The evolution of income and wealth inequality in China

Juan Carlos Conesa
Stony Brook University

and

Yan Wang
Beijing Normal University

Abstract

China's GDP per capita has increased from 400 USD in 1990 to 8,000 USD in 2015. Over the same period inequality in both income and wealth has increased substantially. This paper proposes a general equilibrium multi-sector growth model with rich heterogeneity to quantify the impact on inequality of different changes that took place starting in the early 1990s. We find that rural-urban migration has alleviated the increase in inequality by narrowing the rural-urban income gap, and that the emergence and growth of the private sector is both a fundamental engine of growth and the key driving force behind the increasing inequality. Our quantitative exercise suggests that income concentration will keep increasing until the 2050s. Finally, we find that implementing reforms in labor market and financial markets could result in a significant decrease in income and wealth concentration.

JEL Codes: D31, E20, J11, O43, P23, P25

Keywords: Inequality, Structural transformation, Urbanization, Labor market segmentation, Entrepreneur

1 Introduction

> Inequality, not scarcity, that persecutes governors; chaos, not poverty, that haunts them.
>
> — Confucius

This paper focuses on understanding the forces behind increasing income and wealth inequality in China since the 1990s. We develop a novel three sector overlapping generation growth model with rich individual and firm heterogeneity in order to study this process. Two key driving forces are introduced into the model starting at the beginning of the 1990s. First, the economic reforms in early 1990s that admitted and supported the growth of a private sector. Second, there is a massive movement of people from rural to urban areas. We build population and migration estimates from census data and a 1% population survey, quantify the amount of earnings risk faced by rural, native urban and migrant workers, as well as the amount of risk faced by entrepreneurial firms in the private sector. With all these ingredients, the model predicts an evolution of inequality that is line with that observed in China in the 1990-2015 period, as reported in Piketty, Yang, and Zucman (2019).

Before China launched its "reform and open up" policy in 1978, China's economy was segmented into two separated parts, rural and urban, where people in rural areas worked in collective communes and urban people worked in state-owned firms. In early 1980s the "family contract responsibility" was enacted in the the rural areas, boosting agricultural productivity significantly, and absorbing the labor laid off from agriculture the Village and Township Enterprise firms started to grow. Since most of the income disparity at that time came from the rural-urban gap, the inequality level in China was at a very low level.

Followed by a discussion of the compatibility between the socialist ideology and the private economy, Deng Xiaoping's south talk in 1992 clarified China's future economics development path and started a new era of high economic growth. From then on, inequality levels took off, in the year 2015 China's inequality level is higher than that in France and getting close to that of the U.S., see Figure 1.1 for the evolution of income and wealth concentration from 1989 to 2015 (Piketty, Yang, and Zucman 2019). The top 10% income rich in China took about 30 percentage points of total income in 1989, and this share increases to 41 percentage points in 2015, while the corresponding change is 8 percentage

points in the U.S. and -1 point in France. The change in the top 10% wealth concentration is even larger, 26 percentage points in China, compared to 7 points in the U.S., and 4 points in France. The first objective of this paper is to quantify the impact of the emergence of the private sector and rural-urban migration in accounting for this large increase in inequality.

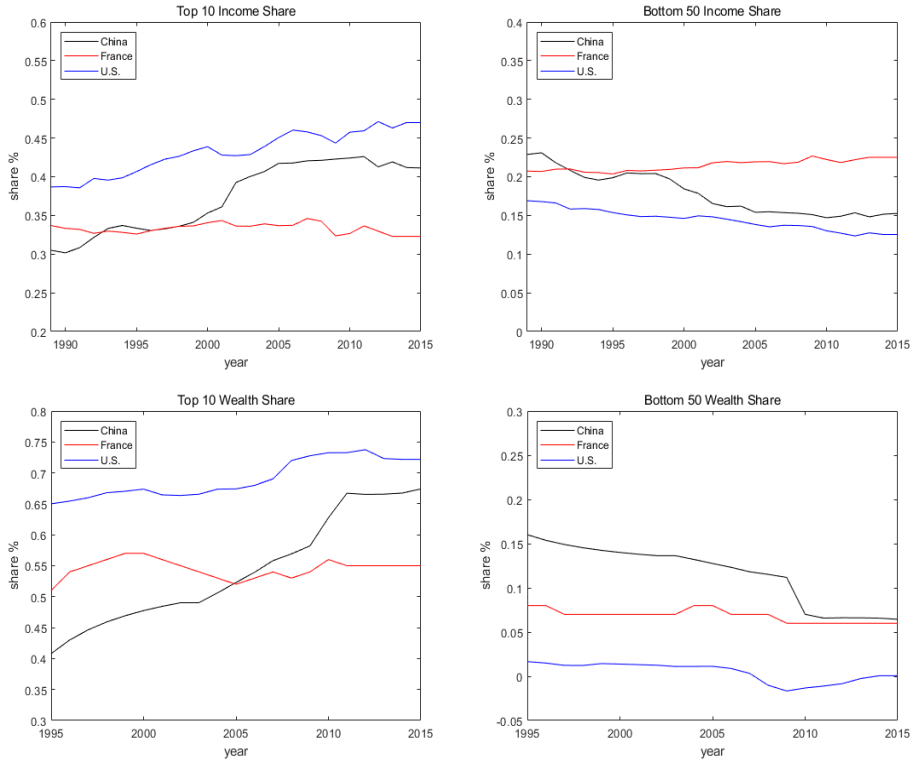


Figure 1.1: Income and Wealth Distributions among Countries. Data is from Piketty, Yang, and Zucman (2019).

In order to account for the evolution of the income and wealth distribution, understanding large changes in the population distribution is fundamental, especially in China where disparity between rural and urban population, and disparity between urban migrants and urban natives, are significant. We use several rounds of census data sets and 1% population surveys to construct demographic dynamics. The demographic model is rich enough to incorporate age distributions within each population group and especially the distribution of resident duration within the rural-urban migrant group.

In the initial steady state, that corresponds to the year 1989, there are two production sectors. A rural sector that produces agricultural goods with labor as the only input, and in the urban areas there is a production technology that produces non-agricultural goods with labor and capital. Firms in urban areas are not privately owned (e.g. State Owned Enterprises) and have access to credit and hire more educated urban natives with higher wages. There is little mobility across rural-urban areas before 1990. Starting in 1990 we introduce exogenously into the model the two changes mentioned above: The dynamics of population projections and migration from rural to urban areas, and the emergence of a new production sector in urban areas. All these changes induce a process of structural transformation regarding the output and employment shares of the rural sector, urban non-private sector and urban private sector, and associated with this process income and wealth inequality increase.

As in Conesa and Wang (2020), we model the new production sector as firms owned by entrepreneurs, and these privately owned firms are more productive, they face tight borrowing constraints and hire less-educated migrant workers. This is reminiscent of the dual production model studied in Song, Storesletten, and Zilibitti (2011). This new sector hires rural-urban migrants that are a growing source of cheap labor, but its growth is limited by financing constraints. This feature of the new sector generates a labor force that is segmented by occupation and sector (rural workers, urban non-private workers, urban entrepreneurs, and migrant private workers). Labor market segmentation in China has been widely documented in empirical papers, see Section III, but few structural work has incorporated this feature into the model[1].

Relative to our previous work that focused only on urban economic growth (see Conesa and Wang, 2020), we explicitly model the rural sector, and we measure in the data and incorporate into the model uninsurable income risk for all types of individuals. That way we can meaningfully talk about the evolution of income and wealth inequality. To discipline the quantitative analysis, we estimate labor income processes with a persistent and a temporary stochastic component and a deterministic age component, separately for all these types of agents along the transition using the China Health and Nutrition Survey. Also, we employ the China's Industrial Enterprise Database to estimate the idiosyncratic risk faced by firms in the private sector. The model does remarkably well in reproducing growth and the evolution of inequality in China, as reported by Piketty and his

[1] Zhu et al. (2010) is an exception

co-authors, even though the model was not calibrated to do that.

Kuznets (1955) analyzed the relationship between economic growth and income inequality, and hypothesized that it is well represented by an inverted U-shape. Income inequality, as measured by the income concentration of top quantiles of the distribution, should be first increasing during industrialization and then should be decreasing as the economy continues to grow. We use our calibrated model to predict the trend of income inequality in China and find no inverted U-shape relationship. Income inequality is projected to increase into the 2050s with no sign of a decrease.

We then use the model to quantify the impact of various ingredients of our specification. First, our counterfactuals suggest that rural-urban migration is a huge determinant of high economic growth and has had a moderating impact on inequality by directly reducing the urban-rural income gap. Second, the emergence and growth of the private sector is the main driving force behind the increase in inequality. We finally use the model to quantify the impact of reforms in labor and financial markets. Relaxing the financial constraints faced by the private firms decreases both income and wealth inequality. Similarly, reducing labor market segmentation, through reforms that allow rural-urban migrants to access jobs at the (higher salary) urban non-private sector, also helps to decrease the overall income and wealth concentration.

The rest of the paper is organized as follows. Section II provides a literature review. Section III presents some relevant facts in China which are necessary to understand the high economic growth and fast increasing inequality in the last thirty years. Section IV describes the general equilibrium model. Section V describes the calibration strategy we use, followed by section VI that discusses the model validation. Section VII discusses the projected evolution of inequality in China. Section VIII discusses our counterfactual exercises and the effects of labor and financial market reforms. Section IX concludes.

2 Related Literature

Wealth and income inequality have been extensively studied in the U.S. and other western economies. Saez and Zucman (2016) combines tax returns and household's balance sheets to estimate the evolution of the wealth distribution in the United States since 1913. Piketty and Saez (2003) use tax return data

to show series on top shares of income and wages from 1913 to 1998 in the U.S.. We heavily rely on the findings in Piketty, Yang, and Zucman (2019, hereinafter PYZ 2019), which combines household's surveys, official fiscal data, national accounts, and Hurun rich list [2] to quantify the trends of income and wealth inequality in China from 1978 to 2015.

The standard model with heterogeneous agents is usually a variant of the Bewley-Huggett-Aiyagari type model (Bewley 1986, Huggett 1993, Aiyagari 1994), and has been extensively used to study income and wealth inequality. It is well known that this basic model fails to capture the degree of wealth inequality featured in the data, especially the fact that the distribution is skewed to the right and has a fat tail. The list of potential features to address this failure is very extensive including, just to mention a few, heterogeneity in discount factors, as in Krusell and Smith (1998), or heterogeneity in investment returns, as in Benhabib, Bisin, and Zhu (2011) or Benhabib, Bisin, and Luo (2019). Also, the introduction of super-star income realizations, as in Castaneda et al (2003) or Kindermann and Krueger (2014), that itself builds on pioneering work by Rosen (1981), with recent developments as in Haskel et al. (2012), Aghion et al. (2018), Acemoglu and Autor (2011) or Gabaix et al. (2016). Another strand of the literature focuses on inter-generational linkages, starting with De Nardi (2004). Among the potential explanations there is a large literature, starting with Quadrini (2000) and Cagetti and De Nardi (2006), that argues that entrepreneurship is crucial to understand the fat tail at the top of the wealth distribution. Our work follows this tradition, since the emergence and growth of a new class of entrepreneurs following the economic reforms of the early 1990s is a crucial feature of the Chinese experience.

While most of the literature understanding the income/wealth distribution focuses on the properties of the stationary (long-run) wealth distribution, the focus in this paper is on the evolution of inequality along transition path. Kaymak and Poschke (2016) focus on the transitional dynamics of the wealth distribution in the U.S.. They combine dynastic and life-cycle elements in a Bewley-Huggett-Aiyagari type model to study the effect of changes in taxes and transfers on the evolution of wealth concentration since 1970. Hubmer, Krusell, and Smith (2019) extend the benchmark infinitely-lived heterogeneous-agent model with tax progressivity, portfolio heterogeneity and stochastic idiosyncratic capital re-

[2] Hurun rich list is a list of China's richest people produced by the British journalist and CPA Hurun (Rupert Hoogewerf) since 1999.

turns to explain the evolution of wealth inequality in the U.S. from the late 1960s.

The model in this paper displays different income growth rates among agents, e.g. rural residents, workers in the urban non-private sector, workers in the urban private sector, and entrepreneurs, also the leverage effects of private firms are crucial to explain the fast increase of inequality in China. Jones and Kim (2018) use heterogeneous growth rates among entrepreneurs and creative destruction to explain the top of the income distribution. An essential part of our exercise is the measurement of idiosyncratic productivity shocks for different types of agents, following Storesletten, Telmer, and Yaron (2004) and Guvenen et al. (2007, 2009, 2015). This paper uses a hybrid setting of labor income process from them with heterogeneous individuals who enjoy different income growth rates and also different standard deviations of persistent and transitory shocks.

The study of inequality in China is limited by the lack of data, but also because China is still undergoing a very drastic economic and demographic transition. There are some empirical papers describing and trying to explain China's increasing inequality, especially as several micro data sets have become publicly available in recent years. Tan, Zeng and Zhu (2017) use China Household Financial Survey (CHFS) to describe the inequality of earnings, income and wealth in the year 2010. Knight, Li and Wan (2017, 2018) use the China Household Income Project (CHIP) to explain the increase in inequality of wealth in China between 2002 and 2013, and assign a big role to changes in housing prices. Luo, Li and Sicular (2018) study the long-term evolution of income inequality and poverty from 1988 to 2013, and report a significant reduction in poverty. Khan, Griffin and Riskin (1999) study the increase in income inequality between 1988 and 1995 and argue that increasing inequality is driven by a decreasing labor income share, low output-employment elasticity, and unequal government transfers. Zhong (2011) argues that the aging of population explains the increasing income inequality in rural China from 1993 to 2006. Sicular, Yue, Gustafsson and Li (2007) and Yang (1999) study the rural-urban income gap. Heckman and Yi (2012) argue that human capital disparity due to the Hukou system is important to explain inequality in China.

Our paper is also close to the literature that estimates labor income processes for Chinese households. Ding and He (2018) use the nonpublic Urban House Survey (UHS) data and argue that the dramatic increase in uninsurable permanent

income shocks can explain the increasing inequality of earnings, income, and consumption in urban China. Santaeulàlia-Llopis and Yu (2018) exploit the China Health and Nutrition Survey (CHNS) to argue that increases in labor income uncertainty can offset the gain from economic growth, with households experiencing an increasing difficulty to insure consumption against income risk. Whalley and Zhang (2004) use a general equilibrium model to study the effect of the Hukou system in different steady states.

3 Institutional Features and Empirical Evidence

The Socialist Market Economic System was formally announced in the 14th National Congress of the Communist party of China in 1992. Starting in the early 1990s the central government decided to promote economic development in urban areas, and limit the financing of Village and Township Enterprises. Also political barriers on labor mobility were gradually eliminated to let rural residents move to urban areas in search of job opportunities. This section discusses the main institutional changes occuring since the early 1990s.

The Hukou system, rural-urban migration and the rural-urban gap

The Hukou is a registration system, which works like an inner passport, originated in ancient China to help the government collect taxes. In the planned economy era, Hukou was used to allocate the labor force into agricultural and industrial sectors. However, as the market economy grows, the Hukou system becomes a barrier that distorts labor allocation (Trevor and Zhu 2019).[3] In addition, since citizen's social benefits are tied to their Hukou status, it leads to further inequality and can extend the inequality to future generations (Heckman and Yi, 2012). There are two categories of rural-urban migrants. One is those who physically move from rural to urban areas, with and without changes in their Hukou status. The other is because of reclassification of registered residence from rural to urban without location changes. Following Song, Storeslet-

[3]Ngai, Pissarides, and Wang (2019) study the mobility barriers and under-developed land market in rural China, and argue that people with a rural Hukou are facing high barriers when participating in urban labor markets.

ten, Wang, and Zilibitti (2015), we do not distinguish the two cases and count both categories as rural-urban migration.

We use census data to measure rural and urban population, and the amount of rural-urban migration. China's census goes back to 1953. Starting from 1990 the National Bureau of Statistics (NBS) conducts a census every ten years. Moreover every ten years between two census years there is a 1% population survey. From these data sets we can get the population data in urban, township, and rural areas in each age and gender group. Also the data sets include fertility rate and mortality rate in each age and gender group in urban, township, and rural. The definition of urban, township, and urban is shown in Table 1, consistent with the definition of the National Burea of Statistics of China, and we just translate into English.

Name		Scope
Urban	City	City jurisdiction and city without district, residents committee and other areas connected to the actual construction of the city and the city government.
	Town	County people's government resident and other towns outside the city, residents committee and other areas connected to the actual construction of the county government. Mining areas, development zones, research institutes, universities, and other special areas with permanent population of more than 3,000 people and farms and forest farms.
Rural		Areas except city and town.

Table 1: Division of City, Town, and Rural in the NBS (2008)

To construct our demographic projections we follow the methodology of Hu (2003) and Song, Storesletten, Wang, and Zilibitti (2015). We use the 1990 census, 2000 census, 2010 census data, as well as 1995 1% population survey, 2005 1% population survey and 2015 1% population survey. For example, first we use the census 1990 to obtain population age, gender, location distribution data, the fertility and mortality rates data in the year 1990, and then project the population of urban and rural areas to 1995. The difference between our projection for 1995 and the actual population distribution in the 1995 survey is the accumulated amount of rural-urban migrants during this 5 year interval. Then, we calculate the age-gender specific migration rates within this time frame. Given the migration rates of each 5 year interval from 1990 to 2015, we

can construct the migrants' stock starting from 1990.

Following Song et al. (2015), we make several assumptions in the demographic projection. First, no return migration. Second, after migration, the migrants have the same fertility and mortality rates as urban natives. Third, the migration rates after 2015 are the same as migration rates within 2010-2015 period and the migration process stops in the year 2070. The third assumption is not quantatively relevant, since the stock of potential migrants in the rural areas decreases sharply after decades of young migration. However, Song et al. (2015) ignore the economic difference between the first generation migrants and their descendants. See Figure 9.1 in the Appendix for the migration rates during different time periods. Finally, by using the migration rates, we can construct the distribution of migrants and identify how long they have been living in the urban area, which is crucial for our analysis since how long they have been living in the urban area determines migrants' income and wealth.

Figure 3.1 shows the population (age 20 and above) dynamics of four groups of people: urban native residents, rural residents, first generation migrants, and the descendants of the first generation migrants. First generation migrants are nearly all the rural-urban migrants until 2016, then the second generation of migrants start entering the economy (age 20 and above) and eventually surpass in number first generation migrants a few decades later.

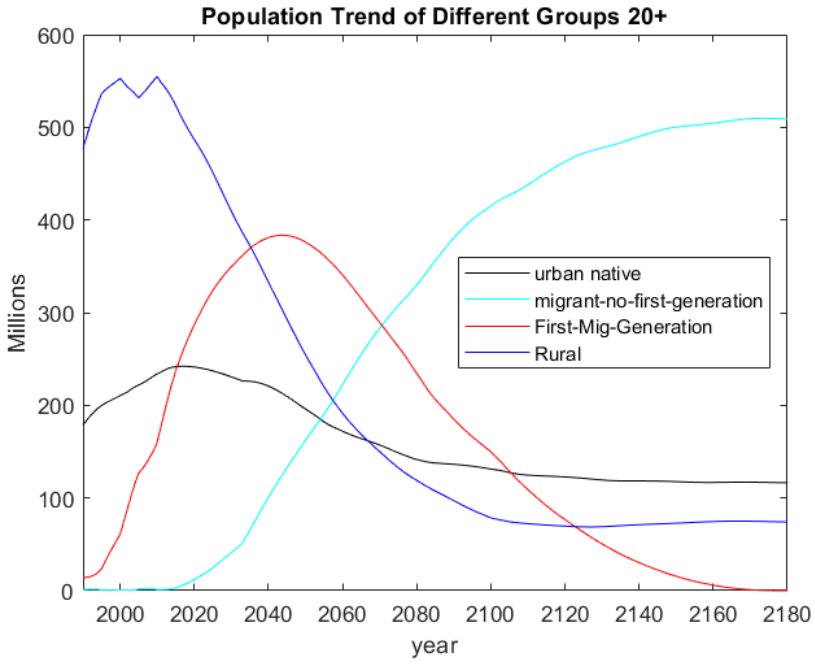


Figure 3.1: Population of Different Groups

After the reform of the Household Contract Responsibility System, agriculture productivity increased. A large amount of rural labor was absorbed by the local Township and Village Enterprises (TVEs), and there is a golden age of the TVEs during 1980s and early 1990s. After that financing in rural area was limited (Huang, 2012) and political power restricted the growth of TVEs. In the end, the central government built a urban oriented and state-owned firms-friendly economic system (Fan and Chen 2005). Economic disparity between urban and rural areas is a crucial factor of the increasing nationwide inequality in China. Figure 3.2 shows the trend of urban-rural income per capita ratio from 1989 to 2015 with the data from PYZ 2019.

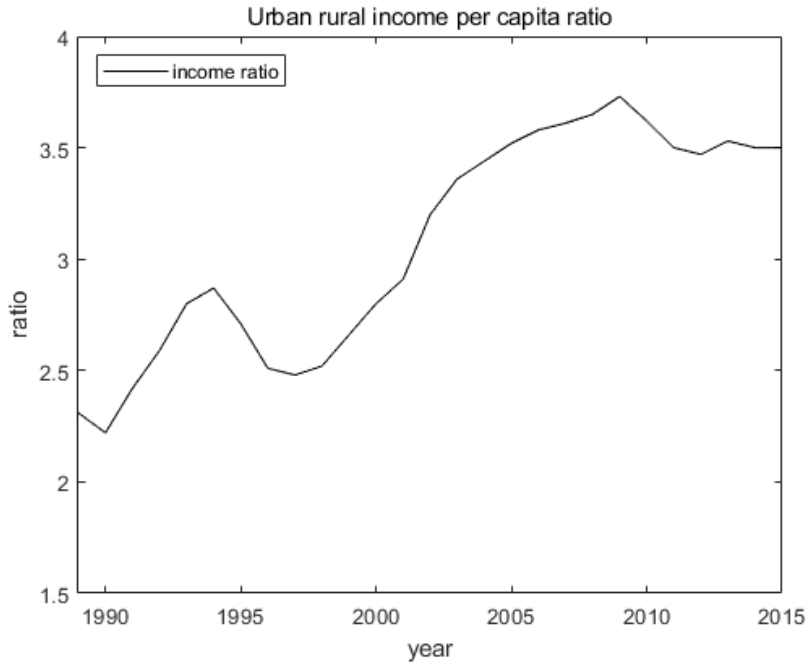


Figure 3.2: Urban-rural income per capita gap. Data is from Piketty, Yang, and Zucman (2019).

The private economy, financial constraints and labor market segmentation

Public ownership playing a dominant role and different economic sectors developing side by side is an important pillar of the socialist system with Chinese characteristics and is the foundation of the socialist market economy. Similar to Allen, Qian, and Qian (2005), we divide China's urban economy into two sectors: (1) the Private Sector, that includes privately owned firms, self-employed, collective-owned enterprises, jointly-owned enterprises, firms with funds from Hong Kong, Macao and Taiwan (HMT), foreign funded firms; (2) the Non-Private Sector includes state-owned enterprises and share-holding corporations Ltd. See Table 2. The reason why we group collective-owned and jointly-owned enterprises in the private sector is that they are operated as private firms and an individual is the de facto owner (Huang 2012, Allen et al. 2005, Fan and Chen 2005).

Sector	Member
Private	Privately Owned Firms
	Collective-Owned Enterprises
	Jointly-Owned Enterprises
	Firms with Founds from HMT
	Foreign Funded Firms
	Self-Employed
Non-Private	State-Owned Enterprises
	Share-Holding Corporations Ltd

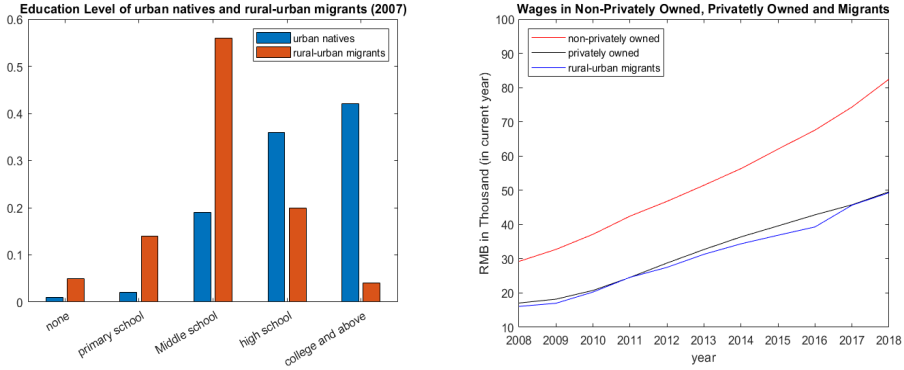
Table 2: Private Sector and Non-Private Sector in Urban China

The private economy has been growing significantly since the early 1990s, when the Chinese government formally admitted its legal status. According to Xinhuanet, in 2017 the output of the private economy accounts for more than 60% of the overall GDP, hires more than 80% of the labor force in urban China, and creates more than 80% of the new jobs. However, the difficulty in raising funds has always been a constraint on the growth of private firms (Song et al. 2011). Bank loans are the major source of external finance for China's companies, however private firms are discriminated compared with state-owned firms, and they heavily rely on self-financing. Allen et al. (2005) mention that bank loans account for 10 percent of the overall financing of fixed asset investment in the private sector from 1994 to 2002. Despite the limited access to external funds, the private sector shows better performance in terms of productivity (Wei and Dollar 2007, Jefferson et al. 2000).

The segmentation of labor markets (rural workers, urban native workers, and migrant workers) is a long-existing phenomenon in China. Within urban areas, non-private sectors which are state-owned and large public firms hire well-educated workers, and most of them are urban residents. Migrants tend to work in the private sector, which is labor intensive and financially constrained. See the education distributions of rural-urban migrants and urban natives in Figure 3.3 (a), and see the wage difference between non-privately owned firms, privately owned firms, and rural-urban migrants in Figure 3.3 (b). There is almost an exact match between the wages paid by the private sector and the wages earned by migrants, while the wages paid in the non-private sector are substantially higher.

Meng and Zhang (2001) study the two-tier labor market in urban China and point that rural migrants are discriminated in both occupational attainment and

wages compared with urban natives. Frijters et al. (2009) say average hourly wage compensation for urban natives is more than double that of rural migrants, and non-wage compensation is even more unequal according to the 2008 wave of the RUMiCI data. Zhang and Wu (2017) argue that occupational segregation explains most of the earnings disparities between urban natives and rural migrants in the urban labor market using the 1% population survey of 2005. Qu and Zhao (2017) argue that there exists a 'glass ceiling' for rural-urban migrants in urban labor markets, and the wage gap is increasing in 2007 using the Chinese Household Income Project (CHIP) data. Zhu (2016) finds that a sizable mean wage gap between urban native workers and rural migrants is increasing from 48% in 2002 to 58% in 2007, and the different returns to individual characteristics contribute more than the differences in individual productivity characteristics per se to the wage gap in 2007 according to CHIP data. Migrants' children often meet high obstacles when choosing local schools in the migration destination. Although they could finish high school in the migration destination province, they cannot take the college entrance examination there. Combined with the fact that education quality in rural is far behind urban, the segmentation generated by the differences in residential status can and often do extend beyond the first generation migrants. Heckman and Yi (2012) offer the same point of view concerned with the barriers of inter-generational mobility among rural-urban migrants.



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

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

Figure 3.3: Two Tier Labor Market in Urban China

Summarizing, there is ample evidence pointing towards the emergence since the

early 1990s of a private sector that is more productive even though it faces strong barriers to obtaining external funds, but grows rapidly thanks to the massive availability of relatively cheap labor due to the arrival of rural-urban migrants and their descendants. Our exercise provides a model of structural transformation in China given those changes and institutional features, and delivers quantitative predictions about the past and future evolution of income and wealth inequality.

4 The model

Given the evidence discussed in the previous section, we now propose a model where rural-urban migration and the emergence of the urban private sector are the exogenous driving forces behind structural transformation and changes in inequality. We consider a three sector overlapping generation model equipped with four types of heterogeneous individuals (rural workers, urban non-private workers, migrants private workers, and private entrepreneurs). Workers make consumption and savings decisions. The new private sector consists of entrepreneurs that run their own firm, make profits, decide how much to save into a riskless asset and how much to invest in their own risky business.

Technology

The rural sector produces agricultural goods that cannot be stored and uses labor as the only input. Technology is given by:

$$F_{R,t}(N_{A,t}) = A_t \chi_t N_{R,t}$$

where $N_{R,t}$ is the labor used, A_t is productivity level, and χ_t is the productivity difference between the rural sector and the urban non-private sector.

The urban non-private sector uses a constant returns to scale technology, produces non-agricultural goods, and uses labor and capital as inputs. Non-agricultural goods can be consumed or invested. Technology is given by:

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

where $K_{F,t}$ and $N_{F,t}$ are capital and labor in the urban non-private sector, and α_F is the capital income share.

The individual's problem

Individuals are differentiated by the place of birth, namely, rural or urban. The individuals that are born in rural areas and stay in the rural area solve the following maximization problem:

$$V_{R,t}(a,j,\varepsilon_{R,t}) = \max_{c_a,c_n,a'} \left\{u(c_a,c_n) + \beta\phi_{R,j}[(1-\kappa_{t,j})EV_{R,t+1}(a',j+1,\varepsilon'_{R,t}) + \kappa_{t,j}EV_{I,t+1}(a',j+1,\varepsilon'_{I,t})]\right\}$$

$$s.t.\ p_t c_a + c_n + a' = (1+r_t)(a+TR_{R,t}) + \varepsilon_{R,t}\omega_{R,j}w_{R,t}$$

$$a' \geq 0,\ c_a \geq \bar{c},\ c_n \geq 0$$

They choose consumption of agricultural goods c_a and non-agricultural goods c_n, and savings a' to maximize their life-time utility $V_{R,t}$, with the state variables a, assets, j age, and $\varepsilon_{R,t}$ idiosyncratic labor productivity shocks. $V_{I,t}$ is the life-time utility of rural-urban migrants defined below. β is the discount factor. $\phi_{R,j}$ is the conditional mortality rate in the rural sector. $TR_{R,t}$ is the bequest from the deceased rural individuals, and we assume those are distributed equally among rural residents. $\kappa_{t,j}$ is the rural-urban migration rate which is time and age dependent. Individuals must consume at least $\bar{c}$ amount of agricultural goods to subsist and cannot borrow. $\omega_{R,j}$ is the deterministic age profile of earnings for rural individuals, and $w_{R,t}$ is the competitive wage in the rural sector. We denote by r_t the competitive net interest rate in the economy. Finally, p_t is the relative price of agricultural goods (the price of non-agricultural goods is normalized to 1).

Rural born people that move to the urban area solve the following maximization problem:

$$V_{I,t}(a,j,\varepsilon_{I,t}) = \max_{c_a,c_n,a'} \left\{u(c_a,c_n) + \beta\phi_{u,j}EV_{I,t+1}(a',j+1,\varepsilon'_{I,t})\right\}$$

$$s.t. \begin{cases} p_t c_a + c_n + a' = (1+r_t)(a + TR_{I,t}) + \varepsilon_{I,t}\omega_{I,j}w_{I,t} \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad for\ j = 1...J_r - 1 \\ p_t c_a + c_n + a' = (1+r_t)(a + TR_{I,t}) \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad for\ j = J_r...J \end{cases}$$

$$a' \geq 0,\ c_a \geq \bar{c},\ c_n \geq 0$$

After moving to the urban area, compared with working in the rural sector, migrants receive different labor productivity process ε_I, different age profile $\omega_{I,j}$ and different wage $w_{I,t}$. Also, we assume that migrants have the same mortality rates of urban areas, and they receive bequests $TR_{I,t}$. Also, they work until age J_r and then retire.

Now we describe the problem faced by urban workers. Up to an exogenous fraction of those individuals make career path decisions while entering into the economy,[4] choosing whether to be workers in non-private firms or to be entrepreneurs:

$$V_{U,t} = max\left\{V_{F,t},\ V_{E,t}\right\}$$

where $V_{F,t}$ denotes the lifetime utility of being a worker in the non-private sector, and $V_{E,t}$ denotes the lifetime utility of becoming an entrepreneur. If they choose to work in the non-private sector, their maximization problem is:

$$V_{F,t}(a, j, \varepsilon_{F,t}) = \max_{c_a, c_n, a'} \left\{u(c_a, c_n) + \beta\phi_{u,j} E V_{F,t+1}(a', j+1, \varepsilon'_{F,t})\right\}$$

$$s.t. \begin{cases} p_t c_a + c_n + a' = (1+r_t)(a + TR_{F,t}) + \varepsilon_{F,t}\omega_{F,j}w_{F,t} \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad for\ j = 1...J_r - 1 \\ p_t c_a + c_n + a' = (1+r_t)(a + TR_{F,t}) \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad for\ j = J_r...J \end{cases}$$

[4]The underlying assumption is that not all urban residents are endowed with viable entrepreneurial ideas and skills.

$$a' \geq 0,\ c_a \geq \bar{c},\ c_n \geq 0$$

where $TR_{F,t}$is the bequest in the non-private sector, $\omega_{F,j}$, $w_{F,t}$, and $\varepsilon_{F,t}$ are the corresponding age profile, competitive wage and labor income idiosyncratic shock in the non-private sector. As an entrepreneur, the maximization problem is:

$$V_{E,t}(a, j, \varepsilon_{F,t}, \xi_t) = \max_{c_a, c_n, a'} \left\{ u(c_a, c_n) + \beta \phi_{u,j} EV_{E,t+1}(a', j+1, \varepsilon'_{F,t}, \xi'_t) \right\}$$

$$s.t. \begin{cases} p_t c_a + c_n + a' = (1 + r_t)(a + TR_{E,t}) + \varepsilon_{F,t} \omega_{F,j} w_{F,t} & for\ j = 1...J_e - 1 \\ p_t c_a + c_n + a' = \pi(a + TR_{E,t}, \xi_t, loan, n) + a + TR_{E,t} & for\ j = J_e...J \end{cases}$$

$$a' \geq 0,\ c_a \geq \bar{c},\ c_n \geq 0$$

Young entrepreneurs work in the non-private sector until age J_e, and then start their own business. As an old entrepreneur they run their business and make decisions on how much labor to hire, n, and how much to borrow from (or deposit) into the bank, *loan*. Profits of private firms are defined as follows:

$$\pi(a + TR_{E,t}, \xi_t) = \max_{loan, n} \{ k^{\alpha_I} ((\xi_t A_t)^{\frac{1-\alpha_I}{\theta}} n)^{\theta} - \delta k_t - w_{I,t} n - \tilde{r}_t loan \}$$

$$k = a_E + TR_{E,t} + loan$$

$$(1 + \tilde{r}_t) loan \leq \eta [k^{\alpha_I} ((\xi_t A_t)^{\frac{1-\alpha_I}{\theta}} n)^{\theta} + (1 - \delta) k - w_{I,t} n]$$

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

and

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

where the private firms use "span of control" technology, with capital input k and labor input n, and capital income share α_I, labor income share θ. ξ_t is the idiosyncratic productivity shock. The idea is that due to the managerial nature of private firms, they face decreasing returns to hired inputs. In addition, private firms also face financial constraints, since they can only borrow a fraction η of the net value of the firm.[5] When entrepreneurs save in the safe asset ($loan < 0$) they receive the competitive interest rate r_t, and when they borrow short-term ($loan > 0$) they face higher interest rates $r_t + spd_t$, where spd_t is the operational cost of the financial sector.

Timing of events. In the beginning of the period, productivity shock is realized. Then given their initial wealth a and bequest $TR_{E,t}$, entrepreneurs make their employment and short-term loan decisions. After getting the profit from their business, entrepreneurs make consumption and saving decisions.

See the appendix for a complete definition of a Competitive Equilibrium. We will assume that the economy starts in a steady state without migration and the urban private sector is not allowed. Then, unexpectedly the urban private sector and migration are allowed.

5 Calibration

Some parameters are determined outside the model, while others are calibrated in equilibrium. Also, some parameters are determined in the initial steady state, and others are determined along the transition. China's economy is assumed to be at a steady state in 1989 with only two sectors: the rural sector and the urban non-private sector. In 1990 the population transition starts and the private sector develops and grows until the final steady state is reached endogenously within a 300 year period.

Demographics. Individuals enter the economy at age 21 and live at most until the age of 90. We set the mandatory retirement age for urban workers to be

[5] It is useful to think of η as the fraction of resources that the bank could recover in the event that the entrepreneur would choose to default.

60, and there is no retirement in the rural sector. The age distributions and the mortality rates for rural residents, urban native residents and migrants are calculated from census and 1% population surveys as described in Section 3, and are directly fed into the quantitative model. We assume a strict labor market segmentation so that rural-urban migrants can only work in the urban private sector, and urban natives can either work in the urban non-private sector or become entrepreneurs. Finally, future entrepreneurs know at age 21 that they will become entrepreneurs at age 40 and save accordingly, and they do not retire.

Determining what fraction of the population can become entrepreneurs is a tough question. Quadrini (2000) reports an estimated fraction of entrepreneurs in the U.S. population at 12% using Panel Study of Income Dynamics 1970−1992 and Survey of Consumer Finances (SCF) 1989 − 1992. Gentry and Hubbard (2004) reports the estimated entrepreneurs fraction 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. According to data from NBS, there were 443,000 private firms in 1996, and this number increases to 14.4 millions in 2017 which is less than 5 percent of the urban native population (the population of urban natives is 300 millions in China). Thus, we set the upper bond of the entrepreneur fraction to be 5 percent.[6]

Preferences and production functions. We use the Stone-Geary utility function, so that individuals first allocate their resource to consume $\bar{c}$ units of agriculture good to subsist, and in the limit α fraction of their total consumption goes to agricultural goods and $1-\alpha$ fraction of their total consumption goes to non-agricultural goods. This type of utility function is widely used in the development and structural change literature, since it can capture the decline of the agricultural share of total output due to a decreasing $\bar{c}$ relative to GDP growth. Also, this functional form has been used in the inequality literature to capture that a large fraction of people accumulate very few assets due to the minimum consumption requirement.

$$U(c_a, c_n) = \alpha log(c_a - \bar{c}) + (1-\alpha) log(c_n),\ 0 \leq \alpha < 1$$

We estimate α from the China Household Nutrition Survey (described in detail below), where the top 10% income rich individuals spend 24% of their total consumption on food. Zhu et al. (2010) calibrate α to be 24% using the agriculture

[6] Increasing this number to 10 percent does not significantly affect the results.

employment data. We calibrate $\bar{c}$ in the initial steady state to target that rural output is 38% of GDP (NBS and Rural Household Survey).

The productivity difference between rural and non-private sectors χ is set to make the relative price of the two goods 1 in the initial steady state. The capital income share α_F is set to 0.5 following Bai et al. (2006), and α_I and θ are both set to 0.4 to have entrepreneurs get 20% of the firms' output as profits (China's Industrial Enterprise Database, 1998 and 1999). The depreciation rate is set to 0.1 following Bai et al. (2006), and the interest spread is set to 0.026 to match the average difference of interest rates between loans and deposits in China from 1990 to 2015 (International Monetary Fund, 2020). See parameters determined outside the model in Table 5.

Age profile and labor income process. Workers in different sectors face very different age profiles and labor income shocks (Ding and He, 2018) , also the variation of the shocks changes along the transition path in China (Santaeulàlia-Llopis and Yu, 2018). We use CHNS to get estimates of workers' idiosyncratic labor income shocks and age profiles. CHNS is an ongoing panel survey project, organized by 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 the only publicly available household level panel data of China throughout the economic transition initiating from late 1980s. 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. In each province and autonomous city a multistage, random cluster process was used to collect the samples. Currently there are ten rounds of the survey data sets (1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, 2011, and 2015), and there were $7,319$ households and $20,914$ individuals surveyed in 2015. Consistent with the definition of rural and urban areas in Table 1, and the definition of private and non-private sectors in Table 2, we use the residence and work unit variables to separate the whole data set into three groups: rural residents, urban residents working in the private sector, and urban residents working in the non-private sector. We use wage earnings as labor income in the urban sectors, and non-capital non-transferred income as labor income in the rural sector. Following shows the regression[7] we use

[7] Minority is a dummy variable. there are 56 ethnic groups in China. "Han" is the majority

for estimation and Figure 5.1 plots the deterministic age profiles in the three sectors.

$$logIncome_i = \beta_0 + \beta_1 gender_i + \beta_2 province_i + \beta_3 minority_i + \beta_4 education_i + \beta_5 survrywave_i + \beta_6 age_i + \beta_7 age^2 + \mu_i$$

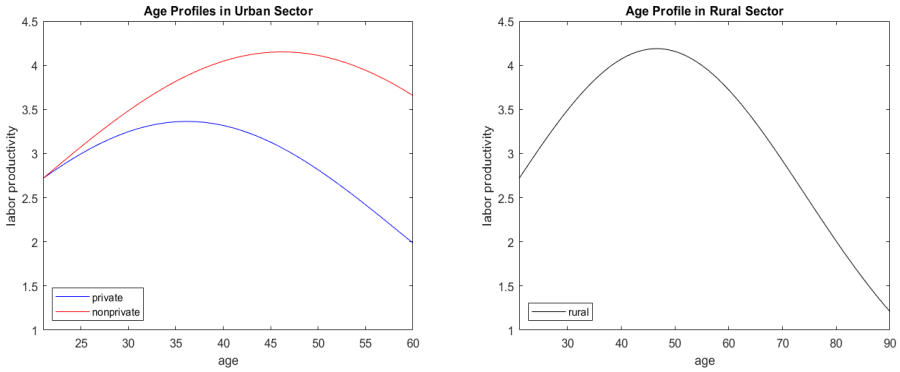


Figure 5.1: Age Profiles

We regress the logarithm income on gender, province, education, ethnic group and age for each survey wave to get residuals. See the following regression details.

$$logIncome_{t,i} = \beta_{0,t} + \beta_{1,t} gender_{t,i} + \beta_{2.t} province_{t,i} + \beta_{3,t} minority_{t,i} + \beta_{4,t} education_{t,i} + \beta_{5,t} age_{t,i} + y_{t,i}$$

We assume the following labor income shock structure:

$$y_t = z_t + \upsilon_t$$

$$z_t = \rho z_{t-1} + \tau_t$$

The residual income y_t is composed of a persistent component and a transitory component, where the persistent component z_t follows an $AR(1)$ process

and others are all minorities. Surveywave is the year that the survey was conducted. Education is a categorical variable: no school, high school and below, high school above.

with a persistence parameter ρ and innovation $\tau_t \backsim N(0, \sigma^2_{\tau,t})$. The transitory shock υ_t is white noise and $\upsilon_t \backsim N(0, \sigma^2_{\nu,t})$. Both υ_t and τ_t are $i.i.d$ and serially uncorrelated. We follow the estimation method by Santaeulàlia-Llopis and Yu (2018). Specifically, we take difference of the residual log income, $\Delta_\Upsilon y_t = y_t - y_{t-\Upsilon}$, where Υ is the year gap between two survey waves. Then we can form the moments, $var(\Delta_\Upsilon y_t)$ and $cov(\Delta_{\Upsilon 1} y_t, \Delta_{\Upsilon 2} y_{t+\Upsilon 2})$, which are functions of $var(y_{t-\Upsilon})$ and $cov(y_{t-\Upsilon}, y_t)$ and our target parameters, ρ, $\sigma^2_{\tau,t}$, $\sigma^2_{\nu,t}$. We calculate $var(y_{t-\Upsilon})$ and $cov(y_{t-\Upsilon}, y_t)$ from data directly, and minimize the distance between model predicted moments and their data counterparts by choosing appropriate parameters.

Table 3 shows the estimated labor income process for the three types of workers.[8] We use Tauchen (1986)'s method to discretize the $AR(1)$ process into a 3 state Markov process, and discretize υ_t into a 3 states process, so there are in total 9 grid points of the labor income process for each type of agent. When determines the support of shock grids, Tauchen (1986) set m equals to 3 in the original paper, which means three times of the unconditional standard deviation of z_t. In this poject we set the m to be 3 also. However, private transfer (from family members and friends) is common in China's economy, which means that directly using the estimated idiosyncratic shock paramerters would increase the precautionary savings of individuals. Thus, after calculation of the transition matrix of different states, we reduce the dispersion of idiosyncratic shock by dividing the shock grids by a value *disp*, where *disp* is calibrated to match the initial steady state interest rate 0.025 in 1989.

Productivity shock in private firms. The data source we used to estimate the firm level's idiosyncratic productivity shock is the China's Industrial Enterprise Database (CIED) from 1998 to 2006. CIED is an annual panel survey conducted by NBS which contains all state-owned firms and non-state owned firms with sales above 5 million RMB in Mainland China. The scope of industry here includes mining, manufacturing, and industry of production and supply of electricity, gas, and water. Following Brandt, Biesebroeck, and Zhang (2009), they construct a panel by linking firm's id, location, main product, legal person name, zip code, and telephone number, and calculate firm's level capital stock

[8] Yu and Zhu (2013) use the CHNS data set 1989-2009 to estimate labor income process by the RIP labor income model without time-varying variance, their estimated persistent shock ρ is 0.852 during $1989-1997$ and 0.888 during $2000-2009$. Santaeulàlia-Llopis and Yu (2018) use the CHNS dataset $1989-2015$ to estimate the labor income shocks with the same model of this paper, and they separate the sample into urban and rural. For the rural sample, ρ is 0.877, and for the urban sample, ρ is 1.048.

	Rural	Non-Private	Private
persistent shocks $\sigma^2_{\tau,t}$			
1990-2003	0.257	0.128	0.171
2004-10	0.250	0.064	0.282
2011-15	0.191	0.031	0.115
transitory shocks $\sigma^2_{\nu,t}$			
1989-2003	0.313	0.056	0.432
2004-10	0.441	0.083	0.268
2011-15	0.326	0.109	0.235
persistent parameter ρ			
	0.848	0.821	0.946

Table 3: Worker's Idiosyncratic Shocks

by the perpetual inventory method. We calculate firm level productivity A as the Solow residuals,

$$A^{1-\alpha_I} = \frac{VA}{k^{\alpha_I} n^{\theta}}$$

where VA is value added at firm level. Then we regress the logarithm of firm level productivity on firm's age, industry, province, and ownership to obtain the residuals[9].

$$\begin{aligned} logA_{t,i} =& \beta_{0,t} + \beta_{1,t} age_{t,i} + \beta_{2.t} province_{t,i} + \beta_{3,t} industry_{t,i} + \\ & \beta_{4,t} ownership_{t,i} + y_{t,i} \end{aligned}$$

We assume the same shock structure as labor income process with a persistent shock and a transitory shock, and use 9 grids to characterize the idiosyncratic productivity shock. Table 4 shows the estimated idiosyncratic shock structure of private sector's productivity.

[9]Ownership is a categorical variable. Different firm types in the survey data that we categorize them in private sector, e.g. private firm, private sole proprietorship firm, private partnership firm, private limited company, Hong Kong, Macao and Taiwan investment enterprises, Joint venture (Hong Kong or Macao, Taiwan-funded), Sole proprietorship enterprises from Hong Kong, Macao and Taiwan, and others. Industry is a categorical variable.We use the data from Brandt, Van Biesebroeck, and Zhang (2012). Following is their description,"Each firm is classified into an industry following the 4-digit Chinese Industry Classification (CIC) system that resembles the old U.S. SIC system. In 2003, the classification system was revised to incorporate more detail for some sectors, while some other sectors were merged. To make the industry codes comparable across the entire period, we constructed a harmonized classification that groups some industries prior to and post the revision ".

Private Firms	
persistent shock $\sigma^2_{\tau,t}$	0.164
transitory shock $\sigma^2_{\nu,t}$	0.732
persistent parameter ρ	0.544

Table 4: Productivity Shocks in the Private Sector

Parameters determined along the transition path. Our initial steady state corresponds to 1989, prior to the existence of the private sector. Therefore we have to calibrate the parameters of the private sector along the transition path. The average productivity difference $\bar{\xi}$ is set to capture the average wage ratio between urban private and non-private sectors during 2008 to 2015 of 0.605 as in Figure 3.3 (b). The parameter of the entrepreneur's borrowing constraint η is set to match that on average the private sector can finance 10% of total capital through bank loans from 1994 to 2002 (Allen et al. 2005). The discount factor β is set to match the average capital-output ratio to be 2.20 from 1992 to 2007 (PWT).[10] And $g = 0.057$ is used to target the average annual GDP growth rate of 9.0% in the period 1999 to 2019. See the parameters determined in equilibrium in Table 6.

parameter	value	definition
J	70	maximum age 90
J_e	21	age to run the private firm 40
E_{bound}	0.05	fraction of population with idea and entrepreneur skill
α	0.24	fraction of consumption for agriculture good (CHNS)
α_F	0.5	capital income share is 50 percent (Bai et al. 2006)
α_I and θ	0.4	20 percent residual profits (CIED)
δ	0.1	10 percent depreciation rate (Bai et al. 2006)
spd	0.026	avg. difference between loans and deposits rates $1990-2019$ (IMF)

Table 5: Parameters determined outside of the model

[10] The Chinese government conducted a 4 trillion investment plan during 2008 financial crisis, and the capital-output ratio started to increase fast since then, which cannot be explained by our model.

	parameter	value	target
Initial SS	$\bar{c}_a$	1.537	rural GDP share is 38 percent in 1989
	χ	0.810	relative price is normalized to 1
	$disp$	2.956	real interest rate is 0.025 in 1989
Transition	ξ	6.750	avg. wage ratio is 0.605, $2008-2015$
	η	0.448	avg. 10 percent asset financed by bank loan, $1994-2002$
	g	0.057	avg. 9 percent annual GDP growth rate, $1999-2019$
	β	0.951	avg. capital-output ratio 2.20, $1992-2007$

Table 6: Parameters determined within the model

6 Model Validation

Model generated inequality

This section shows the model performance in accounting for the evolution of inequality in income and wealth in China from the early 1990s. Remember that in the calibration process we do not target any distribution of income or wealth, the only parameter related to income inequality is the productivity difference between urban private and non-private sectors which is used to target the average wage ratio during 2008 to 2015, and still we only target the average not the entire trend.

Initial Steady State. The following table shows the income and wealth distributions in the initial steady state of the model compared to the data for the year 1989. The model does very well compared with data, the top 10% income rich in the model has 24.0 percent of total income compared to 30.7 percent in the data, the middle 40% income share receives 48.3 percent of income, slightly higher than the data counterpart, 46.9 percent, and the bottom 50% income share is 27.7 percentin the model and it is 22.4 percent in the data. Also the model generates a urban-rural income per capita ratio of 2.110, which is very close to the 2.310 we see in the data.

Unfortunately we do not have data on wealth inequality in the year 1989, we compare data and model generated wealth inequality in 1995.

The Transition Path. The economic transition starts in 1990 when the private economy appears and the migrants gradually start to move to the urban areas. The model captures the main features of the evolution of inequality for both

Income in 1989			
	Top 10%	Middle 40%	Bottom 50%
Data	0.307	0.469	0.224
Model	0.240	0.483	0.277
Urban-Rural Income per Capita Ratio in 1989			
Data	2.310		
Model	2.110		
Wealth in 1995			
	Top 10%	Middle 40%	Bottom 50%
Data	0.408	0.432	0.160
Dodel	0.424	0.481	0.095

Table 7: Initial Steady State

income and wealth, that is, the increasing concentration of both income and wealth starting from 1990. Figure 6.1 shows the evolution of the top 10 , middle 40 and bottom 50 income shares. Although the model overestimates the top 10% income share and underestimates the middle 40% and bottom 50% income shares, it generates trends that are comparable to the data. In the model, from 1990 to 2015 top 10% income share has increased 18.58 percentage points, middle 40% income share has decreased by 8.26 percentage points, bottom 50% income share has decreased by 10.32 percentage points, and corresponding changes in the data are 11.02, 3.27, and 7.75, respectively.

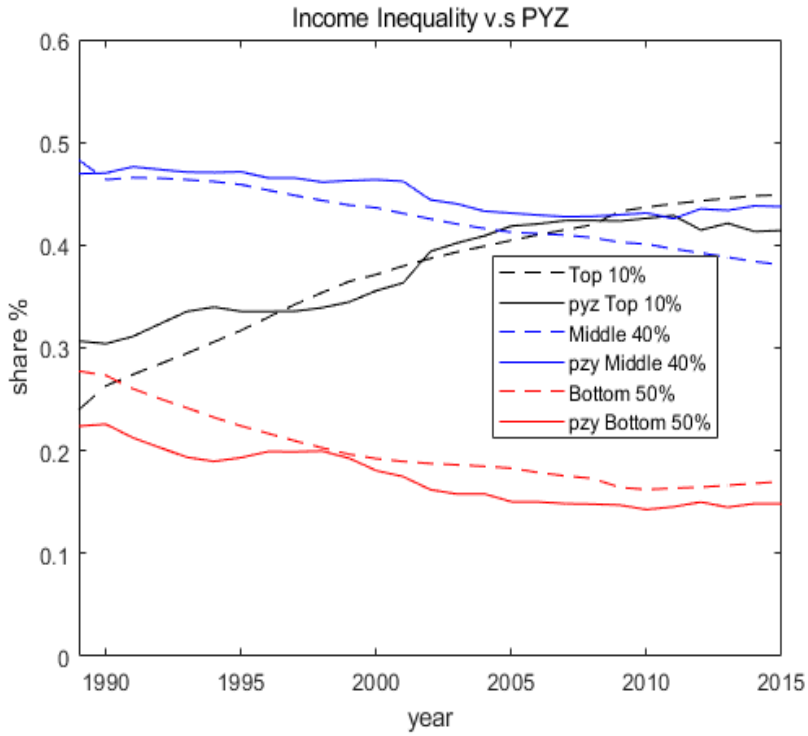


Figure 6.1: Transition–Wealth Inequality

As for wealth inequality, the model generates higher wealth inequality than that in the data. Also, the model does well in explaining the trends in wealth concentration. In the model, from 1995 to 2015, top 10% wealth share has increased 32.16 percentage points, middle 40% wealth has decreased 23.04 percentage points, and the bottom 50% has decreased percentage 9.12 points. In the data, we observe the corresponding changes are 26.60, 17.03 and 9.57, respectively.

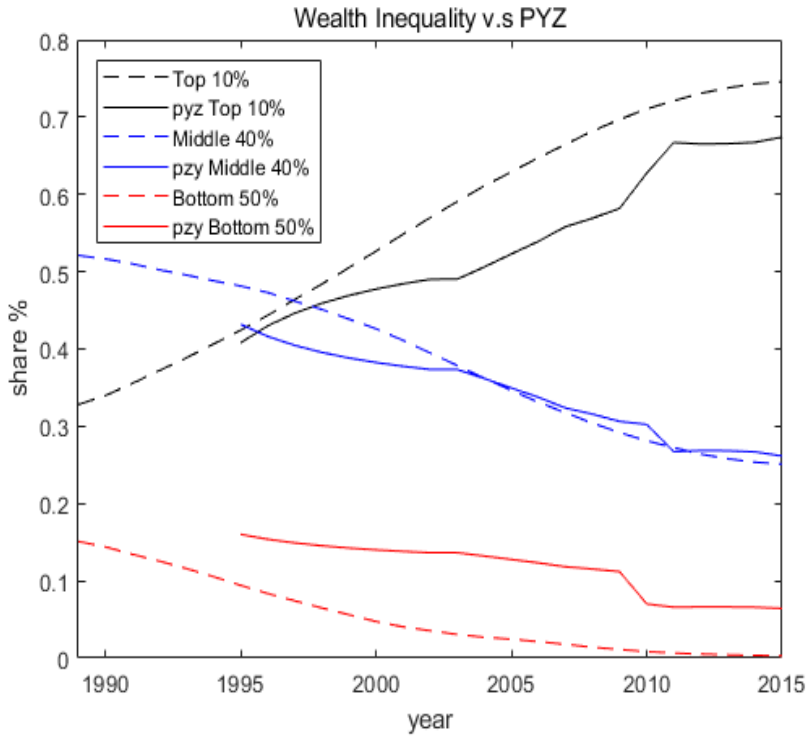


Figure 6.2: Transition–Wealth Inequality

The model predicts an urban-rural income per capita ratio that is consistent with the level and trend of the data counterpart. It predicts correctly that there is a slow down of the increasing urban-rural gap around 2005 and a small decrease of the urban-rural gap after 2010.

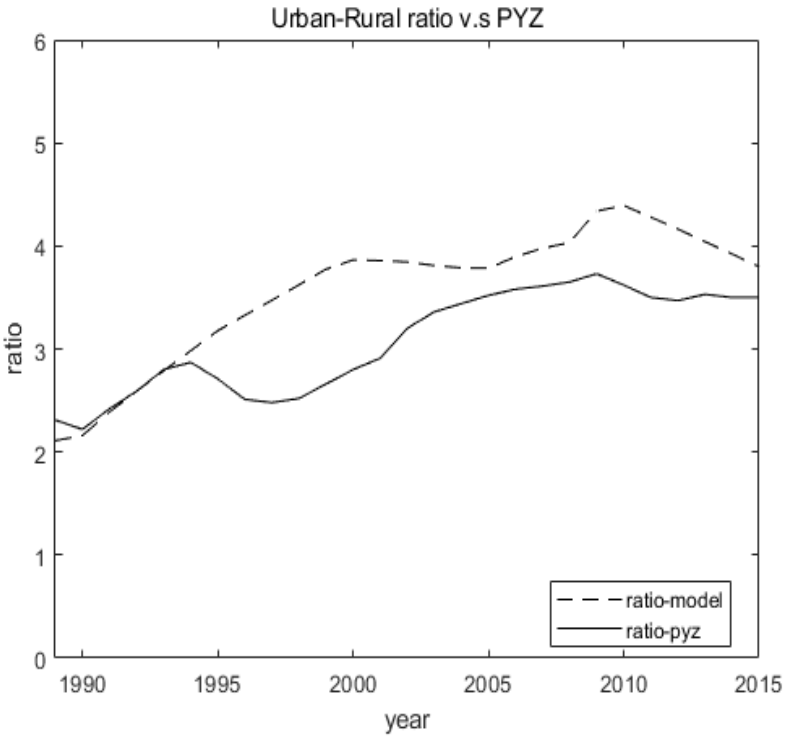


Figure 6.3: Urban-Rural Income per capita Ratio

Rural and Urban

PYZ 2019 also provides the income inequality data at both rural and urban levels, which give us a chance to see the model validation at the regional level. Figure 6.4 shows the evolution of income inequality of rural and urban China from 1990 to 2015. Our model underestimates the income inequality in rural areas, and overestimates the income inequality in urban areas. In this sense, the model fails to capture the large and increasing income inequality in rural China. One apparent reason of this failure is that there are other factors that affect rural individual's labor income except idiosyncratic labor productivity shock, e.g. geographical location, land quality, and local infrastructure, which for simplicity are not modeled. Another reason that might explain the discrepancy is related to the definition of rural vs urban income. When PYZ 2019 collect rural and urban household data, they inevitably count rural households' urban income, either coming from transfers of urban native relatives or the income of rural residents earned in the urban economy (e.g. commuters living in the

urban-rural fringe). In our model there is no flow of income from urban to rural areas, and that might contribute to explain why our model generates less income inequality in rural areas and more income inequality in urban areas compared with PYZ 2019's data.

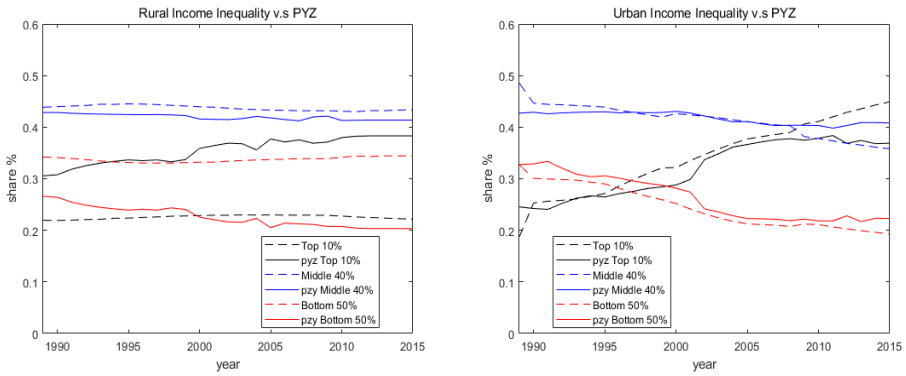


Figure 6.4: Income inequality in Rural and Urban China

7 The future of inequality in China (1989-2058)

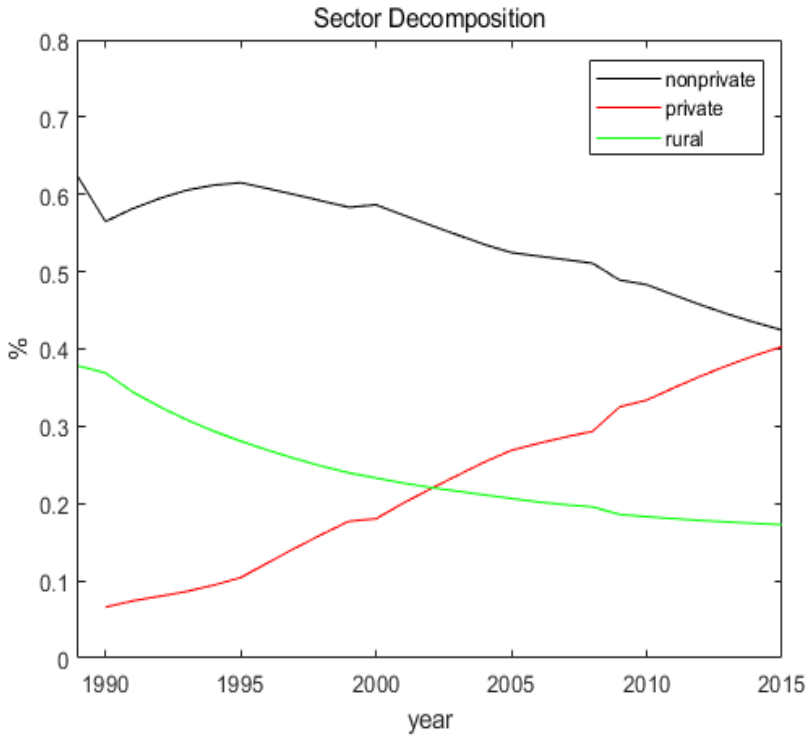


Figure 7.1: Sector Decomposition, 1989-2015

Kuznets (1955) hypothesized an inverse-U shape relationship between industrialization, urbanization and income inequality. In this section, we project the income concentration until 2058. China's GDP per capita has reached $10,000$ U.S. dollar in year 2020, and the growth rate of GDP per capita is two times and even three times the rates in the U.S. or France. (See Figure 7.1.) If we assume an annual GDP per capita growth rate of 5% from 2020, then China's GDP per capita will quadruple by the year 2058, the same level of current France.

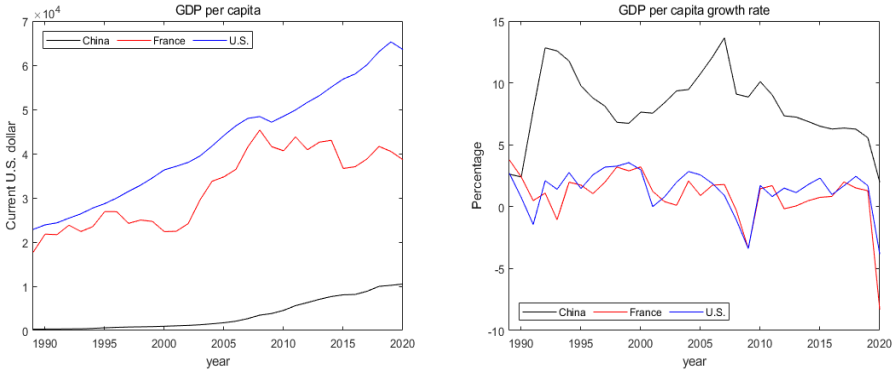


Figure 7.2: GDP per capita, level and growth rate, 1989-2020

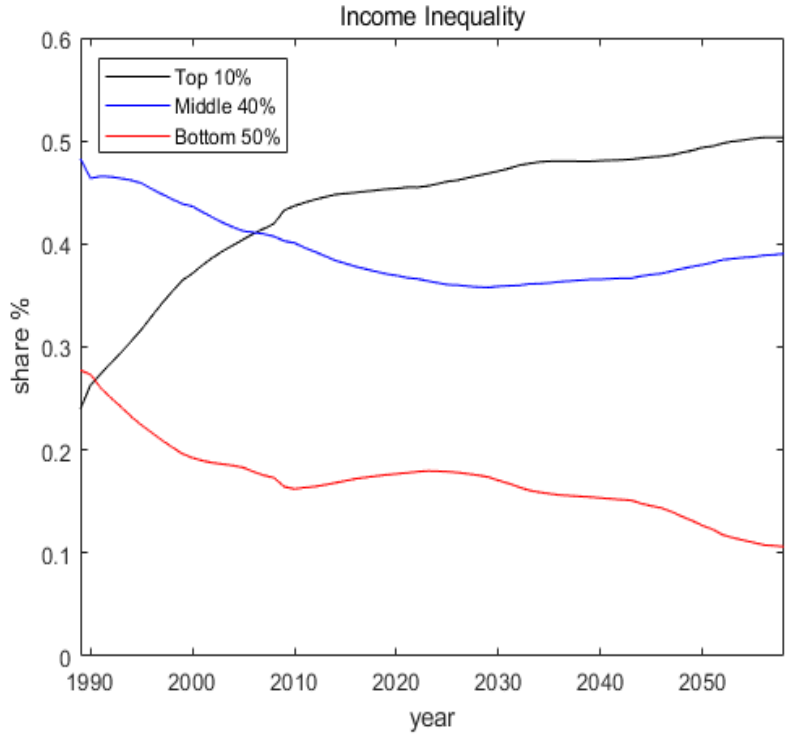


Figure 7.3: Projection of Income Concentration

In Kuznets statistical model the overall economy consists of two sectors, agricultural (A) and non agricultural (B). Sector B has higher level of income per

capita than sector A, and inequality in the distribution of income within sector A may be as wide as that within sector B, but not wider. As the population moves from sector A to sector B, e.g. the phases of industrialization and urbanization, income inequality will first tend to widen, then stabilize and finally decline. Our model does not predict such a trajectory. In our projections income inequality increases until the late 2050s and there is no signal of a reversal in that trend (see Figure 7.2).

The driving force of the ever-increasing income inequality is the ever-widening income inequality in urban China. The income share of rural-urban migrants and their population share (Figures 9.3 and 9.4 in the Appendix) are disproportionate and this asymmetry is increasing along China's development path. In the following section we perform counterfactual analysis to quantify the impact of improving the economic prospects of migrants by decreasing the degree of labor market segmentation.

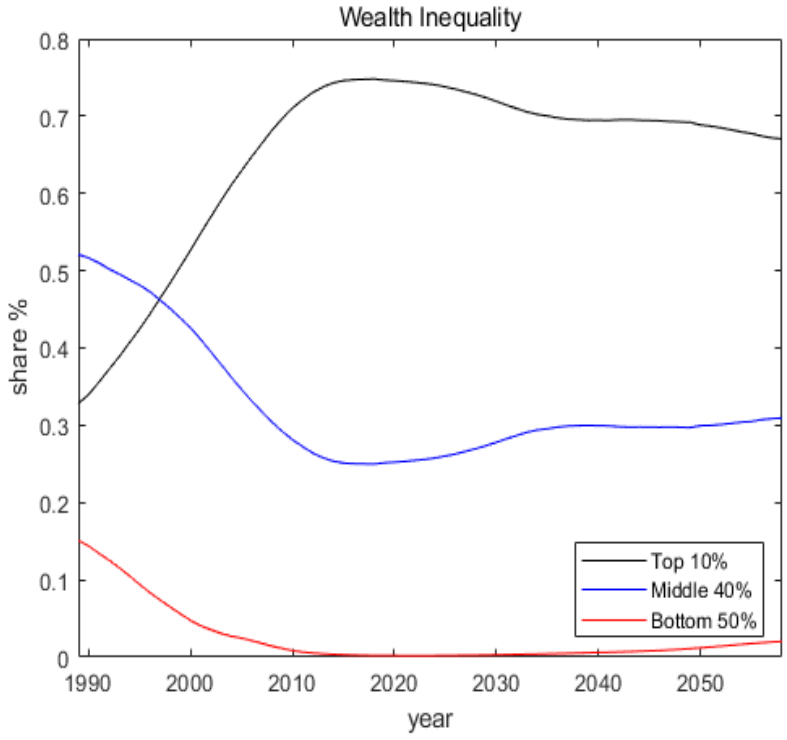


Figure 7.4: Projection of Wealth Concentration

In contrast, the distribution of wealth does follow the shape of a Kuznets Curve. Wealth inequality first widens and peaks in year 2015, then decreases and becomes stable after year 2035, see Figure 7.3. Rural-urban migrants move to urban and begin to save more than their rural counterparts, because after migration they lose their income from land[11] and need to save for retirement. Although they receive relatively low wages compared with urban natives, the increasing wealth of migrants takes up a larger fraction of overall wealth, so the top 10% wealth share decreases, see Figure 9.4 in the Appendix. The middle 40% wealth share increases as the migrants gradually become asset holders. There is little change at the bottom 50% wealth share, since the rural residents, unlucky individuals, and people who have left labor market for a long time hold very little wealth.

The rural-urban income ratio peaks in the year 2010 and decreases all way down to nearly 1 in the year 2058, which is the end period of our time frame. Since we do not model the relative increase in agricultural technology, the relative increase of wage income in rural area comes from the increasing price of agricultural goods, due to the ever-increasing demand for food, and the decreasing labor supply in agricultural production. [12]See the relative price of agricultural goods in Figure 9.7 in the Appendix.

[11] Ngai, Pissarides, and Wang (2019) models the barriers of labor mobility of migrants from rural to urban areas in China, and they emphasize that the loss of income from land is a significant cost when migrants make migration decisions.

[12] Restuccia, Yang, and Zhu (2008) study the over-employment in the agricultural sector, and mention the higher share of employment in agriculture is mainly responsible for low productivity in poor countries.

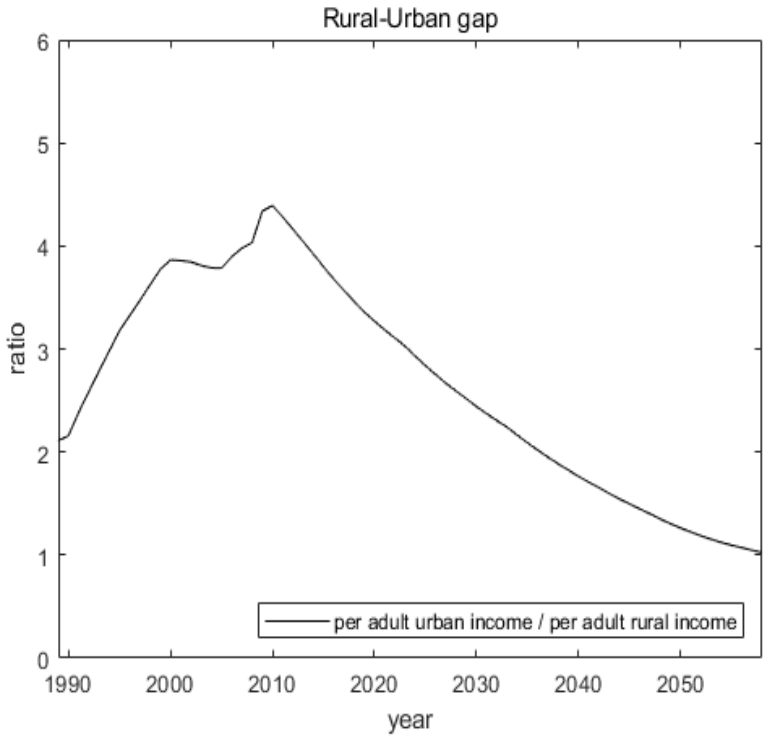


Figure 7.5: Projection of Rural-Urban income ratio

8 Counter-factual experiments

In this section we qunatify the driving forces of the increase of inequality since early 1990, and we study the impact of labor market and financial market reforms on the evolution of inequality.

No migration and no private economy

Urbanization is always accompanied with industrialization and economic growth, and many developed countries have experienced large labor flows from rural to urban areas along their development path. China's rural-urban migration was negligible in 1980s, and the barriers were gradually removed starting in the early 1990s.

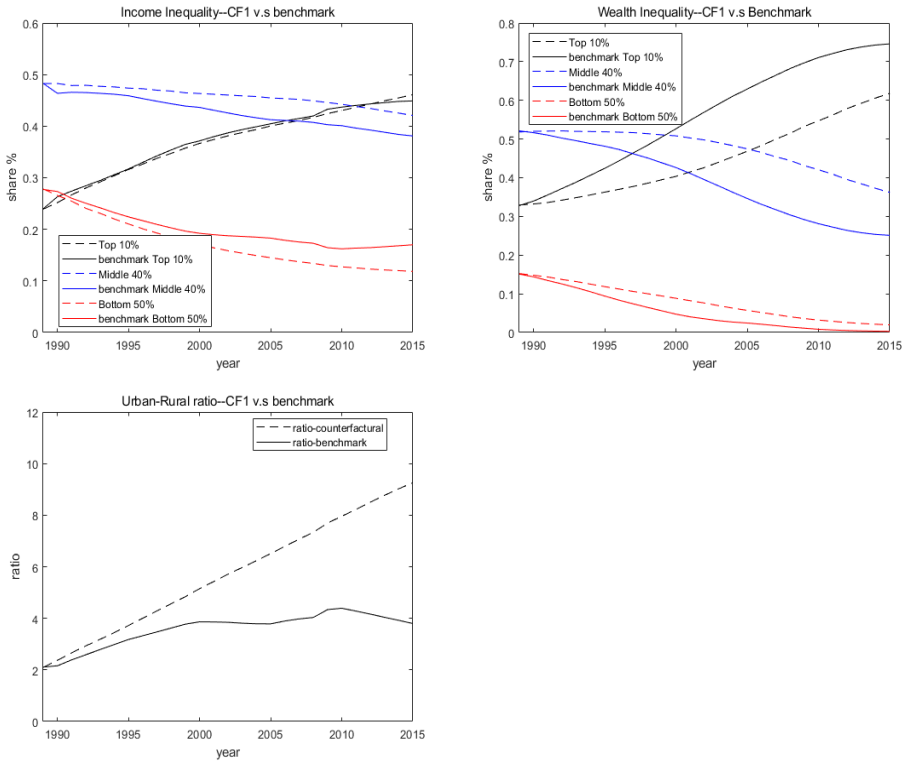


Figure 8.1: Counterfactual 1

Absent rural-urban migration and the emergence of the private sector the income distribution would have been even more concentrated than in our benchmark model. The top 10% income rich's income share is consistent with the benchmark economy, while the income share of the middle 40% increases and the bottom 50% share of total income falls compared with the benchmark. Similarly, wealth inequality is increasing less in the counter-factual than in the benchmark results. Before 2008, wealth is less concentrated compared to the benchmark model, top 10% wealth rich would hold a smaller share, and the middle 40% would have a larger share, with the bottom 50% wealth share is almost unchanged. However, the situation tends to get reversed after 2010, we see a faster increase of the top wealthy's wealth share, and a higer speed decrease of the income share of the middle 40%. In both the benchmark and the counter-factual the bottom 50% wealth poor hold almost zero wealth in 2015.

The key driving force is that in the counter-factual the rural-urban income gap

keeps increasing as time goes by, and it reaches 9.26 in 2015 (see Figure 8.1). Relative demand for the agriculture good is decreasing as the economy becomes rich, so the rural sector will shrink relative to the overall economy along the development path. The total population in rural area barely changes without migration, thus, income per capita keeps falling relative to income per capita in urban areas. This scenario shows that the rural-urban migration has contributed to reduce the rural-urban disparity significantly.

No private economy

In this counter-factual, rural individuals can move to the urban area, but there is no private sector (nor entrepreneurs), and we assume that migrants become economically identical to their urban counterparts and work in the non-private sector. The counter-factual economy shows a moderate income concentration along the growth path and no dramatic changes after the initial steady state. The same happens with wealth concentration, where the change is much less severe than in the benchmark case. The Top 10% wealth share increases 3.2 percentage points during $1989 - 2015$, relative to 22.0 percentage points in the benchmark case. The bottom 50% wealth share mimics both the level and trend of the benchmark case where they hold little wealth share.

The rural-urban income gap level and trend are closed to the benchmark from 1989 to 2005. Notice that the counter-factual assumes that migrants and urban natives are perfect substitutes in the labor market. Figure 3.3(a) shows that they differ drastically in educational levels. Also, this counter-factual implicitly assumes that the non-private sector could absorb all the rural-urban migrants, while it is the private economy that started to provide the majority of job opportunities for migrants.

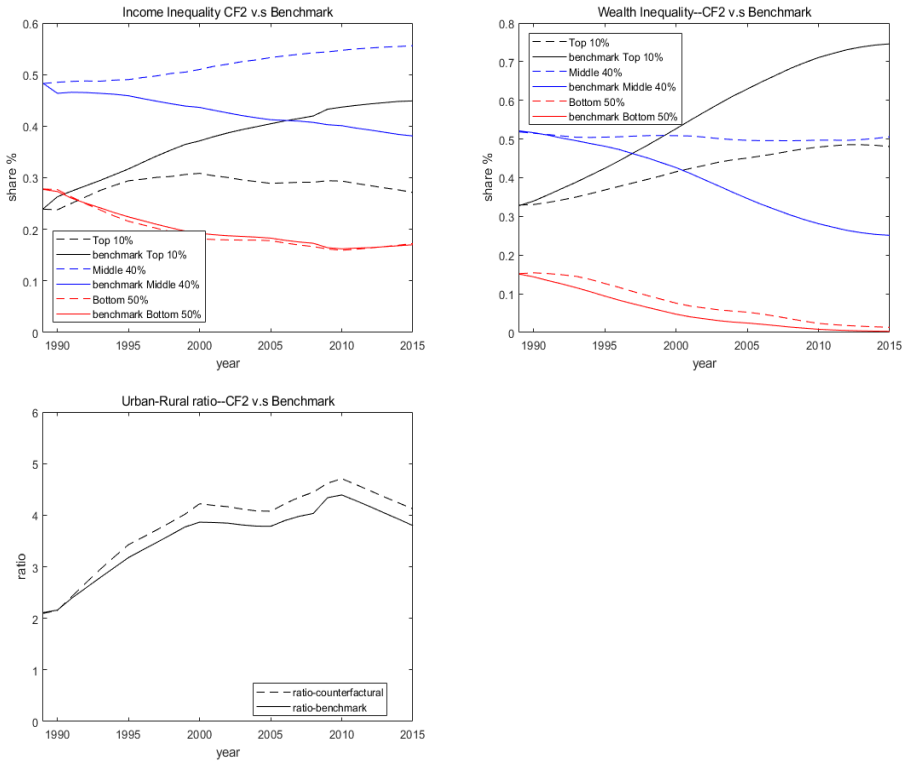


Figure 8.2: Counterfactual 2

Labor market reforms

In this subsection we quantitatively examine the effects of different levels of labor reallocation across sectors. Specifically, we reallocate 10%, 30%,and 50% of rural-urban migrants to the non-private sector. In the benchmark economy, top 10% income share, middle 40% income share and bottom 50% income share are 44.89, 38.10, and 17.01 percent in the year 2058, as shown in Figure 8.3. In the counterfactuals, the top 10% income share becomes 47.25, 41.71, and 36.61 percent, for each level of reallocation respectively. The middle 40% income share increases to 41.63, 45.72, and 49.12. Finally, the bottom 50% income share increases to 11.12, 12.56 and 14.26 percent, for the cases of ten, thirty and fifty percent labor reallocation. The decrease of the top 10% income share and increase of the middle 40% income share comes from the "new middle class" of migrants who hold a rural Hukou and find a job in the urban non-private

sector with higher wages. (See Figure 9.2 and Figure 9.3 in the Appendix for the income share of different groups of people.) However, the bottom 50% income share would change very little, since this part consists of the "unlucky" individuals from different groups and the retired.

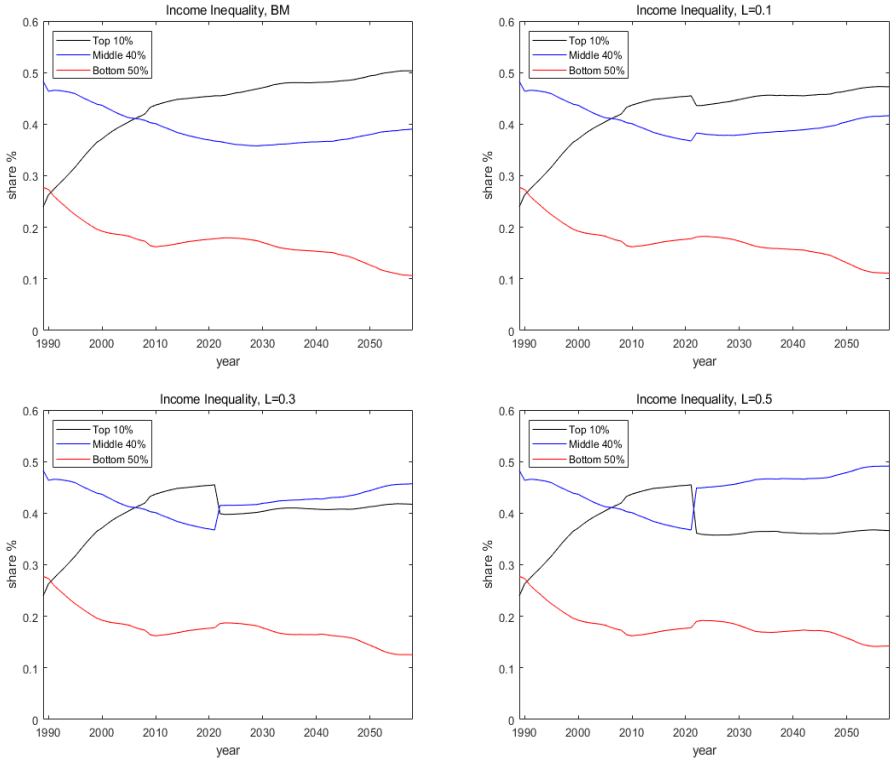


Figure 8.3: Evolution of income inequality with different labor market reforms

The following Figure 8.4 shows the evolution of wealth concentration under different labor market reforms. Same as the changes in the concentration of income, the top 10% wealth share decreases, the middle 40% wealth share increases, and there is a little increase in the bottom 50% wealth share. Compared with the benchmark economy where the top 10% wealth share takes 74.60 percentage points in the year 2058, this share decreases to 64.14, 57.48, and 50.62 percent with 10%, 30%, and 50% rural-urban migrants reallocation, respectively. Compared with the benchmark economy where the middle 40% wealth share was 38.10 in the year 2058, this share increases to 33.54, 39.49, and 45.60 percentage, respectively. The main driving force changing the wealth concentration is

the growing middle class because of the reform. (See Figure 9.2 and Figure 9.4 in Appendix for the wealth share of different groups of people.) However, the 50% wealth poor individuals are not affected much by the proposed labor market reforms and continue to hold very little wealth.

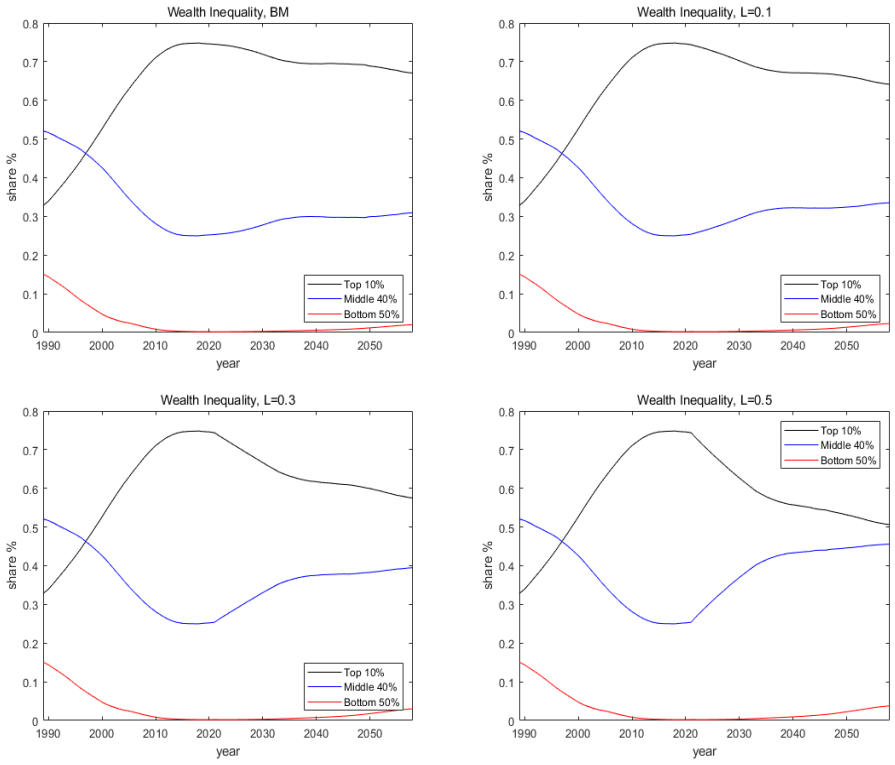


Figure 8.4: Evolution of income inequality with different labor market reforms

Financial market reforms

The relationship between financial development and income inequality has been discussed since 1990*s* in both theoretical and empirical work. Theoretical papers tend to predict that financial development will decrease income inequality or reduce poverty (Galor and Zeira 1993; Banerjee and Newman 1993; Aghion and Bolton 1997), at least after some threshold level of development (Greenwood and Jovanovic, 1990). Empirical papers, in contrast, reach ambiguous conclusions, depending on the countries studied, datasets and estimation methodology used. Some papers say that financial development induces increasing income in-

equality (Jauch and Watzka, 2016), others conclude that financial development can contract the income distribution (see Demirguc-Kunt and Levine, 2009 for a review in this strand), while some find a nonlinear relationship between financial development and inequality (Nikoloski, 2013; Altunbas and Thornton, 2013). In the following counterfactuals we analyze the predictions of our model economy regarding the impact of financial development on inequality in China. Specifically, we gradually relax the borrowing constraints faced by firms in the private sector and discuss the changes in the evolution of income and wealth inequality associated to such changes.

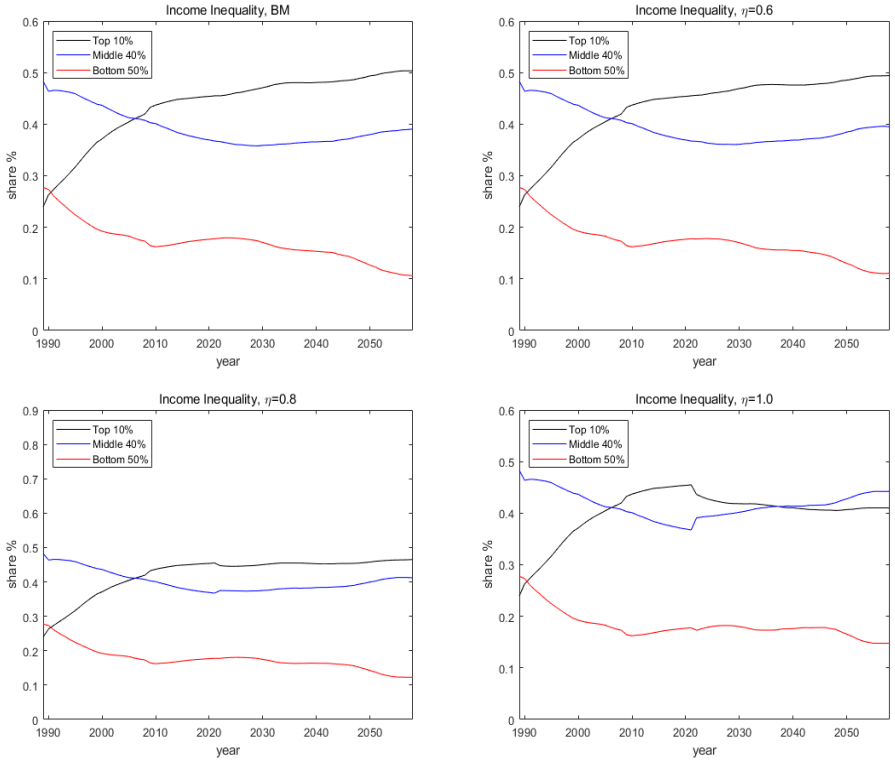


Figure 8.5: Evolution of income inequality with different financial market reforms

Figure 8.5 shows the income distributions after we increase the parameter η to be 0.6, 0.8, and 1.0. Recall that η is the fraction of the net value of private firms that entrepreneurs can pledge to pay their loan, which measures the degree of financial constraints. We assume the changes take place in the year 2022. The

top 10% income share (remember it is 53 in the benchmark) decreases to 49.40, 46.51 , and 41.00 percentage points in year 2058 as η increases to 0.6, 0.8, and 1.0. The middle 40% income share (38 in the benchmark) increases to 39.49, 41.21 , and 44.21 percent in the year 2058 as η, respectively. Finally, the bottom 50% income share (9 in the benchmark) also increases to 11.11, 12.28, and 14.79 percent, respectively. Our results are consistent with the 'indirect effect' in Demirguc-Kunt and Levine (2009). They emphasize the general equilibrium effect of financial deepening which generates increasing demand of low-skilled labor and increases the relative wage of low-skilled group, thus reducing inequality.

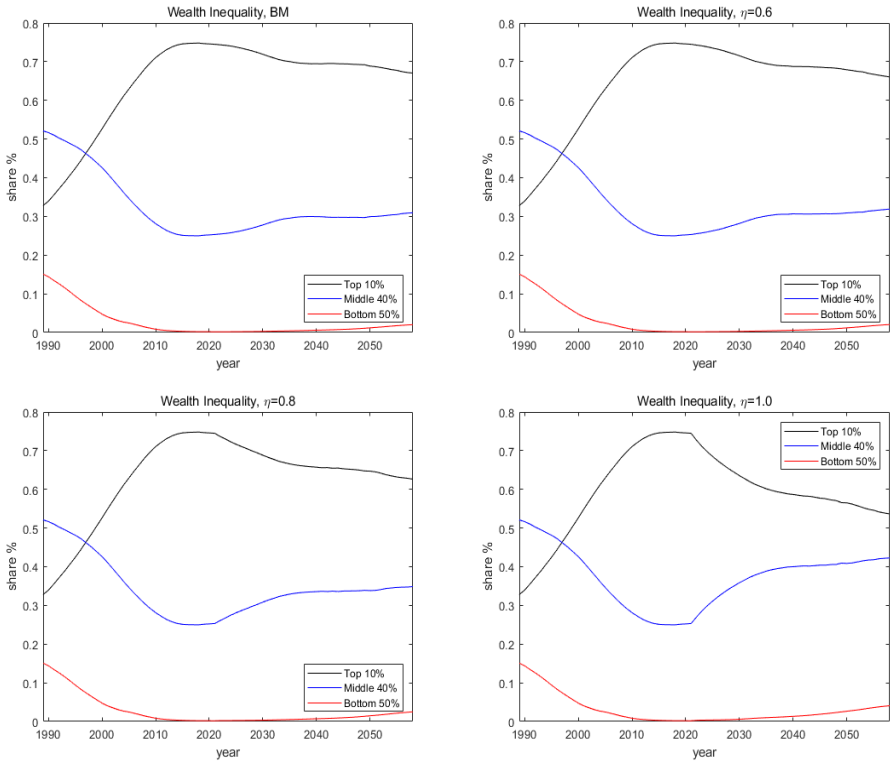


Figure 8.6: Evolution of wealth inequality with different financial market reforms

The impact of financial reforms on wealth concentration are shown in Figure 8.6. Relaxing the borrowing constraints faced by entrepreneurs in the private sector will increase the relative wealth of workers in the private firms. (See

Figure 9.6 in the Appendix for the wealth share of different groups of people.) The increase in private sector workers' wealth comes from the increased wage relative to the non-private sector, and it allows migrants to accumulate more wealth. In the benchmark economy, in the year 2058 the top 10% wealth share is 61.1 percentage points, and this value decreases to 66.04, 62.64, and 53.65 percent with different levels of financial liberalization (e.g. η equals to 0.6, 0.8, and 1.0). In the year 2058, the middle 40% wealth share is 35.6 percent in the benchmark economy, and this value increases to 31.90, 34.87, and 42.28 percent, respectively. As for the bottom 50% wealth share, there is a slight increase relative to the benchmark.

9 Conclusion

We propose a three-sector model of the Chinese economy that has migration and the emergence of a urban private sector as exogenous driving forces. This model generates a process of structural transformation that has key implications for the evolution of income and wealth inequality. Feeding the income processes for different types of workers and the productivity processes for private firms that we estimate from Chinese household and firm level data, the model generates levels and dynamics of inequality over the period $1990-2015$ that are consistent with the data reported in PYZ 2019. The model predicts that inequality in income and wealth will continue in the coming decades.

Using the model in order to quantify counter-factual scenarios provides the following picture. Migration is a fundamental driver of growth and has a moderating effect on increasing inequality by limiting the increase of the rural-urban income gap. Most of the increase in inequality can be attributed to the emergence and growth of the urban private sector, which generates a class of entrepreneurs that accounts for the fast concentration of both income and wealth at the top. Labor market reforms (reducing labor market segmentation) and financial market reforms (increasing access of the private sector to external funds) decrease the concentration in the income and wealth distributions, on top of contributing to higher aggregate income.

In this exercise we have not considered the role played by the tax/transfer system. We leave that for future work.

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Appendix: Migration rates by age and gender

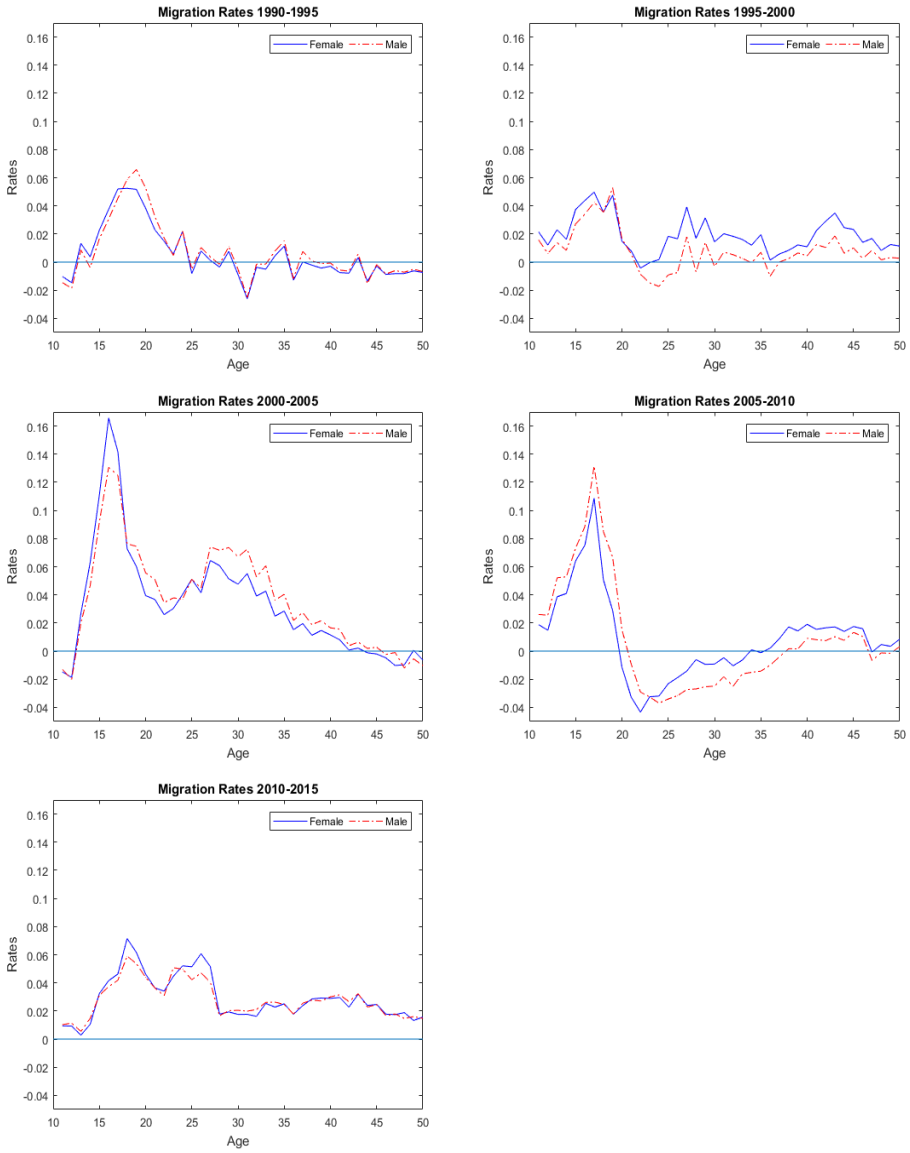

Figure 9.1: Population distribution with different labor market reforms

Population share of different groups of people in labor market reforms.

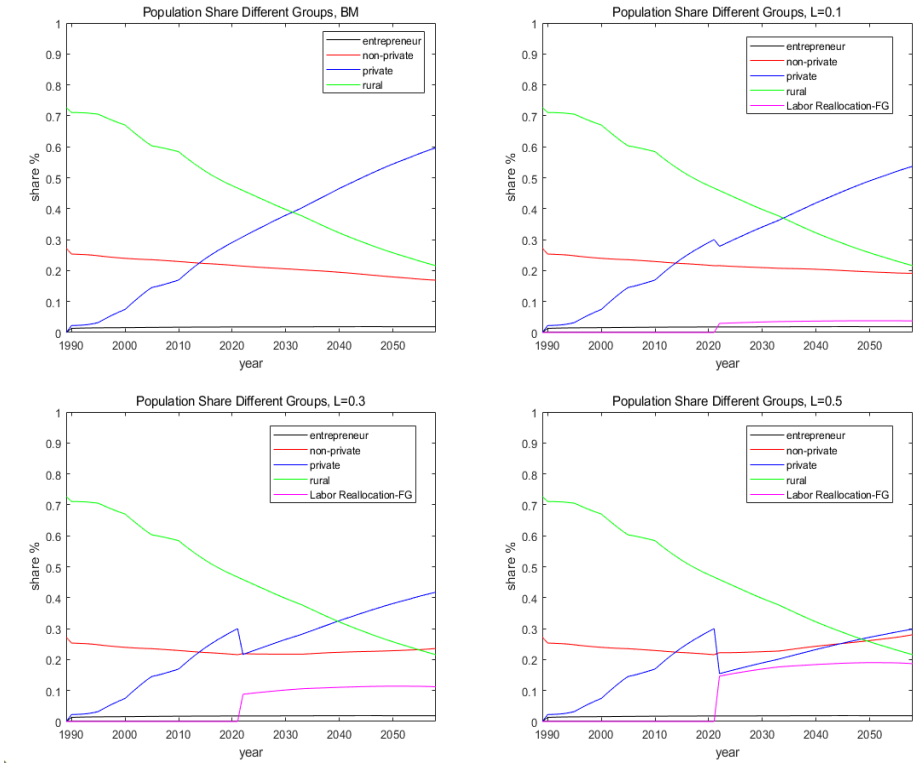

Figure 9.2: Population distribution with different labor market reforms

Income share of different groups of people in labor market reforms.

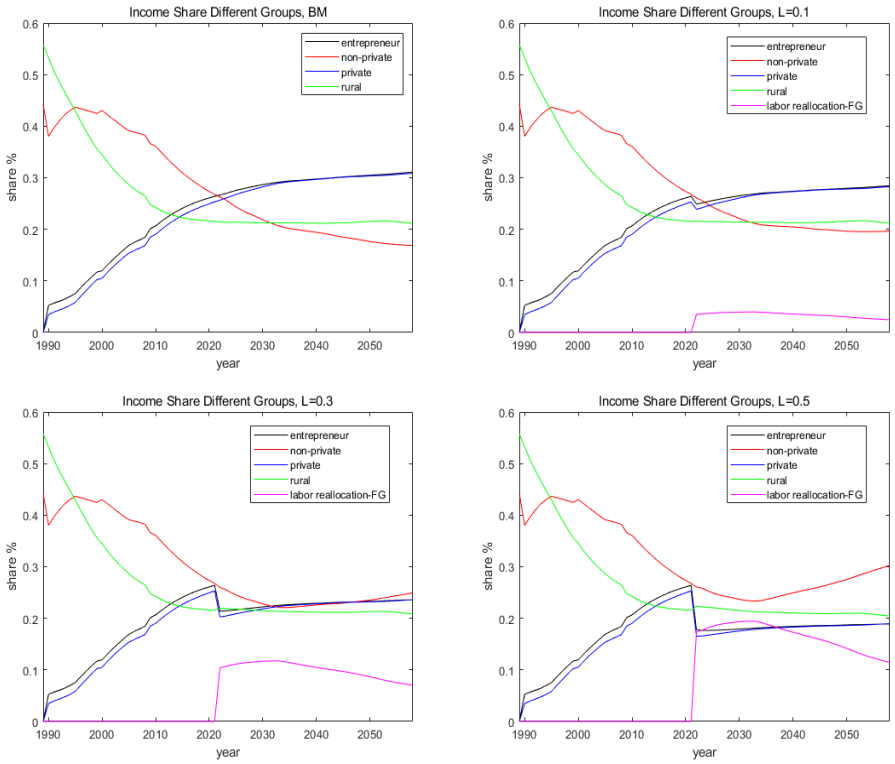

Figure 9.3: Income shares with different labor market reforms

Wealth share of different groups of people in labor market reforms.

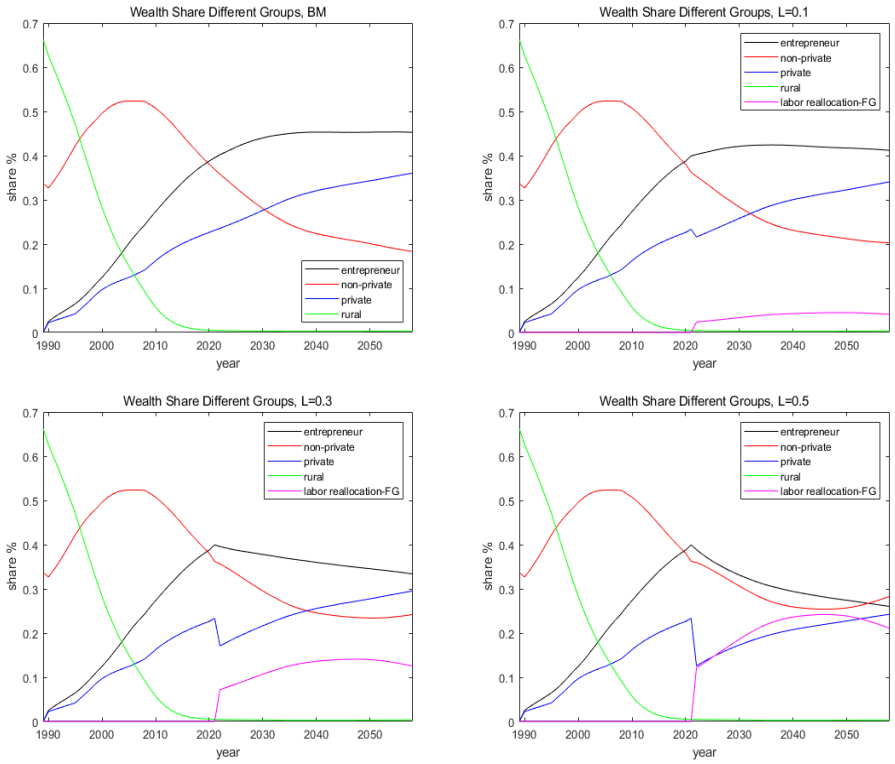

Figure 9.4: Wealth shares with different labor market reforms

Income share of different groups of people in financial market reforms.

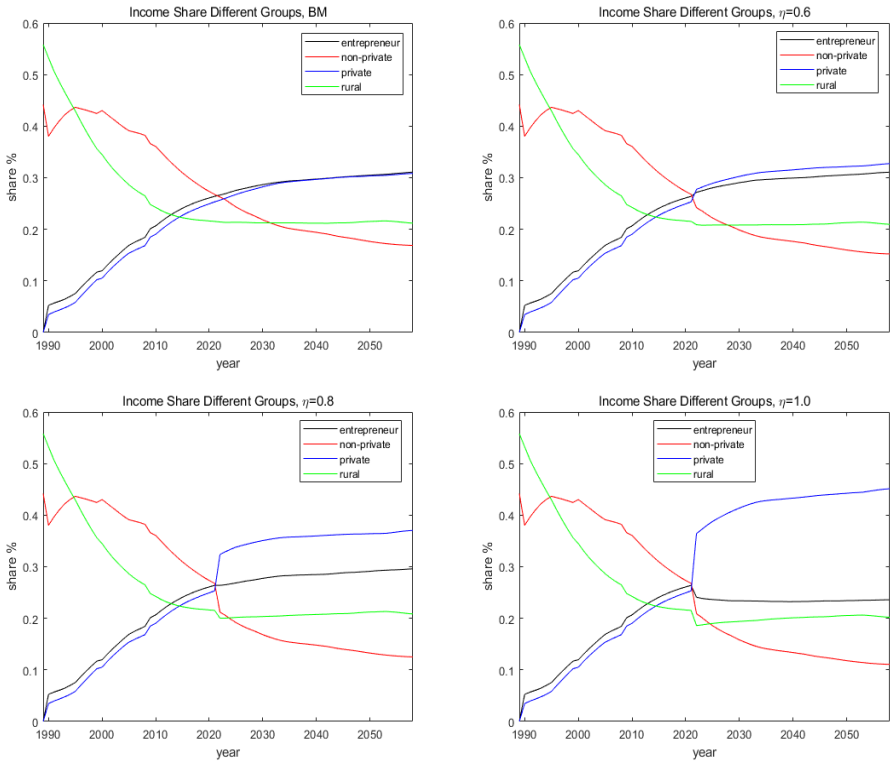

Figure 9.5: Income shares with different financial market reforms

Wealth share of different groups of people in financial market reforms.

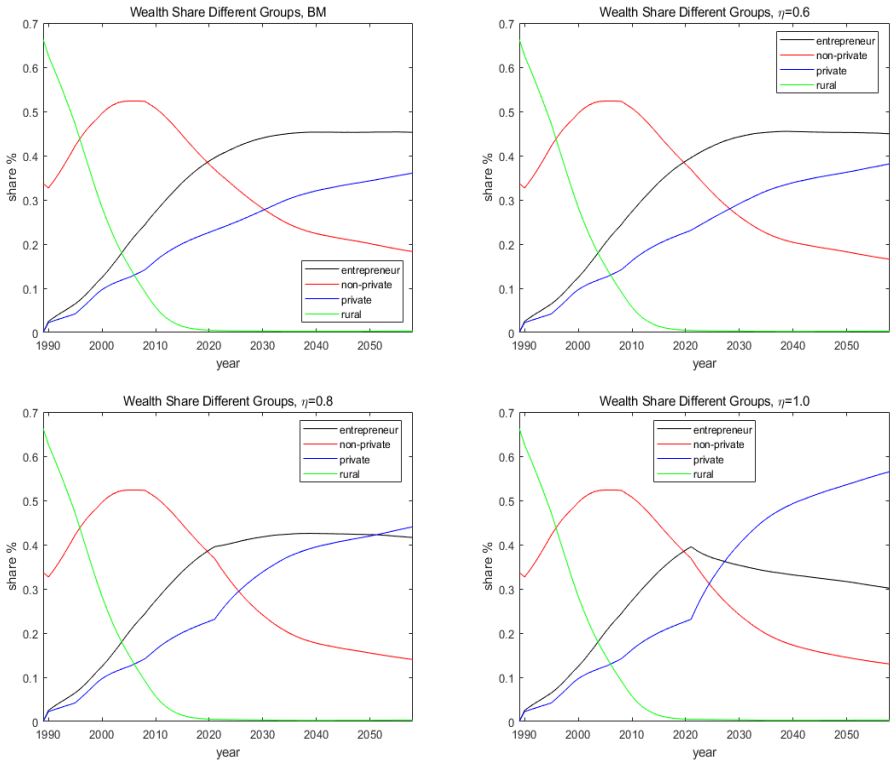

Figure 9.6: Wealth shares with different labor market reforms

Relative price of agricultural good to non agricultural good.

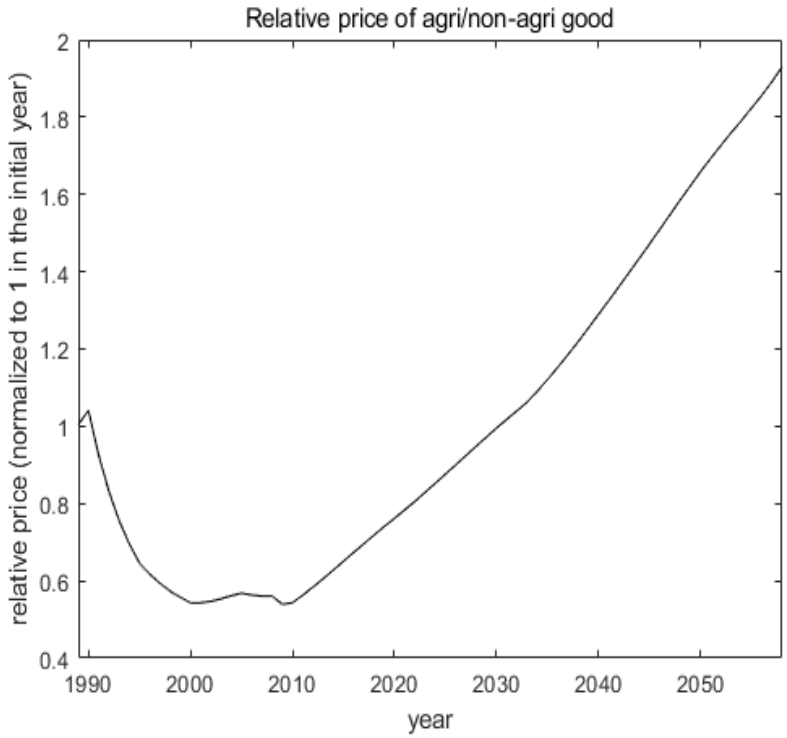

Figure 9.7: Evolution of relative price of agricultural good

Appendix: Definition of a Competitive Equilibrium

Given technology growth rate g, the population distributions of rural $\{R_{t,j}\}$, urban $\{U_{t,j}\}$, and migrants$\{M_{t,j}\}$, a competitive equilibrium is a set of value functions for workers in rural sector, workers in urban private sector, workers in urban non-private sector, and entrepreneurs $\{V_{R,t}(a,j,\varepsilon_R), V_{F,t}(a,j,\varepsilon_F), V_{I,t}(a,j,\varepsilon_I), V_{E,t}(a,j,\varepsilon_F,\xi)\}$, their corresponding decision rules for consumption and asset accumulation, $\{c_{a,R,t}(a,j,\varepsilon_R), c_{n,R,t}(a,j,\varepsilon_R), b_{R,t}(a,j,\varepsilon_R)\}$ for rural workers, $\{c_{a,F,t}(a,j,\varepsilon_F), c_{n,F,t}(a,j,\varepsilon_F), b_{F,t}(a,j,\varepsilon_F)\}$ for workers in urban non-private sector , $\{c_{a,I,t}(a,j,\varepsilon_I), c_{n,F,t}(a,j,\varepsilon_I), b_{I,t}(a,j,\varepsilon_I)\}$ for workers in private sector, and corresponding decision rules $\{c_{a,E,t}(a,j,\varepsilon_F,\xi), c_{n,E,t}(a,j,\varepsilon_F,\xi), b_{E,t}(a,j,\varepsilon_F,\xi), n_t(a,j,\varepsilon_F,\xi), loan_t(a,j,\varepsilon_F,\xi)\}$ for entrepreneurs, distributions of agents $\{X_{R,t}(a,j,\varepsilon_R), X_{F,t}(a,j,\varepsilon_F,\xi), X_{I,t}(a,j,\varepsilon_I), X_{E,t}(a,j,\varepsilon_F,\xi)\}$, transfers $\{Tr_{R,t}, Tr_{F,t}, Tr_{I,t}, Tr_{E,t}\}$, rural production plan $\{N_{R,t}\}$, non-private firms' production plan $\{N_{F,t}, K_{F,t}\}$, private firms' factor demand $\{n_{I,t}(a,j,\varepsilon_F,\xi), k_{I,t}(a,j,\varepsilon_F,\xi)\}$, and prices $\{w_{R,t}, w_{F,t}, w_{I,t}, r_t, p_t\}$ such that:

- Given prices r_t,p_t,$w_{R,t}$, $w_{F,t}$, $w_{I,t}$ and transfers $Tr_{R,t}, Tr_{F,t}, Tr_{I,t}, Tr_{E,t}$, workers in agriculture sector, urban private and non-private sectors choose consumption and saving to maximize their lifetime utility, urban born individuals make their career

decision, and entrepreneurs choose loan and labor to maximize their firm's profits and then consume and save for next period to maximize their lifetime utility.

- Wage in the rural sector $w_{R,t}$ is determined by:

$$w_{R,t} = p_t A_t \chi$$

- Interest rate r_t and wage rate in urban non-private sector $w_{F,t}$ satisfy the marginal productivity conditions:

$$w_{F,t} = (1-\alpha_F) A_t (K_{F,t}/(AN_{F,t}))^{\alpha_F}$$

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

- Wage rate in urban private sector $w_{I,t}$ is determined in the private sector's labor market clearing condition.

- Relative price p_t is determined in the agricultural good clearing condition.

- Intermediary financial sector is competitive. Intermediaries receive deposits from individuals and pay interest rate r_t, and make loans to non-private sector and private sector at interest rate r_t and $r_t + spd_t$ respectively, where spd_t is the exogenously given spread.

- Transfers are given by:

$$Tr_{R,t} = \frac{\sum\limits_{a,j,\varepsilon_R} (1-\phi_{r,j,t}) b_{R,t}(a,j,\varepsilon_{R,}) X_{R,t}(a,j,\varepsilon_r)}{(1+g) \sum\limits_{a,j,\varepsilon_R} X_{R,t}(a,j,\varepsilon_R)}$$

$$Tr_{F,t} = \frac{\sum\limits_{a,j,\varepsilon_F} (1-\phi_{u,j,t}) b_{F,t}(a,j,\varepsilon_F) X_{F,t}(a,j,\varepsilon_F)}{(1+g) \sum\limits_{a,j,\varepsilon_F} X_{F,t}(a,j,\varepsilon_F)}$$

$$Tr_I = \frac{\sum\limits_{a,j,\varepsilon_I} (1-\phi_{u,j,t}) b_{I,t}(a,j,\varepsilon_I) X_{I,t}(a,j,\varepsilon_I)}{(1+g) \sum\limits_{a,j,\varepsilon_I} X_{I,t}(a,j,\varepsilon_I)}$$

$$Tr_E = \frac{\sum\limits_{a,j,\varepsilon_F,\xi} (1-\phi_{u,j,t}) b_{E,t}(a,j,\varepsilon_F,\xi) X_{E,t}(a,j,\varepsilon_F,\xi)}{(1+g) \sum\limits_{a,j,\varepsilon_F,\xi} X_{E,t}(a,j,\varepsilon_F,\xi)}$$

- Financial market clear:

$$\sum_{a,J_e:J,\xi} loan_t(a,j,\xi) X_{E,t}(a,j,\xi) = \sum_{a,j,\varepsilon_F} a_{F,t}(a,j,\varepsilon_F) X_{F,t}(a,j,\varepsilon_F) + \sum_{a,j,\varepsilon_R} a_{R,t}(a,j,\varepsilon_R) X_{R,t}(a,j,\varepsilon_R)$$
$$+K_{F,t} \qquad \sum_{a,1:J_e-1,\varepsilon_F} a_{E,t}(a,j,\varepsilon_F) X_{E,t}(a,j,\varepsilon_F) + \sum_{a,j,\varepsilon_I} a_{I,t}(a,j,\varepsilon_I) X_{I,t}(a,j,\varepsilon_I)$$

- Individual and aggregate behavior are consistent (labor markets clear):

$$N_{R,t} = \sum_{a,j,\varepsilon_R} \varepsilon_{R,t}\omega_{R,j}X_{R,t}(a,j,\varepsilon_R)$$

$$N_{F,t} = \sum_{a,j,\varepsilon_F} \varepsilon_{F,t}\omega_{F,j}X_{F,t}(a,j,\varepsilon_F) + \sum_{a,1:J_e-1,\varepsilon_F} \varepsilon_{F,t}\omega_{F,j}X_{E,t}(a,j,\varepsilon_F)$$

$$\sum_{a,J_e:J,\xi} n_{I,t}(a,j,\xi)X_{E,t}(a,j,\xi) = \sum_{a,j,\varepsilon_I} \varepsilon_{I,t}\omega_{I,j}X_{I,t}(a,j,\varepsilon_I)$$

- Agricultural good and non-agricultural good markets clear.

- Workers and entrepreneur's distributions are time-invariant. The law of motion for distributions satisfies:

$$X_{F,t+1}(a',j+1,\varepsilon') = \phi_{u,j,t}P(\varepsilon'_F|\varepsilon_F)\sum_{\{a:a'=b_{F,t}(a,j,\varepsilon_F)\}} X_{F,t}(a,j,\varepsilon_F)$$

$$X_{R,t+1}(a',j+1,\varepsilon') = \phi_{r,j,t}P(\varepsilon'_R|\varepsilon_R)\sum_{\{a:a'=b_{R,t}(a,j,\varepsilon_R)\}} X_{R,t}(a,j,\varepsilon_R)$$

$$X_{E,t+1}(a',j+1,\varepsilon',\xi') = \phi_{u,j,t}P(\varepsilon'_F|\varepsilon_F)P(\xi'|\xi)\sum_{\{a:a'=b_{E,t}(a,j,\varepsilon_F,\xi)\}} X_{E,t}(a,j,\varepsilon_E)$$

$$X_{I,t+1}(a',j+1,\varepsilon') = \phi_{u,j,t}P(\varepsilon'_I|\varepsilon_I)\sum_{\{a:a'=b_{I,t}(a,j,\varepsilon_I)\}} X_{I,t}(a,j,\varepsilon_I) \text{ and } X_{I,t}(0,j,\varepsilon_I) = M_{j,t}\Omega_{\varepsilon_{I,t}} \quad \text{for } j = 1:J$$

where $\Omega_{\varepsilon_{I,t}}$ is the stationary distribution of idiosyncratic shock of agent I in time t.