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Population Aging, Credit Market Frictions, and Chinese Economic Growth

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Abstract

We build a unified framework to quantitatively examine population aging and credit market frictions in contributing to Chinese economic growth between 1977 and 2014. We find that demographic changes together with endogenous human capital accumulation account for a large part of the rise in per capita output growth, especially after 2007, as well as some of the rise in savings. Credit policy changes initially alleviate the capital misallocation between private and public firms and lead to significant increases in both savings and output growth. Later, they distort capital allocation. While contributing to further increase in savings, the distortion slows down economic growth. Among factors that we consider, increased life expectancy and financial development in the form of reduced intermediation cost are the most important in driving the dynamics of savings and growth.

Keywords: Aging; Credit policy; Household saving; Output growth; China

JEL classification: E21; J11, J13; L52

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1 Introduction

In this paper, we explore how the rapid aging of the Chinese population and the changing credit market frictions have contributed to the evolution of the Chinese economy between 1977 and 2014. The model we develop has three innovations. First, we capture major credit market policies of the last three decades, which are responsible for substantial structural changes among different types of firms. Second, we model endogenous human capital accumulation. Third, we allow credit market frictions to interact with households' savings as well as human capital investment decisions in the presence of a rapidly aging population.

To be more specific, our economy is depicted by an overlapping-generations model where parents and children are connected by inter-vivos transfer. While parents make human capital investment decisions for their school age children, grown children make transfer payments to their elderly parents. On the firms' side, there exist two intermediate goods sectors, one final goods sector, and one education sector. The two intermediate goods sectors differ in capital and labor intensity used in production and in their cost of capital due to government interest rate subsidies, the primary means by which the government influences production in the economy. The labor-intensive sector consists of two types of firms, state-owned firms and private firms. In addition to differences in their productivity, the state firms and the private firms also face different cost of capital. The government finances pensions through a labor income tax and finances credit market subsidies to firms through an income tax that applies to both labor income and pension income. Finally, we capture the financial market friction using intermediation cost.

We demonstrate that there exist important interactions between households and firms in response to these structural changes. All changes on the household side, the lower fertility rate, the lengthened life expectancy, and the reduction in pensions, lead households to save more. The higher savings rate as well as the decline in the working age population affect firms and benefits the capital-intensive sector disproportionately. The same demographic changes also encourage households to invest more in their children's human capital as transfer payments from children serve as an annuity in their old age. The resulting higher human capital leads to a more productive labor force and hence an increase in the effective labor supply, which benefits the labor-intensive sector disproportionately. Thus, both higher savings and increased labor quality lead to higher output growth, while the reduced quantity of labor restricts growth.

Changing government credit subsidies to various firms initially benefit private firms in the labor-intensive sector. This policy raises wages, which further encourages human capital investment. Subsidies to the capital-intensive sector, by contrast, increase capital demand and help raise the deposit rate received by households, thus encouraging household savings but discouraging human capital investment. More importantly, while the credit policies initially alleviate the capital misallocation between state firms and private firms and, hence, help raise output growth, they later lead to capital misallocation between heavy industries and light industries and, therefore, reduce output growth.

Finally, financial developments take the form of reduced intermediation cost in the model. Ceteris paribus, a reduction in the intermediation cost and, hence, a decline in lending cost, pushes up the capital-labor ratio in all firms, leading to a rise in the savings rate. Output grows as a result of capital accumulation.

Using the calibrated model, we show quantitatively that,

- Changes in demographic factors, credit policies, and financial development can explain most of the observed rise in household savings and per capita output growth since 1977.

- Demographic changes account for over half of the per capita output growth from 1977 to 2006 and all of the growth after 2007. They also account for one-quarter of the rise in the savings rate after 1992. Of the factors we consider, the increase in life expectancy is the most crucial, while reductions in the fertility rate and in pension benefits help magnify the impact of this increase.

- Credit policies that reduce the credit tax on private labor-intensive firms alleviate capital misallocation between private labor-intensive firms and other firms and account for 20 percent of the increase in per capita output growth over the period of 1991 to 2006. This policy also explains 6 percent of the reduction in household savings. Credit subsidies to the state labor-intensive firms account for 10 percent of the initial rise of the growth rate of output per capita as well as household savings rate because of capital deepening. After 2007, they reduce growth. Credit policies that subsidize the capital-intensive firms account for 10 percent of the rise in per capita output growth and 20 percent of the rise in savings rate before 2006 because of capital deepening. After 2007, they reduce growth while continuing to raise savings.

- Reductions in the cost of intermediation is crucial in accounting for the savings and output growth dynamics before 1991. They explain 30 percent of the rise in the per capita output growth rate and over 70 percent of the rise in the savings rate.

The rest of the paper is organized as follows. Section 2 presents the motivation and background of the paper. Section 3 discusses the related literature. Section 4 describes the model. Section 5 calibrates the model. Section 6 presents the transition path between the two steady states. Section 7 conducts various counter-factual government policies while Section 8 conducts alternative policy experiments. Section 9 concludes.

2 Motivation and Background

In this section, we draw on existing literature and numerous data sources to document the changes in the Chinese economy since the end of Cultural Revolution in 1976. We first illustrate the rapid growth of the Chinese economy. We then describe the aging of the Chinese population and the contributing factors behind this phenomenon. Lastly, we provide evidence on the evolution of government credit policies and their consequences.

2.1 The Rapid Growth of the Chinese Economy

The Chinese economy has been growing rapidly over the last few decades (Figure 1). Between 1976 and 1980, per capita GDP growth was under 5 percent. After a brief retreat in the mid-1980s, it jumped up to nearly 10 percent in the early 2000s, and hovered at around 7-8 percent afterwards. The growth is even more astounding in relative terms. For example, the per capita GDP in China was about 5 percent of that of the U.S. before 1980. By 2012, the ratio had shot up to over 20 percent. From 1976, China has undergone many dramatic phases both on the household side and on the firms side, which we discuss below.

2.2 The Aging Population

The aging Chinese population is best depicted by the declining young-age dependency ratio, the ratio of people under the age of 15 to the population between 15 and 65, and the declining trend in the population growth rate. According to Figure 2, Panel a, the young-age dependency ratio was close to 80 percent in 1976 but declined to 35 percent by 2012. The population growth rate began to decline in 1976 and reached a trough of 1.4 percent in the mid 1980s. Though the growth rate recovered to its 1976 level in 1987, it began another long decline after that. In 2010, the growth rate was only a tad above 0.5 percent.

There are two underlying causes behind the aging demographics, the reduced fertility rate and the increased life expectancy (Figure 2, Panel b). According to the World Bank data, the birth rate drops gradually from 1.8 per adult in 1976 to 0.75 in 2000 and 0.8 in 2015. The Chinese government started promoting family planning as an effort to curb population growth in 1971. The tactics included initiatives that encouraged postponing marriage until a later age, lengthening birth spacing between children, and reducing the number of children. In the late 1970s, the government adopted a stricter approach and began imposing a limit on the number of children per couple: a two-child limit was implemented nationwide in 1978 followed by the one-child policy announced in 1979. The one-child policy was enforced at the provincial level and some provinces have more relaxed restrictions. There were also exceptions to the policy. For instance, families whose first child is disabled were allowed to have a second child. Families in the rural areas were also allowed to have a second child if the first born was a girl. In 2015, the government abolished the one-child policy amid concerns over an aging population.

Between 1976 and 2015, Chinese life expectancy improved greatly, from a low of 57 years of age for a person at age 23 in 1979 to a high of 74 for the cohort at age 23 in 2015. For the life expectancy series, the year on the x-axis indicates cohort year, i.e., the year when the household turns 23.[1]

2.3 Credit Market Frictions

The Chinese economy experienced several major economic reforms since the late 1970s. The period between the late 1970s and the late 1990s is marked by the continued reallocation of labor from agriculture to nonagriculture sectors and a gradual privatization of state-owned firms in the nonagricultural sectors. The privatization of state-owned firms

[1]To arrive at the life expectancy at 23, we first obtain life expectancy at birth from the World Bank, and then adjust the rate by the mortality rate for those under 5 and the mortality rate for those between 6 and 14. After age 14, we assume the household's survival rate is 100 percent until it reaches the end of its life expectancy. In our calculation, we assume that the life span of those who passed away before age 5 had a life span of 2 years and those who passed away between the ages of 6 and 14 had a life span of 9. Given the death rate for those who passed away under age 5 x, and the death rate for those passed away between the ages of 6 and 14 y, and assume the life span of those born at a particular year to be l, then the life span of those who survived to age 15, z, is the solution to 2*x+9*(1-x)*y+(1-x)*(1-y)*z=1.

is partially accomplished by the introduction of credit policies that reduced financial frictions faced by privately owned enterprises in the labor-intensive sector. For instance, the lending market was gradually deregulated, allowing for both more competition and more flexibility in the pricing of loans (see Brandt, Hsieh, and Zhu 2008, Brandt and Zhu 2010, Hsieh and Klenow 2009, Song, Storesletten, and Zilibotti 2011, 2014, Hsieh and Song 2015). A direct consequence of this policy is that private firms accounted for an increasing share of total employment.

Starting in the late 1990s, however, the government started to implement credit policies that encouraged banks to favor state-owned enterprises (SOE), especially those in heavy industries. For example, Brandt and Zhu (2010) document that in 2007, more than half of all new capital formation went to the state sector. Bai, Lu, and Tian (2018) find that state-owned firms have higher leverage and pay much lower interest rates than nonstate-owned firms between 1997 and 2008. Cong, Gao, Ponticelli, and Yang (2019) show that, for manufacturing firms, the stimulus-driven credit expansion during 2009-2010 disproportionately favored state-owned firms and firms with a lower average product of capital, reversing the process of capital reallocation towards private firms that characterized China's high growth before 2008. Chen, Higgins, Waggoner, and Zha (2019) also find that bank credit in the 2000s, especially between 2009Q1 and 2010Q4, was disproportionally allocated to finance investment in real estate and heavy industries that were populated with state-owned firms.[2]

Besides the credit policies, during the last three decades, the Chinese government has made considerable effort to improve the financial system. For example, the government deregulated the lending rate, allowing for more competition and more flexibility in the pricing of loans. The increase in competition can be seen in the loan share of the four major state-owned banks, which fell from 61 percent in 1999 to 53 percent in 2004, and by the growing equity market (Podpiera 2006).

3 Related Literature

As alluded to in the introduction, the contribution of our paper lies not just in accounting for the growth dynamics of per capita output and the household savings rate over the last three decades but also demonstrating that there exist important interac-

[2]Chang, Chen, Waggoner, and Zha (2015) find that the share of SOEs in capital-intensive industries has increased steadily since the late 1990s.

tions between demographic aging and government credit policies. As such, our paper relates to three strands of literature that are not mutually exclusive. The first seeks to explain the fast growth of total output in China. The explanations explore the role of resource reallocation from agriculture to manufacturing and services (Brandt, Hsieh, and Zhu 2008, and papers cited therein), from state-owned enterprises to private enterprises (Brandt, Hsieh, and Zhu 2008, Hsieh and Klenow 2009, Song, Storesletten, and Zilibotti 2011, 2014, Chen and Irarrazabal 2015, and Liu, Spiegel, and Zhang 2018), or from the capital-intensive industrial sector to the labor-intensive industrial sector (Chang, Chen, Waggoner, and Zha 2015). This literature has mostly been growth accounting exercises with minimal or no modeling of the household side. Relative to this literature, our paper intends to capture the resource allocation/misallocation in a model that explicitly considers the role of household saving and human capital investment on economic growth. To simplify our analysis, we classify agriculture as part of the light industry as in Chang et al. (2015).

The second strand of literature focuses on the high savings rate China has experienced during this period, in particular high household savings. This strand of literature has attributed the high savings rate to the rising private burden of expenditure on education and health care (Chamon and Prasad 2010), long-term care risk (Imrohoroglu and Zhao 2018a), an unbalanced sex ratio (Wei and Zhang 2011), the one-child policy (Banerjee, Meng, Porzio, and Qian 2014, Curtis, Lugauer, and Mark 2015, Choukhmane, Coeurdacier, and Jin 2017, and Ge, Yang, and Zhang 2018), precautionary savings (Chamon, Liu, and Prasad 2013, and He, Huang, Liu, and Zhu 2018), structural shifts in life-cycle earnings (Song and Yang 2010), housing prices (Wang and Wen 2012, and Wan 2015), and the constraints of the household registration system (Chen, Lu, and Zhong 2015). The analyses are generally conducted either in a partial equilibrium framework with the wage and/or interest rate given exogenously or in an environment that has largely ignored the complexity of the evolution of production. Our paper contributes to this literature by adding rich firm dynamics and changing government credit policies and thus allows us to decompose the impact of various sources.

The third literature examines China's current account and implications of capital control policies. This literature includes Song, Storesletten, and Zilibotti (2014), Imrohoroglu and Zhao (2018b), and Liu, Spiegel, and Zhang (2018). Song et al. (2014) explore the effects of capital controls and policies regulating interest rates and the exchange rate. The key feature of their paper is asymmetric productivity and financial constraints faced by state and private firms. Imrohoroglu and Zhao (2018b) add to Song et al. (2014) by including declines in government as well as family insurance to elder households to account for increases in the current account. Liu et al. (2018) focus on the optimal capital account liberalization policies using a two-sector model that seeks to capture the same capital misallocation as those in Song et al. (2014) and Imrohoroglu and Zhao (2018b). Compared with these papers, our paper incorporates the recent government credit policy that favors heavy industry as documented in Chang et al. (2015). The modeling of credit policy is important as it helps account for the capital accumulation observed in more recent times. Furthermore, we add a detailed household sector to the model that complements those in Imrohoroglu and Zhao (2018b), yet differs in that we allow for endogenous human capital accumulation, which serves as an additional link between households and firms.

It is important to point out that our analysis is conducted in a general equilibrium framework with a balanced current account. In other words, we implement strict capital controls. We believe it is important to model the real interest rate in China as endogenous as during the period of our study, with the exception of the Great Recession, when the Chinese government issued a rescue package worth over 4 trillion RMB, the current account balance as a share of total GDP remained under 4 percent and Chinese financial markets were not fully integrated into world financial markets. Importantly, the household savings rate and the investment rate have generally tracked each other and are on the order of 40-50 percent of GDP.

4 The Model

We consider an overlapping-generation model where households are connected through inter-vivo transfers. Production takes place in two industries, capital-intensive industry and labor-intensive industry. While capital-intensive industry consists entirely of state-owned firms, labor-intensive industry contains both state-owned and private firms. The government pays for government policies and the pay-as-you-go social security system through labor income taxes.

4.1 Households

In each period t, a generation of households is born with human capital h. We denote a household's birth cohort by B. We thus have $j = t - B$, where j is the age of the household. A household begins to work at age J_1. It exits the economy at age J_B. The household gives birth to n_B ($n_B > 0$) children at age J_f and retires at age J_r, where $J_1 \leq J_f \leq J_r \leq J_B$. At each age, the household makes consumption and savings decisions. When its children are between the age of 16 and 22, the household also makes human capital investment decisions for them. Labor supply is inelastic. Starting from retirement age J_r, the household also receives transfers from its children, at which point the children would be $J_r - J_f$ years of age, and we assume that $J_f + J_1 \leq J_r$ to ensure that when the household retires, its children have already entered the economy. Additionally, the household receives a social security pension, which is a fraction ς_B of its earnings at the time of retirement. The population grows at an exogenous rate g_t. We omit the time t subscript or the cohort B subscript in our description of the household's problem below.

Labor income is subject to a payroll tax τ_{ss} with the revenue going towards pensions. Labor income as well as social security income are subject to an additional tax τ, which is used to fund government credit subsidizing policies.

We denote the consumption of an age-j household by c_j, savings by a_j, and children's human capital by $h_{c,j}$. The period utility function of a household of age j is

$$\frac{c_j^{1-\sigma}}{1-\sigma}, \tag{1}$$

where σ is the relative risk aversion parameter. The discount factor is denoted by β .

Labor productivity is deterministic and age dependent, with all workers of the same age j facing the same exogenous profile e_j. Given the household's human capital h, the total productivity of the household is given by he_j. Define a household's labor income as

$$E_{B,j} = h_B e_j w_t, \quad if\, j < J_r,$$

and after-tax labor income and pension as

$$y_{B,j} = \begin{cases} (1-\tau-\tau_{ss})E_{B,j}, & \text{if } j < J_r, \\ (1-\tau)\varsigma_B E_{B,J_r-1}, & \text{if } j \geq J_r. \end{cases} \tag{2}$$

That is, a household receives wage earnings before retirement and pension after retirement. Note the pension is taxed at rate τ, while labor income is taxed at rate $\tau + \tau_{ss}$.

We assume that a household spends a fraction Φ_1 of its wage income on each child's consumption until their children turn J_1 years of age. Children start receiving education at age 7. The first 9 years of education is mandatory, and each child's education costs a fraction Φ_2 of the household's wage income. The next 7 years' education is optional, and the level of investment i_h is chosen by the household in terms of efficiency units of labor. In the households' budget constraint, the human capital investment cost amounts to $i_h w$. We discuss this further in the next subsection. We assume that the human capital production function follows $h'_c = h_c + \eta_{j-J_f}(i^h)^\kappa h_c^{1-\kappa}$, where $0 \leq \kappa \leq 1$, and the parameter η_{j-J_f} governs the child-age dependent efficiency in human capital accumulation. This functional form is a slight modification of that used in Manuelli and Seshadri (2014). The transfer to the household's parents is a fraction $\mu_0 n_{B-J_f}^{\mu_1-1}$ of the wage income, where n_{B-J_f} is the number of kids the household's parents have. We assume $0 \leq \mu_1 \leq 1$ to capture the decline of each child's parental transfer with the number of siblings following Choukhmane et al. (2017).

4.1.1 Recursive Problems

Because we allow some parameters to vary by cohort, and because wages, interest rates, and taxes vary over the transition path, households at the same age but from different cohorts solve different problems. To summarize, a household's state space consists of its cohort B, age j, assets a, human capital h, and children's human capital h_c.[3] Table 1 describes a household's decisions at different ages. Let r_d represent the net deposit rate the household faces. We impose an exogenous borrowing constraint: At any given period, the household's financial asset must satisfy $a_j \geq 0$. The household then solves the following problem,

1. $J_1 \leq j < J_f + 7$: the household either does not have children or has children under the age of 7 who do not require formal education yet;

$$
\begin{aligned}
& V_B(j, a, h, h_c) = max_{\{c,a'\}}\{\frac{c^{1-\sigma}}{1-\sigma} + \beta V_B(j+1, a', h, h_c)\} \\
s.t. \quad & c + a' + 1_{(j<J_f)} n_B \Phi_1 E_{B,j} + 1_{(J_r - J_f \leq j < J_B - J_f)} \mu_0 n_{B-J_f}^{\mu_1-1} E_{B,j} \leq (1+r_d)a + y_{B,j}, \\
& a', c \geq 0.
\end{aligned} \tag{3}
$$

[3]Under our modeling structure, once cohort and age are given, the number of siblings and the number of children are determined and, thus, are not state variables.

The left hand side of the budget constraint includes consumption, savings, basic living expense for the children if the household is older than J_f, and the transfer the household makes to its parent when the parent is J_r years of age or older and hasn't exited the economy yet.[4] The right hand side of the budget constraint contains the household's asset plus interest income and after tax labor income.

2. $J_f + 7 \leq j < J_f + 16$: the household has children that must receive mandatory primary as well as middle school education;

$$
\begin{aligned}
& V_B(j,a,h,h_c) = max_{\{c,a'\}}\{\frac{c^{1-\sigma}}{1-\sigma} + \beta V_B(j+1,a',h,h_c)\} \\
s.t. \quad & c + a' + n_B\Phi_1 E_{B,j} + n_B\Phi_2 E_{B,j} + 1_{(J_r - J_f \leq j < J - J_f)}\mu_0 n_{B-J_f}^{\mu_1 - 1} E_{B,j} \leq (1+r_d)a + y_{B,j}, \\
& a', c \geq 0. \qquad (4)
\end{aligned}
$$

Relative to households in the first age group, the household now needs to pay for its children's mandatory education, captured by the fourth term in the budget constraint.

3. $J_f + 16 \leq j < J_f + J_1$: the household has children who are eligible for optional high school as well as college education;

$$
\begin{aligned}
& V_B(j,a,h,h_c) = max_{\{c,a',i^h\}}\{\frac{c^{1-\sigma}}{1-\sigma} + \beta V_B(j+1,a',h,h_c')\} \\
s.t. \quad & c + a' + n_B\Phi_1 E_{B,j} + n_B i_h w + 1_{(J_r - J_f \leq j < J_B - J_f)}\mu_0 n_{B-J_f}^{\mu_1 - 1} E_{B,j} \leq (1+r_d)a + y_{B,j}, \\
& h_c' = h_c + \eta_{j-J_f}(i^h)^\kappa h_c^{1-\kappa}, \qquad (5) \\
& a', c \geq 0, \quad h_c' \geq h_c. \qquad (6)
\end{aligned}
$$

The household now makes human capital investment decisions for its children, and the associated expenditure is captured by the fourth term in the budget constraint $n_B i_h w$. The law of motion for the children's human capital is represented by equation (5), which combines the children's existing human capital with that of investment in a Cobb-Douglas functional form. As discussed earlier, η_{j-J_f} denotes efficiency in human capital accumulation, which is a function of the children's age.

[4]Since a parent gives birth at age J_f, an individual of age j has a parent of age $j + J_f$.

4. $J_1 + J_f \leq j < J_B$: the household no longer has school-age children;

$$
\begin{aligned}
& V_B(j, a, h, h_c) = max_{\{c,a'\}}\{\frac{c^{1-\sigma}}{1-\sigma} + \beta V_B(j+1, a', h, h_c)\} \\
s.t. \quad & c + a' + 1_{(J_r - J_f \leq j < J_B - J_f)}\mu_0 n_{B-J_f}^{\mu_1 - 1} E_{B,j} \leq (1 + r_d)a + y_{B,j} + 1_{(j \geq J_r)}\mu_0 n^{\mu_1} h_c e_{,j-J_f} w, \\
& a', c \geq 0. \qquad (7)
\end{aligned}
$$

At this age group, as in age groups 1 and 2, the household makes only consumption and savings decisions. Its children have left the household and no longer cost anything. The household starts receiving transfer payments from the children after retirement, as captured by the last term on the right hand side of the budget constraint.

4.2 Firms

The economy consists of four sectors, two intermediate goods sectors, one final goods sector, and one education sector. The two intermediate goods sectors differ in their productivity, capital intensity, ownership structure, and importantly the subsidies they receive from the government. We term the sector that uses capital more intensively the capital-intensive sector or heavy-industry sector, and the sector that uses labor more intensively the labor-intensive sector or light-industry sector. This modeling choice, thus, combines the two approaches adopted in the literature on the Chinese economy as represented by Song et al. (2011), Chang et al. (2015), and researchers cited in their respective papers. It also captures important features of the Chinese economy: that the privatization of state-owned enterprises has been concentrated mostly in the labor-intensive sector, including agriculture, and the capital-intensive sector is dominated by state-owned enterprises that enjoy heavy subsidies from the government.

4.2.1 The Final Goods Sector

We denote final goods at time t by Y_t, which is a CES aggregate of the two intermediate goods:

$$Y_t = (\varphi Y_{k,t}^{\frac{\gamma-1}{\gamma}} + Y_{l,t}^{\frac{\gamma-1}{\gamma}})^{\frac{\gamma}{\gamma-1}}. \qquad (8)$$

The subscripts k and l stand for capital- and labor-intensive intermediate goods, respectively, and γ denotes the elasticity of substitution between the two intermediate goods. We normalize the price of the final good to be 1, and use $P_{k,t}$ to denote the price of the capital-intensive intermediate good, and $P_{l,t}$ the price of the labor-intensive intermediate goods. The firm's optimization problem implies

$$\frac{Y_{k,t}}{Y_{l,t}} = (\frac{\varphi P_{l,t}}{P_{k,t}})^{\gamma}. \tag{9}$$

The zero-profit condition for the final good further implies

$$[\varphi^{\gamma} P_{k,t}^{1-\gamma} + P_{l,t}^{1-\gamma}]^{\frac{1}{1-\gamma}} = 1. \tag{10}$$

4.2.2 The Capital-Intensive Intermediate Goods Sector

Motivated by the empirical evidence documented in, among others, Chang et al. (2015), we assume that the capital-intensive sector is populated entirely by state-subsidized enterprises. The production function takes the following Cobb-Douglas form:

$$Y_{k,t} = K_{k,t}^{\alpha_k}(A_{k,t}L_{k,t})^{1-\alpha_k}, \tag{11}$$

where $K_{k,t}$ and $L_{k,t}$ represent capital rented from households and efficient labor inputs, respectively, and $A_{k,t}$ denotes labor augmenting technology. The parameter α_k represents the capital income share in the production of the intermediate goods. The firms in this sector solve the following problem,

$$max_{K_{k,t},L_{k,t}}\{P_{k,t}K_{k,t}^{\alpha_k}(A_{k,t}L_{k,t})^{1-\alpha_k} - (r_{f,t}+\delta)(1-S_{k,t})K_{k,t} - w_t L_{k,t}\}, \tag{12}$$

where $r_{f,t}$ denotes the gross interest rate that is common to both the capital-intensive and the labor-intensive sectors; $S_{k,t}$ $(0 \leq S_{k,t} < 1)$ denotes the proportional interest subsidy firms in the capital-intensive sector receive from the government; δ represents the capital depreciation rate, and w_t is the wage rate per effective unit of labor that is also common to both sectors. Profit maximization generates the following two first-order conditions,

$$(r_{f,t}+\delta)(1-S_{k,t}) = \alpha_k P_{k,t} A_{k,t}^{1-\alpha_k} K_{k,t}^{\alpha_k-1} L_{k,t}^{1-\alpha_k}, \tag{13}$$

$$w_t = (1-\alpha_k) P_{k,t} A_{k,t}^{1-\alpha_k} K_{k,t}^{\alpha_k} L_{k,t}^{-\alpha_k}. \tag{14}$$

Note that we use different notation for the deposit rate and the rate of return to capital, where the difference $\xi_t = r_{f,t} - r_{d,t}$ represents an intermediation cost.

4.2.3 The Labor-Intensive Intermediate Goods Sector

We assume that the labor-intensive sector consists of state-owned and privately owned enterprises. We wish to highlight some important differences between the two type of firms. First, state-owned firms are generally weaker in governance and offer fewer incentives to their managers than private firms. Second, compared with private firms, state-owned firms have better access to borrowing because of their close connection with state-owned banks. This second feature also motivated our modeling of the interest rate subsidy as proportional to the interest rate. Thus, the key differences between the two types of firms are their labor productivity and costs of capital.

We assume that private enterprises have a higher labor productivity and are subject to a higher cost of financing capital in the form of a tax, while the state-owned enterprises receive an interest rate subsidy. In order to capture the effects of a changing mix of firms in this sector, we employ decreasing returns in private inputs as well as an exogenous externality in production to guarantee balanced growth along with an operating cost measured in labor hours that is proportional to the number of i type firms in the sector, where $i = s, p$ (s indicates state-owned firms and p indicates private firms). A zero profit condition allows us to pin down the number of firms $N_{l,i,t}(i = s, p)$ of each type and to endogenize the evolution of the relative share of private and state owned firms in this sector. We assume that firms in each type are symmetric.

Let $K_{l,i,j,t}$ and $L_{l,i,j,t}$ ($i = s, p,\ j = 1, 2, ..., N_{l,i,t}$) denote the capital input and labor input, respectively, employed by firm j of type i at time t in the labor-intensive sector. Let $K_{l,i,t}$ and $L_{l,i,t}$ denote the total capital and labor input, respectively, employed by type i firms, and let $K_{l,t}$ and $L_{l,t}$ denote total capital and labor inputs in the labor-intensive sector at time t. Given the symmetry assumption, we then have $K_{l,i,j,t} = \frac{K_{l,i,t}}{N_{l,i,t}}$ and $L_{l,i,j,t} = \frac{L_{l,i,t}}{N_{l,i,t}}$. Additionally, $K_{l,t} = K_{l,s,t} + K_{l,p,t}$ and $L_{l,t} = L_{l,s,t} + L_{l,p,t}$. The production function of firm j of type i in the labor-intensive sector at time t is as follows,

$$Y_{l,i,j,t} = (K_{l,i,j,t})^{\alpha_l}(A_{l,i,t}L_{l,i,j,t})^{\gamma_l}(K_{l,t})^{1-\alpha_l-\gamma_l}. \tag{15}$$

The parameter α_l indicates capital income share, γ_l indicates labor income share, with $0 < \alpha_l + \gamma_l < 1$, and $A_{l,i,t}$ indicates labor augmenting technology. Note that the production function includes aggregate capital in the sector $K_{l,t}$ as an additional input, which introduces an externality that is necessary to ensure balanced growth. The higher the total capital used in the sector, the more productive firms are. This setup allows both types of firms to coexist in the labor-intensive sector as the production function, without aggregate capital, exhibits decreasing return to scale. Finally, there is a cost of production, $w_t f_{l,i} L_{l,i,t}$, which is a function of the wage rate w_t, and the total labor input $L_{l,i,t}$. The term $f_{l,i}$ is a scaling factor.[5]

We can now write the firm's problem as follows,

$$max_{\{K_{l,i,j,t},L_{l,i,j,t}\}}\{P_{l,t}(K_{l,i,j,t})^{\alpha_l}(A_{l,i,t}L_{l,i,j,t})^{\gamma_l}(K_{l,t})^{1-\alpha_l-\gamma_l}-(r_{f,t}+\delta)(1-S_{l,i,t})K_{l,i,j,t}$$
$$-w_t L_{l,i,j,t}-w_t f_{l,i}L_{l,i,t}\}, \quad (16)$$

where $S_{l,i,t}(i=s,p)$ represents the interest subsidies if $(0 \leq S_{l,i,t} < 1)$ or a tax if $S_{l,i,t}$ is negative. The first order conditions from the profit-maximization problem are,

$$(r_{f,t}+\delta)(1-S_{l,i,t}) = \alpha_l P_{l,t}(A_{l,i,t})^{\gamma_l}(K_{l,i,j,t})^{\alpha_l-1}(L_{l,i,j,t})^{\gamma_l}(K_{l,t})^{1-\alpha_l-\gamma_l}, \quad (17)$$
$$w_t = \gamma_l P_{l,t}(A_{l,i,t})^{\gamma_l}(K_{l,i,j,t})^{\alpha_l}(L_{l,i,j,t})^{\gamma_l-1}(K_{l,t})^{1-\alpha_l-\gamma_l}. \quad (18)$$

The profit for each firm is then,

$$\pi_{l,i,j,t} = (1-\alpha_l-\gamma_l)P_{l,t}(K_{l,i,j,t})^{\alpha_l}(A_{l,i,t}L_{l,i,j,t})^{\gamma_l}(K_{l,t})^{1-\alpha_l-\gamma_l} - w_t f_{l,i}L_{l,i,t}. \quad (19)$$

In equilibrium, the total number of firms will be determined so that the profit for each firm is zero, $\pi_{l,i,j,t}=0$.

4.2.4 The Education Sector

For simplicity, we assume a linear technology that transforms one unit of efficiency labor input into one unit of human capital investment. As such, i_h units human capital investment will cost the equivalent of $i_h w$ units of final goods.

[5]This particular functional form for production cost allows the cost to grow at the same rate as output while the total number of firms of the same type does not change and, thus, helps reserve balanced growth at steady state. Our model is parsimonious in its modeling of firm sizes. We make no attempt to match the Chinese firm dynamics in this paper.

4.3 The Government

The government chooses tax rates and interest subsidies $\{\tau_t, \tau_{ss,t}, S_{k,t}, S_{l,s,t}, S_{l,p,t}\}$ in this economy. Let $\Lambda_{j,t}$ denote the measure of households at age j and time t. We then have

$$\sum_{j=J_r}^{J_B-1} \Lambda_{j,t}\varsigma_B h_B e_{J_r-1} w_{B,J_r-1} = \tau_{ss,t} \sum_{j=J_1}^{J_r-1} \Lambda_{j,t} h_B e_j w_t, \tag{20}$$

$$\begin{aligned}(r_{f,t}+\delta)S_{k,t}K_{k,t} + \sum_{i=s,p}(r_{f,t}+\delta)S_{l,i,t}K_{l,i,t} = \tau_t[&\sum_{j=J_1}^{J_r-1}\Lambda_{j,t}h_B e_j w_t \\ &+ \sum_{j=J_r}^{J_B-1}\Lambda_{j,t}\varsigma_B h_B e_{j-1} w_{B,J_r-1}].\end{aligned} \tag{21}$$

Note that B denotes cohort, or the year the household was born, $B = t - j$.

4.4 Equilibrium

The competitive equilibrium consists of prices $\{P_{k,t}, P_{l,t}, w_t, r_{k,t}, r_{d,t}\}_{t=0}^{\infty}$, government policies $\{\tau_{ss,t}, \tau_t, S_{k,t}, S_{l,s,t}, S_{l,p,t}\}_{t=0}^{\infty}$, allocations $\{Y_{l,i,j,t}, K_{l,i,j,t}, L_{l,i,j,t}\}_{i=s,p;\, j=1,..,N_{l,i,t};\, t=0,..,\infty}$, $\{Y_{k,t}, Y_{l,t}, Y_{l,s,t}, Y_{l,p,t}, K_{k,t}, K_{l,s,t}, K_{l,p,t}, L_{k,t}, L_{l,s,t}, L_{l,p,t}, N_{l,s,t}, N_{l,p,t}\}_{t=0}^{\infty}$, $\{c_{j,t}, a_{j,t}, i^h_{j,t}\}_{j=j_1,..,J;\, t=0,..,\infty}$, and population measure $\{\Lambda_{j,t}\}_{j=j_1,..,J, t=0,..,\infty}$ such that

1. Households maximize utility;
2. Firms maximize profits;
3. Markets clear,
   (a) Goods market: all goods produced by firms are purchased by households;
   (b) Capital market: firms rent capital from households, $\sum_{j=J_1}^{J_B-1} \Lambda_{j,t} a_{j,t} = K_{k,t} + K_{l,s,t} + K_{l,p,t}$;
   (c) Labor market: households supply labor to firms, $\sum_{j=J_1}^{J_r-1} \Lambda_{j,t} h_{j,t} e_j = L_{k,t} + L_{l,s,t} + L_{l,p,t} + \sum_{j=J_1}^{J_r-1} \Lambda_{j,t} i^h_{j,t} n_B$;
4. Government balances the budget.

4.5 Balanced Growth Rates Along the Steady State

Assuming that along the steady state, population grows at rate g_{pop} and labor augmenting technology at all firms grows at rate g_A, then the other variables in the economy will grow at rates as specified in Table 2. To highlight a few, given that human capital investment is specified in terms of efficiency labor units, in the steady state, i_h will remain constant. Our modeling of the labor-intensive sector implies that the number of firms of each type within the sector is constant. The growth rates of the other variables are straightforward.

5 Calibration of the Model

We set our initial steady state to be in 1976. To compute the transition dynamics, given all the exogenous processes discussed above, we find the equilibrium path with a guess on the sequence of interest rates, wages, prices of the intermediate goods, and government income taxes. Using this guess, we solve for consumption, saving, and human capital investment in children for each cohort, and solve the firm's problem each year. We search over the sequences of interest rates, wages, prices of the intermediate goods, and government income taxes until we reach a fixed point. To simplify our computation, the payroll tax rate during transition is calculated each period using the ratio of retirees to the working age population. Therefore, the government's pension expense doesn't always break even along the transition path. The remaining revenue, if there is any, is used to reduce the labor income tax required for the government to break even in implementing credit policies.

The model contains parameters that are fixed over time and stochastic processes that vary over time. We calibrate our fixed parameters and time-varying processes in two stages. In the first stage, we choose some fixed parameters either from the literature or from the data. In the second stage, we jointly calibrate the remaining fixed parameters and exogenous time-varying processes to match certain moments and time-series along the transition path. We do so for fixed parameters because data are limited for some of the earlier years that corresponds to our initial steady state, making it infeasible to identify fixed parameters from the initial state state alone.

5.1 First-Stage Calibration

The first-stage calibration choices are reported in Table 3.

5.1.1 Households

We assume that a household enters the economy at age 23, gives birth to its children at age 25, and retires at age 55. For preferences, we assume a relative risk aversion parameter of one, so that utility is logarithmic. The parameters governing educational expenses, child living expenses, and transfers to parents mostly follow Choukhmane et al. (2017). In particular, we set the living expense of a child as a percent of his parents' labor income to 4 percent (Φ_1). The mandatory education expense parameter Φ_2 is set to match the average 3 percent of income that urban households spend on their children's mandatory education (Figures 3 and 7 of Choukhmane et al. 2017). The parameters describing the transfer payments to parents ($\mu_{0,}$ μ_1) are also taken from Choukhmane et al. (2017).

5.1.2 Firms

Turning to firms, the capital income share of the capital-intensive and labor-intensive sectors, α_k and γ_l, are calibrated to match the respective capital income and labor income shares of the two industries using data provided by Chang et al. (2015).[6,7] The share of capital-intensive sector output in final output as well as the elasticity of substitution between the capital-intensive and labor-intensive sector are chosen according to Chang et al. (2015), who estimate the parameters to match the dynamics of the ratio of output in the capital-intensive sector to that in the labor-intensive sector. The depreciation

[6]Chang et al. (2015) collect their data from two databases: the CEIC (China Economic Information Center, now belonging to the Euromoney Institutional Investor Company) database – one of the most comprehensive macroeconomic data sources for China – and the WIND database – the data information system created by the Shanghai-based company called WIND Co. Ltd., the Chinese version of Bloomberg. The major sources of these two databases are the National Bureau of Statistics (NBS) and the People's Bank of China (PBC) augmented with China Industrial Economy Statistical Yearbooks and China Labor Statistical Yearbooks.

[7]The heavy industry sector includes real estate, leasing and commercial service; electricity, heating and water production and supply; coking, coal gas and petroleum processing; wholesale, retail, accommodation and catering; banking and insurance; chemical; mining; transportation, information transmission and computer services and software. The light industry sector includes food, beverage and tobacco; other manufacturing; metal product; machinery equipment; construction material and nonmetallic mineral product; textile, garment and leather; construction; other services; and farming, forestry, animal husbandry and fishery (Table 11 of Chang et al. 2015).

rate δ is set at a standard 8 percent. We choose g_A so that the growth of GDP in our initial steady state matches per capita GDP growth rate of 2 percent before 1976.

5.2 Second-Stage Calibration

The second-stage calibration includes a set of fixed parameters and all exogenous processes.

5.2.1 Parameters Fixed Over Time

For the household, these fixed parameters include the discount rate β, labor efficiency profiles $\{e_j\}$, the efficiency of human capital investment by children's age $\{\eta_j\}_{j=16}^{22}$, and the weight on human capital investment in the human capital accumulation technology κ. On the firm's side, the parameters include those related to the fixed costs, $\{f_{l,s,}, f_{l,p}\}$, the initial levels of labor augmenting technology in the capital-intensive sector $\{A_k\}$ and in the labor-intensive sector $\{A_{l,s}, A_{l,p}\}$, and the capital income share in the labor-intensive sector α_l.

The targeted moments include the the age profile of earnings in 1992, the age profile of discretionary education expenditures in 2002, the deposit rate faced by households, the relative labor augmented TFP of private firms to state firms in labor-intensive sector, the average relative capital-output ratio of state and private enterprises in 1998-2005. We also normalize the wage rate in 1976 to be 1 and the number of firms in the labor intensive sector to be 1.

We report parameters calibrated in the second stage in Table 4. Note that because our overlapping generations framework abstracts from uncertainties in income, expenditure, and the pension, the model requires a discount factor that is slightly larger than 1 to be consistent with the observed savings rate.[8] As mentioned earlier, the adoption of a decreasing return to scale technology in the labor-intensive sector allows for the co-existence of state and private enterprises when their output are perfect substitutes. Under our assumption, the number of private versus state firms is fixed. Note that under our calibration, the externality from the aggregate capital stock in the production function of the labor-intensive sector, at 0.08, is very small. In Table 5, we present our calibration results. Our model does a reasonably good job at matching the data moments reported there.

[8] For the importance of these risks in explaining Chinese households' savings over time, see the papers cited in the related literature section.

In Figure 3, we depict the model-generated earnings profile in 2002 and the data counterpart from Choukhmane et al. (2017), who in turn obtained it from the Urban Household Survey. In terms of human capital investment, our estimate indicates a declining efficiency with respect to age $\{\eta_j\}_{j=16}^{22}$. We present the age-specific educational expenditure data versus model generated data in Figure 4.[9]

5.2.2 Exogenous Processes

We now describe the calibration of the exogenous processes in the model. In Figure 5 Panels a and b, we chart the life expectancy at age 23 and birth rates per adult in the model against their counterparts in the data, respectively. Note that life expectancy in the model is discrete and can only be increased by integer numbers since the model period is one year. This introduces non-smoothness in aggregates as we discuss in the next section. According to the panel, life expectancy at 23 increases from 57 in 1976 to 80 shortly after 2040. We assume that in the final steady state households expect to live to 80 years of age.

The fertility rate in the initial steady state is chosen to match the population growth rate of 2.05 percent between 1970 and 1976 (World Bank). We assume that in the final steady state, a one-parent household bears 0.75 child at age 25, which is the average fertility rate between 2000 and 2010.[10] We then fit a gradual change of birth rate in the model to match the data.[11]

The pre-1997 urban pension system was primarily based on state and urban collective enterprises in a centrally planned economy. Retirees received pensions from their employers, with replacement rates that could be as high as 80 percent in state-owned enterprises. The coverage, however, was low in private enterprises, especially in rural areas (see, e.g., Sin 2005). Given that 75 percent of the population lived in the rural areas in 1980, we chose a pension replacement rate of 45 percent for the general population for our baseline calibration ς_B. The pension replacement rate declines linearly from 45 percent in 1975 to 20 percent shortly before 2000 and stays there afterwards.[12]

[9]To reduce the number of parameters, we estimate the efficiency function as a polynomial of degree 2 with respect to age.

[10]Since our household consists of a single adult, we divide the average number of children per household 1.5 by 2 to obtain 0.75.

[11]Since fertility is fixed at age 25, to generate a gradual change of population distribution, the change of fertility has to follow a constant rate and to stop in 25 years.

[12]The Chinese government provided widespread pension coverage before the 1980s. The reforms introduced since then have been incomplete and insufficient. Gu and Vlosky (2008) report that in 2002 and 2005, 40-50 percent of the elderly in cities and more than 90 percent of the elderly in rural

The time series of intermediation cost and three credit subsidy rates are chosen to match the overall capital-output ratio in the economy, the relative output as well as the relative capital in the capital-intensive sector to that in the labor-intensive sector, as well as the changing employment share of private firms between 1980 and 2012. The aggregate capital-output ratios over time are constructed from the Penn World Table. The data on the relative output and relative capital are taken directly from Chang et al. (2015). The private employment share is constructed as follows. Using the 2012 Chinese Statistical Yearbook Table 4-2 ("Number of Employed Persons at Year-end in Urban and Rural Areas"), we count individuals as working in private firms if they do not work in either state-owned units or collective-owned units in urban areas, are self-employed, or work in private enterprises in rural areas.

Figure 6 depicts the four exogenous processes on the firm side. Each of those processes is estimated using a logistic function with a 6th-order polynomial.[13] Thus, in total, there are 24 parameters to be estimated. The resulting three subsidy rates are shown in Panel a. We normalize interest subsidies in the capital-intensive sector and state labor-intensive-sector to be zero in the initial steady state. The negative large interest subsidy or tax is necessary to ensure a very small private sector in the initial steady state as seen in the data. We assume that in the final steady state, no interest subsidies apply to any industry or any type of firm, and we also set intermediation costs to zero.

According to Figure 6 Panel a, credit taxes to private labor-intensive firms begin to decline in 1977 and are largely gone by 2005, consistent with the narrative of the first stage of the financial reform discussed in Section 2.3. Credit subsidies to state-owned labor-intensive firms barely change in 1977 but pick up in the 1990s. These subsidies peak in 2010, coinciding with the peak in bank loan growth rates, which occurred at the height of the government fiscal stimulus plan (Figure 1 in Chen et al. 2017). Credit subsidies to capital-intensive firms are instituted later, accelerate in the mid to late 1990s, which is consistent with with the narrative on financial regression given in section 2.3. Subsidies to the capital-intensive firms peak in 2025. Although the large fiscal stimulus plan ended in 2010, the data show that the bank loan-to-GDP ratio remains elevated

areas did not have a pension. According to Song et al. (2014) and Sin (2005), the Chinese pension system provided a replacement rate of 60 percent to those retiring between 1997 and 2011 who were covered by the system. As the urban population was less than 40 percent of the Chinese population from 1980-2011, the pension coverage rate is calibrated to be 20 percent of the population.

[13]Specifically, we assume that the credit subsidy rate $S_{i,j,t}$ follows the following process, $S_{i,j,t} = exp(\iota_{i,j,0}+\iota_{i,j,1}t+\iota_{i,j,2}t^2+\iota_{i,j,3}t^3+\iota_{i,j,4}t^4+\iota_{i,j,5}t^5)/[1+exp(\iota_{i,j,0}+\iota_{i,j,1}t+\iota_{i,j,2}t^2+\iota_{i,j,3}t^3+\iota_{i,j,4}t^4+\iota_{i,j,5}t^5]$. A similar expression is used for the process of the intermediation cost.

well into 2016 (Chen et al. 2017). Note that we do not pick the peak of any of the subsidy rates, rather the shapes of the subsidy rates are jointly determined so that the model reaches towards the final steady state determined by the fixed parameters we assume and generates a transition path that fits the data moments described in Figure 7.

The intermediation cost follows the logic of Song et al. (2011) and captures operational costs, red tape, etc. In other words, this cost is an inverse measure of the efficiency of intermediation. Panel b of Figure 6 charts the intermediation cost, that is, the wedge between the deposit rate and the capital rental rate faced by the firms, absent credit subsidies. We estimate the initial intermediation cost to be 9.52 percent. The intermediation cost falls to zero by 2050.

In Figure 7, we chart model implications against data for targeted statistics on the firm's side: the ratio of output in the capital-intensive sector to the output in the labor-intensive sector, the ratio of capital input in the capital-intensive sector to that in the labor-intensive sector, private firms' employment share in total employment, and the overall capital-output ratio in the economy. The model does a good job fitting these targeted moments. Since the 1990s, capital-intensive heavy industry has become increasingly important both in terms of capital input and in terms of total output. Private firms have also become increasingly important. Their share of employment went from near zero in the early 1980s to over 40 percent by 2015. The economy-wide capital-output ratio has also been trending up during our sample period.

6 Transition Dynamics

6.1 Non-targeted Data Moments Versus Model Implied Moments

In this section, we describe the model's fit of some key data moments that were not used in parameterizing the model. Therefore, how well the model accounts for these data represents a test of the model's capabilities. Figure 8 presents both the model-implied data and the actual data regarding the young-age dependency ratio. The model matches the fast aging of the Chinese population quite well. In 1976, the young-age dependency ratio was over 75 percent. By 2012, the ratio declined to 35 percent.

In Figure 9, we chart the price dynamics of wage growth and return to capital net of depreciation. The data on wage growth come from the Chinese Statistical Yearbook of various years. It is an average of state-owned units, urban collective-owned units, and units of other types of ownership. While our model-implied wage growth rates fall below the data, they do capture the general upward trend. The model-implied marginal product to capital exhibits a downward trend, consistent broadly with those calculated in Bai et al. (2006), especially the return of capital net of taxes on output (their Figure 7), which we include as our data here.

We now turn to the two aggregate series that are of particular interest to us: aggregate savings as a ratio of total output and per capita output growth. Figure 10 charts the two series. The aggregate savings rate is provided by Chang et al. (2015). To arrive at the per capita output growth, we first dividereal GDP at chained PPPs (2011 US $) by total population, both of which are obtained from the Penn World Table, take the growth rates, and then HP filter the series.

The model captures the increasing pattern of savings rate reasonably well, although it under-predicts the savings rate for the periods before 1995 and misses the decline between 1995 and 2000. Note that the model includes an exogenous 2 percent of output growth per capita through the exogenous changes in the labor augmenting technologies. The model generates substantially greater that 2 percent growth due to endogenous behavioral responses to the changes in demographics and credit market frictions. Since the model abstracts from business cycle fluctuations, it could not match the fluctuations of growth rate in GDP per capita. Finally, as mentioned earlier, the discrete change in life expectancy leads to sudden increases of retirees. As a result, the savings rate and per capita output growth exhibit zig-zag patterns, especially with respect to per capita output growth.

6.2 The Transition Path

To understand the time paths of the aggregate savings rate and the per capita output growth rate, we present summary statistics regarding the benchmark transition dynamics in Table 6. We divide time into four periods: 1977 to 1991; 1992 to 2006; 2007 to 2021; and 2022-2071. The numbers are annual growth rates averaged over the years covered, with the exception of the savings rate and the interest rate, which are in levels.

In the benchmark model, we observe that total growth of per capita GDP increases gradually, peaking during the years between 2007 and 2021, before slowing down to 2 percent in the final steady state. The savings rate exhibits a similar pattern, as does the interest rate, the wage growth rate, the per capita capital growth, and the per capita labor growth rate. Note that the population growth rate consistently falls to a negative 1.14 percent in the final steady state, a direct result of the implementation of the one-child policy, which was initially offset by the increase in life expectancy.

The dynamics of capital per capita is driven by both the demand and the supply of capital. All changes on the household side, the lower fertility rate, the lengthened life expectancy, and the reduction in pensions, lead households to save more. The increase of the subsidy rates for various types of firms and the reduction of intermediate costs lead to an increase in the demand for capital in the first 5 decades. In other words, the increase of both the demand of capital and the supply of capital lead to a drastic rise of savings rate and capital per capita. After 2021, the gradual drop in the interest rate subsidy leads to a decline in capital demand, and, thus, a reduction in the savings rate and capital per capita.

The fast growth of labor per capita is a result of endogenous human capital accumulation in the model. All changes on the household side, especially the lower fertility rate and the lengthened life expectancy, encourage households to invest more in their children's human capital as transfer payments from children serve as an annuity in their old age. The resulting higher human capital leads to an increase in the effective labor supply.

The total factor productivity (TFP), computed as the Solow residual, in the capital-intensive sector is constant, while TFP in the labor-intensive sector exhibits a hump-shape, peaking in the period between 1992 and 2006.[14] Although labor augmenting technologies for all three types of firms grow at the same constant rate, TFP in the labor-intensive sector grows faster than TFP in the capital-intensive sector during the transition path because of the shift of production from less productive state-owned firms to more productive private-owned firms. Thus, during the transition, per capita capital growth, per capita labor growth, and TFP growth in the labor-intensive sector all contribute to per capita GDP growth.

[14]We calculate the TFP for the capital-intensive sector as $\frac{Y_{kt}}{K_{kt}^{\alpha_k} L_{kt}^{(1-\alpha_k)}}$. We approximate the TFP for the labor-intensive sector by $\frac{Y_{lt}}{K_{lt}^{(1-\gamma_l)} L_{lt}^{\gamma_l}}$.

7 Decomposing the Savings Rate and the Output Growth Rate

This section provides a decomposition of the impact of demographic changes represented by the increase in longevity, the implementation of the one-child policy, and the reduction in the pension replacement rate. We also analyze, in detail, the effects of credit policy changes characterized by credit subsidies to different industries and different enterprises in shaping the time-series path of the aggregate savings rate as well as the per capita output growth rate. We do this by running a sequence of counterfactual experiments where we implement demographic changes or credit policy changes with each change being examined in isolation. The interest rate, the wage rate, and relative prices are all solved in general equilibrium. The payroll tax rate is calculated as discussed above, that is, using the fraction of retirees. As in the benchmark, the income tax rate together with any possible surplus or deficit due to payroll tax revenue funds government credit subsidies. In our discussion, the percentage contribution is calculated by dividing the changes in savings rate or per capita output growth associated with each policy change by that in the benchmark analysis.

7.1 The Role of Demographic Changes

We now investigate the role that demographics play in shaping the time path of the aggregate savings rate and the per capita output growth rate absent any changes in credit policies. In each experiment, interest rate subsides and intermediation costs are fixed as in the initial steady state.

7.1.1 Demographic Changes in Isolation

In the top panel of Table 7, we report the results where only life expectancy increases over time. We then report results where we either implement the one-child policy or reduce the pension replacement rate. Of the three factors that we study, increases in longevity have the most impact on the economy. Compared with the benchmark economy, they alone account for almost all of the rise in GDP per capita and 30 percent of the rise in the savings rate after 2007. These effects come mostly from household saving more for retirement (recall that households retire at age 55) as indicated by the rise in the per capita capital stock. Per capita labor efficiency, on the other hand, rises more slowly as more educated young people gradually enter the labor force. Given the extra incentive to save, interest rates during the transition are lower than they are in the benchmark. Wage growth is also weaker in the transition than it is in the benchmark.

The reduction in the fertility rate raises GDP per capita immediately. It alone accounts for almost half of the rise in GDP per capita in the first 15 years and one-third of the rise in the next 15 years. Though the rise continues till 2071, it is much slower than that in the benchmark. As households now invest more in their children's human capital for old age transfer payments, labor per capita increases. It alone accounts for almost all of the rise in labor per capita in the first 15 years and three-fourths of the rise in the next 15 years. Interest rates decline, but wage growth rates rise. The rise in the growth of per capita capital comes entirely from drops in total population, thus, total capital grows at about the same rate as that in the initial steady state. This is confirmed by the fact that the savings rate barely changes along the transition. TFPs in both sectors hardly move. Thus, we conclude that the increase in the growth rate of GDP per capita comes from the increase of both capital per capita and labor per capita.

Finally, without changes in the fertility rate and, more importantly, without changes in life expectancy, reductions in the pension replacement rate do not have much impact on the economy. What drives this result is that households initially live only two years after retirement, too short for the pension replacement rate to matter greatly.

We have also conducted experiments where we implement the new life expectancy path together with either the decline in the fertility rate or the decrease in the pension replacement rate. To save space, we do not present the results in the table. Not surprisingly, the effects are now larger than when we implement either the decline in the fertility rate or the decrease in the pension replacement rate alone, though it remains that the bulk of the changes come from the lengthening of the life expectancy. Put differently, the increase in the life expectancy plays a crucial role in driving the rise in the savings rate and the growth in per capita output, and the decline in the fertility rate and the drop in the pension replacement rate help magnify these effects.

7.1.2 Demographic Changes Combined

We now conduct our final demographic change experiment, where we implement all three changes together but still abstract any credit policy changes. The results are reported in Table 8. As can be seen, demographic changes account for over half of the per capita output growth prior to 2007 and all of its growth after 2007. In terms of savings, demographic changes account for over one-fourth of the rises in savings rate. Some of the rise in per capita output growth comes from the reduction in population, while others parts of the rise come from capital deepening as well as human capital accumulation.

7.2 The Role of Credit Policies and Financial Development

We now turn to investigate how credit policies and intermediation costs help shape the time path of the aggregate savings rate as well as per capita output growth. In each experiment, demographics are fixed as in the initial steady state.

7.2.1 Credit Policy Changes in Isolation

In this subsection, we conduct three experiments: changing subsidies to private firms in the labor-intensive sector only; changing subsidies to state-owned labor-intensive firms only; and changing subsidies to firms in the capital-intensive sector. The results are presented in Table 9. Before we discuss the results, it is important to keep in mind that credit taxes levied on the private labor-intensive firms begin to decline at the beginning of our transition period and end by 2010, while subsidies to the state-owned firms in the labor-intensive sector peak in early 2010 and die out completely by 2050 (depicted in Figure 6). Recall also that state-owned firms in the labor-intensive sector are less productive than the private firms (Table 4).

The decline in taxes on interest expenses of private firms leads to resource reallocation from state firms to private firms in the labor-intensive sector. As reported in the top panel of Table 9, these credit policy changes raise the TFP in the labor-intensive sector as private firms are more productive than state-owned firms, and, hence, contribute to per capita output growth. Quantitatively, the contribution is about 20 percent before 2007.[15]

According to the middle panel of Table 9, the initial rise in the subsidies to the state-owned firms in the labor-intensive sector increases demand for both capital and labor, and more so for capital at the beginning of the transition. As a result, interest rates rise. Wage growth also moves up, but not nearly as fast as it does in the benchmark. In response, households begin to save more but slightly decrease their human capital investment. This policy change also raises per capita output growth in the beginning

[15]The initial decline in per capita output growth before 1991 is largely driven by the reduced demand for capital.

because of capital deepening, but it subtracts from trend growth after 2007 because of the distortionary effect associated with taxes needed to finance the subsidies. Savings also rise by about 12 percent before 2007.

Turning to the bottom panel of Table 9, credit policies that benefit capital-intensive firms raise the demand for capital and have a huge impact on interest rates. As a result, savings rise. What is noticeable is that although per capita output growth initially rises because of capital deepening, it falls below the 2 percent trend growth rate after 2007 because these subsidies misallocate capital across sectors and also because of the distortionary effects associated with taxes needed to finance the subsidies.

7.2.2 Reduction in Intermediation Costs

During the period of our study, the development of the financial sector also leads to consistent declines in intermediation costs, which implies that the deposit rate households face gradually approaches the return to capital earned by the firms. In Figure 6, we have shown the exogenous process of this decline. In Table 10, we conduct an experiment where we only allow the intermediation cost to decline over time without the other changes discussed above.

An immediate effect of the decline in the intermediation cost is that the deposit rate moves up since the demand for capital for all firms increases. Savings also go up significantly in response. Compared with the benchmark economy, the decline in the intermediation costs alone accounts for two-thirds of the rise in the savings rate in the first 15 years and half of the rise in the next 15 years. The growth in labor efficiency units becomes negative as households invest less in human capital becaue of the changing relative return to savings. Total output per capita grows since the increase of capital dominates the drop in effective labor.

7.2.3 Credit Policy Changes and Financial Development Combined

We now conduct another experiment where we implement all the credit policies as well as the development in the financial market and report the results in Table 11. As expected, these changes boost per capita output growth and greatly increase household savings prior to 2007. After 2007, however, the credit market distortions that promote capital-intensive industries over labor-intensive industries, while still encouraging household savings, now subtract from the economic trend growth. Because of the higher return to capital, households invest less in their children's human capital, leading to a decline in efficiency units of labor supply.

8 Alternative Experiments

In this section, we investigate the role endogenous human capital investment plays in our analysis. We also study an alternative fertility policy, assuming that the fertility rate will gradually reach 1.25 per adult starting in 2015.

8.1 The Role of Endogenous Human Capital Investment

One unique feature of our model is the introduction of endogenous human capital investment. It allows households to save by investing in their children and affecting their expected old-age transfer payments from their children. In other words, with additional spending on children's education, a household can improve its children's labor efficiency and hence wage income. Since the old-age transfer from children to parents is proportional to the child's labor income, higher human capital investment means higher wages and hence higher transfer payments. At the aggregate level, human capital investment improves labor quality and drives growth. For savings, in the short run, households will save less for old age with endogenous human capital investment. In the long run, however, the additional income associated with human capital investment may lead them to save more with endogenous human capital investment than they would without endogenous human capital investment.

To quantitatively examine the importance of this margin, we conduct an experiment where we do not allow households to endogenously invest in human capital. Instead, we fix their human capital investment per child relative to income by age at the same ratio as in the initial steady state (shown in Figure 4) but we do implement all the other policies as we did in the benchmark and then solve the general equilibrium problem along the transition. We report the new transition path for selected statistics at the top panel of Table 12. To understand the result, it is important to point out that human capital is a stock variable. It takes a whole cycle, 32 years (55-23) to be precise, for the whole working population to have benefited from the endogenous accumulation of human capital. We, therefore, do not expect big exchanges until after 2006.

According to the top panel in Table 12, without endogenous human capital investment, households save more than they do in the benchmark. This pushes down the increases in the interest rate relative to that observed along the benchmark in the first 30 years. The credit subsidy policies that benefit the labor-intensive firms initially imply that wages also rise. Under the new regime, the per capita capital stock in the beginning increases more than it does in the benchmark but falls behind its benchmark behavior after 2007. Growth in labor efficiency units per capita, on the other hand, consistently lag behind their benchmark counterpart. Both factors lead to much slower growth in per capita output, especially in the medium to long run, lowering it by 3.5 percentage points after 2007.

8.2 Reversing the One-Child Policy

In 2013, the one-child policy that had been in place since the late 1970s was relaxed by the Chinese government. Under the new policy, families could have two children if one parent, rather than both parents, was an only child. This policy in practice affected mostly urban couples. In 2016, the Chinese government completely abolished the one-child policy. Starting in October 2015, all Chinese couples are allowed to have two children. In this section, we investigate the effect of this new fertility policy.

Figure 11 plots the new fertility path. Under the new path, we raise the fertility rate gradually in 2015 and assume that the rate reaches 1.25 per woman in 2040 and then stays there. In the bottom panel of Table 10, we report our new results, where we implement the new fertility path along with all other changes carried out in the benchmark analysis. Given the extended period of time it takes for the fertility path to take effect, we only expect major changes in the 2022-2071 periods and the final steady state.

As observed in the bottom panel of Table 12, there is little change prior to 2022. For the periods between 2022 and 2071, the new fertility policy subtracts 60 basis points from the expected per capita GDP growth, which amounts to over 10 percent of that growth. Savings, by contrast, rise by 1 percentage point during the same period and 6 percentage points in the new steady state.

9 Conclusions

In this paper, we build a unified framework that brings together important changes on the households' side as well as the firms' side of the Chinese economy to account for its rapid growth and elevated savings rate. On the household side, we focus on aging demographics arising from the one-child policy and increased life expectancy. We also consider the effects engendered by the reduction in the pension replacement rate. On the firm side, we focus on government credit policies that have favored different industries over time. Our model also features endogenous human capital investment that has been a prominent part of the Chinese growth experience.

Our analysis indicates both the demographic changes and the government policies played important roles in driving China's high rate of savings and fast growth. While the demographic changes did not take effect until the mid-1990s, the impact associated with government policies was much more immediate. This is particularly true for output growth. Importantly, though human capital investment in the short run crowds out capital investment and, hence, output growth, in the long run, it raises both savings and output growth substantially.

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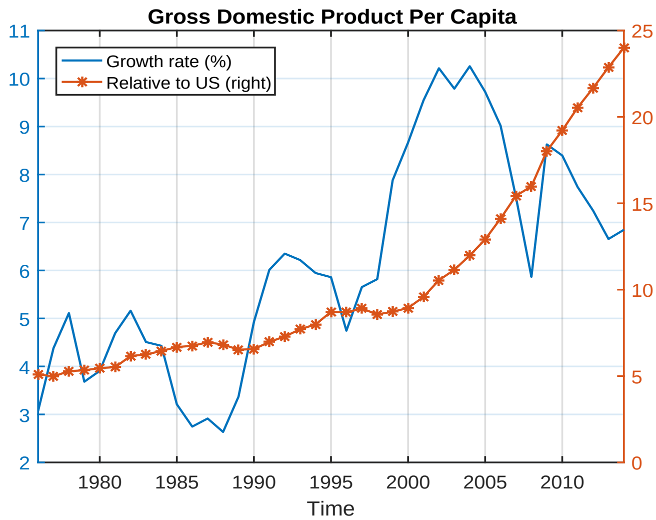

Figure 1: **The Growing Chinese Economy** This figure depicts the per capita GDP growth rate of the Chinese economy and the relative per capita GDP in China to that in U.S. Data come from the World Bank/Haver Analytics. To arrive at the per capita output growth, we first divide output-side real GDP at chained PPPs (2011 US$) by total population, take the growth rates, and then HP filter the series.

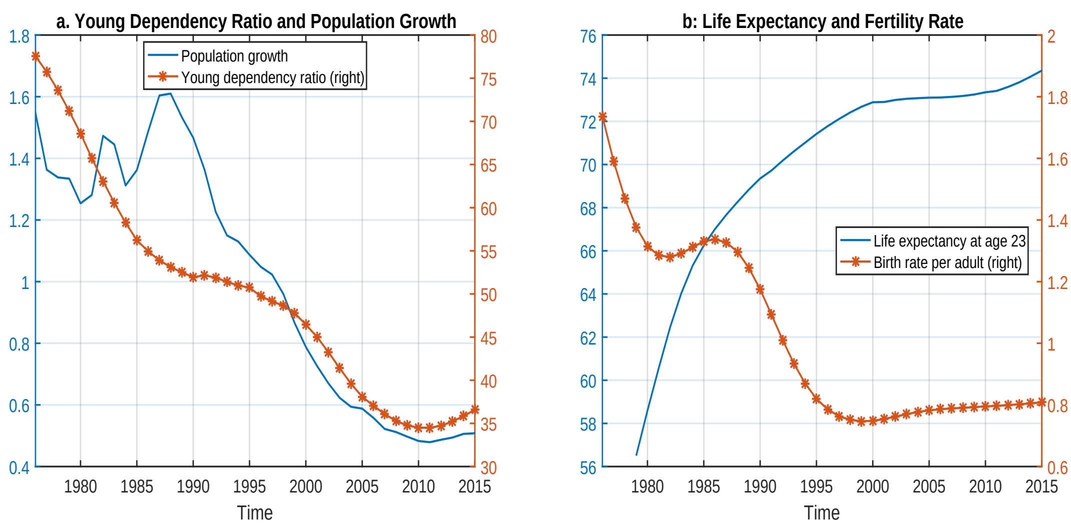

Figure 2: **The Aging Chinese Demographics** This figure describes population growth rate and young-age-dependency ratio (panel a), and the life expectancy and the fertility rate per adult (panel b). The young-age-dependency ratio is defined as the ratio of population aged 15 and below to the population between age 15 and 65. Data source: World Bank.

Figure 3: **Age-Income Profiles** This figure depicts the labor efficiency units by age for the Chinese economy. Data source: Urban Household Survey. Wages include wages plus self-business incomes.

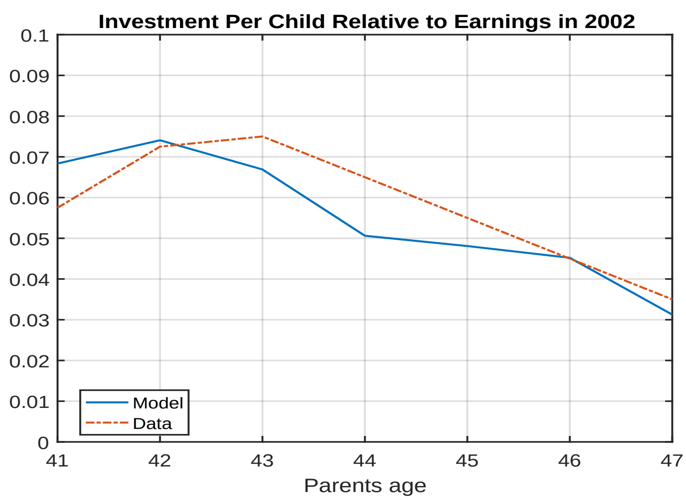

Figure 4: **Optional Education Expenditure Profiles** This figure depicts optional education expense per child as a fraction of parent earnings. The data come from Figure 3 in Choukhmane et al. (2017) (the green area that corresponds to discretionary education expenditure. See the main text of the paper.)

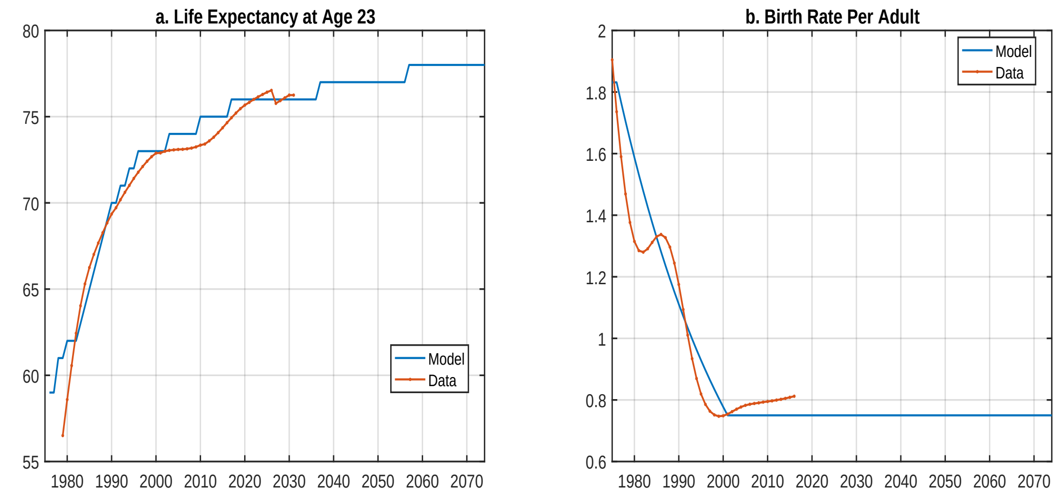

Figure 5: **Exogenous Processes Along the Transition** Panel a depicts life expectancy at age 23. Panel b depicts fertility rate defined as the average number of births per adult. Life expectancy after 2012 is a projection by the World Bank

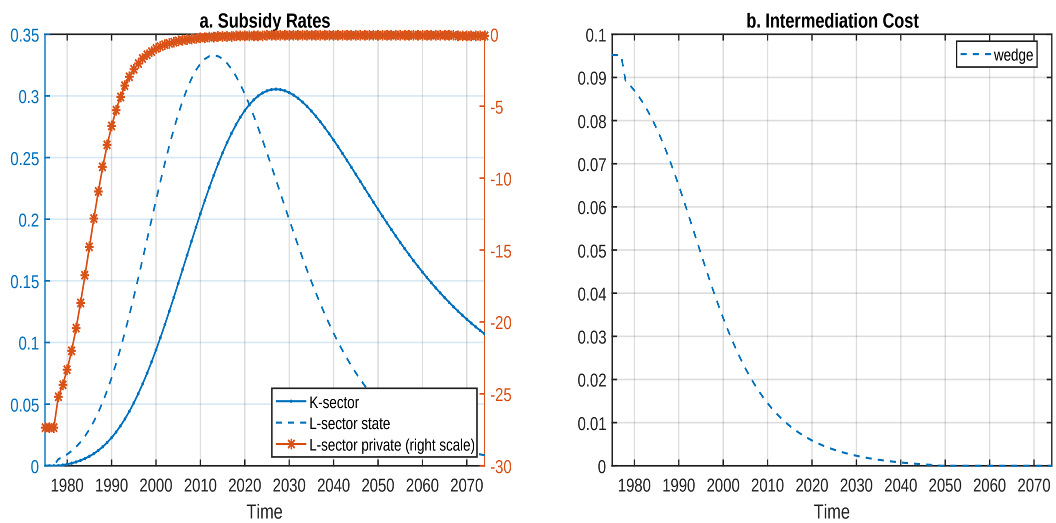

Figure 6: **Exogenous Processes Along the Transition** Panel a depicts exogenous government interest subsidy changes along the transition path. Panel b describes the intermediation cost.

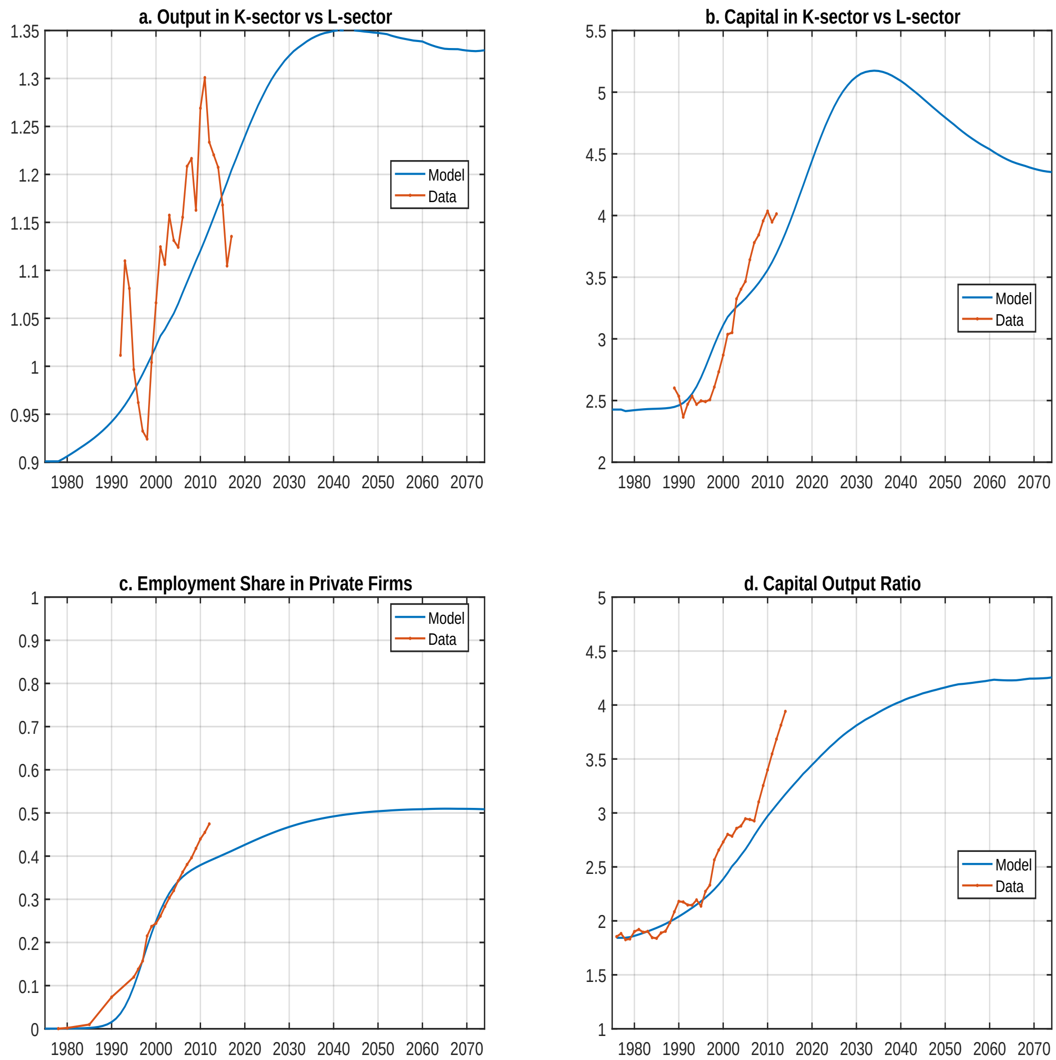

Figure 7: **Firm Dynamics Along the Transition: Data versus Model** Data source: Panels a and b: Chang et al. (2015); panel c: Chinese Statistical Yearbook; panel d: World Bank, Penn World Table.

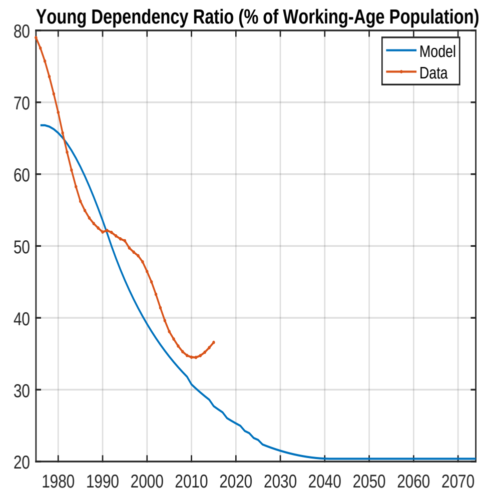

Figure 8: **Household Dynamics Along the Transition** The young dependency ratio is defined as those under age 15 to those between the ages 15 and 65. Data source: World Bank, Penn World Table.

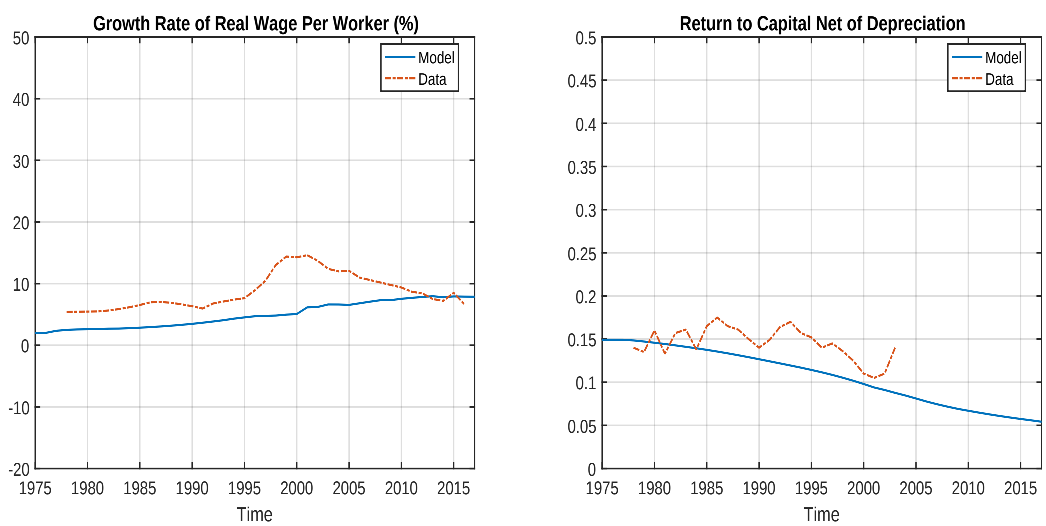

Figure 9: **Price Dynamics Along the Transition** Panel a plots growth rate of wage per worker. Panel b describes the marginal product of capital. The data in panel a come from table "Average Wage of Staff and Workers and Related Indices" under Section 5 from various years of Chinese Statistical Yearbook.

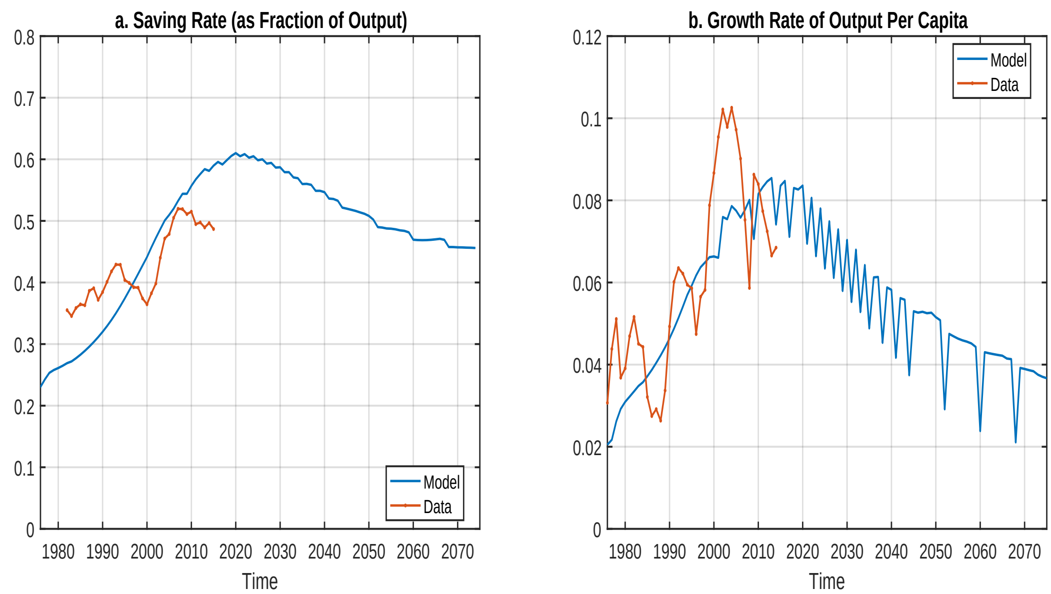

Figure 10: **Savings Rate and Per Capita Output Growth: Model Versus Data** Aggregate savings include household and corporate savings but exclude government savings. The aggregate savings rate are provided by Chang et al. (2015). To arrive at the per capita output growth, we first divide output-side real GDP at chained PPPs (2011 US$) by total population, both obtained from the Penn World Table, take the growth rates, and then HP filter the series.

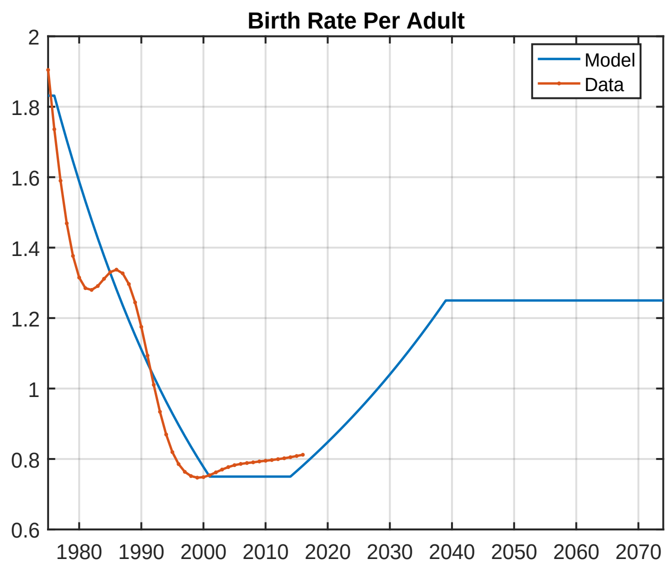

Figure 11: **Alternative Fertility Path**

Table 1: Household Decisions

Age	$[J_1, J_f+6]$	$[J_f+7, J_f+15]$	$[J_f+16, J_f+22]$	$[J_f+23, J_r-1]$	$[J_r, J_B]$
Consumption	yes	yes	yes	yes	yes
Savings	yes	yes	yes	yes	yes
Children's human capital investment	no	mandatory	optional	no	no
Make transfer			if $J_r - J_f \leq j \leq J_B - J_f$		
Receive transfer	no	no	no	no	yes
Receive pension	no	no	no	no	yes

Note. This table describes decisions that a household makes at different ages. The symbol J_1 is the age at which the household enters the economy; J_f is the fertility age; J_r is the age at which they receive transfer from their children, which is also the retirement age; and J_B is the terminal age when the household exits the economy. Mandatory education is for children between the age 7 and 15. High school and college education between age 16 and 22 is optional.

Table 2: Growth Rates Along the Steady State for Major Economic Variables

Parameter	Description	Growth Rates
Λ	Population measure	g_{pop}
$Y, Y_k, Y_l, Y_{l,i}$(i=s,p)	Aggregate output	$(1+g_A)(1+g_{pop})-1$
$K, K_k, K_l, K_{l,i}$(i=s,p)	Aggregate capital	$(1+g_A)(1+g_{pop})-1$
$L, L_k, L_l, L_{l,i}$ (i=s,p)	Aggregate labor	g_{pop}
$N_{l,i}$(i=s,p)	Number of firms	0
W	Per efficiency unit of wage	g_A
$c_j, a_{j+1}(j=J_1,...,J_B)$	Individual consumption and assets	g_A
i_h	Endogenous human capital investment	0

Note. This table describes the growth rates for different variables at the the steady state.

Table 3: Fixed Parameters: First Stage

Parameter	Description	Value	Source
Household			
$\{J_1\}$	{Initial age, life expectancy at 23}	{23}	World Bank
$\{J_f, J_r\}$	{Fertility, retirement age}	$\{25, 55\}$	
σ	Relative risk aversion	1	Macro literature
$\{\Phi_1, \Phi_2\}$	Children living, required educ. exp.	{0.040, 0.030}	CHIP
$\{\mu_0, \mu_1\}$	Transfer to parents	{0.1512, 0.6500}	Choukhmane et al. (2017)
Firms			
α_k	Capital income share in k-sector	0.6312	Data, Chang et al. (2015)
γ_l	Labor income share in l-sector	0.6839	Data, Chang et al. (2015)
φ	Share of k-sector in final good prod.	0.85	Chang et al. (2015)
γ	Elasticity of subst. bt. k- and l-goods	2	Chang et al. (2015)
δ	Capital depre. rate in k- and l-sectors	0.08	Standard
g_A	Exogenous growth rate	2%	

Table 4: Calibration of Fixed Parameters: Second Stage

Parameter	Description	Value
Household		
β	Discount rate	1.0065
$\{\eta_j\}_{j=16}^{22}$	Human capital invest. efficiency	{2.5292 11.5593 5.9404 2.7656 1.9016 1.4544 1.1049}
$\{e_j\}_{j=j_1}^{J_r-1}$	Labor efficiency profile	See Figure 3
$\varkappa$	Weight on human capital invest.	0.135
Firms		
$\{f_{l,s}, f_{l,p}\}$	Fixed cost parameters	{0.12, 201.9}
A_k	Labor augmenting technology in k-sector	0.1525
α_l	Capital income share in l-sector	0.2345
$[A_{l,s}, A_{l,p}]$	Labor augumenting technology in l-sector	[0.5657, 1.7915]

Table 5: Calibration Results

Moments	Model	Data
Education expenditure by age in 2002		Figure 4
Ratio of TFP of private l-sector to state l-sector	2.22	2.22 (Song et al. 2011)
Capital-output ratio of state firms (1998–2005)	2.66	2.65 (Song et al. 2011)
Interest rate in 1976(%)	5.400	5.000 (IMF)
Wage rate in 1976	1	1 (normalization)
Number of firms in L-sector	1	1 (normalization)

Table 6: Savings and Growth Rates: Benchmark

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
Benchmark						
GDP per capita growth rate (%)	2.00	3.55	6.57	7.94	5.15	2.00
Savings rate	0.23	0.28	0.42	0.57	0.53	0.40
Interest rate (%)	5.40	6.13	7.53	8.45	6.63	2.09
Wage growth rate (%)	2.00	2.77	4.38	3.36	2.38	2.00
K per capita growth (%)	2.00	4.44	8.64	9.64	5.54	2.00
L per capita growth (%)	0.00	0.72	2.09	4.35	2.70	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.43	2.27	1.58	1.39	1.36
Population growth rate (%)	2.45	1.74	0.80	0.47	-0.41	-1.14

Table 7: Decomposing Savings and Growth Rates: Demographic Changes

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
Increasing life expectancy						
GDP per capita growth rate (%)	2.00	2.07	3.12	7.14	4.85	2.00
Savings rate	0.23	0.23	0.26	0.33	0.32	0.27
Interest rate (%)	5.40	5.39	4.92	4.92	3.74	2.38
Wage growth rate (%)	2.00	2.02	2.23	1.77	2.22	2.00
K per capita growth (%)	2.00	2.09	3.42	6.83	5.13	2.00
L per capita growth (%)	0.00	0.05	1.11	5.50	2.52	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.65	2.60	2.45
Reducing fertility rate						
GDP per capita growth rate (%)	2.00	2.72	3.61	3.58	2.65	2.00
Savings rate	0.23	0.23	0.23	0.22	0.18	0.17
Interest rate (%)	5.40	5.40	5.39	5.13	4.73	4.67
Wage growth rate (%)	2.00	2.00	2.03	2.09	2.02	2.00
K per capita growth (%)	2.00	2.72	3.64	3.70	2.68	2.00
L per capita growth (%)	0.00	0.71	1.55	1.45	0.60	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	1.73	0.80	0.09	-1.02	-1.14
Reducing pension						
GDP per capita growth rate (%)	2.00	2.09	2.13	2.08	2.01	2.00
Savings rate	0.23	023	0.24	0.24	0.23	0.23
Interest rate (%)	5.40	5.33	5.21	5.15	5.13	5.13
Wage growth rate (%)	2.00	2.04	2.02	2.01	2.00	2.00
K per capita growth (%)	2.00	2.14	2.15	2.09	2.01	2.00
L per capita growth (%)	0.00	0.05	0.11	0.06	0.00	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45

Table 8: Decomposing Savings and Growth Rates: All Demographic Changes

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
GDP per capita growth rate (%)	2.00	2.89	4.91	8.43	5.84	2.00
Savings rate	0.23	0.24	0.27	0.33	0.29	0.21
Interest rate (%)	5.40	5.32	4.66	4.25	2.55	0.46
Wage growth rate (%)	2.00	2.06	2.31	1.86	2.31	2.00
K per capita growth (%)	2.00	2.97	5.32	8.24	6.26	2.00
L per capita growth (%)	0.00	0.82	2.83	6.79	3.35	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	1.73	0.80	0.47	-0.41	-1.14

Table 9: Decomposing Savings and Growth Rates: Credit Policy Changes

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
Changing subsidies to private firms in l-sector						
GDP per capita growth rate (%)	2.00	1.88	2.87	2.72	1.95	2.00
Savings rate	0.23	0.22	0.22	0.23	0.22	0.23
Interest rate (%)	5.40	5.47	5.65	5.49	5.15	5.25
Wage growth rate (%)	2.00	1.94	2.68	2.53	2.01	2.00
K per capita growth (%)	2.00	1.72	2.34	3.11	1.97	2.00
L per capita growth (%)	0.00	-0.04	0.26	0.21	-0.07	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.45	2.51	1.42	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45
Changing subsidies to state-owned firms in l-sector						
GDP per capita growth rate (%)	2.00	2.17	2.30	1.60	1.94	2.00
Savings rate	0.23	0.24	0.25	0.24	0.23	0.23
Interest rate (%)	5.40	5.44	5.78	6.19	5.63	5.40
Wage growth rate (%)	2.00	2.15	2.42	2.01	1.83	2.00
K per capita growth (%)	2.00	2.28	2.67	1.61	1.83	2.00
L per capita growth (%)	0.00	0.05	-0.06	-0.40	0.09	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45
Changing subsidies to k-sector						
GDP per capita growth rate (%)	2.00	2.15	2.44	1.76	1.54	2.00
Savings rate	0.23	0.24	0.27	0.29	0.25	0.23
Interest rate (%)	5.40	5.40	5.71	6.92	7.46	5.40
Wage growth rate (%)	2.00	2.09	2.39	2.36	1.82	2.00
K per capita growth (%)	2.00	2.30	3.13	2.47	1.21	2.00
L per capita growth (%)	0.00	0.04	-0.06	-0.70	-0.22	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45

Table 10: Decomposing Savings and Growth Rates: Changing Intermediation Cost

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
Changing intermediation cost						
GDP per capita growth rate (%)	2.00	2.45	2.55	2.01	1.92	2.00
Savings rate	0.23	0.26	0.32	0.34	0.35	0.36
Interest rate (%)	5.40	6.11	7.41	7.78	7.61	7.56
Wage growth rate (%)	2.00	2.53	2.99	2.60	2.08	2.00
K per capita growth (%)	2.00	3.13	3.81	2.75	2.02	2.00
L per capita growth (%)	0.00	-0.14	-0.52	-0.64	-0.17	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45

Table 11: Decomposing Savings and Growth Rates: All Credit Policy Changes

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
GDP per capita growth rate (%)	2.00	2.74	2.98	1.24	1.45	2.00
Savings rate	0.23	0.27	0.37	0.40	0.36	0.36
Interest rate (%)	5.40	6.15	8.23	10.28	10.23	7.57
Wage growth rate (%)	2.00	2.76	3.62	2.85	1.77	2.00
K per capita growth (%)	2.00	3.66	4.92	2.41	1.21	2.00
L per capita growth (%)	0.00	-0.08	-0.74	-1.72	-0.30	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.36	1.36	1.36	1.36	1.36
Population growth rate (%)	2.45	2.45	2.45	2.45	2.45	2.45

Table 12: Household Savings and Per Capita Growth Rates: Alternative Experiments

Moments	Initial SS	1977-1991	1992-2006	2007-2021	2022-2071	Final SS
Fixed Human Capital Accumulation						
GDP per capita growth rate (%)	2.00	3.83	6.48	4.40	1.50	2.00
Savings rate	0.23	0.29	0.45	0.55	0.43	0.40
Interest rate (%)	5.40	6.28	8.77	7.73	4.68	2.07
Wage growth rate (%)	2.00	3.06	4.82	3.81	2.16	2.00
K per capita growth (%)	2.00	5.02	8.93	6.76	1.60	2.00
L per capita growth (%)	0.00	0.71	1.42	0.29	-0.63	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.41	2.34	1.60	1.37	1.36
Population growth rate (%)	2.45	1.73	0.80	0.47	-0.41	-1.14
Alternative Fertility Policy						
GDP per capita growth rate (%)	2.00	3.55	6.57	7.88	4.54	2.00
Savings rate	0.23	0.28	0.42	0.57	0.53	0.46
Interest rate (%)	5.40	6.13	7.53	8.45	6.06	2.69
Wage growth rate (%)	2.00	2.77	4.38	3.36	2.33	2.00
K per capita growth (%)	2.00	4.44	8.64	9.58	4.88	2.00
L per capita growth (%)	0.00	0.72	2.09	4.30	2.15	0.00
TFP in k-sector growth (%)	0.73	0.73	0.73	0.73	0.73	0.73
TFP in l-sector growth (%)	1.36	1.43	2.27	1.58	1.39	1.36
Population growth rate (%)	2.45	1.72	0.78	0.60	0.40	0.90