The role of demographics and migration for the future of economic growth in China

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Abstract

China's real GDP has been growing by almost 10 percent a year for the last three decades. For how long should we expect this spectacularly high growth to continue? We evaluate in a quantitative two sector model with segmented labor markets and financial frictions the prospects for China's future growth under different policy scenarios. In our model the high growth rate observed in China since the early 1990s is fueled by the large increase in urban labor supply, because of rural-urban migration, and the emergence of private enterprises that absorb those migrant workers. Our simulations suggest that the rapid aging of its population will significantly decelerate urban labor force and economic growth starting around 2040. In a counterfactual exercise we show that substantial relaxation of labor market segmentation and financial constraints faced by private enterprises cannot compensate for that deceleration.

1 Introduction

During the last three decades China has experienced spectacularly high growth rates in real GDP (around 10 percent per year). This paper provides a quantitative analysis of the future prospects for such high rates of economic growth. We quantify the impact on economic growth of demographics and urban-rural migration, and incorporate into the model two salient frictions present in the Chinese economy: The segmentation of labor markets (due to the Hukou system[1]), and the tight financial constraints faced by private firms. Our results suggest that we can expect high economic growth until 2040, followed by a significant deceleration after that.

In 1990 GDP per capita in China was 317 USD. After nearly 10% economic growth for decades, GDP per capita was close to 10,000 USD in 2018 (according

[1]The Hukou is the system of household registration in mainland China. Rural migrants face very severe restrictions to obtain a Hukou of urban areas, and that limits their ability to participate in the labor market and their access to several public services and insurance schemes.

to World Bank and IMF data). Before the economic takeoff, China's economy was heavily industry oriented and dominated by state-owned companies. In early 1990s, China engaged in several economic experiments to allow for private companies to operate. Meanwhile, the government gradually allowed people born in rural areas to move to and work in urban areas. In 2017 286 million rural migrant live in urban areas, accounting for 35% of urban population, according to China's National Bureau of Statistics (NBS).

However, it is commonly perceived that this high economy growth will reach a bottleneck in the near future. The former One-Child policy, together with other socioeconomic factors, have depressed the fertility rate for decades, and the old age dependency ratio is projected to reach 50% in 2050 (United Nations, 2013). Because of the former Hukou system and the underdevelopment of China's capital markets, the allocation of productive resources across sectors is distorted. Workers with a rural Hukou and their descendants have a much more difficult time to access pre-college education in the cities they migrate to. After entering the urban labor market, migrants are working almost exclusively in the private sector and labor-intensive industries, with a smaller salary and little social protection. Financial frictions, in addition, prevent private firms from reaching their potential capacity.

This paper provides a quantitative model consistent with the high economy growth of the last 30 years, and uses it to predict the economic growth rate in the future under different policy scenarios. We propose a two-sector model (the non-private and private sector), where overlapping generations of households that differ in their geographical origin (and therefore their Hukou status) work in very segmented labor markets. We assume that rural migrants can only work in the emerging private sector, while urban born residents work for the non-private traditional sector with higher wages. Following Song et al. (2011), we model the private sector as family owned businesses that rely on individual savings and have limited access to external funding. Given age-gender-specific migration rates, fertility rate and mortality rate, we project the structure of urban populations (consisting of both urban and rural-born households), and feed it exogenously into our model.

Our quantitative simulations suggest that economic growth will significantly decelerate around 2040. The non-private sector starts decelating a lot earlier, around 2018-2020, since the mass of urban born workers starts shrinking earlier. Between 2020 and 2040 this initial deceleration of the non-private sector is still compensated by a booming private sector that absorbs an increasing labor force triggered by rural-urban migration flows.

One of the counterfactuals we have performed consists of increasing substantially access to credit by private firms. This additional capital available to the private sector increases output, even though the increase in external credit is partially offset by a decrease in entrepreneurs' savings. The other counterfactual we perform focuses on reducing the labor market segmentation, by allowing some fraction of the migrants to work in the non-private sector. Both counterfactuals reduce the misallocation of resources across the two sectors and increase the level of GDP relative to the benchmark, but do not change the conclusions

regarding the timing in the deceleration of economic growth.

Of course we are not the first ones to look at economic growth in China. Song et al. (2011) is the closest in spirit to our exercise, since they also make the distinction between a non-private sector and a private sector of entrepreneurs facing severe borrowing constraints. Relative to them we construct and introduce in the model demographic/migration projections, we assume segmented labor markets (given the Hukou system), and we endogenize the mass of entrepreneurs through an occupational choice. In addition, we focus on economic growth prospects at long horizons instead of the dynamics of the current account.

The rest of the paper is organized as follows. Section 2 describes some of the relevant empirical evidence since the 1990s. Section 3 describes the theoretical model and characterizes the equilibrium. Section 4 discusses the quantitative implications of the model with the aid of a calibrated economy. Section 5 performs counterfactual reforms. Section 6 concludes.

2 Economic growth in China: Empirical evidence since the 1990s

2.1 Political reforms and the raise of the private sector

Back in 1978 the 3rd Plenary Session of the 11th Central Committee of the Communist Party of China promoted Deng Xiaoping to become the new leader, and marked the beginning of the 'Reform and Opening Up' period. At the beginning the strategy did not have a significant impact, there was a huge debate of whether stimulating the private economy would go against communism, and entrepreneurs hesitated to start up businesses and increase investment in the private sector. In 1992 Deng Xiaoping gave a series of talks in south China and clarified that the priority was to develop the Chinese economy, regardless of the ownership structure of firms. That signaled the beginning of the development of the private sector and the start of the high growth period (see Figure 1).

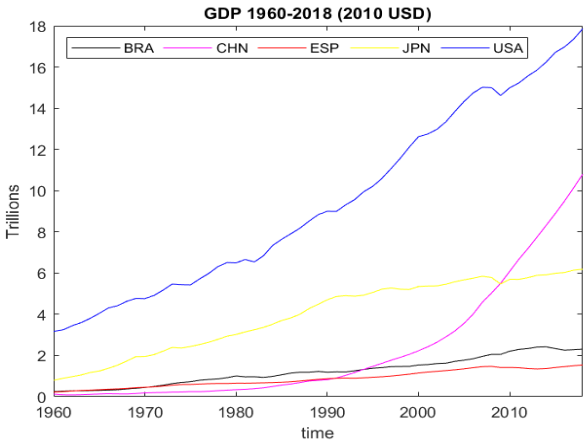


Figure 1: GDP in five countries

Notes: This figure shows the GDP trends (World Bank data) in five countries: Brazil (BRA), China (CHN), Spain (ESP), Japan (JPN), and the United States of America (USA).

The National Bureau of Statistics (NBS) classifies firm ownership into different categories (See Table 1). 'Private' here means owned by natural individuals and not publicly traded in stock markets. China's private sector has been growing since the early 1990s and in 2017 it accounts for more than 60% of GDP and creates more than 90% of the new jobs (National Development and Reform Commission, 2018).

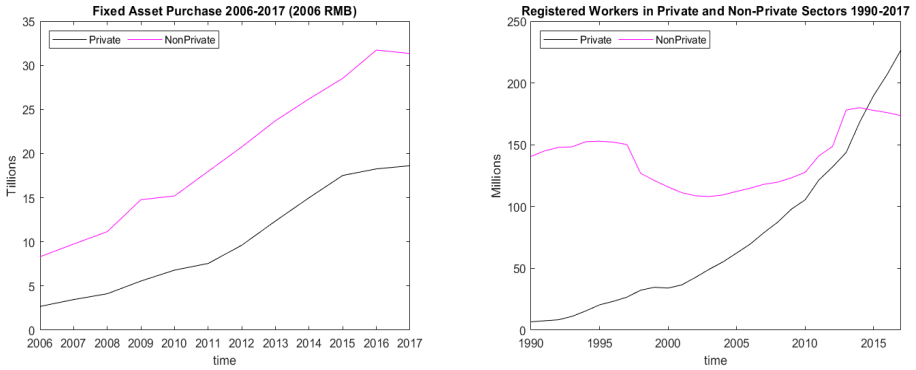
Non-Private Economy	Private Economy
State-owned	Private
Collective units	Self-employed
Cooperative units	
Joint ownership units	
Limited liability corporations	
Share-holding corporations	
Share-holding corporations limited	
Units with funds from Hong Kong, Macao and Taiwan	
Foreign funded units	

Table 1: Firm ownership in China (NBS)

Figure 2 shows the time series of fixed asset purchase[2] and registered labor

[2]Fixed asset purchases (Gu Ding Zi Chan Tou Zi) is different from fixed asset investment, which is a part of GDP. It is generally used to reflect the progress of the project and the degree of activity of the investment projects. Fixed asset purchases include the value of land, old buildings and old equipment purchased in the current year.

hired[3] depending on the sector. Fixed asset purchases in the non-private sector has grown by a factor of four, while in the private sector it has grown by a factor of seven.



(a) Fixed Asset Purchases in the two sectors (NBS) (b) Registered workers in the two sectors (NBS)

Figure 2: Growth of the private sector in China

Employment in the private sector has grown so fast that is now larger than that of the non-private sector. Notice that in the private sector employment has grown disproportionately more than investment, which is a potential indicator of credit constraints in that sector.

2.2 Demographic trends

2.2.1 The aging of the population

The population of China is experiencing a process of very rapid aging. After the 'One Child policy' in the 1980s, the total fertility rate in China dropped dramatically to the lowest in the world (1.22 in 2000, according to Census Data). In the coming decades the people born before the 'One child Policy' are reaching old age, and the generations born after the policy account for the majority of the working force. According to population reports of the United Nations, China's old age dependency ratio is going to reach 50% in 2050. Although in 2013 China has partially abolished the 'One Child Policy' and moved towards a new 'Two Child Policy' (and may get rid of birth planning altogether in the near future), the increase in the fertility rate has been small.

[3]It is widely documented that a significant fraction of labor in the private sector is not registered and is working with informal contracts, Huang (2009).

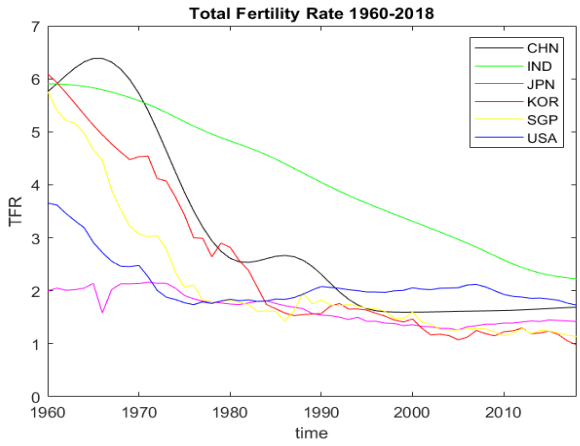


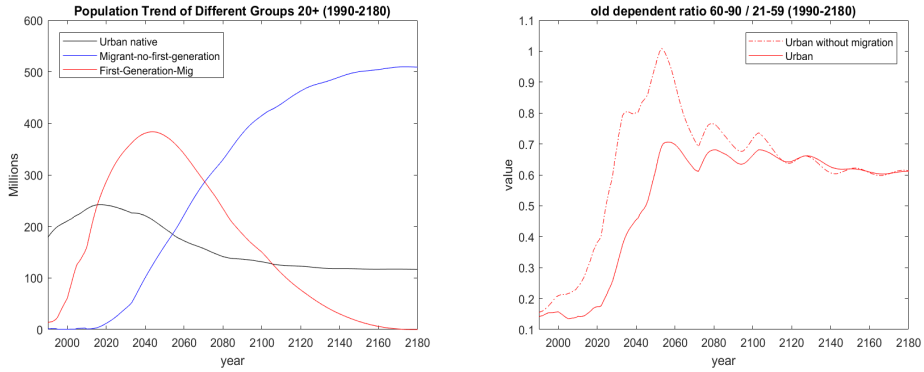
Figure 3: Total Fertility Rate in six countries

Notes: This figure shows the trends of total fertility rates (World Bank data) of six countries: China (CHN), India (IND), Japan (JPN), South Korea (KOR), Singapore (SGP) and the United States of America (USA).

As of now China is experiencing low fertility rates, even though they are still higher than in some other eastern Asian countries with low fertility rate, such as Japan, South Korea and Singapore (see Figure 3).

2.2.2 Rural-Urban migration

In the last 30 years high economic growth has been accompanied by a massive process of rural–urban migration. This population dividend is believed to be one of the main sources that fuel China's high economic growth. In 2017, 286 millions people moved from rural to urban areas with or without the change of registration of residence (Hukou system). Following the same methodology of Hu (2003) and Song et al. (2015), we use census data (1990, 2000, 2010) and the 1% population surveys (1995, 2005, 2015) to construct demographic projections that distinguish between urban residents, rural residents and rural-urban migrants, and also keep track of the distribution of migrants in urban areas. Specifically, we estimate the annual migration rates by gender and age, and then calculate the distribution of rural-urban migrant trends. We made the following assumptions: 1) after moving to urban areas, migrants will have the same mortality and fertility rates as original urban residents; 2) migration rates are constant within each time interval, e.g. 1990-1995, 1996-2000, 2001-2005, 2006-2010, 2011-2015, and constant after 2015; 3) migration ends after 2070; 4) migrants prefer to stay in the urban area (no reversal of migration flows). The total fertility rate in urban areas after 2020 is chosen to be 2.07 in order to make the population size stable after 2180.



(a) Population trends in three groups

(b) Old-Age Dependency Ratio

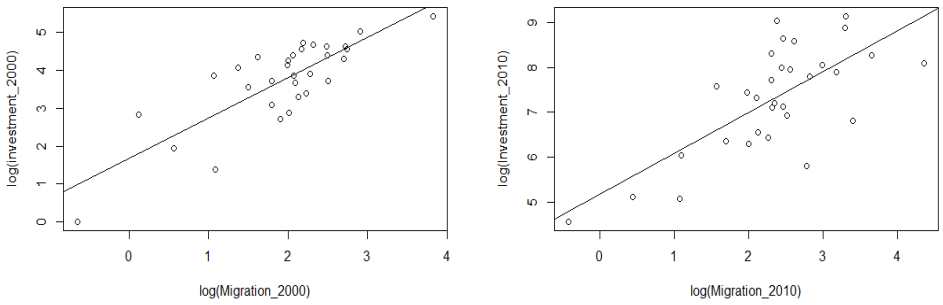
Figure 4: Population dynamics

Figure 4(a) plots the distribution of urban population. Notice how initially population growth is driven by first generation migrants, and eventually most of the population are the descendants of those migrants. Figure 4(b) plots the old age dependency ratio. The ratio is increasing fast and the rural-urban migrants are relatively younger than urban native residents, so migration has alleviated the magnitude of aging in urban areas.

2.3 Labor market segmentation in China

Labor market in urban China has two tiers. In the first tier non-private firms offer jobs with higher wage and better social protection and hire highly educated workers (even with the same education level there is a discrimination against rural Hukou). The second tier labor market is less regulated with lower wage and less protection where private firms are the major employers.

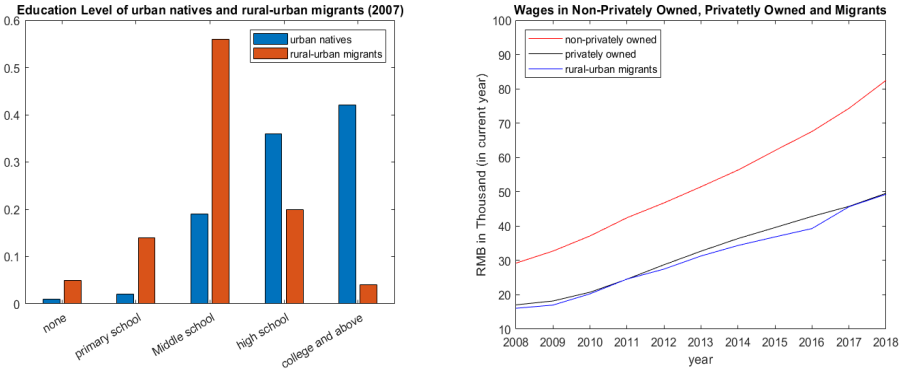
Figure 5 plots the correlation between the amount of rural-urban migrants and the fixed asset investment in the private sector at the province level in China in years 2000 and 2010. Each point represents a province or municipality. It shows that the number of rural-urban migrants and the amount of fixed asset investment in private firms are positively correlated in both years.



(a) 2000 (b) 2010

Figure 5: Rural-Urban Migration and Investment in Private Sector (NBS, Economic Census and Population Census)

There are many studies about the difficulty faced by rural-urban migrants obtaining a formal urban job because of lack of education, social connections, and information (Meng 2001, Huang 2009, Meng 2012, Wu and Zheng 2016). Other studies talk about the working conditions of migrants. Migrants receive little legal and social protection, have little (or none) pension coverage or employer sponsored health insurance (Frijters, Meng 2009, Wang 2011, Wu and Zhang 2017). In addition, migrants' children often meet obstacles when choosing local schools, and also face limited access to college since the college entrance examination and acceptance rates differ among provinces. The segmentation generated by differences in residential status (the Hukou system) can and often does extend beyond the first generation migrants. See Li et al. (2017) for a discussion of the Hukou system and its consequences for labor market segmentation.



(a) Education Distribution (male aged 16-60, female aged 16-55, CHIP 2007)

(b) Wages of non-private, privately owned sectors and rural-urban migrants (NBS)

Figure 6: Two Tier Labor Market in Urban China

Figure 6(a) shows that migrants are significantly less educated than urban residents. Moreover, when we look at wages in Figure 6(b), we observe that the level and evolution of migrant wages is almost identical to the level and evolution of private sector wages. In contrast, non-private sector wages are significantly higher. We interpret this wage evidence as additional support for our assumption of severe labor market segmentation, with less educated migrants working in the low-wage private sector.

2.4 Credit Frictions

It has been documented that state-owned and public firms receive credit preference while private firms are financially constrained and rely much more heavily on internal financing. In Figure 2 we observe that while by 2015-17 the private sector already absorbs more employment than the non-private sector, the private sector receives only but a small fraction of investment. Allen et al. (2005) study the financial resources used by China's private firms, and find that bank loans only account for 10 percent of their investment during 1994-2002.[4]

This friction in the allocation of capital causes large aggregate inefficiencies (Song et al. 2011, Chang et al. 2015). At the same time, the increase in capital used in the high return private sector along the development transition can explain a significant part of the increase in measured aggregate productivity (Brandt et al. 2012, Zhu 2012, and Hsieh and Klenow 2009). In the counterfactuals we will examine the quantitative implications of ameliorating these credit frictions.

[4]The distinction we make between private and non-private firms is consistent with the National Bureau of Statistics in order to make other macroeconomic variables comparable with data. Allen et al. (2005) group together state-owned enterprises and share-holding corporations into non-private sector, and consider all other forms of ownership as private sector.

3 The Model

We now set up our benchmark two-sector overlapping generations model. There are two types of firms/sectors, that operate in fully segmented labor market and firms in the private sector face tight financial constraints. Households are finitely-lived and differ by their residential status. We take the number of rural-urban migrants exogenously from our data projections. A given fraction of urban born residents have an occupational choice, since they choose whether to be workers in the non-private sector or to become entrepreneurs and operate a family owned private firm.

3.1 Production technologies

Firms of type F (non-private sector) are financially integrated, they have access to credit and hire urban workers. Their technology is of the standard Cobb-Douglas type:

$$F_F(K_{F,t}, N_{F,t}) = K_{F,t}^{\alpha_F}(A_t N_{F,t})^{1-\alpha_F},$$

where A_t denotes aggregate total factor productivity that will be growing at an exogenous rate, $K_{F,t}$ and $N_{F,t}$ denote the inputs of capital and labor, respectively.

In contrast, firms of type I (private sector) are family owned, they face tight financial constraints and hire rural migrants. Notice that we are assuming a very strong form of labor market segmentation. Entrepreneurs operate a Lucas (1978) span-of-control technology. Profits for an entrepreneur with wealth holdings a_E are given by:

$$\pi(a_E + TR_{E,t}) = \max_{n,loan} \{k_{I,t}^{\alpha_I}((\xi A_t)^{\frac{1-\alpha_I}{\theta}} n_I)^{\theta} - \delta k_{I,t} - w_t n_I - \tilde{r}_t loan\}$$

$$k_{I,t} \leq a_E + TR_{E,t} + loan$$

$$(1+\tilde{r}_t)loan \leq \eta[k_{I,t}^{\alpha_I}((\xi A_t)^{\frac{1-\alpha_I}{\theta}} n_I)^{\theta} + (1-\delta)k_t - w_t n_I]$$

$$0 < \alpha_I + \theta < 1$$

and

$$\tilde{r}_t = \begin{cases} r_t & if\ loan \leq 0 \\ r_t + spd_t & if\ loan > 0 \end{cases}$$

Given the exogenous productivity ξA_t (ξ denotes a productivity differential across sectors) entrepreneurs decide how much labor to hire, n, and the size of the short-term loan, that we denote as *loan*.

The borrowing constraint implies that the size of the loan is limited by a fraction of the funds available at the end of the period. A plausible interpretation of this type of borrowing constraint is that the entrepreneur can only commit to

pledge a given fraction η of the value of the firm to guarantee the repayment of the loan. Better enforcement of contracts and/or better liquidation procedures would result in higher values of η.

If the loan is positive it means that the entrepreneur is borrowing in order to increase capital beyond her resources, which are the sum of her own wealth a_E and $TR_{E,t}$, that denotes the bequests that entrepreneurs receive. We also allow for the possibility that the entrepreneur is saving part of her wealth at a risk-free interest rate r_t, that happens when *loan* takes a negative value. We denote by spd_t the operational cost of the financial sector, the wedge between lending and borrowing rates.

3.2 Urban residents

Every period a fixed fraction of urban residents at the beginning of their life-cycle make an occupational decision. If they choose to be a worker, they will work for the non-private sector until age J_r, and retire afterwards. In contrast, if they choose to be an entrepreneur, then they will work for a finite number of periods in the non-private sector, and at age J_e they will start operating their own private firm with their accumulated wealth.

Thus, the occupational choice is given by:

$$V^*_{U,t} = max\left\{V^*_{F,t}(0,1),\ V^*_{E,t}(0,1)\right\}, \tag{1}$$

where the choices are to maximize the life-time utility of being a non-private worker, $V^*_{F,t}(0,1)$, or being an entrepreneur, $V^*_{E,t}(0,1)$.

For households that choose to be workers their problem is:

$$V_{F,t}(a_F, j) = \max_{a'_F, c_F} \left\{u(c_F) + \beta\phi_j V_{F,t+1}(a'_F, j+1)\right\} \tag{2}$$

$$s.t. \begin{cases} c_F + a'_F = (1+r_t)(a_F + TR_{F,t}) + \omega_{F,j} w_{F,t} & for\ j = 1...J_r - 1 \\ c_F + a'_F = (1+r_t)(a_F + TR_{F,t}) & for\ j = J_r...J \end{cases}$$

$$a'_F \geq 0,\ c_F \geq 0$$

Here ϕ_j is the survival probability of an individual of age j, $TR_{F,t}$ are the unintentional bequests that urban residents receive, $\omega_{F,j}$ denotes the age-profile of labor productivity of urban residents in the non-private sector, and $w_{F,t}$ is the competitive wage rate of workers in the non-private sector.

If the household chooses to be an entrepreneur, then their problem is:

$$V_{E,t}(a_E, j) = \max_{a'_E, c_E} \left\{u(c_E) + \beta\phi_j V_{E,t+1}(a'_E, j+1)\right\} \tag{3}$$

$$s.t. \begin{cases} c_E + a'_E = (1+r_t)(a_E + TR_{E,t}) + \omega_{F,j} w_{F,t} & for\ j = 1...J_e - 1 \\ c_E + a'_E = \pi(a_E + TR_{E,t}) + a_E + TR_{E,t} & for\ j = J_e...J \end{cases}$$

$$a_E^{'} \geq 0,\ c_E \geq 0$$

The difference in terms of career path is that by becoming an entrepreneur at age J_e, they use their accumulated wealth and the bequests they received in order to generate profits in their private business, and they do not retire. We assume that entrepreneurs receive an amount of transfers, $TR_{E,t}$, that is potentially different from that of urban households who decide to become workers. This way we capture in a very crude way the notion of family business.

3.3 The problem of rural-urban migrants

Migrants work in the private sector and retire at age J_r . Their maximization problem is the following:

$$V_{I,t}(a_I, j) = \max_{a_I', c_I} \left\{ u(c_I) + \beta \phi_j V_{I,t+1}(a_I^{'}, j+1) \right\} \tag{4}$$

$$s.t. \begin{cases} c_I + a_I^{'} = (1+r_t)(a_I + TR_{I,t}) + \omega_{I,j} w_{I,t} & for\ j = 1...J_r - 1 \\ c_I + a_I^{'} = (1+r_t)(a_I + TR_{I,t}) & for\ j = J_r ... J \end{cases}$$

$$a_I^{'} \geq 0,\ c_I \geq 0$$

where $TR_{I,t}$ are the unintentional bequests that migrants receive, $\omega_{I,j}$ denotes their age-profile of labor productivity, and $w_{I,t}$ is the competitive wage rate of workers in the private sector. While the maximization problem is the same for all migrants and their descendants, in equilibrium we need to keep track of first generation migrants and their arrival time, since we assume that first generation migrants arrive to the urban area with zero initial assets. Then, in every period of time there will be a distribution of migrants with the same age that differ in their arrival time, and therefore in their equilibrium wealth holdings.

3.4 Definition of equilibrium

A competitive equilibrium is a set of value functions for all households (urban workers, migrant workers, and entrepreneurs) and their corresponding decision rules, measures of households over all those characteristics for every period, unintentional bequests/transfers, production plans and a vector of prices such that: 1. Everybody behaves optimally according to the decision problems stated above; 2. Firms equalize the marginal productivity on inputs of production to their price; 3. The different markets (remember labor markets are segmented) for inputs of production and the final goods clear; 4. The measures of households evolve according to the exogenous demographic trends and occupational decisions of households.

4 Calibration and results for the benchmark economy

The benchmark economy is initialized to 1989, where we assume that the economy was in a balanced growth path with only one sector, the non-private sector, and no migration. Starting in 1990 the private technology starts to be available, at the same time that rural-urban migration starts. We project the magnitude and the age composition of migration flows from data and then feed those exogenously into the model.

In order to assign values to the parameters we proceed as follows. Some parameters are taken directly from the data, while others are jointly determined in equilibrium in order to match selected moments in the data. We assume logarithmic utility for all agents.

Demographic parameters. People start their economic life at age 21, and live up to a maximum of 90 years (the maximum age is $J = 70$), workers retire at age 60 ($J_r = 41$), and if young urban workers decide to become entrepreneurs they will start operating their business at age 40 ($J_e = 21$). Population flows, age-profile of migrants, fertility rates and survival probabilities are taken directly from the data and our projections (see Figure 4). As for the fraction of population that can become entrepreneurs, Quadrini (2000) reports a fraction of entrepreneurs in the U.S. population of 12%, using the Panel Study of Income Dynamics 1970-1992 and Survey of Consumer Finances (SCF) 1989-1992. Gentry and Hubbard (2004) reports the estimated fraction of entrepreneurs to be 11.5% using SCF 1989 also in the U.S.. And Hipple (2004) estimates the fraction to be 11.1% in U.S. using Current Population Survey 2003. We assume that 10 percent of urban natives have entrepreneurial skills, and that puts an upper bound on the maximum number of entrepreneurs.

	value	Description	source
J	70	maximum age 90	
J_r	41	retirement age 60	
J_e	21	age turning to entrepreneur 40	
δ	0.1	annual depreciation rate 10%	Bai et al. (2006)
α_F	0.5	capital share of 1/2 in nonprivate sector	Bai et al.(2006)
α_I	0.4	capital share of 1/2 in private sector	Bai et al.(2006)
θ	0.4	average entrepreneur residuals 20%	NBS (1998-2017)

Table 2: Parameters determined outside the model

Age Profile. Workers in different sectors face very different age profiles. We use the China Household and Nutrition Survey (CHNS) to get estimates of workers' age profiles. CHNS is an ongoing panel survey project, organized by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health at the Chinese Center for Disease Control and Prevention. It is also an ever-expanding survey,

and fifteen provinces and autonomous cities were surveyed in 2015 (Beijing, Chongqing, Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanghai, Yunnan, and Zhejiang), which covers areas at different development stages in China. Consistent with the definition of private and non-private sectors in Table 1, we use the residence and work unit variables to separate the urban observations into two groups: urban residents working in the private sector and urban residents working in the non-private sector. We use wage earnings as the measure of labor income and Figure 7 plots the deterministic age profiles in the two sectors.

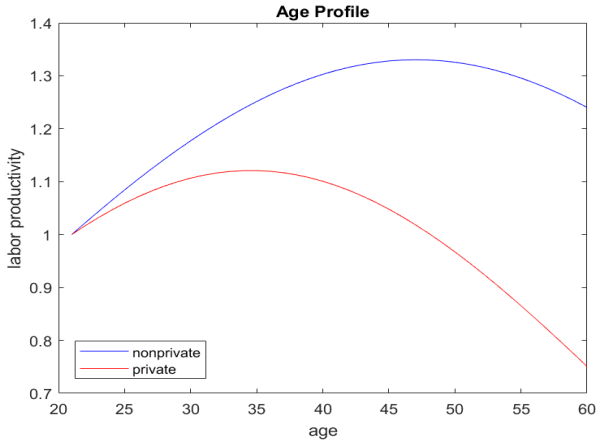


Figure 7: Age profile of labor productivity in the two sectors

Technology parameters. We rely on work by Bai et al. (2006) and assume an annual depreciation rate of 10 percent and a capital income share of 50 percent. In addition, the capital income share and the labor income share in the private sector are chosen so that the rents accruing to the entrepreneur are 20 percent of value added.

In order to determine the rest of the parameters we proceed as follows. We compute the transition of the model economy and iterate on the value of the remaining parameters in order to match selected moments at particular periods during the transition path. Data availability constrains our choice of the periods used for different empirical targets.

We choose the discount factor β to match the capital-output ratio of 2.72 in 2005 from the Penn World Table 9.1. We choose the borrowing constraint parameter η so that the average loan as a fraction of investment in the private sector in the period 1994-2002 is 10 percent, consistent with the findings in Allen et al. (2005).

In order for the benchmark economy to attain growth rates close to 10 percent we need fast technological progress, and we find a calibrated value of labor augmenting technology growth of 4.9 percent. We fix this high value for all of

our time period considered. Imrohoroglu and Zhao (2018) calculate the average TFP growth to be 6.2 percent from 1976 to 1985 and also calculate and project the average TFP growth to be 5.8 percent from 1980 to 2050. Zhu and Brandt (2010) calculate the average non-agricultural TFP growth to be 4.38 percent from 1988 to 1998, and 4.38 from 1998 to 2007. It seems unreasonable to expect this fast pace of technological progress indefinitely, so in that sense our benchmark is a very optimistic scenario about the evolution of technological progress.

We calibrate the productivity difference between the two sectors, ξ, so that private sector wages during the period 2008-2017 are 0.606 relative to non-private sector wages. That implies a value of ξ of 8.11. Chang et al. (2015) calibrate the relative difference between a labor-intensive and a capital-intensive sector to be 4.98. Song et al. (2011) calibrate the relative difference in productivity between state-owned and non-state-owned firms within the manufacturing sector to be 4.79. In comparison to Song et al. (2011) we obtain a larger productivity differential, and the reason for the difference is that we assume labor market segmentation while they don't. The assumption that less educated migrants work in the private sector implies that the model requires a higher productivity differential between private firms and non-private firms in order to match the wage ratio between the two sectors.

	Description	Moments to Match	Value
β	discount factor	$K/Y = 2.72$ (2005)	0.965
η	borrowing constraint	$loan/Investment_{private} = 0.10$ (94-02 Avg.)	0.020
g	technology growth rate	annual GDP growth $= 0.094$ (89-18 Avg.)	0.049
ξ	productivity difference	$wage_I/wage_F = 0.606$ (2008-2017 Avg.)	8.110

Table 3: Parameters calibrated in equilibrium

Table 3 reports the parameter values used, together with the data target that is most related to that specific parameter, with the understanding that the four parameters are jointly determined in order to match all four targets simultaneously.

4.1 The benchmark results and model validation

Now we compare the trends in economic variables generated by the model to the data. Figure 8(a) plots the model and data output for the period 1989-2018. Notice that the model captures the bulk of growth experienced in that period in China, even though the model is much smoother since it relies on technology growing at a constant rate. The model economy captures some key features of the evolution of investment. See Figure 8(b). Namely, the model is consistent with the fact that non-private investment is larger than private investment, that non-private investment is hump-shaped, and that private investment is growing faster than non-private sector. Nevertheless, the model economy under predicts

investment, especially in the non-private sector.[5]

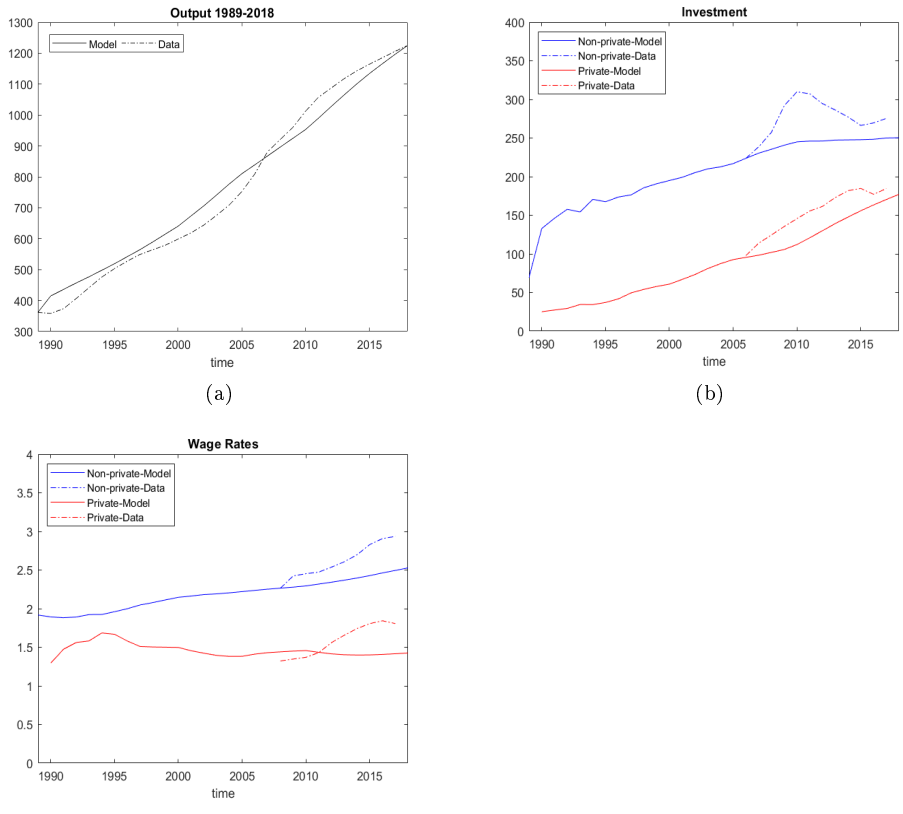


Figure 8: Transition in the Calibrated Economy

Notes: Output, investment, and wages are all price level deflated and technology growth detrended. The value has no economic meaning. For investment figure (b) and wage rates figure (c), data and non-private sector's value are set to be equal at the first year when data is available. Data of investment ranges from year 2006 to year 2017. Data of wage rates ranges from year 2008 to year 2017.

Regarding the evolution of wages in both sectors the benchmark model targets the average wage ratio between the two. The model underestimates the growth of wages after 2010, indicating that in the data wages have been growing significantly faster than 4.9 percent (the rate of technological progress), while the model only captures a small fraction of that in the non-private sector.

[5] As far as we know, there is no investment data for each ownership structure. With the aggregate level data and the data of fixed asset purchases for each ownership, we assume that the fraction of investment in private sector is equal to the fraction of fixed asset purchases in the private sector, and in this way we calculate the investment trends of both sectors.

6

All in all, these results give us some confidence that the model captures in a parsimonious way the salient features of recent capital accumulation and economic growth in urban China, with the caveat regarding the higher growth in wages observed in the data.

4.2 Model implications for future economic growth

Now we turn to the discussion of the implications of the model regarding the future evolution of the Chinese economy. The model predicts, as shown in Figure 9(a), that output detrended by technology will continue to grow until 2040, even though non-private output stops growing -relative to trend- around 2020. The output of private sector surpasses the output of non-private sector in 2015 and becomes the main force of economic growth for the following two decades. Figure 9(b) shows the projected evolution of the labor force, so that we can see that the demographic trends are the main driving force of China's economic growth in the past decades and continue to be so in the future.

[6] Li et al. (2012) argue that the growth rate of real wages has been higher than productivity growth since the late 1990s across all sectors and worker types.

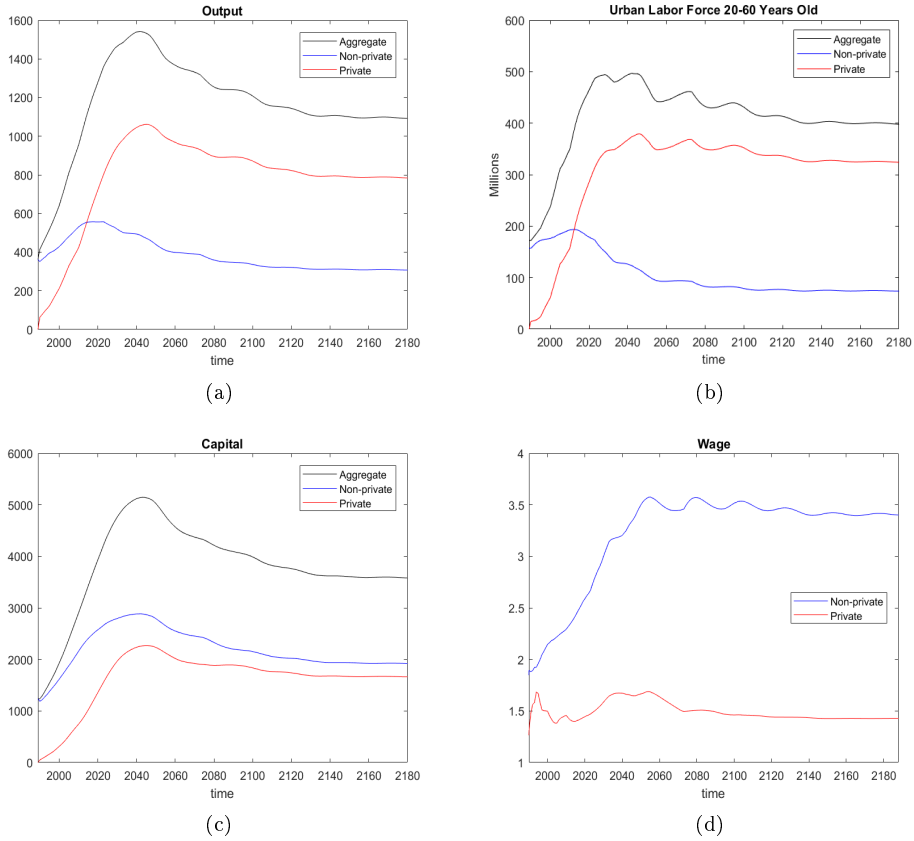


Figure 9: Growth Projections

Notes: Output, capital, and wages are all technology growth detrended. The value has no economic meaning.

The aggregate level of capital, Figure 9(c), mimics the trend of aggregate output after detrended by technology growth. However, the capital stocks peaks around 2040 in both sectors, so that capital continues to grow in the non-private sector even its growth decelerates drastically. This feature is driven by the presence of tight financial constraints in the private sector. At the same time the wage gap between the two sectors continues to grow, even beyond 2040, as in Figure 9(d). That is the result of the increasing capital together with the relative scarcity of urban workers, whose number starts falling around 2020. This observation is consistent with the evidence provided by Li et al. (2012), who conjecture that demographics and migration flows play a big role in accounting for wage increases.

5 Counterfactual experiments

5.1 Relaxing financial constraints

In our first counterfactual we quantify the impact of tight borrowing constraints in the private sector. In order to do so, we decrease the tightness of the financial constraint that entrepreneurs face starting from year 2020. See the implied evolution of output relative to the benchmark economy (Figure 10). We increase the value of η (it was 0.02 in the benchmark economy) to be 0.1, 0.3, and 0.5.

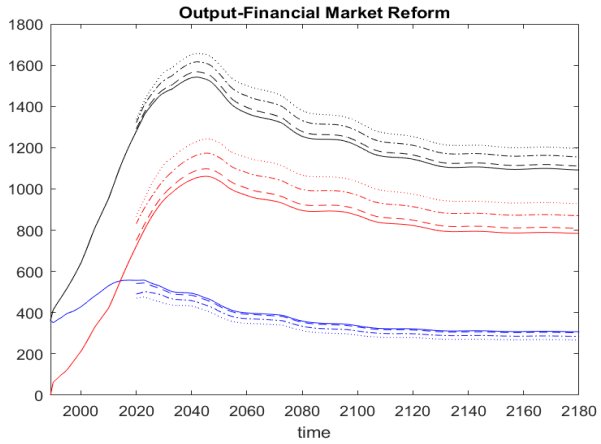


Figure 10: Output Gain from Financial Market Reform

Notes: This figure shows the technology growth detrended output under different financial market scenarios starting in 2020. The value has no economic meaning. The black lines, red lines, and blue lines refer to output at the aggregate level, output in the private sector and output in the non-private sector, respectively. The solid line refers to the benchmark results ($\eta = 0.02$), and the lines with decreasing density refer to corresponding reforms with $\eta = 0.1,\ 0.3,\ 0.5$, respectively.

Clearly, improving access to financing in the private sector increases aggregate output substantially, since it increases more output in the private sector than it reduces it in the non-private sector. This reflects the improved allocation of capital, and it generates a level effect in terms of output. Still, that in itself does not change the conclusion regarding the reversal of growth, which is driven by the dynamics of demographics.

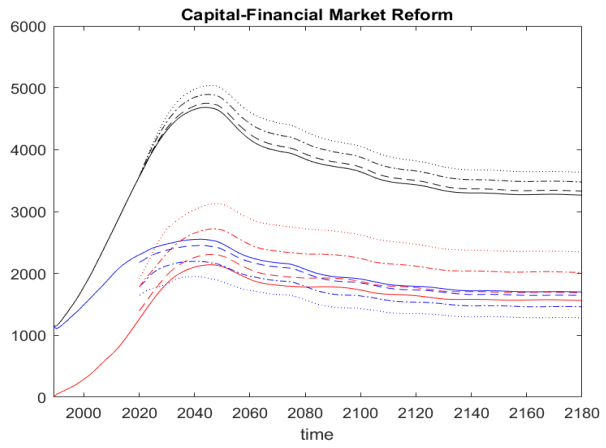


Figure 11: Capital Changes from Financial Market Reform

Notes: This figure shows the technology growth detrended capital under different financial market scenarios starting in 2020. The value has no economic meaning. The black lines, red lines, and blue lines refer to capital at aggregate level, capital in private sector and capital in non-private sector, respectively. The solid line refers to the benchmark results ($\eta = 0.02$), and the line with decreasing density refer to corresponding reforms with $\eta = 0.1,\ 0.3,\ 0.5$, respectively. When $\eta = 0.3$, the capital stock of private sector and non-private sector will be equal in year 2020; when $\eta = 0.5$, the capital stock in the private sector would be 116.6% of the non-private sector.

In Figure 11 we show the implied evolution of capital compared to the benchmark economy for the three different scenarios. The level of capital increases a lot on impact in the private sector, while it decreases in the non-private sector, but the peak in terms of aggregate capital still happens at the same time.

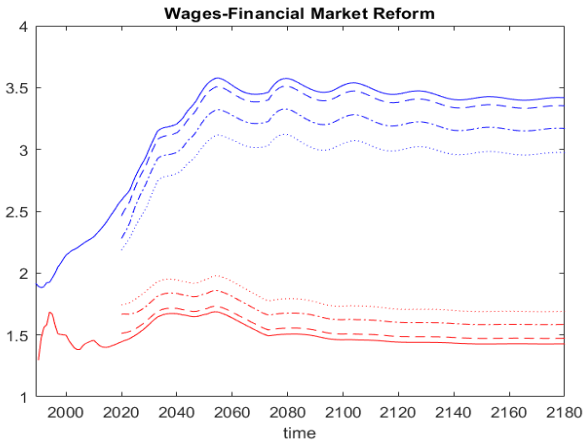


Figure 12: Wage Changes from Financial Market Reform

Notes: This figure shows the evolution of the detrended wages under different capital reforms starting in 2020. The value has no economic meaning. The red lines and blue lines refer to the wage rates in the private sector and the non-private sector, respectively. The solid line refers to the benchmark results ($\eta = 0.02$), and the lines with decreasing density refer to corresponding reforms with $\eta = 0.1,\ 0.3,\ 0.5$, respectively.

As expected, improving the access to capital of the private sector contributes to decreasing the gap in wages across sectors substantially. That is a direct implication of the reallocation of capital across the two sectors.

5.2 Integrating labor markets

In our second counterfactual we quantify the impact of integrating labor markets. In order to do so, we allow a constant fraction of rural-urban migrants to work in the non-private sector starting from year 2020. Figure 13 reports the implied evolution of output compared to the benchmark economy. We evaluate three cases that allow 10 percent, 30 percent, and 50 percent of rural-urban migrants to work in the non-private sector. We assume that the first generation of migrants who move to the non-private sector will still keep their original labor productivity. However, their descendants will work in the non-private sector with the same labor productivity as urban natives.

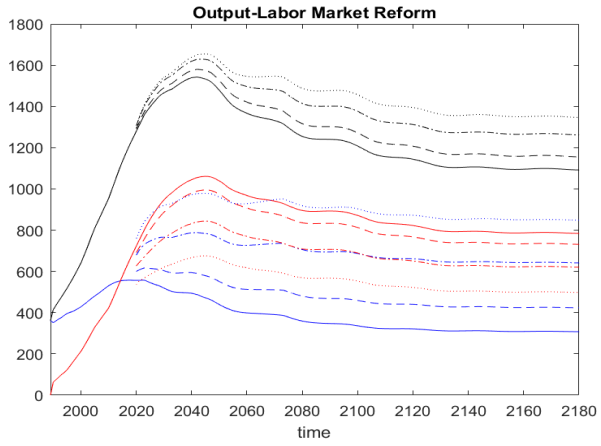


Figure 13: Output Gain from Labor Market Reform

Notes: This figure shows the technology growth detrended output under different labor market scenarios starting in 2020. The value has no economic meaning. The black lines, red lines, and blue lines refer to output at the aggregate level, output in the private sector and output in the non-private sector, respectively. The solid line refers to the benchmark results, and the lines with decreasing density refer to corresponding reforms with percentage of labor reallocation 0.1, 0.3, 0.5, respectively.

Allowing part of the migrants to join the labor force in the non-private sector allows this sector to grow for longer than in the benchmark. Still total output still peaks in 2040, but now it is both sectors that peak then, because a substantial fraction of migrants sustain growth for longer in the non-private sector. Figure 14 plots the evolution of the labor force in the two sectors under the different labor market scenarios.

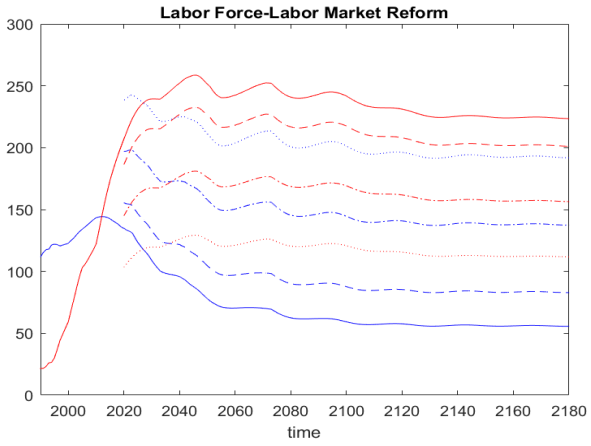


Figure 14: Labor Force Changes from Labor Market Reform

Notes: This figure shows the evolution of the labor force under different labor market reforms starting in 2020. The value has no economic meaning. The red lines and blue lines refer to labor force in the private sector and the non-private sector, respectively. The solid line refers to the benchmark results, and the lines with decreasing density refer to corresponding reforms with percentage of labor reallocation 0.1, 0.3, 0.5, respectively.

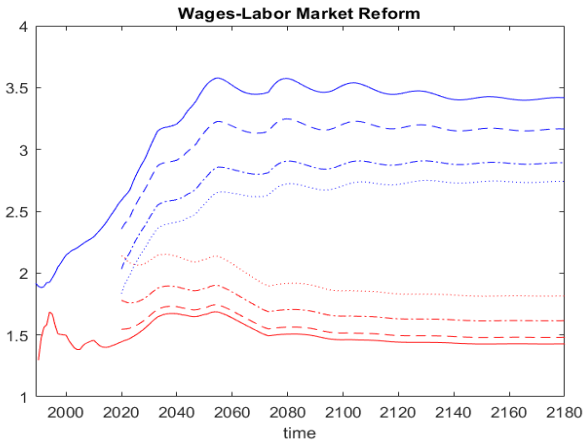


Figure 15: Wage Changes from Labor Market Reform

Notes: This figure shows the evolution of wage rates under different labor market reforms starting in 2020. The value has no economic meaning. The red lines and blue lines refer to the wage rates in the private sector and the non-private sector, respectively. The solid line refers to the benchmark results, and the lines with decreasing density refer to corresponding reforms with percentage of labor reallocation 0.1, 0.3, 0.5, respectively.

Notice that the reallocation of labor across sectors contributes substantially to wage equalization across sectors.

5.3 Integrating labor markets and relaxing financial constraint

In this counterfactual, we explore the situation where we implement both counterfactuals at the same time, labor market reform and financial market reform take place simultaneously. Specifically, in 2020 we let 50% of rural-urban migrants work in the non-private sector and relax the financial constraint, that is, increase η to be 0.5 in 2020.

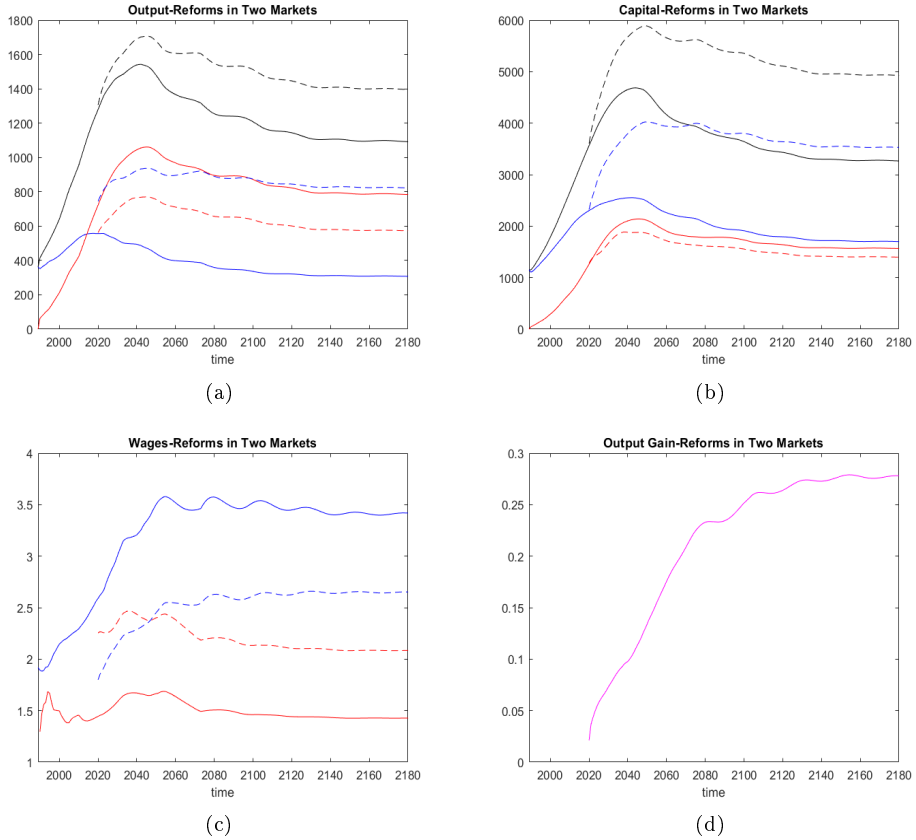


Figure 16: Growth Projections

Notes: Figure 20(a) and Figure 20(b) show the technology growth detrended output and the technology growth detrended capital of the benchmark case and the two-markets-reform case starting in 2020. The black lines, red lines, and blue lines refer to aggregate level, private sector level and non-private sector level, respectively. The values have no economic meaning. Figure 20(c) shows the evolution of wage rates in the two sectors. The solid line refers to the benchmark result, and the dash line refers to the two-markets-reform case. Figure 20(d) shows the output gain of the two-markets-reform compared with the benchmark.

Figure 16 shows that the combination of both types of reforms results in a large efficiency gain, with an increase in aggregate output of 2 percent on impact, and then over time this efficiency gain increases up to 27 percent higher output. This efficiency gain is accompanied also by a dramatic reduction of wage dispersion across sectors, especially on impact even though in the long run there is still substantial difference in wages driven by productivity differences.

While the efficiency gains of a better allocation of resources across sectors are potentially very large, we still find that the main conclusions regarding the

timing of growth projections are unaffected. Namely, we still find a progressive deceleration of growth from 2020 to 2040, and real GDP growth falling behind productivity growth after 2040.

6 Conclusions

China has experienced extraordinary economic growth in the last three decades, with an annual growth rate close to 10 percent in real GDP. We have constructed demographic projections from fertility and migration data, that allow to track the composition and size of the labor force in urban areas. The extraordinary growth experimented is the outcome of massive migration to urban areas and the development of the private sector since the economic reforms of the early nineties. This extraordinary growth has taken place despite the limited access to credit of the private sector and a very pronounced degree of labor market segmentation.

Our results suggest that the phase of very fast growth is starting to decelerate and could be over by 2040. In the non-private sector it might have already peaked in 2020. Potential reforms alleviating the access to credit or the reallocation of workers across sectors can generate substantial efficiency gains, but do not change the fundamental pattern of growth, which is driven by demographics.

In our quantitative exercise we have assumed that technology growth will continue at the high levels experienced in the past going forward into the future. Our exercise is silent about the potential evolution of technology growth, and focuses only on the impact of demographics/migration and the gains from reducing misallocation of resources in urban China. Allowing rural-urban migrants to officially register as urban residents and enjoy the same public services as urban natives is important to encourage migration and to contribute as well to the accumulation of human capital, both factors would fuel China's economic growth.

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