 |
| | $R_2$ | Social security eligibility age of men: 60 | 7 |
| | $\tau^b$ | Social security replacement ratio | 0.75 |
| | $G$ | Exogenous public expenditure | 5.38 |
| **Demographics** | $\{\delta_j^o\}_{j=1,\ldots,12}$ | Mortality rate of grandparents | See Appendix |
| | $\{\delta_j^c\}_{j=1,\ldots,8}$ | Fertility rate | See Appendix |
| **Preference** | $\beta$ | Discount factor | 0.90 |
| | $\gamma$ | Risk aversion | 1.5 |
| **Wage process** | $\alpha_0^m$ | Intercept: men (normalization) | 0 |
| | $\alpha_1^m$ | Age linear: men | 0.054 |
| | $\alpha_2^m$ | Age quadratic: men | – 2.5e-3 |
| | $\rho_\zeta$ | Persistence of income shock: women | 0.77 |
| | $\sigma$ | Std. dev. of income shock: women | 0.35 |
| **Time allocation** | $\{\kappa_\pi\}_{\pi=2,3,4}$ | Child care hours: daily 10 hours | 0.42 |
| | $q^{\text{school}}$ | School hours: daily 8 hours | 0.33 |
| | $\underline{q_n}$ | Minimum child care provision: daily 2 hours | 0.09 |
| | $\bar{n}$ | Working hours: daily 8 hours | 0.33 |

population before 2002 is around 75%, I thus set social security benefit to be 75% of personal average lifetime earnings until entitlement age. Social security is paid until the death of the individual.[22] Lee, Zhao, and Zou (2019) and He, Ning, and Zhu (2019) consider a more general social security rule that is partial indexed to economic growth.

[22]Technically speaking, this only applies to the social account, while the remaining individual account will be reimbursed to the children or spouse of the individual when the old dies before the individual account runs out.

**Children and child care** Instead of keeping track of children age directly, I group households by children's age as in Table 4. The state of age group to evolve following a transition matrix induced by the fertility and aging process of children.

Table 4: Child care requirement by children age groups

| $\pi$ | Age group | $\kappa_\pi$ in daily hours |
|---|---|---|
| 1 | never give birth | 0 |
| 2 | child age $\in [0, 2]$ | 10 |
| 3 | child age $\in [3, 6]$ | 10 |
| 4 | child age $\in [7, 16]$ | 2 |
| 5 | child age $> 16$ | 0 |

Children need child care for 10 hours per day. For children under age 6, the household can only purchase formal child care hours at unit price $p_n$. Children over 6 attend public schooling for $8$ hours per day. I also impose a 30 minutes of minimum child care hours per day. The price of formal child care is important in determining how much households change labor supply and child care hours in response to the social security policy and will be calibrated internally. When formal care price is low enough that the reduced grandparental hours can be largely absorbed by an increase in purchase of formal care, mothers will be able to continue working and the aggregate. In the benchmark, I set $\xi_1 = \infty$. In this case, child care price is insensitive to the market demand.

**Working hours** In the benchmark, I assume that working hours are the same for both men and women and for all ages, except for women in the period of child birth to allow for maternal leave policy. I assume that each individual spends 8 hours per day on sleeping and has at most 16 hours of total disposable time for working, leisure and child care. I thus set the working hours to be $\frac{1}{3}$, which corresponds to 8 hours per day of working on full-time jobs.

**Wage income processes** I directly estimate estimate men's wage process from the data. I use a second-order age polynomial approximation for the population between age 24 and 60 in the UHS. I assume that income shocks is 0 for men at all ages.

Women's income shock $\zeta$ follows an AR(1) process:

$$\zeta_j = \rho_\zeta \zeta_{j-1} + \epsilon_j, \epsilon_j \sim \mathcal{N}(0, \sigma^2).$$

In Appendix A, I present estimation results of income shock processes by gender, and by occupation for women by matching the variance and up to 2 lags of auto-variance of the residuals of wage regressions.[23] The results show that the variance of transitory shocks is slightly larger for high-skilled women, while the persistence and the variance of the permanent shocks are very similar across low- and high-skilled women. In the benchmark, I set the income shock processes to be the same for women in both skill types. Without a good prior on the correlation between income shocks, I assume that income shocks for individuals in the same household (mother and grandmother) are independent.

Women's human capital accumulation parameters $\{\rho_{k,0}, \rho_{k,1}, \rho_{k,2}\}_{k=1,2}$ and occupational wage premia $\{\alpha_k\}_{k=1,2}$ will be calibrated internally using wage growth moments by age-occupation-employment status groups, as will be clear in the next section.

**Occupational choice probability** I assume that the unobserved shocks to occupational choice are independently and identically distributed across individuals and occupations and follow the type I extreme value distribution with mean zero and variance $\sigma_e^2$. This assumption allows me to obtain a simple formula of the choice probability which can be written as:

$$\mathbb{P}(k^{\text{yf}} = v) = \frac{\exp(\text{EV}_v/\sigma_e)}{\sum_{k=1,\ldots,K} \exp(\text{EV}_k/\sigma_e)},$$

[23]The estimated shock processes are consistent with Yu and Zhu (2013) and He, Ning, and Zhu (2019), who document the labor income and household income processes with moments constructed from various waves of China Health and Nutrition Survey (CHNS).

where $\mathrm{EV}_v$ is the expected value function of choosing occupation $v$, after adjusting for the training costs but before the realization of unobserved labor market shocks in period 1, i.e.

$$\mathrm{EV}_v(\mathbf{x}, \pi, a) = \mathbb{E}V_1(\mathbf{x}, \pi, a - \psi_v | k^{\mathrm{yf}} = v).$$

## 4.3 Internally calibrated parameters

Table 5 presents three main blocks of parameters that are calibrated internally. As is common in structural models, these moments are jointly determined by the whole set of parameters, but each moment may convey relatively more relevant information on one of the parameters.

Table 5: Internally calibrated parameters

| Parameter | Description | Value |
|---|---|---|
| | Preference & child care price | |
| $\nu$ | Intensity of leisure | 0.42 |
| $\omega^y$ | Utility weight on child care: young | – 0.10 |
| $\omega^o$ | Utility weight on child care: old | – 0.30 |
| $p^n$ | Child care unit price | 4.0 |
| | Occupational choice | |
| $\psi_2$ | Training cost of high-skilled occupation | 1.50 |
| $\sigma_e$ | Std. dev. of occupational choice shock | 0.10 |
| | Wages and human capital evolution | |
| $\rho_{1,1}$ | High-skilled: intrinsic learning speed | 0.055 |
| $\rho_{1,2}$ | High-skilled: age-slope of learning | – 4e-3 |
| $\rho_{1,0}$ | High-skilled: depreciation in non-employment | – 0.10 |
| $\rho_{2,1}$ | Low-skilled: intrinsic learning speed | 0.025 |
| $\rho_{2,2}$ | Low-skilled: age-slope of learning | – 2e-3 |
| $\rho_{2,0}$ | Low-skilled: depreciation in non-employment | – 0.04 |
| $\alpha_1$ | High-skilled: wage premium | – 0.42 |
| $\alpha_2$ | Low-skilled: wage premium | – 0.50 |

The first block includes parameters about preference and child care price, which are set to match moments about time allocation of employment and child care. $\nu$ controls the relative utility weight on leisure to consumption, thus is chosen to match the aggregate female employment rate of $77\%$ between age 24 and 50. $\omega^y$ and $\omega_2$ control the taste for child care of the old and young generations, and child care price $p_n$ affects the incentive to use market formal care. A larger $\omega^y$ would imply more child care hours of mothers when $\omega^o$ and $p_n$ are controlled the same. I thus choose $\omega^y$ and $\omega^o$ to match the mean child care time of 18 weekly hours from the young women and 12 weekly hours from the old women conditional on the provision. I set $p_n$ to be the mean wage of women employed in low-skilled occupation in steady state when other moments are matched.

The second and the third block of parameters are related to occupational choice and human capital evolution processes. The role of training cost of high-skilled occupation and the variance of the unobserved labor market shock and their identification is described in Appendix B. I set the training cost of the low-skilled occupation to 0 and choose the training cost of the high-skilled occupation to match the aggregate employment share of high-skilled occupation. The estimated training cost $\kappa_2 = 1.50$ which is equivalent to around 5 years of women's average income at age 24. The variance of the unobserved shock is estimated to match the data pattern that women with children at age 24 are $7.0\%$ more likely to choose low-skilled occupations than those who do not have children.

The parameters of human capital evolution are chosen to match the wage growth moments for young and old women and by employment history in Table 2. Without selection, the mean wage growth by age will be equal to the model-implied age-specific human capital growth rate for the continuously employed. The estimation shows at early career, high-skilled women accumulate human capital at $5.5\%$ annually and low-skilled women accumulate at $2.5\%$ annually. In both occupations, learning-through-employment dies out at around 24 years of career (age 48).[24] The (relative) wage loss of non-employment relative to the continuously-employed in the model is a combination of human

[24] Researchers find evidence of a declining learning speed by age in other countries as well. For example, using matched employer-employee data from Germany, Gregory (2019) find that the learning speed declines by $4\%$ yearly as workers age.

capital depreciation of non-employment and the lost human capital accumulation on-the-job, thus is used to identify the depreciation of human capital in periods of non-employment. I find that human capital depreciates at 4% annually in the low-skilled occupation and depreciates at a faster speed of 10% annually in the high-skilled occupations.[25] Since wages of men are set externally, I choose wage premium of low- and high-skilled occupations to match the gender wage premium and skill premium of the high-skilled women.

## 4.4 Model fit of employment

In the previous section, I show model fitness at the micro-level in term of young and old women's labor supply. In this section, I show that the model also matches the aggregate employment rate and the employment share of the high-skilled occupation.

**Employment rate by age** Figure 6 presents the model fit of female employment by age. The model does a good job in fitting the employment of both young and old women. To be more specific, the model generates a drop in the employment rate around the age of social security entitlement to a similar degree in the data, which shows that my model captures the labor supply incentives to value of non-employment – a combination of monetary value social security benefits relative to wages and value from taking care of children.

Intergenerational time transfer in the form of grandparental child care apparently affects the model fit of employment rate by age. Figure 7(a) compares the fit of employment rate under benchmark with two hypothetical cases without grandparental child care. The first case directly illustrates the quantitative importance of the size of grandparental child care. In this case, I fix all parameters to the benchmark but do not allow grandparents to provide childcare. As denoted by the black dashed line, employment rate of young women drops to a large degree, while the employment rate of old

[25] This is consistent with Blundell et al. (2016) who find that human capital depreciation rate is higher for women with a university degree than women with a high school degree in the UK, and Adda, Dustmann, and Stevens (2017) who find that depreciation rate is higher for women in abstract occupations than women in routine or manual occupations in Germany.

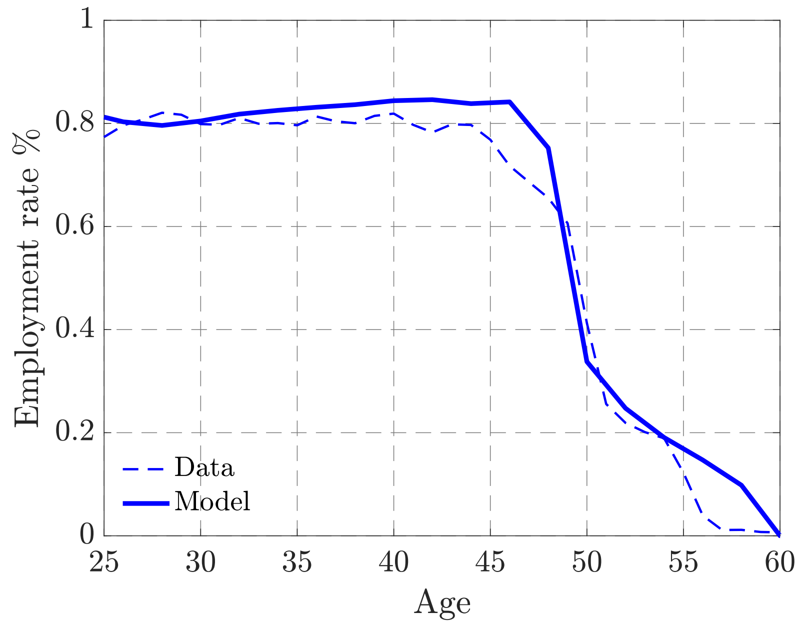


Figure 6: Model fit: female employment over the lifecycle

women increases. This reflects that grandparental child care is more substitutable with mothers' own hours given the benchmark market formal child care price $p^n$. To see the importance of distinguishing grandparental child care from other sources of non-parental care, I consider the second case where I further reduce $p^n$ to match child care hours of young women. $p^n$ can thus be interpreted as the average unit price of all non-parental child care including paid market formal care and free grandparental care. An interesting U-shaped pattern of employment rate of young women emerges. This is because, given the model age difference of 24 between the young and the old generation, the youngest women use low grandparental child care hours as their corresponding old are not retired yet while women at older ages rely more on grandparental child care. The second case shows the quantitative importance of portfolio choice of non-parental child care (market vs. grandparental) by young women's age.

Another less obvious element that enables me to match employment rate is the dynamic human capital accumulation. In the benchmark, human capital growth is faster at younger ages, which implies a higher opportunity cost of non-employment for younger women. To illustrate the role of age-dependent human capital accumulation, I consider an alternative model in which human capital growth rate is con-

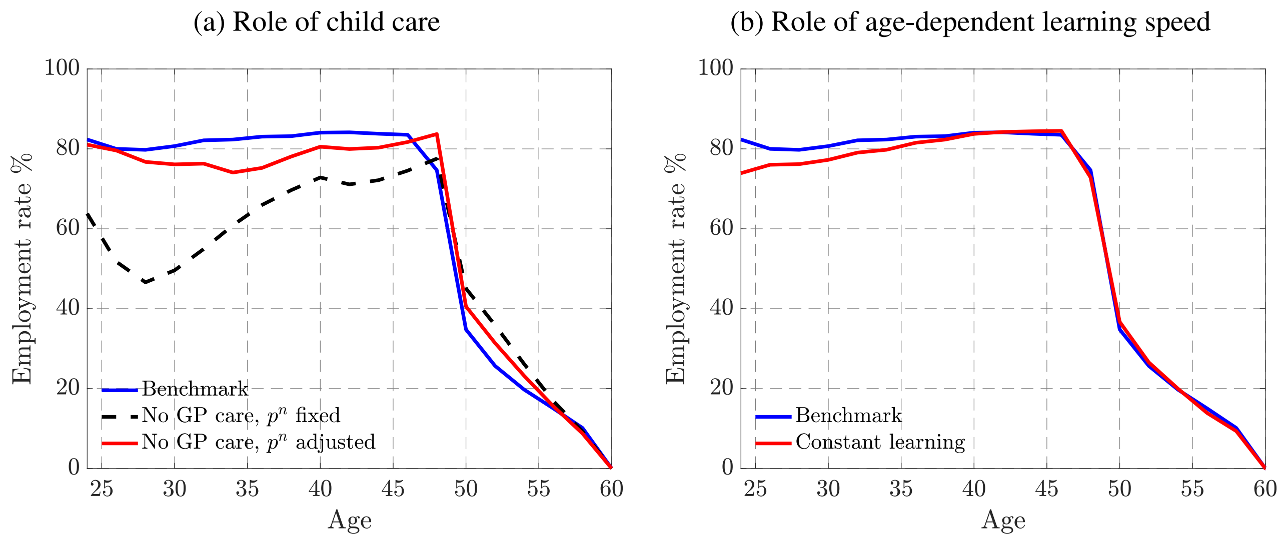


Figure 7: Role of model elements to match employment rate over the life cycle

stant over the life cycle. The alternative model without age-dependence of human capital accumulation imposes a lower opportunity cost of non-employment at younger ages, thus predicts a lower employment up to 10% at early career and thus an increasing age profile of employment rate before age 50, as shown in Figure 7(b).

**Model fit by occupation** Figure 8(a) presents the model fit of the fraction of high-skilled women in employment over the life cycle and Figure 8(b) presents the model fit of mean wages by age.

In the data, the employment share of high-skilled women increases at the beginning of career and drops gradually between age 30 and 50. After age 50, employment share of high-skilled women increases again. My model generates a similar pattern. In the model, the low-skilled are less attached to the labor market thus will drop out the labor force when they have children, which explain the increase in employment share of the high-skilled before age 30. When children grow up, the low-skilled women return to work, bringing down employment share of the high-skilled. Upon age 50, women are eligible to retire. However, high-skilled women face a larger income cut to retirement with higher wages on the job, thus will retire at a slower speed than their low-skilled cohort.

In the Appendix B, I further present model fits of child care time allocation by young and old women

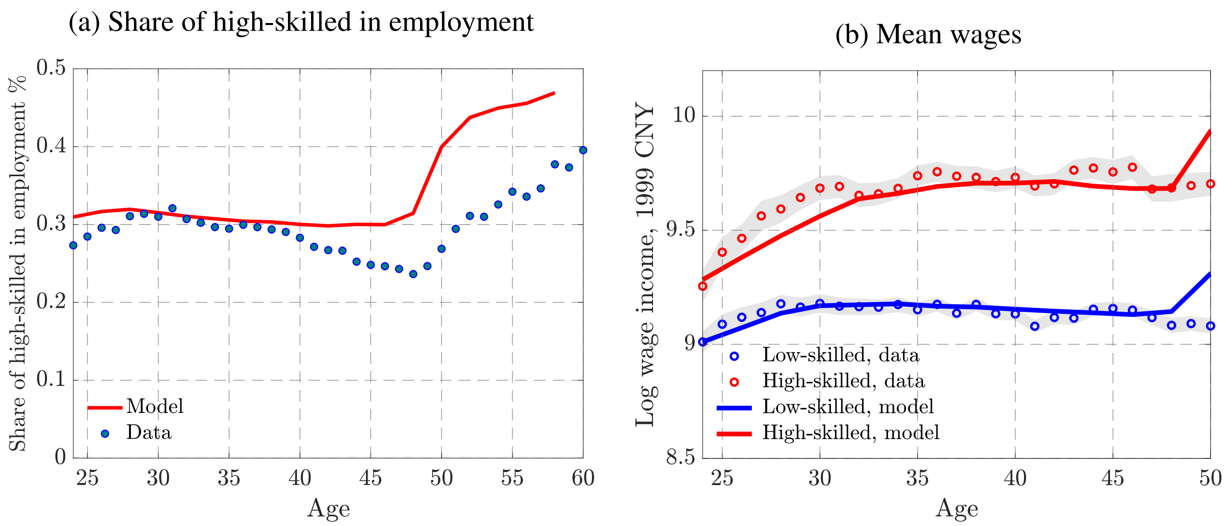


Figure 8: Model fit: occupational employment and wages

to show that my model correctly captures the costs of child care in female labor supply decisions.

## 4.5 Model validation

In this section, I validate my model as to the fitness of empirical evidence of labor supply and child care. I first present the model fitness of an empirical estimate about the marginal effect of the presence of old household members on young women's labor supply. I next show that my model reproduces the results from a literature of using the social security eligibility age policy as regression discontinuity experiment to estimate the impact of retirement on child care provision. These exercises validate my model at the micro-level decision-making and also informs the magnitudes of policy impacts.

**Marginal effects of grandparents on young women's labor supply** Labor supply elasticities are informative about the goodness of fit in terms of child care incentives in determining mothers' and grandmothers' labor supply. Equation (5) presents a Probit regression model to estimate the marginal effect of determinants of female labor supply:

$$\text{emp}_i^{\text{m}} = \mathbb{1}[\beta_0 + \beta_1 \text{GP}_i + \beta' \boldsymbol{X}_i + \epsilon_i > 0] \quad (5)$$

and I apply the above specification to the model-generated data for women between ages 24 and 40. In Equation (5), $\text{emp}^{\text{m}}$ is the binary indicator of young women's employment status, GP refers to the presence of old, and $\boldsymbol{X}$ includes control variables of the linear and quadratic of experience, and women's occupation. The care of interest involves the coefficient of variable GP, which measures how much the probability of employment changes for young women when the women's parents or parent-in-laws are alive compared to those who have the same states except for losing parents or parent-in-laws. In the structural model, this coefficient summarizes the effects from intergenerational time transfer and added income.

Table 6: Marginal effects of presence of the old generation

| | Model | Data |
|---|---|---|
| Women with children aged [0,6] | 0.244 | 0.261 |
| All women with children | 0.074 | – |
| All women | 0.038 | 0.066 |

In Table 6, I report the marginal effects for women by presence of children estimated from the model-generated data to those using data from various empirical literature. Li (2017) estimates that the marginal effect of variable $GP$ in determining employment of young women to be 0.261 for women with children younger than 6, the model generates a coefficient of 0.241. Maurer-Fazio et al. (2011) estimates the marginal effect with samples of all women (including those with older children, or without children) to be 0.066 with samples from the 1 percent Micro Samples of the Population Censuses of China. Hare (2016) obtains a similar estimates of 0.061 using samples from 1991 – 2011 Waves of China Health and Nutrition Survey (CHNS). However, my model falls short of this estimate and generates 0.038. Table 6 shows that the model achieves relatively good job in matching the marginal effects, especially for women with young children. A naive extrapolation of this marginal effect would predict that under the new policy change, when the old women return to work, the employment rate change of women(mothers) would decrease by this change in the old women's employment times the corresponding marginal effects.

# 5 Experiments

In this section, I consider a policy counterfactual that raises women's social security eligibility age from 50 to 60. Non-employed women between 50 and 60 are no longer eligible for social security incomes. In the policy counterfactual, I assume that the government pays social securities with the same benefit accrual formula, and human capital evolves according to the same functional specifications. Additionally, exogenous shocks, such as the birth/death shocks of household members and incomes shocks to individuals, are assumed to follow the same stochastic processes. As the social security revenues will change under the new policy, I consider allow the government to reimburse the revenues to households in proportional tax cuts, with a new tax rate $\tau^{CF}$ such that

$$\tau^{CF}\sum_i w(x,\mathcal{T}^{CF})^i \mathbb{1}_{\{n(x,\mathcal{T}^{CF})^i=\bar{n}\}} - \sum_i b(z^i)\mathbb{1}_{\{r^i=1\}} - G = 0$$

## 5.1 Impact on female careers

Figure 9 presents the main results by occupation. Figure 9(a) plots the deviation of employment rates from the baseline. The employment rate of high-skilled women barely changes until age 45, after which, the employment rate rises since under the policy reform, old women can no longer receive social securities between age 50 and 60. Low- and high-skilled women behave differently in important ways. First, the employment rate of young low-skilled women drops by 13 $\%$ on average before age 45, a larger scale than the high-skilled women. This gap is more significant for women at early career. Low-skilled women make lower wages and accumulate human capital at a slower speed, thus having lower opportunity cost of non-employment. Low-skilled women has a larger labor supply elasticity and drop out of labor force at a higher probability when they receive less child care support from the old generation. Second, the policy brings a more persistent drop in the employment rate of low-skilled women between ages 35 and 45, up to around 7$\%$. This is due to the fact that human capital growth is faster at early career, thus the reduction in early career employment implies large losses of human capital. The alternative model with constant learning speed would predict a recovery of employment rates after age 35, which again justify my modeling choice of age-dependent human capital accumulation. Lastly, low-skilled women also have a lower increase in the employment rate for ages above 50. The old low-skilled women have lower wages and are more likely to stay non-employed to take care of grandchildren.

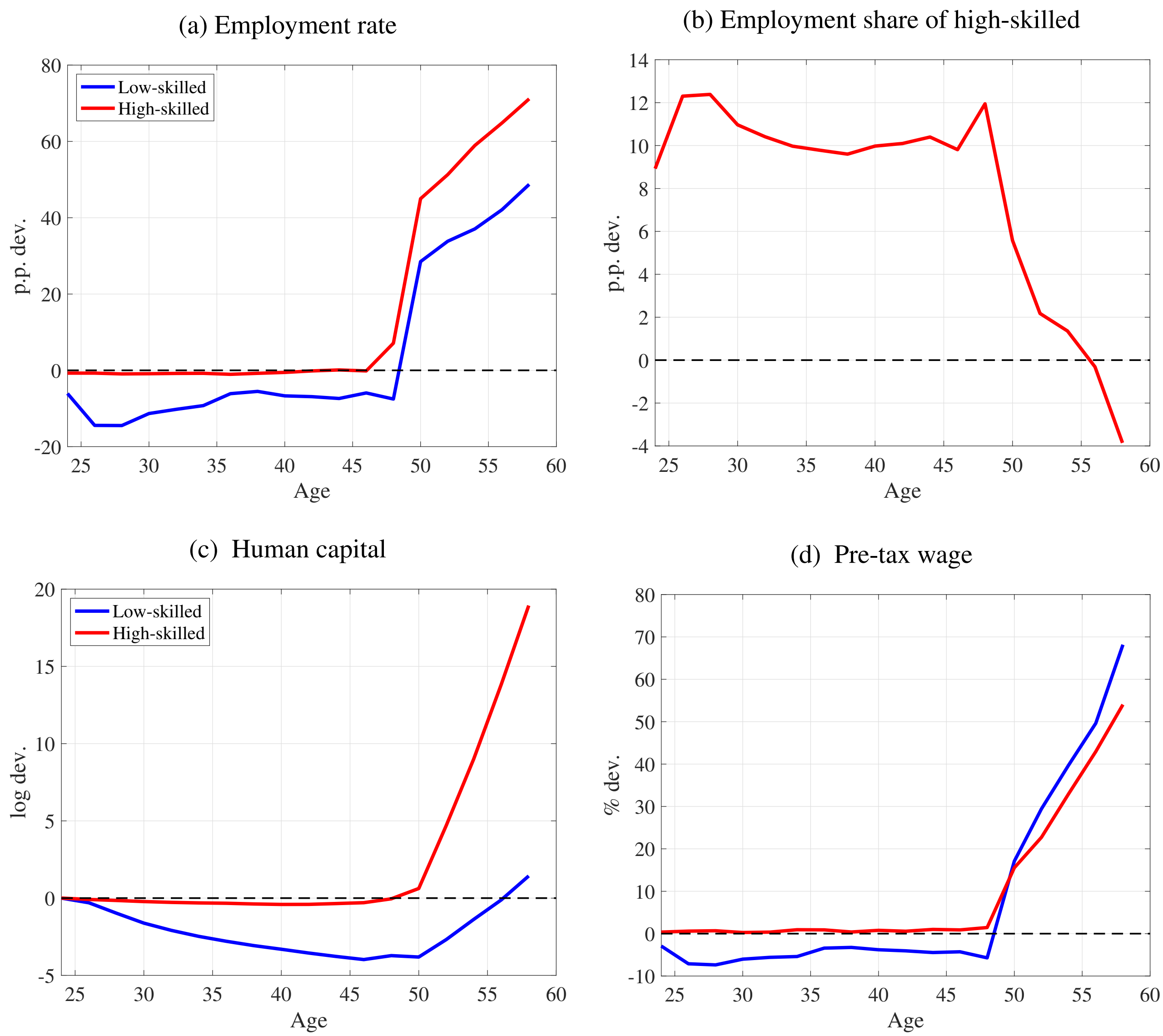


Figure 9: Policy impact by occupation

The change in share of high-skilled women as a fraction of employment is also reflected in the change of share of high-skilled women in employment, as shown in Figure 9(b). The share of high-skilled labor increases at the beginning since women choosing the low-skilled occupation are less attached. As the low-skilled return to work when children grow up, the employment share of high-skilled drops as a fraction of employment. For age above 50, the employment rate of high-skilled increases more in absolute values as shown in the left top panel, it however drops as a fraction of employment.

Figure 9(c) plots log deviation of human capital from the baseline. As can be seen from the figure, since the employment rate of high-skilled women does not change, their human capital does not change either. The employment rate of low-skilled drops at all ages before age 45, thus human capital loss accumulates in this age range. After age 50, the employment rates for both low- and high-skilled women increase, thus both have higher average human capital relative to that in the baseline. In particular, due to human capital losses at younger ages, low-skilled women's human capital catches up only after age 56.

Figure 9(d) plots the log deviation of wage earnings, i.e. the product of employment rate and the mean wage conditional on employment. To make it comparable between the baseline and the counterfactual, I use the pre-tax wages. Without the selection of employment, the drop in wage earnings will be the combination of the drop in employment rate and the drop in human capital. As a result, the change in wage earnings for the high-skilled is close to 0 at all ages, while the low-skilled have a larger loss of wage earnings, and the loss is higher up to 15% at the beginning of career and continues at around 12% till age 45. After age 50, due to the increase in employment rate, the wage earnings also exceed that in the baseline, and the low-skilled have a slightly larger increase.

Figure 10 presents the impact on aggregate employment. The aggregate employment rate drops by 9% before age 30 and by around 5% between 35 and 45. The employment rate between ages 50 and 60 rises to around 65%. Note that this response is larger than the estimates of policy impact of delaying social security entitlement in many other countries. The reasons are as follows. First, I look at a relatively younger group of population between ages 50 and 60. I abstract away from health shocks that will typically be an issue for older population. Second, in developed countries, there are other

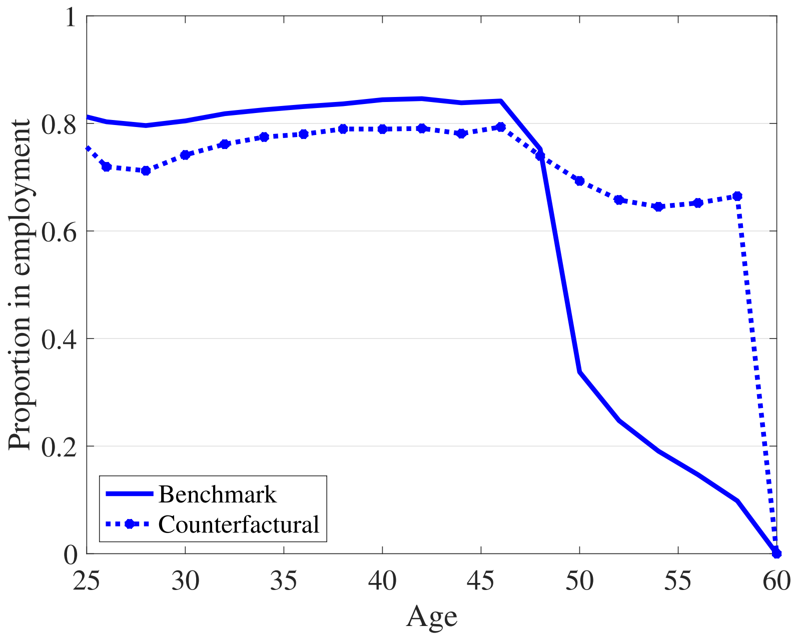


Figure 10: Policy impact on aggregate employment rate by age

types of social insurance programs that the old can claim in response to the reduction in social security benefits. For example, people can apply for disability insurance as substitute for social security.[26] In China, people mainly rely on social security for insurance.[27]

In the Appendix B, I further present the impact on human capital and wages. As shown in Figure 9(c), human capital of low-skilled women decreases relative to that in the benchmark while human capital of high-skilled women remain the same. However, the share of high-skilled women increases, making the aggregate human capital close to that in the benchmark. In a model without occupational choice, women do not have the option to choose high-skilled occupation to insure themselves against the reduction in social security incomes, and the effect of reduction in employment dominates, which leads losses of aggregate human capital to a larger degree.

[26]See, for example, Li (2018) for the United States and Díaz-Giménez and Díaz-Saavedra (2009) for Spain.

[27]Note also that in the model women transit from the young to the old generation at age of 48 and there is a sharp increase of grandchildren once becoming the old. This leads to an additional drop of employment. In reality, the process of having grandchildren will be more smoothed and the employment effects may take longer to happen.

**Role of age-dependent human capital growth** Figure 11 further presents the policy effect on employment and wage incomes.The constant learning model predicts a higher drop of employment rate by age 35 and the employment rate recovers after age 35. The deviation of pre-tax wage income behaves similarly.

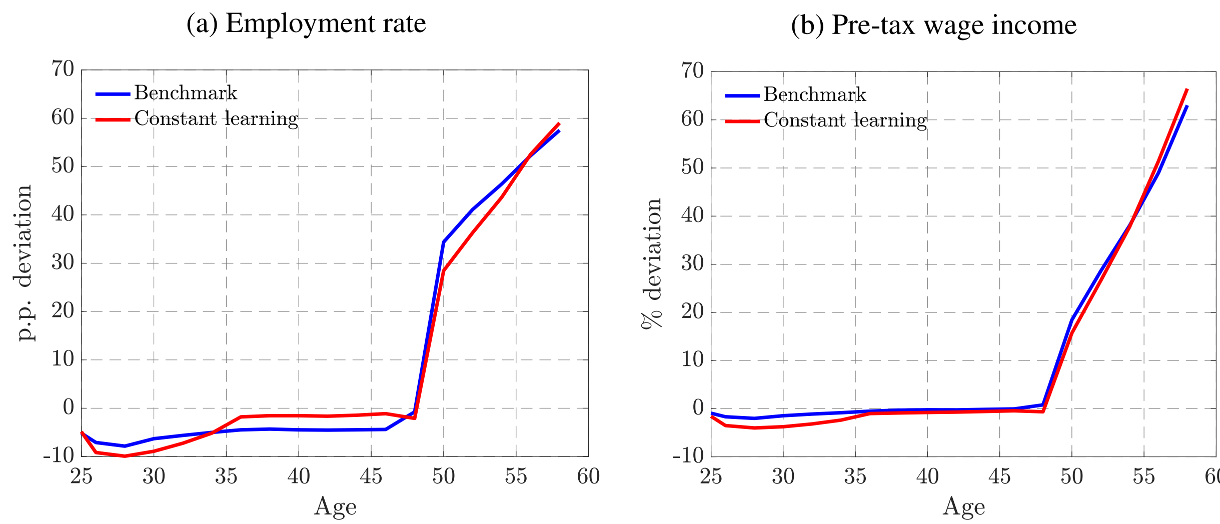


Figure 11: Policy effects under alternative assumptions of learning

These patterns are robust when we fix the occupational choice and/or household distribution to the associated benchmark cases.The results clearly show that the constant learning model fails to capture the labor supply at different ages.

**Lifetime impacts** Table 7 summarizes the overall impact on employment and earnings over the life cycle and by age 40. The net PDV of sequence of earning flows of type $w_t$ for a individual $i$ from period $S$ to $T$ is defined as:

$$PDV^i = \sum_{t=S}^{T} \beta^{t-S} w_t^i \mathbb{1}_{\{n_t^i = \bar{n}\}}$$

I compute the PDV for pre- and after-tax wage earnings and labor earnings, which is the summation of wage earnings and social security benefits.

Table 7: Summary of overall impacts on women

| | | Lifetime | By age 40 |
|---|---|---|---|
| Total working years (yrs) | | +3.1 | -1.0 |
| Emp. share of high-skilled (p.p.) | | +7.9% | +10.4% |
| PDV of | pre-tax wage earnings (log) | +2.5% | -2.6% |
| | after-tax wage earnings (log) | +5.4% | +3.9% |
| | labor earnings (log) | +2.2% | +3.9% |
| Household savings rate (p.p.) | | + 7.1% | |

Although it is a policy that increase the entitlement age by 10 years, women's average total working years only increase by 3.1 years, this is due to the reduction in employment rate of young women. Pre-tax increases to a smaller level, implying that the reduction in human capital may play a role besides the movements in employment rate. In fact, the pre-tax wage earnings Labor earnings refer to the summation of wage earnings and social security earnings, which increases by a smaller scale than the wage earnings since in the baseline, women tend to receive social securities for more year.

# 6 Robustness

## 6.1 Population aging

In this section, I present the policy impact in an economy with population aging. I consider a case in which the death hazard is half of that in the benchmark at all ages. This increases the life expectancy by around 2.5 years, which reaches the life expectancy of the population in the United States in 2020. Population aging affects the economy in two main ways. First, the share of households with old increase, which affects the monetary and time transfers across generations. Second, the old are expected to collect social securities for longer time, having an impact on the government budget.

Table 8 summarizes the impacts. Employment drop for younger women slightly decreases since

Table 8: Policy effects in the economy of population aging

| | | Lifetime | By age 40 |
|---|---|---|---|
| Total working years (yrs) | | +3.2 | -1.0 |
| Emp. share of high-skilled (p.p.) | | +9.2% | +12.5% |
| PDV of | pre-tax wage earnings (log) | +2.8% | -0.8% |
| | after-tax wage earnings (log) | +4.6% | +1.0% |
| | labor earnings (log) | +1.4% | +1.0% |
| Household savings rate (p.p.) | | + 5.5% | |
| Household welfare | | -0.04% | |

more households can use grandparental child care. Combined with the fact that more women are incentivized to choose high-skilled occupations, the average lifetime working years increase more than that in the case without population aging. Households have to finance retirement for longer years, which should lead to more savings. Interestingly, since more women are employed in high-skilled occupations, households don't increase savings as much as in the case without population aging. The overall welfare impact is still slightly negative.

## 6.2 Alternative social security entitlement ages

In practice, the policy change may be conducted in a gradual increase in the entitlement, which potentially takes several years to happen. In Figure 12, I plot the impact on employment, incomes and welfare by raising the entitlement age to every two years. Again the policy impacts on employment and incomes are evaluated at the steady state and the welfare change is evaluated with the stationary distribution under the benchmark economy.

Several interesting points rise in the comparisons. Despite the overall pattern of increase in total working years and decrease in working years up till age 40. The drop in employment for young women slows down after the entitlement age is raised to 56. Three measures of PDV of earnings grow

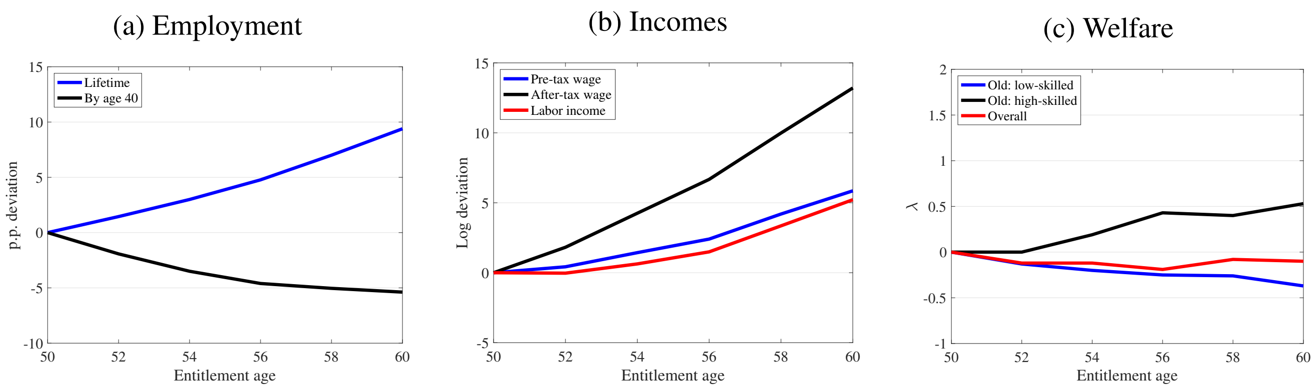


Figure 12: Policy effect by alternative social security ages

faster when entitlement age is raised to smaller years and more slowly when raised to longer years. The overall welfare change is smaller, less than 0.2% for all cases. However, as I highlighted in the previous section, this small overall change masks large heterogeneity that household with high-skilled old women gains and households with low-skilled old women loses. And the welfare change for each subgroup moves monotonically to the years of delaying entitlement.

## 6.3 Formal child care supply

In this subsection, I relax the assumption in the main text to allow the supply elasticity of child care to be at different levels. Recall that in the speciation of formal care supply function as equation (2), $\xi_1 > 0$ refers to the case where child care supply is elastic with supply elasticity to formal care price given by $\frac{1}{\xi_1}$. When $\xi_1 = 0$, the economy features perfectly elastic formal care supply.

Table 9 summarizes the policy effects by varying the level of formal child care supply elasticity. In the benchmark, I assume that the formal child care supply is perfectly elastic. Blau (1993) reports that the supply elasticity of formal care is between 1.2 and 1.9 in the United States. I experiment 0.5 and 0.1, low levels of supply elasticity, along with Blau's estimate of 1.2.

The main conclusion is that the policy effects change monotonically with the assumption of supply elasticity. The results are robust in a wide range of elastic environments. The results is more different when the formal care supply is extremely inelastic. When formal care supply is less elastic, formal child

Table 9: Sensitivity to formal care supply elasticity

| Supply elasticity $\frac{1}{\xi_1}$ | | $\infty$ Benchmark | 1.2 | 0.5 | 0.1 |
|---|---|---|---|---|---|
| Child care price (log) | | 0 | +1.8% | +3.8% | +11.3% |
| Frac. using grandparental care (p.p.) | | -15.5% | -15.0% | -14.4% | -12.9% |
| Frac. using market formal care (p.p.) | | +6.8% | +6.0% | +5.2% | +3.3% |
| Choice prob. of high-skilled (p.p.) | | +7.5% | +6.7% | +6.0% | +3.1% |
| Total working years | Lifetime (yrs.) | +3.1 | +3.0 | +2.8 | +2.4 |
| | By age 40 (yrs) | -1.0 | -1.0 | -1.1 | -1.3 |
| Lifetime PDV of earnings | pre-tax wage (log) | +2.5% | +2.2% | +1.6% | +0.8% |
| | after-tax wage (log) | +5.4% | +5.1% | +4.8% | +3.7% |
| | labor (log) | +2.2% | +1.9% | +1.9% | +0.5% |
| Household savings rate, (p.p.) | | +7.1% | +6.8% | +6.7% | +5.7% |

care price increases more. Under the new policy, less households will use grandparental child care and more households will use market formal care. When formal child care price increases more, choosing formal care is less profitable, households will alternatively use parental or grandparental care. Women below age 40 have a larger reduction in employment and the overall increase in lifetime employment is smaller. Reduction of employment will bring about less gains of earnings. Lastly, when child care price is higher, household savings rate also decreases.

# 7 Concluding remarks

In this paper, I develop a dynamic OLG model to quantitatively investigate the impact of a potential policy reform in China to delay women's social security entitlement from age 50 to 60 on their employment, human capital, wages and welfare over the life cycle. Under the new policy, employment rate of women between age 50 and 60 increases to around 65%, while employment rate of women under 40 drops by around 6%. Reduction in early career employment leads to persistent loss of human capital and earnings. Intergenerational time transfer and age-dependent human capital accumulation are the key elements to drive the results.

There are several potential avenues for future research to enrich the understanding of the policy effects. Firstly, in this paper, time is perfectly substitutable across child care provider and ignores the policy impact on the quality of children. Besides large literature on documenting the impact of maternal care on children's cognitive development, Del Boca, Piazzalunga, and Pronzato (2018) further examine the impact of grandparental child care on children's cognitive skill development using UK data. Incorporating children skills will help us better understand the long-run effects of the policy change. However, Truskinovsky (2021) reports a small increase to more generous informal care subsidies by exploiting generosity of state-level subsidy policies, which suggests that grandmothers' care is potentially inframarginal to other sources of informal child care providers.

Secondly, throughout the paper, the collection of household members will only be thought as making economic decisions together, while I do not make any assumption on whether the household members are physically living together or not. Large literature has been documenting the relationship between the need of child care and intergenerational co-residence of parents and grandparents (see, for example, Compton and Pollak (2014) and Garcia-Moran and Kuehn (2017)).[28] Future work may also take the location choice into account.

Lastly, I consider the difference of grandparents only up to their gender differences. Using data from Italy, Bratti, Frattini, and Scervini (2018) documents that the labor supply of woman is more elastic to the child care availability of their mothers than of their mothers-in-law (and fathers and fathers-in-law). I do not take into account the gender of children into account either. By extending the model to allow for more types of household members and group-specific preferences to match group-related moments, I will be able to speak to these issues and obtain more accurate policy effects.

[28] Garcia-Moran and Kuehn (2017) develops a model with the endogenous jointly decision of intergenerational co-residence and labor supply of mothers.

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# Online Appendix for
# *Social Security and Female Labor Supply in China*

Han Gao

# A Data

## A.1 Labor market

I use the Urban Household Survey (UHS) of China to construct moments on labor market, including employment status, occupations, and wages. The UHS is a nationally representative survey of the urban economy of China, administered by the National Bureau of Statistics (NBS) of China. Compared with other commonly used datasets, the UHS has advantages of a large sample size, full coverage of all provinces, a special focus on the urban economy and detailed variables about employment, as discussed in Feng, Hu, and Moffitt (2017). The employment status variable in the data refers to the time of interview. I pool observations between year 2007 and 2009 as the sample for main investigation.

### A.1.1 Construction of employment rate

I construct labor market status of individuals from survey data on individual employment status from the UHS.[29]In Table A1, I present the population share under the original 15 UHS employment status codes for the population between age 20 and 75 in the UHS 2002-2009. I further assign workers into status of self-employment (S), employment (E), non-employment (N), retirement (R), and economically non-active population (P), using the original codes. To construct employment rate, I first drop observations of self-employment and economically non-active population and apply the following formula:

$$\text{employment rate} = \frac{E}{E+N+R}.$$

Non-employment rate and retirement rate are defined similarly.[30]

[29]The census yearbook categorizes labor market status to only four categories: employed workers, business owners, self-employed workers and family workers, which does not meet my need to investigate social security programs. See 2016 as an example http://www.mohrss.gov.cn/2016/indexch.htm

[30]Under the current social security policy, self-employed workers participate in social security programs on a voluntary basis. Self-employed workers also have different patterns of labor supply behavior from wage workers. I exclude self-employed workers all through the analysis.

Table A1: Employment share by occupation in the UHS %

| Code | Original Category | Status | Overall | Women |
|---|---|---|---|---|
| 1 | Staff and workers in state-owned economic units | E | 29.46 | 22.32 |
| 2 | Staff and workers in collectively-owned economic units | E | 2.95 | 2.86 |
| 3 | Staff and workers in other types of economic units, such as foreign-owned enterprises | E | 10.64 | 9.39 |
| 4 | Self-employed workers or enterprise owners | S | 5.47 | 4 .15 |
| 5 | Private firm workers | E | 10.37 | 9 .68 |
| 6 | Retired and reemployed | R | 2.01 | 2.65 |
| 7 | Other employees | E | 3.27 | 3.52 |
| 8 | Students at school | P | 1.88 | 2.53 |
| 9 | Houseworkers, responsible for housekeeping | N | 2.79 | 5.08 |
| 10 | Retired, not reemployed | R | 23.40 | 27.62 |
| 11 | People who are unable to work due to disabilities and illnesses | P | 0.27 | 0.20 |
| 12 | People waiting to be assigned a job | N | 0.74 | 0.71 |
| 13 | People without a job and actively looking for a job | N | 4.39 | 5.24 |
| 14 | People waiting to enter higher levels of schools | P | 0.03 | 0.03 |
| 15 | Other non-employed people | N | 2.35 | 4.01 |
| Obs. | | | 168,724 | 86126 |

Despite the large sample size, the UHS is subject to several limitations. First, the UHS has inadequate coverage of population without local residential registration (also known as *Hukou*), which may underestimate the employment, as argued by Feng, Hu, and Moffitt (2017). With the potential bias in mind, I restrict the observations to have local residential registration all through the paper. Second, the UHS does not provide a clear distinction between the (voluntary) non-employment and the unemployment. Individuals in the Current Population Survey (CPS) need to conduct specific searching activities in a four week reference period to be classified as unemployed. However, neither the qualification of searching activities nor the reference period is provided in UHS. In this paper, I do not distinguish between the reason of not working and refer to both voluntary and involuntary non-employment as non-employment.

**Employment status by gender** Figure A1 provides a summary of share of population by employment status for women and men between age 25 and 65. Women work between age 25 and 50 and gradually retire between age 50 and 50. There are around10-20% of women in the non-employment status. Men retire at a later age, around age 50. Men also have a smaller share of population in non-employment rate in all ages.

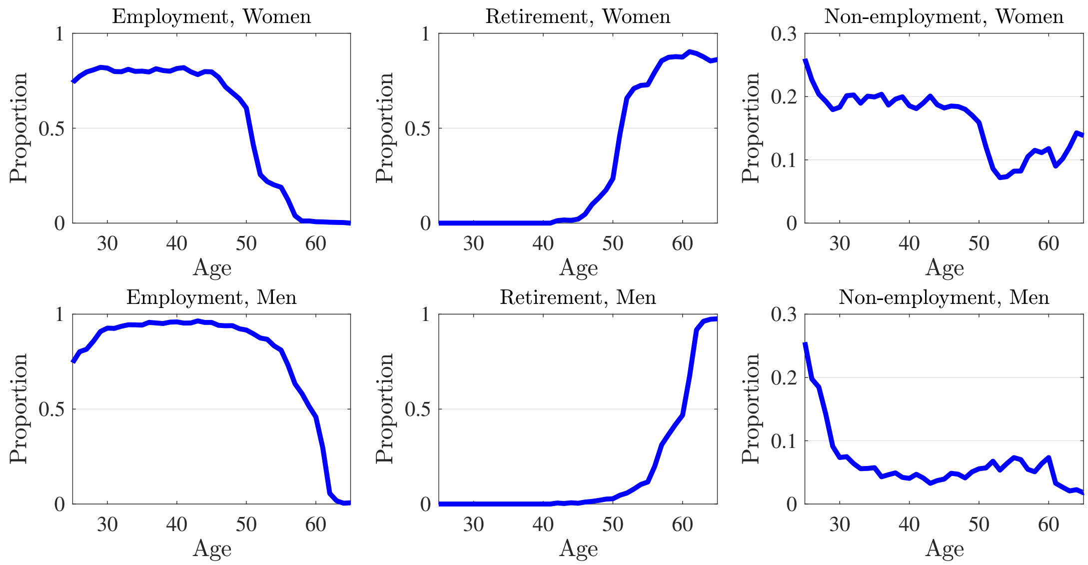


Figure A1: Age profile of employment status, by gender

**Age distribution of retirement** Figure A2 documents the age distribution of retirement incidence using the UHS. Early retirement has been adopted in practice to reduce financial burdens of the firms, especially under the reform of state-owned enterprises. Around 40% men retire before the statutory minimum eligibility age of 60 and around 25% women retire before the minimum eligibility age of 50. This pattern is consistent with the findings of Feng and Hu (2008) using CHNS data for an earlier time period of various years between 1991 and 2006.

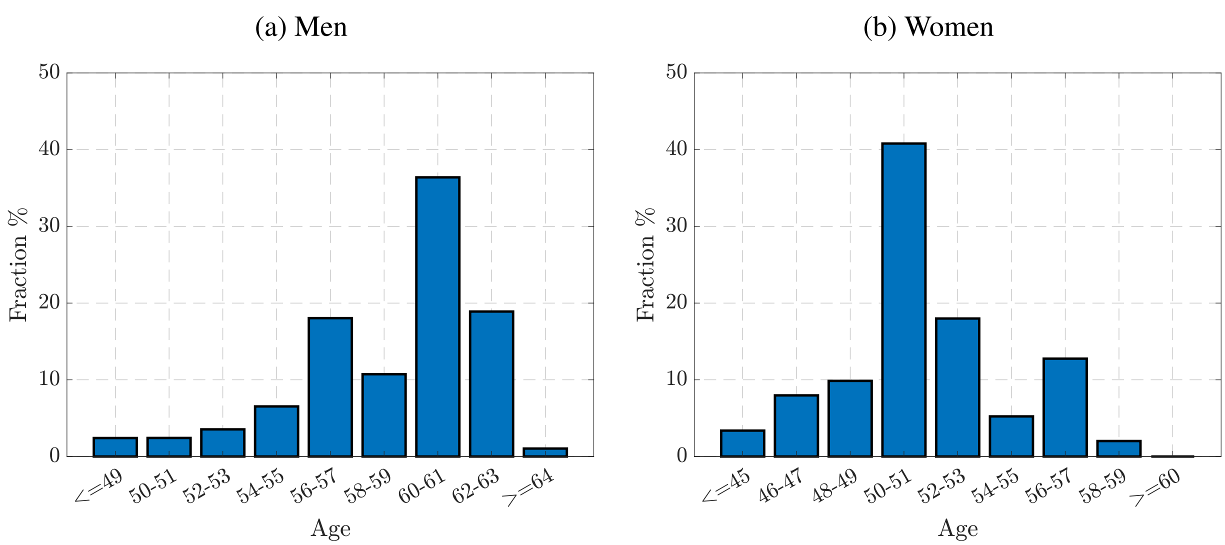


Figure A2: Distribution of retirement age

### A.1.2 Occupations

**Occupational codes** I further restrict the the grouping of occupations into two main categories in the main text —- high-skilled occupations refer to abstract occupations and low-skilled occupations include both routine and manual occupations. Table A2 documents the employment share and wage by occupation of Chinese women. Women earn more wages in occupations that use more abstract skills intensively, such as managerial, technical, and professional occupations. I thus classify these occupations as high-skilled and others as low-skilled for future use.

Table A2: Employment and wages by occupation of urban women, age 24-50, UHS 2007

| Code | Occupations | Skill classification | Emp. share % | Wage Mean | Wage Median |
|---|---|---|---|---|---|
| 1 | Managers and officials | H | 2.23 | 29288 | 23806 |
| 2 | Engineers, professional workers, technicians, artists and teachers | H | 20.60 | 25634 | 21597 |
| 3 | Clerical workers | L | 30.65 | 20789 | 16920 |
| 4 | Sales workers | L | 28.84 | 14003 | 11050 |
| 5 | Farmers, fishermen, foresters | L | 0.54 | 14838 | 12395 |
| 6 | Production workers, operators | L | 12.94 | 14990 | 12000 |
| 7 | Military-related workers | – | 0.15 | 19145 | 15040 |
| 8 | Others | – | 4.04 | 13812 | 10851 |

**Occupational switch** Table A3 presents the annual switching rate across occupations by gender. The transition rates look similar across men and women.

Table A3: Annual transition rates across occupations

| | H | L | Obs. |
|---|---|---|---|
| H | 0.919 | 0.081 | 5493 |
| L | 0.023 | 0.977 | 18441 |

Women

| | H | L | Obs. |
|---|---|---|---|
| H | 0.913 | 0.087 | 7546 |
| L | 0.031 | 0.969 | 19558 |

Men

### A.1.3 Income shocks

Income shocks $y_{it}$ follow the process

$$y_{it} = \eta_{it} + \nu_{it}, \qquad \eta_{it} = \rho\eta_{it-1} + \xi_{it}$$

where $\nu_{it} \sim i.i.d.\ N(0, \sigma_q^2)$ and $\xi_{it} \sim i.i.d.\ N(0, \sigma_p^2)$ are transitory shock and permanent shock, respectively. Simple algebra gives that the variance and the covariances by lag-$s$ follow

$$var(y_{it}) = var(\eta_{it}) + var(\nu_{it}) = \frac{\sigma_p^2}{1-\rho^2} + \sigma_q^2$$
$$cov(y_{it}, y_{it-s}) = cov(\eta_{it} + \nu_{it}, \eta_{it-s} + \nu_{it-s}) = cov(\eta_{it}, \eta_{it-s}) = \rho^s \frac{\sigma_p^2}{1-\rho^2}$$

The variance and covariance of $y_{it}$ up to 2-period lags can be used to estimate the parameters $(\rho, \sigma_p, \sigma_q)$. I thus construct the income shocks $y_{it}$ using data from the UHS and estimate the associated parameters following the above method. To be more specific, $y_{it}$ is the residual from a wage regression model on factors including age, age-squared, occupations, year dummy, and regional dummy, Table A4 summarizes the results for men, women and women by occupation.

Table A4: Persistence and variance of income shocks

| Parameters/ Moments | Men | Women | | |
|---|---|---|---|---|
| | | Overall | Low skill | High skill |
| $\rho$ | 0.864 | 0.878 | 0.893 | 0.899 |
| $\sigma_p^2$ | 0.063 | 0.060 | 0.053 | 0.053 |
| $\sigma_q^2$ | 0.178 | 0.226 | 0.234 | 0.250 |
| $var(y_{it})$ | 0.250 | 0.294 | 0.293 | 0.308 |
| $cov(y_{it}, y_{it-1})$ | 0.230 | 0.257 | 0.233 | 0.248 |
| $cov(y_{it}, y_{it-2})$ | 0.184 | 0.202 | 0.208 | 0.223 |

Compared with men, the permanent income shock process for women is more persistent and has lower variance and the transitory shocks have a larger variance. The difference between the shock processes of low-skilled and high-skilled women is small. In this case, I set the income shocks to be the same for all women in my calibration.

The results are consistent with Yu and Zhu (2013) and He, Ning, and Zhu (2019), who document the labor income and household income processes with moments constructed from various waves of China Health and Nutrition Survey (CHNS).

### A.1.4 Intensive margin of labor supply

Figure A3 presents weekly working hours of urban employment by gender and age group between year 2010 and 2015 from the National Bureau of Statistics of China.

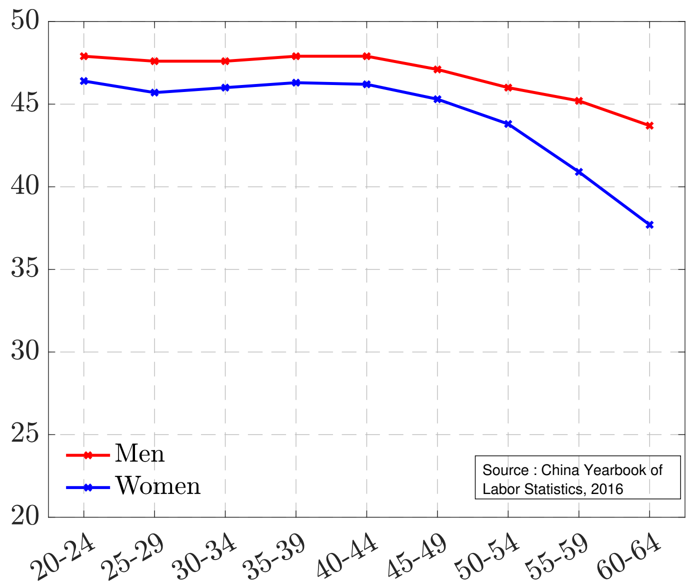


Figure A3: Weekly working hours by gender and age

In Table A5, I use 2013 survey data of China Household Income Project (CHIP) to document the working hours of mothers with children under 18. Despite the small while still national representative sample size, the employment rate aligns well with the UHS. More than $95\%$ of the observations provides information on the working hours, and less than $3\%$ of the employed observations report less than $20$ working hours per week in year 2013. It clearly shows that the high employment rate of Chinese mothers is not a consequence of adjusting hours toward part-time jobs.

Table A5: Distribution of weekly hours for women with children of age <18, CHIP 2013

| Age | Obs. | emp. | frac. with hours | $\leq$ 10h | $\leq$ 20h | mean | p25 | median | p75 |
|---|---|---|---|---|---|---|---|---|---|
| 25 – 29 | 89 | 80% | 94% | 3.0% | 3.0% | 42 | 39 | 41 | 55 |
| 30 – 34 | 193 | 86% | 100% | 0% | 0% | 43 | 41 | 41 | 55 |
| 35 – 39 | 311 | 86% | 97% | 0% | 2.7% | 43 | 41 | 41 | 55 |
| 40 – 44 | 330 | 84% | 98% | 0.4% | 2.2% | 44 | 41 | 41 | 55 |
| 45 – 49 | 85 | 78% | 100% | 1.5% | 3.0% | 46 | 41 | 43 | 65 |
| 50 – 54 | 32 | 25% | 88% | 0% | 0% | 39 | 37 | 41 | 45 |
| 55 – 59 | 85 | 8.2% | 71% | 20% | 20% | 36 | 30 | 48 | 52 |

## A.2 Child care

I use the first wave of the China time use survey conducted in 2008 (CTUS-2008) to construct time allocation of childcare from household members at the household level. I will also use variables on expenditure from the UHS for moments about childcare expenditure.

### A.2.1 Survey design of CTUS-2008

The first wave of CTUS was conducted by the National Bureau of Statistics of China in year 2008. The survey interviewed 37,142 individuals between age 16 and 75 from 16,616 households (including 19621 individuals from 9,049 households for the urban subsamples) covering 234 cities(or equivalent districts) in 10 provinces(or municipality cities).[31] The survey is designed to be national representative and the ten provinces.[32]

Table A6: 1-digit activity codes in CTUS 2008

| 1-digit Code | Activities | Subcategories |
|---|---|---|
| 0 | Personal care | sleeping, dining, health-related self care, religious activities, smoking |
| 1 | Work and work-related activities | working in the main job or other jobs, job search, working-related training activities |
| 2-4 | Production activities at home | farming, fishing or forestry activity, food production or house construction activities, paid sales or service activities |
| 5 | Unpaid housework | food preparation, grooming, shopping, petting, and appliance set-up, repair, and maintenance |
| 6 | Caring others | caring children, adult children, or unpaid caring activities for other households |
| 7 | Education | education in school, online education, pre-work training, studying to apply for certificates |
| 8 | Entertainment | reading, watching videos, or using Internet for personal interest, sports, arts and performances, and socializing activities |

The survey asks questions of the activities about the place to conduct the activity, the transportation method used to get the place, the length of the activity(minimum of 15 minutes) and the person who

[31]The second wave was conducted in year 2018. However, it is not yet published for public use. More details about the survey can be found on http://data.stats.gov.cn/ifnormal.htm?u=/images/timefind/index.html&h=1070.

[32]The provinces are Beijing, Zhejiang, and Guangdong, Hebei, Heilongjiang, Anhui, Henan, Sichuan, Yunan and Gansu.

is accompany when the activity is conduct. The survey also asks whether there is a secondary activity when a primary activity is on-going. The activities that the survey considers cover 115 3-digit activities under 8 1-digit activities. The 1-digit activity codes are provided in Table A6. Besides the information of time diary of activities, the survey also contains information on individuals' age, race, relationship to the head, marital status, education and current employment status. However, the survey only interviews individuals between age 15 and 74, thus all information on children within the household is missing. In Table A7, I compare the distribution of individual characteristics and household size in the CTUS and the UHS, which confirms the national representativeness of CTUS.

Table A7: Comparison between CTUS and UHS

*Panel A. individual characteristics*

| | CTUS - 2008 | | | UHS - 2008 | | |
|---|---|---|---|---|---|---|
| | Overall | Men | Women | Overall | Men | Women |
| Age | 43.22 | 43.61 | 42.84 | 43.21 | 43.28 | 43.15 |
| (std.) | (13.53) | (13.70) | (13.36) | (14.52) | (14.70) | (14.35) |
| College | 0.332 | 0.371 | 0.296 | 0.304 | 0.336 | 0.260 |
| Married | 0.836 | 0.848 | 0.825 | 0.794 | 0.796 | 0.793 |
| Employed | 0.621 | 0.696 | 0.552 | 0.595 | 0.680 | 0.512 |
| Retired | 0.189 | 0.155 | 0.221 | 0.216 | 0.166 | 0.264 |
| Observations | 19566 | 9466 | 10100 | 60692 | 30059 | 30633 |
| (fraction) | | (0.484) | (0.516) | | (0.495) | (0.505) |

*Panel B. household size distribution*

| | CTUS - 2008 | UHS - 2008 |
|---|---|---|
| Mean Size | 2.16 | 2.48 |
| (std.) | (0.65) | (0.87) |
| Size =1 | 10.84% | 7.83% |
| Size =2 | 65.01% | 49.14% |
| Size =3 | 21.28% | 32.92% |
| Size =4 | 2.74% | 7.92% |
| Size =5+ | 0.12% | 2.19% |
| Observations | 9046 | 24425 |

### A.2.2 Imputation of child care

The CTUS interviews each individual on a weekday and a weekend of the same week and record time diary on activities in these two days into a weekday and a weekend module accordingly. The CTUS classifies activities under 8 1-digit categories and 115 3-digit categories. Table A8 documents the 3-digit activity codes related to childcare. For any given time in a day, the survey first asks questions on a primary activity, including the activity code this activity belong to, the time length of the activity, the transportation method to conduct activity and other people present when conducting the activity. The survey further asks whether the individual conducts a secondary activity during the time conducting the primary activity. The same questions apply if there is any secondary activities. Besides the information on the time diary, the survey also contains information on individuals' age, race, relationship to the head, marital status, education and employment status.

Table A8: Childcare activity codes in CTUS

| Code | Activity | Descriprition |
|---|---|---|
| 611 | Physical or daily life care | dressing, feeding, bathing children, medical activities for children |
| 612 | Educational care | educating children, reading for children, chatting or playing with children |
| 613 | Looking after children | watching children when children are playing |
| 614 | Activities out of household | taking children to public, such as amusement park, hospital, or school |

I consider three measures of child care activities: **primary child care**, **secondary child care**, and **total child care**. Primary child care time refers to the total time on activity codes 611-614 as primary activity. Secondary child care time is defined similarly as the total time on activity codes 611-614 as secondary activity. Total child care is the sum of the primary and secondary child care time. I use primary child care for the moments as it best matches the assumption of exclusive usage of time in my model. The survey interviewed each household twice in a week of May 2008, once in between Monday and Friday and once in Saturday or Sunday, to capture the time use difference between typical working days and weekends. To construct **weekly child care hours**, I first construct child care hours from both the weekday and the weekend module to get a representative weekday and a representative weekend child care hours respectively, and weight child care time in two modules by days in a week using the following formula:

$$\text{Weekly hours} = \text{weekday childcare hours} \times 5 + \text{weekend childcare hours} \times 2$$

To characterize the distribution of the grandparental child care, I consider both the **extensive margin** as the probability of providing grandparental child care for a grandparent and the **intensive margin** as child care hours conditional on providing grandparental child care.

I impute child care hours by young and old women as follows. First, since the CTUS does not provide information on the child's relationship to the interviewee for a child care activity, I assume that child care activities conducted by individuals over age 50 are grandparental. The imputation error is the probabilities of being the children of the couple conditional on being observed within the household. I document from UHS these conditional probabilities in Table A9.

Table A9: Imputation error of treat child care from couples above 50 as grandparental only

| Age of husband | Children under 15 | Children under 10 | Children under 6 |
|---|---|---|---|
| 50 – 74 | 7.42% | 1.98% | 0.44% |
| 50 – 59 | 16.5% | 7.78% | 3.69% |
| 50 – 54 | 33.6% | 10.53% | 4.35% |

Second, the CTUS does not provide the information on whether a individual has grandchildren or how many grandchildren this individual has. To impute the extensive margin for a given demographic group, I take the ratio of the probability of having positive grandparental child care for a certain group in the CTUS to the probability of having grandchildren for the same group in the urban sample of CHARLS. In practice, I construct the probabilistic distributions at age-gender-employment status cell and obtain the extensive margin for a more aggregate group by weighting each cell's population share. The imputation procedure should provide valid estimates as long as the sample size is large enough since both CTUS and CHARLS are designed to representative of the population.

### A.2.3 Childcare expenditures

Day-caring expenditure (f6323) in the UHS refers to *all payments to day-caring center, kindergarten or individuals for taking caring of children, including preschool expenses, but not including food*. Day-caring expenditures are separately recorded from other housekeeping activities for household in which housemaids provide day-caring services. The definition of day-caring expenditure thus matches the market childcare expenditure of $p^k q^k$ in the model. As a robustness check, I also consider two more general definition of market childcare to include expenditures on living and educational expenses.

- Definition 1: day-caring (f6323);
- Definition 2: day-caring + dormitory and accommodation fees (f6327)

- Definition 3: definition 2 + tuition fees +tutoring and extracurricular classes (f6321,f6322,f6325) + textbooks, software and supplies (f631)+ other educational (f6328)

Table A10 reports by the age of children the fraction of households using market childcare and ratio of childcare expenditures to total non-durable consumption in a household. As can be seen from Table A10, both the fraction of households and the consumption expenditure vary by children age groups, which in the model will be reconciled by different childcare costs.

Table A10: Child care expenditures in UHS, Source: UHS 2007-2009

| Measure | Overall | | Age Group $[0,2]$ | | Age Group $[3,6]$ | | Age Group $[6,16]$ | |
|---|---|---|---|---|---|---|---|---|
| | Freq. | Exp. Share | Freq. | Exp. Share | Freq. | Exp. Share | Freq. | Exp. Share |
| def. 1 | 18.54% | 6.32% | 13.84% | 5.19% | 59.56% | 7.60% | 6.84% | 3.26% |
| def. 2 | 20.50% | 6.00% | 14.29% | 5.12% | 60.51% | 7.53% | 9.30% | 3.18% |
| def. 3 | 47.58% | 6.90% | 19.46% | 5.54% | 75.14% | 8.17% | 42.86% | 6.31% |
| obs. | 20,469 | | 1,799 | | 4,300 | | 14,370 | |

### A.2.4 Co-residing old generation

In Table A11, I provide summary statistics about the characteristics of the old generation who live in the same household with any of their grandchildren using the demographic information from the UHS. The amount, age and employment status of the coresiding grandparents conveys the information on the availability of grandparental childcare that the young households can receive. Column 2-4 refers to the probability of living with at least one grandparent, the mean amount of grandparents that a child is living with and the mean amount of grandparent couples that a child is living with. Column 5-7 and Column 8-10 document the same statistics when I restrict the grandparents to be retired and under 65, respectively. I document the same statistics for both the overall children group and also by children's age. This table clearly shows that living with grandparents is very common in China. The probability is declining in children's age. This, on the one hand, reflects the aging or mortality of grandparents. On the other, may also be a consequence that grandparents tend to move to live with children when there is larger demand for childcare from the perspective of the young households.

Table A11: Statistics of grandparents living in the same household with grandchildren, Source: UHS

| Child age | Total | | | Retired | | | Under 65 | | | Women | Men |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prob. | Num. | Couple | Prob. | Num. | Couple | Prob. | Num. | Couple | Prob. | Prob. |
| 0 – 15 | 0.274 | 0.465 | 0.185 | 0.210 | 0.216 | 0.103 | 0.191 | 0.308 | 0.113 | 0.257 | 0.202 |
| 0 – 2 | 0.458 | 0.827 | 0.358 | 0.331 | 0.475 | 0.138 | 0.418 | 0.736 | 0.308 | 0.443 | 0.372 |
| 3 – 6 | 0.379 | 0.663 | 0.274 | 0.276 | 0.415 | 0.135 | 0.315 | 0.528 | 0.206 | 0.358 | 0.294 |
| 7 – 15 | 0.218 | 0.357 | 0.135 | 0.174 | 0.264 | 0.089 | 0.123 | 0.185 | 0.060 | 0.201 | 0.152 |

### A.2.5 Demographic processes

Figure A4 present the trends of life expectancy by gender and fertility per women since 1960 from the World Bank.[33,34] As can be seen from the figures, both the fertility rate and life expectancy experienced a large change between 1960 and 1990 and tend to change at a lower rate after year 2000. I choose the mean values between year 1990 and 2000 as the benchmark steady state values.

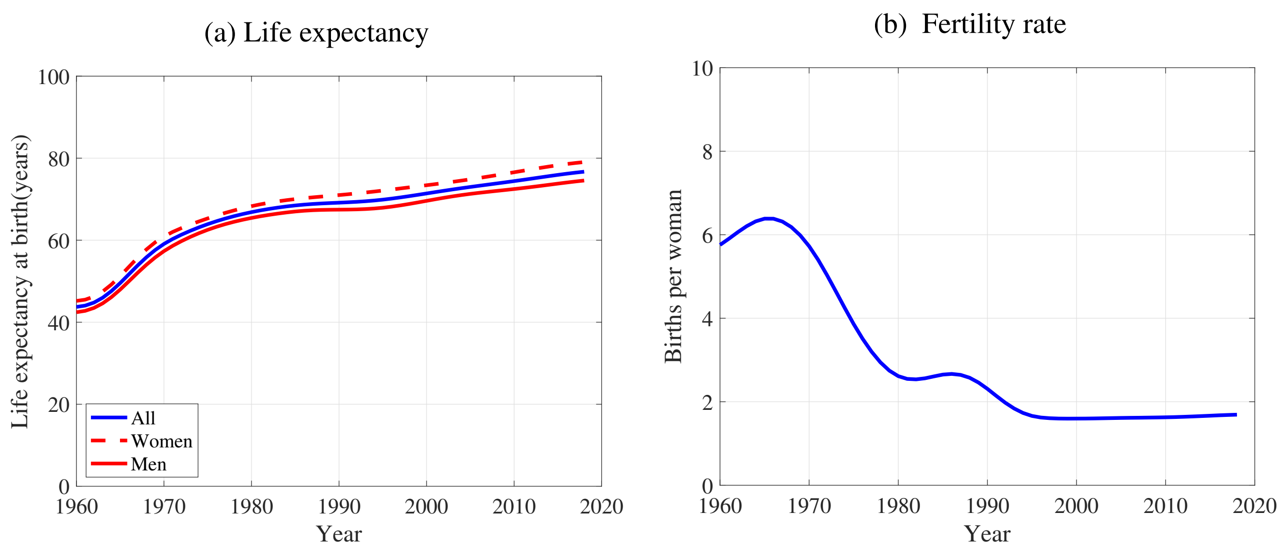


Figure A4: Demographics over time

Source: World Bank

[33]Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year.

[34]Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

# B Model and computational details

## B.1 Definition of steady state equilibrium

Let $\Lambda = (j, s, a, \pi)$ denote the vector of states for households and $\mu(\Lambda)$ be the distribution of households over the state space. Given interest rate $r$, childcare supply function, and a set of government policies $\{\tau, R_1, R_2, \tau_b\}$, a stationary recursive competitive equilibrium for this economy is a collection of (i) value functions $V_j(s, a, \pi)$; (ii) formal care price $q^n$; (iii) policy functions for employment, private consumption, leisure, childcare from each household member, formal care, and savings $\{\{n^{i\star}(\Lambda), c^{i\star}(\Lambda), l^{i\star}(\Lambda), q^{i\star}(\Lambda)\}_{i\in\mathcal{I}}, q^{n\star}(\Lambda), a'^{\star}(\Lambda)\}$ such that

1. Given prices and the government policies, the policy functions solve the dynamic programming problems in Equation (3) and $V_j(s, a, \pi)$ is the associated value function;

2. Government budget is balanced as in equation (1);

3. Formal care market clears with

$$Q^{n,S} = Q^{n,D}$$

   where aggregate childcare demand $Q^{n,D}$ is induced by the aggregating over policy function $q^{n\star}$ from households' problem

$$Q^{n,D} = \int q^{n\star}(\Lambda) d\mu(\Lambda)$$

   and aggregate childcare supply $Q^{n,S}$ satisfy equation (2);

4. The distribution of households is stationary with

$$\mu(\Lambda) = \int \Gamma(\Lambda) d\mu(\Lambda)$$

   where $\Gamma(.)$ denote the aggregate law of motion induced by the policy functions.

## B.2 Numerical solution algorithm

**Notations** I use value function $V_j^S$ to denote the value function for single generation households (households without the old generation). Since retirement is an absorbing state, I use two value functions for households with grandparents — $V_j^R$ for households in which the old women are retired, and

$V_j^N$ for households in which the old women are not yet retired (either employed or non-employed in the previous period).

Conditional on being a single-generation household, the household can choose either working or being non-employed, I further define value function conditional on the employment choice as $V_j^{SE}$ and $V_j^{SN}$ respectively. For households with retired old women, the household chooses the employment of the young women only as well, and the associated value functions are denoted as $V_j^{RE}$ and $V_j^{RN}$. For a household with non-retired old woman, the household chooses the retirement and employment for the old woman and the employment of the young woman, i.e. the labor supply choice for the household will be the product of young and old woman's employment choice: $\{E, N\} \times \{E, N, R\}$ .There are 6 conditional value functions: $\{V_j^{N,EE}, V_j^{N,EN}, V_j^{N,ER}, V_j^{N,NE}, V_j^{N,NN}, V_j^{N,NR}\}$.

It is also easy to see that the unconditional value functions $\{V^S, V^N, V^R\}$ take the value of the maxima of the associated value functions conditional on employment choice.

Under the current social security policy, retirement is not a feasible state before age 50, thus $V_j^R$ is well-defined after age 50. Similarly, $V_j^N$ is well-defined before age 60. I set the value function to be negative infinity in periods when those value functions are not well-defined.

**Numerical solution** Given government policies (income tax and social security rules) and prices (wage function, interest rate, and child care prices)

1. Guess the last period unconditional value function $\{V_T^S, V_T^R\}$. [35]

2. Given the unconditional value function in period $T$, iterate backward to solve the conditional value functions in period $T-1$. To achieve so, I fix the labor supply choices of women and optimizing over the consumption/savings and childcare/leisure decisions. The unconditional value functions will be computed as the maxima of the associated conditional value functions.

3. Continue Step 2 to iterate backward from period $T-2$ to period 1.

4. Update the value function in period $T$. In this step, I firstly compute the value function in period-1conditional on the occupational choice of young woman.Next, I compute the occupational choice probability following: [36]

$$\mathbb{P}(k^{\text{yf}} = v) = \frac{\exp(\text{EV}_v/\sigma_e)}{\sum_{k=1,\ldots,K} \exp(\text{EV}_k/\sigma_e)}$$

[35] $V^N$ is not defined in this period.

[36] When the upfront cost of an occupation exceeds the household asset holding, the value function is set to be negative infinity and the choice probability is set to be 0.

where $\text{EV}_v$ — the expected value function after the occupational choice and before the realization of exogenous shocks,[37] is given by

$$\text{EV}_v(\mathbf{x}, \pi, a) = \mathbb{E}V_1(\mathbf{x}, \pi, a - \psi_v | k^{\text{yf}} = v)$$

5. Repeat Steps 1-4 until $\{V^S, V^N, V^R\}_{j=1,...T}$ are converged.
6. Simulate the economy for 5000 dynasties for 2000 model periods
   - To solve the optimization problem in a given period, I interpolate the value functions conditional on the labor supply choice, and assign the household with the labor supply decision that achieves the maximum and the optimized consumption/savings and childcare/leisure choices associated with the conditional value function.
   - At the beginning of period 1, I interpolate the value functions to compute the occupational choice probability, and assign the young women to the occupation according to the realized unobserved labor market shocks.
7. Use the last cohorts (old and young) with complete life as the sample of proxy of the stationary distribution to construct the interested moments.

In computing the model with endogenous childcare prices, I take Step 1 to Step 5 as an inner loop given market childcare price, and use a bisection method to solve for the outer loop of the childcare price until the excess demand of market childcare is zero.

## B.3 Model fitness of the benchmark economy

### B.3.1 Childcare time allocation

**Childcare arrangements by children's age** I present in Table A12 the model fit of childcare arrangements across parental, grandparental and formal care hours for children in different age groups to be informative about the substitution among them, which will be important in understanding how childcare hours adjust in counterfactuals. Table A13 presents the unconditional mean of childcare hours by each provision method and by children's age.

[37] Fertility shock, mortality shock, and income shocks.

Table A12: Model fit: childcare methods

| Age group | Fraction of using | | | Exp. share of |
|---|---|---|---|---|
| | Formal care | Grandparental | Non-parental | formal care |
| **Data** | | | | |
| Overall | 0.18 | | | 6.32% |
| 0 – 2 | 0.14(0.19*) | (0.79*) | (0.93*) | 5.19% |
| 3 – 6 | 0.60(0.49*) | (0.56*) | (0.80*) | 7.60% |
| 7 – 15 | 0.068 | | | 3.26% |
| **Model** | | | | |
| Overall | 0.18 | 0.56 | 0.75 | 5.84% |
| 0 – 2 | 0.12 | 0.75 | 0.87 | 10.9% |
| 3 – 6 | 0.53 | 0.62 | 0.93 | 5.41% |
| 7 – 15 | 0.060 | 0.16 | 0.61 | 4.79% |

Note: (*) refers to moments constructed from CHNS

Table A13: Model fit: childcare hours

| Age group | Parental hours | | Non-parental hours | | | Total |
|---|---|---|---|---|---|---|
| | Mother | Father | Total | Grandparents | Formal care | |
| **Data** | | | | | | |
| Overall | 9.74 | 4.93 | | | | |
| 0 – 2 | 15.00 | 6.11 | | | | |
| 3 – 6 | 11.79 | 5.47 | | | | |
| 7 – 15 | 8.70 | 4.35 | | | | |
| **Model** | | | | | | |
| Overall | 10.09 | 7.39 | 15.33 | 11.75 | 3.58 | 32.81 |
| 0 – 2 | 13.81 | 10.05 | 23.33 | 21.49 | 1.84 | 46.43 |
| 3 – 6 | 13.57 | 8.54 | 27.96 | 15.45 | 12.51 | 50.07 |
| 7 – 15 | 6.71 | 5.55 | 7.64 | 7.00 | 0.64 | 19.90 |

**Childcare by employment status** In Table A14, I further present the model fit of the childcare by employment status for both mothers and grandmothers. In the top panel of the table, I compare the employment rate and childcare hours by employment status of mothers. The model produces a slightly lower employment rate for mothers between age 30 and 39 while overestimates the reduced employment effect for mothers between age 25 and 29. The model fits well with the fact that non-employed mothers provide significant more childcare hours compared with the employed mothers in the same age group. The model also matches the declining childcare hours by mothers' age due the aging of children. Consistent with Feng and Zhang (2018)

Table A14: Model fit: childcare by employment status

| Age | Emp. rate | | Hours of employed | | Hours of non-employed | |
|---|---|---|---|---|---|---|
| | model | data | model | data | model | data |
| Mothers | | | | | | |
| 25 – 29 | 0.56 | 0.76 | 11.78 | 15.07 | 26.68 | 26.45 |
| 30 – 34 | 0.75 | 0.82 | 8.37 | 13.95 | 16.39 | 19.86 |
| 35 – 39 | 0.78 | 0.83 | 5.03 | 9.98 | 10.65 | 15.21 |
| Grandmothers | | | | | | |
| 50 – 54 | 0.49 | 0.22 | 7.03(0.17) | 8.01(0.22) | 17.86(0.80) | 17.84 (0.39) |
| 55 – 59 | 0.30 | 0.10 | 8.23(0.05) | 7.67(0.23) | 13.23(0.70) | 15.00(0.41) |
| 60 – 64 | – | – | – | – | 6.51(1.00) | 13.26(0.30) |
| 65 – 69 | – | – | – | – | 8.04(1.00) | 9.71(0.20) |

Note: () refers to extensive margin

### B.3.2 Auxiliary wage regressions

In this section, I present model fit of two auxiliary wage regressions. Although the coefficients cannot be directly interpreted as their structural analogs, these coefficients are used by empirical works to be suggestive about the direction of the economic forces.

**Wage regression on interruptions** In Table A15, I regress the logged wage on variables of interruption, worker's experience, occupation, and their interactions. Worker experience is categorized into groups of less than 5 years, 5-10 years and over 10 years. In the data, the negative coefficient for the indicator of non-employment in the previous period suggests that there might be human capital depreciation in periods of non-employment. The coefficient of experience between 5 and years is close to the coefficient of experience over 10 years, which suggests that learning is faster at younger ages. The coefficients on the interaction of interruption with mid-career experience and the indicator of high-skilled occupation are negative, which suggests that non-employment is more costly for high-skilled women.

**Wage regression with children** In Table A16, I regress the logged wage on age, age squared, the age of children in the household, occupation of women and their interactions. This specification is typically

Table A15: Model fit: log wage, interruption, experience, and occupations

| Dummy Variables | Data Coeff. | Data S.E. | Model Coeff. |
|---|---|---|---|
| Interruption | – 0.3043* | (0.1683) | – 0.0907 |
| Exp $\in (5, 10]$ | 0.1481*** | (0.0247) | 0.0961 |
| Exp $> 10$ | 0.1782*** | (0.0105) | 0.2528 |
| Occ. high | 0.4003*** | (0.0185) | 0.2107 |
| Interruption $\times$ Exp $\in (5, 10]$ | – 0.6342** | (0.2688) | – 0.0061 |
| Interruption $\times$ Exp $> 10$ | – 0.3274 | (0.1978) | – 0.0484 |
| Interruption $\times$ Occ. high | – 0.0281 | (0.2712) | 0.1303 |
| Occ. high$\times$ Exp $\in (5, 10]$ | 0.0872*** | (0.0240) | – 0.0448 |
| Occ. high$\times$ Exp $> 10$ | 0.0281 | (0.0208) | – 0.0115 |
| Interruption$\times$ Occ. high$\times$ Exp $\in (5, 10]$ | – 0.0201 | (0.0408) | – 0.2959 |
| Interruption$\times$ Occ. high$\times$ Exp $> 10$ | – 0.0512 | (0.0392) | – 0.0441 |
| Observations | 47935 | | 50000 |

*Note:* **Interruption** refers to non-employment in the previous period.

used to suggest the cost of children reflected in the wage compensation. My model does not fit the sign and the magnitude of the coefficients of the indicator of children's age though.

Table A16: Model fit: log wage, children and occupations

| Variables | Data Coeff. | Data S.E. | Model Coeff. |
|---|---|---|---|
| Age | 0.1007 *** | (0.0092) | 0.1090 |
| Age$^2$ | – 0.0013 *** | (0.0001) | – 0.0015 |
| Child $< 7$ | – 0.1208*** | (0.0098) | 0.0177 |
| Child $\geq 7$ | – 0.2027 *** | (0.0105) | – 0.0197 |
| Occ. High | 0.2518 *** | (0.0119) | 0.2050 |
| Occ. High $\times$ Child $< 7$ | 0.0717 *** | (0.0139) | 0.0150 |
| Occ. High $\times$ Child $\geq 7$ | 0.1306 *** | (0.0148) | 0.0870 |
| Observations | 41781 | | |

### B.3.3 Occupational choice

**Employment and wages** Table A17 presents the fitness of moments on occupational employment and occupational wage premium. In the model, training cost of high-skilled occupation $\kappa_2$ is identified with the aggregate employment share of high-skilled occupation. The standard deviation is related to the elasticity of choice probability to the presence of children at age 24. Alternatively, I choose $\sigma_e$ to match choice probability for those with children, which implicitly targets the relative difference between women with children and those without.

Table A17: Model fit: occupational employment and wages

| | Model | Data |
|---|---|---|
| Initial high-skilled emp. shr. | 0.257 | 0.271 |
| With children at age 24 | 0.218 | 0.220 |
| Without children at age 24 | 0.277 | 0.291 |
| Lifecycle high-skilled emp. shr. | 0.316 | 0.292 |
| Wage premium of high-skilled | 0.283 | 0.198 |
| Gender wage premium | 0.160 | 0.268 |

**Intergenerational persistence** Table A18 presents the intergenerational persistence of occupational choice, i.e., the probability that a young woman choose the same occupation with the old woman in the same household. In the benchmark of social security entitlement at age 50, the young woman choose low-skilled occupation with probability 0.8505 when the old woman chose the low-skilled occupation, and with a lower probability 0.6392 when the old chose the high-skilled occupation. When the old women chose the high-skilled occupation, she earns more wages and accumulate more assets, which relaxes the monetary budget constraint of young women in periods in need of childcare, thus lead the young women to choose high-skilled occupation with a higher probability through this channel. However, when

Table A18: Intergenerational persistence of occupations

| | | Young: Low | Young: High |
|---|---|---|---|
| Old | Low | 0.8505 | 0.1495 |
| | High | 0.6392 | 0.3608 |

Overall of BM economy: 0.7650

| | | Young women: Low | Young women: High |
|---|---|---|---|
| Old | Low | 0.8007 | 0.1993 |
| | High | 0.6060 | 0.3904 |

Overall of CF economy: 0.7007

## B.4 Sensitivity

### B.4.1 Occupational choice

I consider two alternative set of parameters for the occupational choice problem

- No shock: unobserved shock is set to be 0
- 2 st. dev. : standard deviation is set to be twice of the estimated value

and I fix all other parameters to be the same in the baseline, including the training cost of high-skilled occupation.

Table A19 presents the share of choosing high-skilled occupation for all women, and women by presence of children at the age of 24, in benchmark and the above-mentioned two alternative cases. The elasticity of choice probability to the presence of children is the key moment that parameter of standard deviation affects. As described in Section 8, when the standard deviation is larger, occupational choice probability is less sensitive to the policy change. As can be seen from the table, varying the standard deviation only will lead to a change in the levels of choice probability. To be more specific, probability of choosing high-skilled occupation is higher with lower standard deviation of unobserved shocks. However, the change in the overall choice probability after the policy change is very similar among the three cases. The policy change widens the gap between choice probability of women with children at age 24 and that of women without, and this effect is decreasing in the size of the standard deviation. This again shows that the standard deviation of unobserved shocks affects the moments related to the elasticity of choice probability to state variables.

Table A19: Sensitivity: standard deviation of the unobserved shock

| | Benchmark | | No shock | | 2 st. dev. | |
|---|---|---|---|---|---|---|
| | Ret = 50 | Ret = 60 | Ret = 50 | Ret = 60 | Ret = 50 | Ret = 60 |
| Fraction of high-skilled | 0.250 | 0.324 | 0.397 | 0.466 | 0.214 | 0.279 |
| With child at age 24 | 0.218 | 0.291 | 0.390 | 0.425 | 0.196 | 0.258 |
| Without child at age 24 | 0.267 | 0.342 | 0.400 | 0.487 | 0.223 | 0.290 |
| Gap | 0.049 | 0.051 | 0.010 | 0.062 | 0.027 | 0.032 |

### B.4.2 Social security benefits

Table A20, I present the key moments that the level of social security benefits will affect in the model. I show the moments by setting the social security replacement ratio the benchmark value 0.75 and alternative values 0.45, 0.6, and 0.9.

**Labor supply elasticity to SS entitlement** With more generous social security benefits, the value of retirement increases relative to the value of employment, thus the labor supply elasticity will increase. Compared to low-skilled women, the high-skilled women have a larger gap between wages and social security income under the assumption of constant social security replacement ratio. The low-skilled women thus in general have a higher labor supply elasticity. Additionally, the gap of labor supply elasticities between the low- and high-skilled decreases as the generosity of social security increases. When the replacement ratio is 0.90, the low- and high-skilled have very similar labor supply elasticity.

**Employment rate** The labor supply elasticity also affects the employment rate of old women. Under a higher generous social security replacement ratio, employment rate for both low- and high-skilled women decreases, and the gap of employment rates between low- and high-skilled women decreases.

**Marginal effects of old** Under a higher generous social security replacement ratio, the old are more likely to quit and transfer more time to the young, implying a higher marginal effect.

Table A20: Sensitivity to social security benefits

| SS replacement ratio | | 0.75 Benchmark | 0.45 | 0.6 | 0.9 |
|---|---|---|---|---|---|
| Elasticity of retirement | Overall | 0.413 | 0.246 | 0.344 | 0.473 |
| to SS entitlement | Low-skilled | 0.423 | 0.281 | 0.365 | 0.471 |
| $\gamma_3$ | High-skilled | 0.380 | 0.138 | 0.274 | 0.473 |
| Employment rate | Overall | 21.3% | 34.4% | 26.7% | 16.8% |
| Age $\geq 50$ | Low-skilled | 16.0% | 26.2% | 20.1% | 12.5% |
| | High-skilled | 36.0% | 57.1% | 45.2% | 28.5% |
| Marginal effect of | Overall | 0.040 | 0.057 | 0.044 | 0.040 |
| presence of old | With Children | 0.068 | 0.086 | 0.072 | 0.070 |
| $\beta_1$ | With Children $< 7$ | 0.225 | 0.212 | 0.219 | 0.230 |