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Market formation in China from 1978[☆]

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ABSTRACT

This paper studies the formation of market economy in China from 1978 to 1992, a period in which market economy was introduced and developed alongside planned government procurement for agricultural goods. Under the "dual track system" (DTS), rural farmers were obligated to fulfill government procurement before selling to the market, whereas urban consumers enjoyed de facto subsidies to agricultural products. Using a neoclassical general equilibrium model with heterogeneous firms and workers and input-output linkage, this paper exploits historical data and analyzes allocation, prices, and the formation of markets in China during this DTS period. Theoretically, while DTS will distort the resources allocation between rural and urban (misallocation effect), it selects workers and farmers in the rural (selection effect). What is more, comparing to the economy under Soviet-style big bang reform, DTS activates industrialization by providing intermediate goods with lower-than-market price (activation effect). Quantitatively, directly switching to market economy in 1978 would decrease total output by 4.5% as the activation effect dominates. On the intensive margin, reform on DTS (procurement price was getting closer to market price) had contributed to total output by 4.4% from 1978 to 1992.

1. Introduction

This paper studies the formation of market economy in China from 1978 to 1992, a period in which market economy was introduced and developed alongside planned government procurement for agricultural goods. Unlike big bang reform in Soviet Union, DTS built a bridge between the planned and market systems in China. How and how much did it activate Chinese economy at very beginning? How much has the price distortion affected different sectors? Using a neoclassical general equilibrium model with heterogeneous firms and workers and input-output linkage, we exploit historical data and analyze allocation, prices, and the formation of markets in China during this DTS period. As it is believed that the agricultural reform in the 1980s mainly contributed to China's growth, understanding DTS will help understand the rise of the Chinese economy as well as the effect of opening the internal market and gradual reform.

Under DTS, farmers were obligated to sell agricultural products to the government at a given price before selling the remaining products in the market. Urban workers and enterprises enjoyed quota benefits that allowed them to buy agricultural products at a lower price from the government.[1] Before DTS, there was no market, these products could only be sold to the government. As agricultural productivity was low, a minuscule quantity of agricultural products was left over after procurement. Hence the whole economy was under the plan: firms produced a certain quantity of products, and there was not much agricultural product surplus for the market. However, as agricultural productivity increased, the economy deviated from the plan. There was an increasing amount of agricultural products, as well as a labor surplus in rural areas, and firms also expanded. This unplanned economic situation forced the government to relax market regulations, and to make a smooth transition, the government introduced DTS (one good with two prices) to

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[1] Although, in the real economy, the selling price from the government was usually higher than the purchasing price to cover transportation and other costs, we ignore these costs in the model for simplicity.

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partially open the market. Furthermore, to have sustainable growth and be afraid of market fluctuation, in the early stage of development, the government implemented the policy to "*help some people get rich first and then help the others*". In the context of DTS, government subsidized urban firms and consumers via quota benefit and taxed the rural people through the procurement. By the end of 1992, this policy was totally abolished, and all agricultural products were free to be traded in.

The internal market openness was an important policy, and the market structure changed dramatically from the late 1970s. Historical data shows that the price-adjusted market trade share of agricultural products increased from 5% in 1975 to 45% in 1992. It is believed that the change was mainly due to the relaxation of the procurement requirement. In addition, the procurement price for composite agricultural products has been increasing since 1978. In particular, the ratio of market price to procurement price was 1.8 in 1978, dropped to 1.1 in 1989, and in 1992 it was almost 1.[2]

We will focus on the impact of this procurement policy. First, it distorts the allocation of agricultural goods as urban firms enjoy the quota benefit, which in turn will affect the firm entries. Second, procurement placed burden on rural people, which will select them in farming and manufacturing production, shaping the labor allocations. In order to consider them all, we build a neoclassical general equilibrium model with heterogeneous firms and workers and input-output linkage.

In the model, there are two separate labor markets: rural and urban. Rural has farmland and enterprises (Township and Village Enterprises, TVEs), while urban only has enterprises. There are two goods in the economy: agricultural goods and manufacturing goods. Agricultural goods can only be produced on farmland; and manufacturing goods can be produced in enterprises in both rural and urban. In addition, both goods can be used as consumption goods and intermediate goods. There is no migration between rural and urban,[3] but rural people could choose to be a farmer or a worker in rural enterprises. While farmers can plant on the land for free, workers don't have this right. However, farmers have an obligation regarding procurement, but workers can waive it.

In addition, there are two types of ability: farming and manufacturing, which can be used only in agricultural goods and manufacturing goods production respectively. Enterprises are different in terms of productivity and the manufacturing of agricultural products. While urban enterprises enjoy the quota benefit with respect to purchasing a certain amount of agricultural products below the market price, rural enterprises can only purchase the products at the market price.

Furthermore, although both enterprises and workers take the procurement and quota as given, essentially DTS was implemented to accelerate urban economy first and then to help rural people get rich. More generally, the quantity on procurement and quota reflect the magnitude the government values the urban and rural. In the model, the procurement and quota quantity are determined by the government to maximize the total weighted social welfare. As the weight on urban varies across years, the procurement level will change. Hence our analysis could only focus on the procurement directly instead of the weights on rural or urban.

Theoretically, there are three main mechanisms on DTS: activation effect, selection effect, misallocation effect. While the first one is on the extensive margin, the latter two are effects on the intensive margin. Activation effect captures the effect that, comparing with economy under Soviet-style big bang reform, as urban enterprises enjoy the quota benefit, the gross manufacturing output could be larger, which in turn will increase the agricultural goods output as the intermediate goods supply increases. This mechanism is especially effective when there is migration barrier. First, due to the migration barrier, there is a labor productivity gap between urban and rural, and the subsidy in intermediate goods will narrow this gap and hence achieves the second best outcome. Second, when there is surplus labor force in rural, marginal product of intermediate goods is high, then an increasing supply of intermediate goods will alleviate the negative impact of migration barrier under some circumstance. Selection effect represents that procurement requirement will play a role as screening machine–only rural people with relative high farming ability will stay as farmers. When the procurement price decreases, people who are less capable on farming in rural areas are more likely to work in rural enterprises, which will increase the labor productivity through both decrease of labor force and increase of average farming ability, while the total output of agricultural products decreases which also shrinks its supply as intermediate input. However, since the labor force in the rural enterprise gets more, the net impact on rural enterprise output is ambiguous. Misallocation effect means that some low productive firms in urban can survive due to quota benefit, whereas firms with higher productivity in rural may not survive. As the intermediate input price for urban enterprise becomes lower, enterprises with low productivity enter the market and the total output increases, which increases agricultural goods production. The results are similar when the procurement quantity decreases, except that urban output will decrease because of less quota benefit. Therefore, in the intensive margin effect, the impact of DTS is ambiguous.

For the quantitative analysis, we calibrate the model to the Chinese economy each year from 1978 to 1992 and conduct several counterfactual experiments. Firstly, we take 1978 as benchmark and compare with the market economy, and we also study the intensive margin effect as the weight on urban changes. Secondly, we take each year of 1979–1992 as benchmark and replace parameters with 1978's value. Thirdly, we decompose the impact of different factors on economic growth and welfare. Finally, we study the economy with second-hand market and frictionless economy as two extensions.

The quantitative results show that directly switching to market economy in 1978 would decrease total output by 4.5% but increase rural welfare by 43.9% in equivalent consumption. That is to say, DTS has activated economy with sacrificing rural's welfare. On the other hand, from 1978 to 1992, the procurement price is getting closer to market price, which had contributed positively to total output by 4.4% and rural welfare by 14.1%, and it contributed negatively to agricultural output by 18.1% and total welfare by 11.3%. The quantitative results also confirmed that productivity improvement contributed mostly to Chinese economic growth. Furthermore, in the economy with second-hand market, there is not much change in output of different sectors, but the welfare changed significantly. For example, comparing to benchmark in 1978, the total output would decrease by 6%, the rural welfare would decrease by 36%. However, in frictionless economy, the impact is much larger. The total output in 1978 would be tripled comparing to benchmark, and the rural welfare would increase by more than 23 times.

Before delving into the details of the paper, we highlight one of contributions. In a recent debate between gradual and sudden transition, we take the stand that the gradual reform could activate the economy, pushing it out of low-equilibrium trap. The main mechanisms are the following. First, due to the migration barrier, there is a labor productivity gap between urban and rural, and the subsidy in intermediate goods will narrow this gap and hence achieves the second best outcome. Second, given there is no migration allowed, the market economy is distorted. However, this distortion will be alleviated by subsidizing manufacturing production in urban, as industrialization requires agricultural goods as intermediate inputs. And this effect will be amplified through input-output linkage in both sectors. This mechanism is similar to the argument in Liu (2019) that given there exists distortions, subsidizing upstream might alleviate the overall distortion, as the upstream absorb more distortion through intermediate goods demanding, although in our setup, it is hard to tell which sector is upstream as they use intermediate goods from each other. We call this virtuous circle as "activation effect" or "extensive margin effect" in contrary to detrimental effect the

[2] More details on DTS are documented in Section 2.

[3] We ignore the migration because, in the data, the migration rate was only 0.19% in both 1978 and 1992. There is more discussion in Section 8.

distortion usually cause, while we refer other two effects as "intensive margin effect", including "misallocation effect" and "selection effect" as discussed above.

This study provides a framework to understand market formation, particularly when the market is partially open. The current Chinese economy is still under transition to fully market economy. This dual track economy exists in different scenarios. For example, there are different interest rates for State Owned Enterprises (SOEs) and Private Owned Enterprises (POEs). While SOEs, taking advantage of low interest rate, can survive with lower productivity, POEs can borrow from SOEs, which is similar to the second-hand market discussed in the extension. The current model is easy to extend to incorporate these scenarios and have policy implications. Moreover, the question studied in this paper can be related to discussions about the role of industry policies and subsidies to infant industries, which is prevalent around the world especially in developing countries. The dual track system aims to protect urban enterprises as China went through the unprecedented episode. Therefore, a better understanding about the dual track system during this period would provide new empirical evidence about the impact of industry protection on the aggregate economy.

1.1. Related literature

We emphasize both the extensive and intensive margin effects of DTS in this paper. The analysis on extensive margin relates to studies on the economic transition from planned economy to market economy, and the analysis on intensive margin effect relates to the studies on misallocation and selection in agricultural productivity. We summarize them as follows.

On one hand, research on the Chinese economic transition from a planned to a market economy usually covers property rights and firm ownership (Jin and Qian, 1998; Li, 1997; Naughton, 1994; Qian and Xu, 1993). Among them, Jin and Qian (1998) study the role of Township and Village Enterprises (TVEs), and Li (1997) studies the impact of economic reform on state-owned enterprises (SOEs). Different from these studies, our paper studies the procurement policy on goods markets. While Byrd (1991) analyzes the static and dynamic impacts of DTS on Chinese industry, Sicular (1988) builds a theoretical model to analyze DTS in China's agricultural sector. Our paper closely relate to Sicular (1988) as we both study the procurement on agricultural goods. While she focuses on interaction of procurement and market price, we mainly study the impact on aggregate outcome and allocative efficiency.

Some studies also analyze the effect of DTS on efficiency; however, there is no common agreement. While Lau et al. (2000) show that under some standard conditions, the dual track approach to market liberalization was a Pareto improvement, Young (2000) argues that the incremental reform would lead to the fragmentation of the domestic market and the distortion of regional production when considering rent-seeking incumbents. Similar to McMillan et al. (1989) who propose that the incentive will change under the market price, we also take the stand on former one but emphasize that DTS will activate the economy through the virtuous circle of input-output linkage.

In addition, a section of the literature compares Chinese economy with Eastern European economies (McMillan and Naughton, 1992; Murphy et al., 1992; Sachs and Woo, 1994; Li, 1999; Roland and Verdier, 2003). Murphy et al. (1992) present a theory of partial economic reform and explain the reasons for the failure of reforms in Russia in contrast to the successful Chinese reforms. Li (1999) also compares the Soviet-style big bang reform and the Chinese dual track reform and concludes that a transition policy is necessary to have a smooth transition. Guriev (2019) discusses several alternative explanations on the question of why Soviet Union did not follow China to reform the economy. Our study also relates to Cheremukhin et al. (2017) who identify and study the impact of frictions on structural transformation of Russia in 1885–1913 and 1928–1940 from an agrarian to an industrial economy.

On the other hand, our intensive margin analysis is related to research on misallocation and selection in agricultural productivity. The literature on misallocation covers the measurement, causes, and consequences (Hsieh and Klenow, 2009; Buera et al., 2011; Song et al., 2011; Midrigan and Xu, 2014; Restuccia and Rogerson, 2017 among others). We contribute to the literature by interpreting DTS as a specific cause of misallocation, which distorts the market price of agricultural goods. As we focus on DTS of agricultural goods, it also relates to literature on agricultural productivity (Restuccia et al., 2008; Adamopoulos and Restuccia, 2014; Chen, 2017). Adamopoulos et al. (2017) emphasize the role of selection across sectors, considering the constraint on productive farmers. While they claim that productive farmers choose an occupation in a non-agricultural sector, Lagakos and Waugh (2013) predict the opposite. Our model is in line with the former because their model is calibrated with Chinese data.

As the agricultural and manufacturing goods production are connected through input-output linkage, our study also relates to Jones (2011) and Liu (2019) among others. In particular, Liu (2019) argues that, in a distorted economy, subsidizing the upstream industries will generate positive network effects in China. We had a similar results that, given labor market distortion, price subsidy in agricultural goods had a positive effect on aggregate output.

1.2. Organization of the paper

This paper is organized as follows: section 2 documents the main facts, section 3 describes a quantitative model, section 4 illustrates the main mechanisms, section 5 calibrates the model, section 6 presents the quantitative results, section 7 presents the results under alternative parameters, section 8 discusses issues on migration and capital, and section 9 concludes.

2. Facts

This section describes the main statistic characteristics of DTS. The data is mainly collected from the National Bureau of Statistics (NBS) of China. The left panel of Figure E.23 presents the ratio between procurement price and market price for composite materials from agricultural products. As shown in the figure, this ratio was increasing from the middle of the 1970s. This means that the procurement price was getting closer to the market price. The fact that all the values were less than 1 implies that the procurement price was lower than the market price.

NBS also provides information on the trade value in the market and under procurement. Market openness is calculated as the ratio of the value of agricultural products traded in the market to the aggregate value of that from both the market and procurement. In addition, a price-adjusted ratio value is also calculated by dividing price ratio on trade value from procurement.[4] Right panel of Figure E.23 shows the trends of market share under both cases from 1953 to 1992. Starting from the middle 1970s, the market trade share increased from around 10%–45%, which confirms that the agricultural products market in China became more open.

One may think that the reduced difference between procurement price and market price may be due to the composition effect. As the economy grows, grain accounts for a small portion of the agricultural output, whereas cash crops such as cotton are more important. Furthermore, if the price between the two tracks is smaller for cash crops than it is for grains, then even if the price difference of individual crops does

[4] The price-adjusted market share is calculated as: $\frac{V_{market}}{V_{market}+\frac{V_{all}-V_{market}}{price\ \ ratio}}$, as price ratio is always less than 1, this adjusted share is smaller than the un-adjusted share.

not change, the composition effect implies that the aggregated price difference is smaller. To address this issue, we compare the output data on grains and cash crops as shown in left panel of Figure E.24. It shows that although, starting from 1978, the ratio of grain to the total of agricultural products decreased, by 1992, this ratio was still higher than 75%. Therefore, the potential composition effect cannot be substantial, and the fact that, in 1992, the procurement price was close to the market price is probably mainly due to the change of policy on procurement.[5]

In addition, while agricultural productivity increased rapidly from 1978, the labor market in China was segmented through the "Hukou" system. To absorb the surplus rural labor force, more township and village enterprises (TVEs) were established, particularly after 1984. Data on TVEs were collected from Chinese Statistics Yearbook (CSY) or from the China TVEs Yearbook; however, there is some inconsistency between these two sources. The value in the TVEs Yearbook is generally higher than that in CSY. In our study, we use the data from CSY because it is more promising and popular in the literature. The data have four components in the rural enterprises based on ownership: township, villages, private, and mixed. Because the data on TVEs includes only the township enterprises before 1984, two versions of the statistic characteristics are calculated. In the first version (v1), only township enterprise data is used, and in the second version (v2), all the four components are included. As shown in Figure E.25, both the number of TVEs and its employment share in rural areas had increased. In 1984, there was a large increase in the number of private TVEs, the output value share of which increased from 15% to 30%. Therefore, the jump in 1984 was mainly due to the addition of private TVEs in the data.

The right panel of Figure E.24 presents the log value of the number of urban enterprises from NBS. The number of urban enterprises increased from the early 1970s. In what is similar to the case of TVEs, it also includes four components: SOEs and private, mixed, and others, including foreign enterprises. As only SOE data are available for the period before 1984, two versions are presented. The first version includes only SOEs, and the second version includes all of them; the jump in the figure is due to the inclusion of private enterprises after 1984.

In sum, the data shows that between 1978 and 1992, the market share of agricultural products increased a great deal; the ratio of procurement price to market price increased; the mass of TVEs and employment share in TVEs increased; and the mass of urban enterprises increased.

3. A model on DTS

3.1. Environment

In the model, there are two separate labor markets: rural and urban. Rural has farmland and enterprises, but urban only has enterprises. There are two goods in the economy: agricultural and manufacturing. While agricultural goods can only be produced on farmland, manufacturing goods can be produced in enterprises in both rural and urban. In addition, both of them can be used for consumption and intermediate input. Furthermore, there is no migration between rural and urban, but rural people could choose to be a farmer or a worker in rural enterprises. While farmers can plant on the land for free, workers don't have this right. However, farmers have an obligation regarding procurement, but workers can waive it. On the other hand, urban people can only work in urban enterprises. Enterprises are heterogeneous in productivity z, workers are heterogeneous in two-dimension ability $h = (h_F, h_E)$ where h_F is the ability of farming to yield agricultural product and h_E is the ability to produce manufacturing goods.

The procurement and quota are modeled as follows. On the procurement side, for each unit of land, workers on farmland have an obligation to sell at least $\overline{Q}$ units of agricultural products at price $\overline{P}_a$ to the government, and after fulfilling this obligation, they are free to trade in the market. On the quota side, urban enterprises are eligible to buy agricultural products at price $\overline{P}_a$ from the government; however, the total amount is limited by $\overline{q}$. There is no second-hand market, that is, firms are not allowed to sell agricultural goods brought from government as quota benefit in the market.

Furthermore, although both enterprises and workers take the procurement and quota as given, essentially DTS was implemented to accelerate urban economy first and then to help rural people get rich. More generally, the quantity on procurement and quota reflect the magnitude the government values the urban and rural. In the model, the procurement and quota quantity are determined by the government to maximize the total weighted social welfare. As the weight on urban varies across years, the procurement level will change. Hence our analysis could only focus on the procurement directly instead of the weighted on rural or urban.

3.2. Agricultural goods production

Agricultural goods are produced on rural farmland, and land is equally distributed among farmers. Denote $\overline{Z}$ the total amount of farmland and L_{RF} the total number of farmers, then the land size for each farmer is $Z_{RF} = \frac{\overline{Z}}{L_{RF}}$.[6] Given the intermediate goods x_a and agricultural productivity A_a, the production function for a farmer h is

$$y_a(h) = A_a(Z_{RF}^{\eta} h_F^{1-\eta})^{1-\alpha_a} x_a^{\alpha_a},$$

where α_a is the share of intermediate goods, $1 - \alpha_a$ is the share of factor inputs, η is the land share of factor inputs. Given the ability distribution $G(h)$ and the total labor force L_R in rural area, aggregate production of agricultural goods is the aggregation of output from workers on farmland denoted as RF

$$Y_a = L_R \int_{RF} y_a(h) dG(h). \tag{1}$$

Given the procurement requirement $\overline{Q}$ for each piece of land, farmers choose intermediate input x_a and quantity selling to government Q_a to maximize the net value of agricultural goods production

$$\max_{x_a>0, Q_a \geq \overline{Q} Z_{RF}} P_a A_a (Z_{RF}^{\eta} h_F^{1-\eta})^{1-\alpha_a} x_a^{\alpha_a} - P_m x_a - (P_a - \overline{P}_a) Q_a. \tag{2}$$

3.3. Manufacturing goods production

Manufacturing goods could be produced in rural (R) and urban (U) areas. In sector $j = R, U$, denote A_j is the location specific productivity, H_j is the human capital level, x_j is the input of agricultural goods, the production function for a firm z is

$$y_j(z) = A_j z^{\gamma_j} (H_j^{1-\alpha_j} x_j^{\alpha_j})^{1-\gamma_j}, j = R, U$$

where $1 - \gamma_j$ is the span of control and $\alpha_j, 1 - \alpha_j$ denote the share of agricultural goods and human capital respectively. The assumption that both agricultural goods and manufacturing goods are used as intermediate goods follows Jones (2011) but differs from Restuccia et al. (2008) where only manufacturing goods are used as intermediate goods. This is based on the fact that, in the context of China, the Input-Output table shows the share of agricultural goods used in producing non-

[5] Due to lack of procurement price information on this two types of crops, we couldn't have more precise calculation.

[6] In the real economy, land is equally distributed across households weighted by member number; however, for split households or moved workers, the policy is not clear at the national level. Some may still have land, while others may not. To avoid this confusion, we assume that the land is distributed only among people who are still working on farmland.

agricultural goods is significant.[7]

Following Brandt et al. (2018), we assume productivity z follows Pareto distribution $F(z)$, and there are potential mass M_j enterprises and only non-negative profit firm will enter the market. The total output is the aggregation over active firms denoted by D_j, in particular,

$$Y_j = M_j \int_{D_j} y_j(z) dF(z), j = R, U. \tag{3}$$

As there is no labor mobility across rural and urban areas, the wage rate will be different, denoted by w_R and w_U. Given entry cost C_R, the profit for firm z in rural is

$$\pi_R(z) = \max_{H_R, x_R} \; P_m y_R(z) - w_R H_R - P_a x_R - C_R. \tag{4}$$

The profit for firm z in urban is

$$\pi_U(z) = \begin{cases} \max\limits_{H_U, x_U} \; P_m y_U(z) - w_U H_U - \overline{P}_a x_U - C_U & \text{if } x_U \le \overline{q} \\ \max\limits_{H_U, x_U} \; P_m y_U(z) - w_U H_U - P_a x_U + (P_a - \overline{P}_a)\overline{q} - C_U & \text{if } x_U > \overline{q}. \end{cases} \tag{5}$$

In the case of $x_U > \overline{q}$, the profit function can be written as

$$\pi_U(z) = P_m y_U(z) - w_U H_U - \left(1 - \frac{P_a - \overline{P}_a}{P_a} \frac{\overline{q}}{x_U}\right) P_a x_U - C_U.$$

As $0 < \frac{P_a - \overline{P}_a}{P_a} \frac{\overline{q}}{x_U} < 1$, the quota benefit and the procurement price imply a lower-than-market input price in general, and $\frac{P_a - \overline{P}_a}{P_a} \frac{\overline{q}}{x_U}$ is an implicit distortion on intermediate goods allocation due to quota benefit. Hence, in this model, the distortion is caused by quota benefit. As the amount of input x_U increases, the ex-post price $(1 - \frac{P_a - \overline{P}_a}{P_a} \frac{\overline{q}}{x_U}) P_a$ gets closer to the market price P_a; and the price distortion decreases as x_U increases.

3.4. Workers

A worker's utility depends on consumption of agricultural goods (a) and manufacturing goods (m)

$$u(a, m) = \theta log(a - \overline{a}) + (1 - \theta) log(m),$$

subject to budget constraint $P_a a + P_m m \le I$, where θ is the weight on agricultural goods; $\overline{a}$ is the subsistence level of agricultural goods; P_a, P_m are the market prices of agricultural and manufacturing goods, respectively, and I is worker's income. Then the indirect utility function is

$$V(I) = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1 - \theta) log\left(\frac{1 - \theta}{P_m}\right)\right] + log(I - P_a \overline{a}).$$

Rural workers could choose working in rural enterprises (*RE*) or on the farmland (*RF*). The income in *RE* is from the wage and share of profit from rural enterprises, that is,

$$I_{RE}(h) = w_R h_E + \frac{\Pi_R}{L_R} \tag{6}$$

where $\Pi_R = M_R \int_{D_R} \pi_R(z) dF(z)$ is the total profit from rural enterprises, and people in rural share the profit equally. On the other hand, the net income for farmer with ability h is given by

$$I_{RF}(h) = (1 - \alpha_a) P_a y_a(h) - (P_a - \overline{P}_a) Q_a + \frac{\Pi_R}{L_R} \tag{7}$$

It can be rewritten as $I_{RF}(h) = [(1 - \alpha_a) - \frac{P_a - \overline{P}_a}{P_a} \frac{Q_a}{y_a(h)}] P_a y_a(h) + \frac{\Pi_R}{L_R}$, then $\frac{P_a - \overline{P}_a}{P_a} \frac{Q_a}{y_a(h)}$ is the price distortion faced by farmers which is caused by procurement. In particular, as $Q_a < y_a(h)$ and $\overline{P}_a < P_a$, this distortion is increasing in procurement level Q_a.

Workers in urban areas will only work in urban enterprises *UE* whose income come from urban wage and profit share. The total profit from urban enterprises is $\Pi_U = M_U \int_{D_U} \pi_U(z) dF(z)$, which is equally distributed among the urban people, then the income for urban household is $I_U(h) = w_U h_E + \frac{\Pi_U}{L_U}$.

3.5. Government

In the above setting, both enterprises and workers take the procurement ($\overline{Q}$) and quota ($\overline{q}$) as given. Essentially DTS was implemented to accelerate urban economy first and then to help rural people. More generally, the quantity on procurement and quota reflect the magnitude the government values the urban and rural. Hence, in the model, the procurement and quota quantity are determined by the government to maximize the total weighted social welfare.[8]

As a direct effect, high procurement will hurt farmers' welfare but make urban people better off. However, as manufacturing goods output increases, the intermediate goods in agricultural production will be cheaper, which will improve farmer's welfare. The total welfare in urban is the aggregate of all the urban workers, $L_U \int_U V(I_U(h)) dG(h)$, and the welfare in rural is the sum of enterprises workers and farmers, $L_R[\int_{RE} V(I_{RE}(h)) dG(h) + \int_{RF} V(I_{RF}(h)) dG(h)]$. Denote χ_U the weight on welfare for urban household, the government's problem is to set the procurement and quota level to maximize the total welfare, that is,

$$\max_{\overline{q}, \overline{Q} \ge 0} \; \chi_U L_U \int_{D_U} V(I_U(h)) dG(h) + (1 - \chi_U) L_R \left[\int_{RF} V(I_{RF}(h)) dG(h) + \int_{RE} V(I_{RE}(h)) dG(h)\right] \tag{8}$$

$$s.t. M_U \int_{D_U} min\{x_U(z), \overline{q}\} dF(z) = \overline{QZ} \tag{9}$$

where the budget constraint says the government will sell all the agricultural goods brought from farmers to urban firms as the quota benefit. Therefore, in this model, procurement and quota are endogenously determined, as the weight on urban varies across year, the procurement level will change, and the impact on economy will be different.

3.6. Equilibrium

In order to characterize the equilibrium, we define the following aggregate variables. The total demand for manufacturing goods as intermediate input is

$$x_a = L_R \int_{RF} x_a(h) dG(h) \tag{10}$$

The total demand for agricultural goods as intermediate input is

[7] Data of Input-Output table from 1981 to 1992 shows that while the share of non-agricultural goods used in producing agricultural goods is 0.157, the share of agricultural goods used in producing non-agricultural goods is 0.066. It is a bit lower because the price of agricultural goods is generally much lower; however, it is persistent and high in some industries (e.g., the food industry, the textile industry, etc.). More details are documented in Table E.1 and Table E.2.

[8] In the reality, the government can control both the procurement quantity and price. For simplicity, we only consider about government will choose the quantity instead of both. In the current model, the procurement price is set to be proportional to market price, and the ratio is set to the data directly, then as market price change, the procurement price will change as well, which is different from Sicular (1988) who assumes the price is exogenous and does some comparative statics. Quantitatively, even if we allow the government to choose the procurement price, as long as we still target the price ratio in the data, it wouldn't affect the benchmark economy. In addition, as in the market economy we set this ratio as 1, it won't affect the market economy either. Therefore, quantitatively, it wouldn't affect our conclusion on activation effect, that is, the comparison between DTS and market economy.

$$x_j = M_j \int_{D_j} x_j(z)dF(z), j = R, U \tag{11}$$

The total demand for agricultural goods for consumption in rural area is

$$a_R = L_R \int_{RE} a_{RE}(h)dG(h) + L_R \int_{RF} a_{RF}(h)dG(h) \tag{12}$$

The total demand for agricultural goods for consumption in urban area is

$$a_U = L_U \int_{UE} a_U(h)dG(h) \tag{13}$$

The total demand for manufacturing goods for consumption in rural area is

$$m_R = L_R \int_{RE} m_{RE}(h)dG(h) + L_R \int_{RF} m_{RF}(h)dG(h) \tag{14}$$

The total demand for manufacturing goods for consumption in urban area is

$$m_U = L_U \int_{UE} m_U(h)dG(h) \tag{15}$$

The total human capital demand in sector $j = R, U$ is

$$H_j^D = M_j \int_{D_j} H_j(z)dF(z), j = R, U \tag{16}$$

The total human capital supply in rural area is

$$H_R^S = L_R \int_{RE} h_E dG(h) \tag{17}$$

The total human capital supply in urban area is

$$H_U^S = L_U \int_{UE} h_E dG(h). \tag{18}$$

3.7. Equilibrium

The equilibrium is characterized by agricultural goods selling to government $\{Q_a\}$ and intermediate goods $\{x_a(h)\}$, labor allocation in rural $\{L_{RF}, L_{RE}\}$, enterprises factor input $\{H_j(z), x_j(z)\}, j = R, U$, and procurement and quota level $\{\overline{Q}, \overline{q}\}$, wage rate $\{w_R, w_U\}$, and goods prices $\{P_a, P_m\}$ such that.

1. $\{Q_a, x_a(h)\}$ maximizes rural worker income as in equation (2).
2. $\{L_{RF}, L_{RE}\}$ is the result of the occupation choice for rural people, as in equations (7) and (6).
3. $\{H_j(z), x_j(z)\}, j = R, U$ maximizes enterprise profit in equations (4) and (5).
4. $\{\overline{Q}, \overline{q}\}$ solves government's problem to maximize total welfare as in equations (8) and (9).
5. w_R, w_U, P_a, P_m clear labor markets and goods markets.
   (a) Rural labor market clear, $H_R^D = H_R^S$, as in equations (16) and (17).
   (b) Urban labor market clear, $H_U^D = H_U^S$ as in equations (16) and (18).
   (c) Agricultural goods market clear, $Y_a = x_R + x_U + a_R + a_U$ as in equations (1) and (11)–(13).
   (d) Manufacturing goods market clear, $Y_R + Y_U = x_a + m_R + m_U$ as in equations (3), (10), (14) and (15).

4. Theoretical results

In this section, we illustrate three main mechanisms of DTS: activation effect, selection effect, misallocation effect. Activation effect captures the idea that as urban enterprises enjoy the quota benefit, the gross manufacturing output could be larger, which will increase the agricultural goods output as the intermediate goods supply increases. Selection effect represents that procurement requirement will play a role as screening machine–only rural people with relative high farming ability will stay as farmers. Misallocation effect means that some low productive firms in urban can survive due to quota benefit, whereas firms with higher productivity in rural may not survive. To illustrate these mechanisms, we simplify the benchmark model and only focus on one channel in each subsection in below.

4.1. Activation effect

To illustrate the activation effect, we simplify the model in the following way. Both worker's ability and firm's productivity are homogeneous, agricultural goods are produced in rural, enterprises are located only in urban, and there is no migration. Procurement is determined by the government to maximize the total welfare. Otherwise it largely follow the quantitative model as presented in Appendix A.1.

We compare the general equilibrium results in market economy with that in the DTS in the case of $x_U \le \overline{q}$. Given procurement requirement $\overline{Q}$, denote $\frac{\overline{P}_a}{P_a} = \kappa_P$, and normalize $P_m = 1$, market clear condition under DTS requires

$$[1 - \theta(1 - \alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta} + \theta(1 - \kappa_P)\overline{QZ} - [(1 - \theta)\overline{a}]L_R$$
$$= (1 - \theta)\overline{a}L_U - \theta\frac{C_U}{P_a} + \left(\frac{\kappa_P P_a}{\alpha_a(1 - \gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}$$
$$\left\{1 + \theta\kappa_p\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1 - \gamma_U)}\right]\right\} \tag{19}$$

such that $\left(\frac{\kappa_P P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \le \overline{QZ}$. On the other hand, the equilibrium condition in market economy implies

$$[1 - \theta(1 - \alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta} - [(1 - \theta)\overline{a}]L_R$$
$$= (1 - \theta)\overline{a}L_U - \theta\frac{C_U}{P_a} + \left(\frac{P_a}{\alpha_a(1 - \gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}$$
$$\left\{1 + \theta\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1 - \gamma_U)}\right]\right\}. \tag{20}$$

While the left hand sides of equations (19) and (20) are agricultural goods supply in urban ($Y_a - a_R$) under DTS and market economy respectively, the right hand sides are agricultural goods demand in urban ($a_U + x_U$) under DTS and market economy respectively.

Fig. 1 compares the equilibrium price and outputs under DTS (P_a^D) and market economy (P_a^M), which is also summarized in Proposition 1. It shows that if κ_P and A_a are small enough, under DTS the outputs in both agricultural and manufacturing sector are higher. That is to say, DTS activates the economy when agricultural productivity is low enough. Note we take κ_p as exogenous, and P_a is general equilibrium price, by this setting, procurement price is also general equilibrium result but subject to the price distortion.

Proposition 1. *In the homogeneous model, 1) there always exists $P_a^M > \kappa_P P_a^D$; 2) the manufacturing goods gross output under DTS is always higher than market economy; 3) when κ_P and A_a are small enough, the agricultural goods gross output under DTS is also higher than that in market economy.*

Proof. see Appendix A.1.6.

4.1.1. Role of lacking migration

To better illustrate activation effect, we highlight the role of lacking migration. First, due to the migration barrier, there is a labor productivity gap between urban and rural, and the subsidy in intermediate goods will narrow this gap and hence achieves the second best outcome. Second, given the labor mobility is forbidden, there are surplus labor force in rural, that is, the marginal product of intermediate goods is very high, then subsidizing urban might increase intermediate goods supply in rural which in turn will increase agricultural goods production. Technically, suppose there is subsidy dX_u to urban as intermediate goods, it will increase manufacturing output and also the product sold to rural as intermediate goods, denoting it as a function of subsidy $f(dX_u)$, then as long as the marginal product of intermediate goods in rural (MPX) is high enough so that $MPX \cdot f(dX_u) > dX_u$, then the gross agricultural output will be higher. This mechanism is similar to the argument in Liu (2019) that, given there exists distortions, subsidizing upstream might alleviate the overall distortion, as the upstream absorb more distortion through intermediate goods demanding, although in our setup, it is hard to tell which sector is upstream as they use intermediate goods from each other.

We then compare the economy with and without migration graphically, showing that the results might change if there is no migration barrier. presents the comparison between market economy and DTS with migration under case of $x_U \le \overline{q}$ where the parameters are the same as those used in Fig. 1. Comparing it with the results without migration in Fig. 1 shows that, with migration, manufacturing goods production in urban would be higher under market than DTS and the agricultural goods production is still higher under DTS. Moreover, in this case, we have $x_U^M < x_U^D$ and $x_a^M > x_a^D$.[9] The interpretation is that in the market economy urban firm will purchase less intermediate goods ($x_U^M < x_U^D$), however, as there is more labor force, the output is higher ($y_U^M > y_U^D$). On the other hand, as more people migrate to urban, it is more profitable for farmers to buy more intermediate goods ($x_a^M > x_a^D$), but the output is still lower under market economy as the labor force effect dominates.

4.2. Selection effect

To illustrate the selection effect, we study the occupational choice in rural, assuming enterprises are only located in urban and migration between rural and urban is allowed.[10] Given $P_a > \overline{P}_a$, the constraint is always binding, that is, $Q_a = \overline{Q} Z_{RF}$. Then there is a cutoff of ability profile regarding occupational choice in rural area

$$h_E = L(h_F) = \frac{1}{w_U}\left\{(1-\alpha_a)P_a\left(\frac{\alpha_a P_a}{P_m}\right)^{\frac{\alpha_a}{1-\alpha_a}}[A_a(Z_{RF}^{\eta}h_F^{1-\eta})^{\beta_a}]^{\frac{1}{1-\alpha_a}} - (P_a-\overline{P}_a)\overline{Q}Z_{RF}\right\},$$

and the ability profile of workers in enterprises is $UE = \{h : h_E > L(h_F)\}$, and for farmers, it is $RF = \{h : h_E < L(h_F)\}$. Then, the direct effect of high procurement is that, as $\overline{Q}$ increases or $\overline{P}_a$ decreases, people who are less capable on farming in rural areas are more likely to work in enterprises as shown in Fig. 3, which will increase the labor productivity through both decrease of labor force and increase of average ability, while the total output of agricultural products decreases.

However, there is an indirect or feedback effect. Since $Z_{RF} = \frac{\overline{Z}}{L_{RF}}$, the average land size Z_{RF} is getting larger, then it will discourage the migration. Hence the magnitude of effect is unclear even in partial equilibrium, and it will be further examined in section 6.

4.3. Misallocation effect

To illustrate the misallocation effect, we focus on urban enterprise's behavior assuming enterprises are only located in urban and migration between rural and urban is not allowed. As shown in Appendix A.4, given a fixed entry cost C_U, there exists productivity cutoff z_U^*, z_L, z_H such that the intermediate goods demand function and profit function are

$$x_U(z) = \begin{cases} 0 & z \le z_U^* \\ x_L(z) & z_U^* < z \le z_L \\ \overline{q} & z_L < z \le z_H \\ x_H(z) & z > z_H \end{cases}, \text{ and } \pi_U(z) = \begin{cases} 0 & z \le z_U^* \\ \pi_L(z) & z_U^* < z \le z_L \\ \pi_M(z) & z_L < z \le z_H \\ \pi_H(z) & z > z_H \end{cases}.$$

This mechanism is similar to Guner et al. (2008). The interpretation is that the unproductive firm ($z \le z_U^*$) will not enter the market. Low productive firm ($z_U^* < z \le z_L$) will have intermediate input under the quota benefit ($x_L(z) < \overline{q}$).[11] There is a positive mass of firm that will have intermediate input $\overline{q}$. If the firm wants to buy agricultural goods above the quota level, the marginal cost (price) of agricultural goods will jump from $\overline{P}_a$ to P_a; hence, firms with productivity slightly higher than z_L may not be able to cover this cost and stick to the quota level. Then the very productive firm will have a higher intermediate input ($x_H(z) > \overline{q}$).

Fig. 4 illustrates the demand and profit function. The left panel shows that less firm will enter the market if there is no procurement ($z^* < z_c^*$), and the right panel shows that firm will invest less in intermediate goods if there is no procurement as the dash line is below the solid line in the figure. The following proposition summarizes results of comparative statics in partial equilibrium.

Proposition 2. *With DTS, the entry level productivity z_U^* is increasing in C_U, $\overline{P}_a$, w_U and decreasing in A_U, and the cutoff z_L is increasing in $\overline{P}_a$, $\overline{q}$, w_U and decreasing in A_U. In addition, the welfare for rural (urban) people is decreasing (increasing) in procurement.*

Proof. Lemma A.4.1- Lemma A.4.3 in Section A.4 will prove this proposition.

5. Calibration

As in Brandt et al. (2018), firm productivity z follows Pareto distribution with minimal productivity $z_{R,min} = z_{U,min} = 1$, that is, $F(z) = 1 - (\frac{1}{z})^{\theta_j}, z > 1, j = U, R$, with $\theta_R = \theta_U = 1.05$, and we also set $\gamma_R = \gamma_U = 0.15$. In addition, as in Adamopoulos et al. (2017), the abilities jointly follow log normal distribution $G(h_F, h_E) \sim LN(\mu, \Sigma)$ where $\mu = (\mu_F, \mu_E)$ and $\Sigma = \begin{pmatrix} \sigma_F^2 & \sigma_{FE} \\ \sigma_{FE} & \sigma_E^2 \end{pmatrix}$. The parameters are $\mu_F = 0.16$, $\mu_E = 0.88$, $\sigma_F = 1.48$, $\sigma_E = 0.95$, and $\rho_{FE} = -0.35$, that is to say, ability h_F and h_E are negatively correlated. On the contrary, Lagakos and Waugh (2013) use US data and assume the abilities following Fréchet distribution $G_1(h_F) = e^{-h_F^{-\theta_F}}$, $G_2(h_E) = e^{-h_E^{-\theta_E}}$ and the parameters are $\theta_F = 5.3$, $\theta_E = 2.7$, $\rho = 3.5$.[12] As the result in Adamopoulos et al. (2017) is based on Chinese data, we assume that it also follows joint log normal distribution in our study.

[9] This result is not shown in the figure, but it can be computed in Appendix A.2.

[10] Note this is not quite consistent with quantitative model that migration is not allowed. Ideally, we would like to keep all the things consistent with quantitative model and get some partial results. However, if we omit urban enterprises, only assuming worker choose between the agricultural sector and rural enterprises, then we have to further assume rural enterprises will enjoy quota benefit, which is also not consistent with quantitative model. More importantly, as we emphasize the procurement in the paper, we would like to keep this consistent throughout the paper, that is, only urban enterprises will enjoy the quota benefit.

[11] The existence of $x_L(z) < \overline{q}$ is due to no second-hand market, otherwise firms can sell quota benefit under the market price and hence they will buy intermediate goods at least at quota level regardless productivity. We will further quantify the impact with second-hand market in section 6.4.

[12] In Lagakos and Waugh (2013), joint distribution takes the following function form: $G(h_F, h_E) = C_p[G_1(h_F), G_2(h_E)], h_F > 0, h_E > 0$,
where
$C_p(u, v) = -\frac{1}{\rho}\log\left[1 + \frac{(e^{-\rho u}-1)(e^{-\rho v}-1)}{e^{-\rho}-1}\right]$.

The potential mass of enterprises M_R, M_U are assumed to be proportional to labor force in rural enterprises and urban enterprises respectively, without losing generality, we assume that $M_R = L_{RE}, M_U = L_U$. In addition, L_R, L_U are from employment ratio in rural and urban, respectively; $\frac{\overline{P}_a}{P_a}$ is the procurement to market price ratio; from the Input-Output table, the share of intermediate goods in non-agricultural goods in agricultural production is $\alpha_a = 0.157$, which is lower than 0.4 in the US as in Restuccia et al. (2008). The share of agricultural goods used as intermediate goods is $\alpha_R(1 - \gamma_R) = 0.066$, which is much lower than the average share of the intermediate goods 0.68 in Jones (2011). This share gives $\alpha_R = 0.078$ as in Adamopoulos et al. (2017); the land share to labor share ratio is $\frac{\eta}{1-\eta} = \frac{0.36}{0.46}$, which implies $\eta = 0.439$. Then the land share is $(1 - \alpha_a)\eta = 0.370$ and labor share is $\alpha_a\eta = 0.473$, which are close to those in Adamopoulos et al. (2017). We set $\theta = 0.005$ as in literature (e.g. Chen, 2017). Table 1 summarizes the results.

We calibrate the rest of parameters in two steps. First, we target the average value between 1978 and 1992 in the data. Urban productivity A_U is normalized as 1. Agricultural productivity A_a is calibrated to match the output ratio between rural enterprise and agriculture Y_R/Y_a where Y_R is the real value of output in TVE, Y_a is the total real value of agricultural output selling in market and under procurement. Rural productivity A_R is calibrated to match the output ratio between urban and rural enterprises Y_U/Y_R where Y_U is the real value of output in urban. The entry costs are calibrated as in Brandt et al. (2018) that assuming that the human capital of a margin firm is 1, that is, $H_R(z_R^*) = 1$,and $H_U(z_U^*) = 1$, hence the entry cost can be written as $C_j = \frac{\gamma_j w_j}{(1-\alpha_j)(1-\gamma_j)}, j = R, U$. The welfare weight χ_U is calibrated to match market share (ms) which is defined as the proportion of agricultural goods value selling in market to the total value. Subsistence level $\overline{a}$ is calibrated to match the employment share in rural enterprises L_{RE}/L_R; and total land size $\overline{Z}$ is calibrated to match the average earning ratio between urban and rural E_U/E_R, where E_U, E_R are the average household disposable income in urban and rural respectively.

Table 2 lists the parameters in this step. Generally the model matches the average value well except for it overestimates the employment ratio in rural enterprises. Note that $\chi_U = 0.9178$ implies the government value urban much higher than rural. This is consistent with the real economy that, at the beginning of reform the urban is favored by the policy.[13] In addition, $C_R < C_U$ implies the entry cost in rural is much lower than that in urban. It is consistent with facts in Figure E.25 that, in the early stage, there is a large number of TVEs entering the market.

Second, we assume total land size $\overline{Z}$ is constant across year and calibrate other parameters year by year. In particular, C_R, C_U, M_R, M_U and $\overline{a}, \chi_U$ are calibrated in the same way as the first step. The productivities A_a, A_R, A_U are calibrated to match the real outputs Y_a, Y_R, Y_U year by year by normalizing the average values to be 1. Table 3 summarizes the parameters. In the calibration, we simulate the model and minimize the error between the simulated moment and the data moment as in Lagakos and Waugh (2013), and the detail of this algorithm is in Appendix B.

Fig. 5 presents the model and data for targeted moments in each year where the dash line represents the data and the solid line represents the model for targeted variables where the output Y_a, Y_R, Y_U are normalized as 1 in average for both the data and the model. It shows the model matches data well. Moreover, Fig. 6 shows it also match the following untargeted moments well: agricultural goods price (P_a), average earning in rural and urban (E_R, E_U), procurement level ($\overline{Q}$). The dash line is data and the solid line is model. All the variables are normalized as 1 in average value for both the data and the model. Finally, Fig. 7 presents the parameters across years, including agricultural productivity (A_a), rural productivity (A_R), urban productivity (A_U), weight on urban in social welfare (χ_U), number of potential entrant in urban and rural (M_U, M_R), entry costs in urban and rural (C_U, C_R). It shows that there is a clear trend of all the parameters which is important for counterfactual analysis.

[13] This is said in the early stage of development that "help some people get rich first and then help the others".

6. Quantitative analysis

With the parameters calibrated, we quantitatively analyze the impact of DTS in several experiments. Firstly, we take 1978 as benchmark and do counterfactual analysis on different factors, and we also study the scenario when switching to market economy in 1978. Secondly, we take each year of 1979–1992 as benchmark and study the effect when parameters are set with 1978's values. Thirdly, we decompose the impact of different channels on economic growth and welfare. Fourthly, we study the economy with second-hand market and frictionless economy as two extensions.

6.1. Counterfactual analysis

To understand the mechanism and importance of each factor, we take 1978 as benchmark and set parameters with 1992's value. In Table 4, the column of "benchmark" is the results in 1978, and each column under "counterfactual case" lists the results when setting this parameter in 1992's value while keeping others the same as in 1978; and in the column of "market", we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$, that is, the government doesn't set procurement requirement.

The results show that if the economy was set to market economy, the total output (Y) would decrease by 4.5% (from 2.408 to 2.299). This could be explained by several effects in the model. First, the selection effect was weakened as the employment ratio on farmers (L_{RF}/L_R) increased from 0.743 to 0.971, and there were less active firms in rural (M_R^*) and lower output (Y_R). Second, the misallocation was also alleviated as the procurement price was as high as market price, and there were less active firms in urban (M_U^*) and lower output (Y_U). Furthermore, as the total output of manufacturing goods was lower, the intermediate goods in agricultural goods production (x_a) was less. Combining it with the result that the number of farmers were more could explain the result of slight change of agricultural goods output (Y_a). Finally, the results in the table also confirm that under DTS the labor productivity gap between urban and rural (2.264/(0.073/0.743)) is less than that in the market economy (2.159/(0.071/0.971)).[14]

In contrast to output, the impact on welfare is more significant. Although there is not much change on urban welfare (V_U), the rural welfare (V_R) has increased from −1.93 to − 1.566. Given the logarithm utility function, we compute the equivalent consumption (EC) as the

[14] Here we omit the output from rural enterprise, as it is not comparable, and also we don't incorporate agricultural price as we emphasize the real term, actually the agricultural price difference is 2.98/1.96, which will even narrow the gap if incorporated. Formally, we compute the labor productivity gap as follows

$LG = \frac{Y_U/L_U}{[(Y_a-Q)P_a+Q\overline{P}_a+Y_R]/L_R}$

By definition, $ms = \frac{(Y_a-Q)P_a}{(Y_a-Q)P_a+Q\overline{P}_a}$ and given price ratio $\frac{\overline{P}_a}{P_a}$ (denote as χ_P), we can solve Q as

$Q = \frac{(1-ms)}{ms*\chi_P+(1-ms)} Y_a := \chi_Q Y_a$

and then plugging in we have

$LG = \frac{Y_U/L_U}{\{[(1-\chi_Q)+\chi_Q\chi_P]Y_aP_a+Y_R\}/L_R}$

given under DTS, $ms = 0.11$, $\chi_P = 0.6$ and $P_a = 2.98$, $Y_a = 0.073$, $Y_R = 0.01$, $Y_U = 2.264$, then $LG = 15.45\frac{L_R}{L_U}$, while under market economy, $\chi_Q = 0$, $P_a = 1.96$, $Y_a = 0.071$, $Y_R = 0.002$, $Y_U = 2.159$, then $LG = 61.16\frac{L_R}{L_U}$ which is much larger than that under DTS.

value generating the utility, hence EC of V_R has increased by 43.9%.

In addition, the procurement price ratio ($\frac{\overline{P}_a}{P_a}$) has similar impact as the market economy. The total output would decrease by 6.5%, and the EC for rural would increase by 28.3%. While the weight on urban (χ_U) would increase the rural welfare by 60.3%, it slightly increase the total output by 0.3%. Finally, the counterfactual analysis on productivities (A_a, A_R, A_U) shows that they would have higher impact on output. For example, if A_a was set with the value in 1992, the agricultural output would increase from 0.073 to 0.227, and the total output would increase from 2.408 to 2.528. And it could benefit both rural and urban people, in particular, the EC for rural, urban and all people would increase by 13.2%, 1.9%, and 2% respectively. The results for A_R and $A_U$are similar and presented in Table 4.

6.1.1. Activation effect

In section 4.1, we emphasize the role of migration barrier in explaining the mechanism of activation effect. Migration barrier will distort labor market, while DTS will alleviate this friction, which eventually might improve the aggregate outputs. Then there is a natural question that whether DTS can improve the outputs if the labor market distortions across sectors are not as large as in the current setting. To answer this question, we set that firms in urban sectors have the same production parameter values and entry cost as rural firms. This will close the productivity gap between urban and rural firms and shut down the distortion alleviation channel brought by the DTS.

Table 5 presents the results for this exercise. The column of "benchmark" lists results under DTS in 1978, and in the column of "market", we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$. These results are the same as that in Table 4. While each column under "$A_U = A_R, C_U = C_R$" list the results further setting productivity and entry costs in the urban same as that in the rural. It shows that the aggregate output (Y) under market economy is 62% higher than that under DTS (from 0.1491 to 0.2419). This confirms that the role of alleviation labor market distortion is quite important, but we are hesitate to conclude that this mechanism contribute 66.5% (in counterfactual analysis in section 6.1, DTS increases output by 4.5%) as we are combining two different economies. This result is intuitive as, comparing to market economy, DTS alone will distort the manufacturing goods production.

Finally, note that in the benchmark economy, A_R is much lower than A_U, then when setting A_U equal to A_R the output from urban enterprises is pretty low as not many firms will enter the market. And also both the aggregate output and welfare is much lower than benchmark cases.

6.2. Results across years

In this counterfactual analysis, we take each year of 1979–1992 as benchmark and set the parameters with 1978's values. The results are presented in Fig. 8. It shows the counterfactual result of market economy in each year is similar to that in 1978, that is, if the economy were switched to market economy directly, V_R would be higher and Y_R would be lower. It means that rural people would be better off in market economy, but the rural enterprises would be worse off.

In addition, Fig. 9 presents the counterfactual analysis results on $\frac{\overline{P}_a}{P_a}$ and χ_U. In the counterfactual case, the welfare for rural people (V_R) would be lower and rural enterprise output (Y_R) would be higher. This result is intuitive given the procurement price is lower and χ_U is relative higher (government favored urban people more) in 1978.

6.3. Decomposition

In this subsection, we compare DTS with other factors in a decomposition exercise. First, we group the parameters into following channels: productivities (A_a, A_R, A_U), DTS ($\chi_U, \frac{\overline{P}_a}{P_a}$), firm mass ($M_U, M_R$), employment ratio ($L_U, L_R$) and entry cost ($C_U, C_R$). Then we set the year of 1992 as baseline economy, and each time we compute the counterfactual result by setting the parameter with 1978's value. Denote the counterfactual result of variable X on channel i as X_i, we compute the ratio $s_i = \frac{X_{1992} - X_i}{X_{1992} - X_{1978}}$ to measure how much the result will change under counterfactual case relative to the change in benchmark, where X_{1978} and $X_{1992}$are the benchmark result in 1978 and 1992 respectively. The contribution of each channel is computed as $ct_i = \frac{s_i}{\sum s_i}$ presenting the importance of channel i relative to other channels. We also compute the residue as $1 - \sum s_i$ to capture the impact from all the other factors in the model (e.g. subsistence level $\overline{a}$) and out of the model. The results of this exercise is summarized in Table 6. While $\sum s_i$ is always positive, ct_i could be negative, in which case, counterfactual result X_i is higher than X_{1992}. For example, the impact of DTS on (Y_a, Y_R, V_U, V_{total}) are negative, which means that DTS was successful on improving the agricultural output, TVE output, urban welfare and total welfare. This is consistent with the change of selection effect: in the counterfactual case, the average land size (Z_{RF}) would be higher than baseline economy. On the other hand, the impact on (Y_U, Y, V_R) are positive, meaning that adjustment of DTS from 1978 to 1992 has accelerated the growth of urban enterprise and the total output and rural welfare. On the magnitude, productivities are the main contributor to both output and welfare which is consistent with Zhu (2012). DTS plays a negative role on (Y_a, V_{total}), and the contribution (absolute value) is 18.1% and 11.3%; on the other hand, it contributes positively to (Y, V_R) with contribution of 4.4% and 14.1%.

6.4. Second-hand market

In the benchmark model, we assume there is no second-hand market, so that urban enterprise can use the quota benefit only for production. In this subsection, we add second-hand market in the baseline economy. Firms can sell quota benefit under the market price and hence they will buy intermediate goods at least at quota level regardless productivity. In this case, quota is essentially a subsidy of $(P_a - \overline{P}_a)\overline{q}$, and firm's problem is

$$\max_{H_U > 0, x_U > 0} \; P_m y_U(z) - w_U H_U - P_a x_U + (P_a - \overline{P}_a)\overline{q}$$

then the entry-level productivity is $z_U^* = \frac{C_U - (P_a - \overline{P}_a)\overline{q}}{\gamma_U \overline{y}_U}$ where

$$\overline{y}_U = A_U^{\frac{1}{\gamma_U}} \left\{ \left[\frac{(1-\alpha_U)(1-\gamma_U)}{w_U} \right]^{(1-\alpha_U)} \left[\frac{\alpha_U(1-\gamma_U)}{P_a} \right]^{\alpha_U} \right\}^{\frac{1-\gamma_U}{\gamma_U}}.$$

Therefore, in this case, more firms will enter the market. In addition, we assume the procurement level is the same as that in the baseline model, which means government takes as granted that there is a full commitment of no second hand market when marking decision, and the quota benefit is determined by budget balance $\overline{QZ} = M_U \int_{z_U^*}^{\infty} \overline{q} dF(z)$.

6.4.1. Comparison with benchmark economy

We compare the results in Fig. 10 and Fig. 11. The dash line represents the benchmark value and solid line is the counterfactual economy. There is not much change in output of different sectors, but the welfare changed significantly. As shown in Fig. 10, the lower welfare in rural is mainly due to the lower labor force and intermediate input and less active firms in rural although the wage rate and land size is higher. The higher welfare in urban is due to higher wage rate and more active firms in the urban as shown in Fig. 11. To compare the results precisely, Table 7 presents the results in 1978, and it shows that comparing to benchmark, the total output will decrease by 6%, the rural welfare will decrease from −1.93 to −2.376, in terms of CE, it decreases by 36%.

6.5. Frictionless economy

In this subsection, we will compare the benchmark economy with a fully frictionless economy by removing procurement, labor mobility barrier and land rent restriction. For simplicity, we assume that urban people in urban will only work in enterprises (rural or urban), and people in rural can work in enterprises (rural or urban) or work as a farmer. Given the land rent market, farmers choose intermediate input x_a, and land size Z_{RF} to maximize the net value of the production of agricultural goods,

$$\max_{x_a>0, Z_{RF}>0} P_a A_a (Z_{RF}^{\eta} h_F^{1-\eta})^{(1-\alpha_a)} x_a^{\alpha_a} - P_m x_a - R(Z_{RF} - \overline{Z}/L_R).$$

When choosing to work in RF, the net income for farmer with ability h is given by

$$I_{RF}(h) = P_a[1-\alpha_a-(1-\alpha_a)\eta]y_a(h) + R\frac{\overline{Z}}{L_R} + \frac{\Pi}{L},$$

where $\Pi = \Pi_R + \Pi_U$ is the total profit by both rural and urban enterprises and $L = L_R + L_U$ is the total labor force. When allowing migration, the indifference condition $V(I_{RU}) = V(I_{RF})$ implies the cutoff curve

$$P_a(1-\alpha_a-(1-\alpha_a)\eta)y_a(h) + R\frac{\overline{Z}}{L_R} = w_U h_E.$$

As there is full mobility on migration, the wage rate in rural enterprise and urban enterprise should be the same, $w_R = w_U = w$. Then the objective for firm is

$$\max_{H_j, x_j} P_m y_j(z) - wH_j - P_a x_j,\ j = R, U$$

6.6. Equilibrium

The equilibrium in frictionless economy is characterized by agricultural input quantity $\{Z_{RF}(h), x_a(h)\}$, enterprises input $\{H_j^D(z), x_j(z)\}$, labor supply $\{H_j^S\}$, land rent R, wage rate w, and goods price P_a, P_m, such that.

1. $\{Z_{RF}(h), x_a(h)\}$ maximizes rural farmer's income
2. $\{H_j^D(z), x_j(z)\}$ maximizes enterprise profit
3. $\{H_j^S\}$ is the result of occupational choice
4. R, w, P_a, P_m clear land market, labor markets and goods markets
   (a) Land market clear, $\overline{Z} = L_R \int_{RF} Z_{RF}(h) dG(h)$
   (b) Labor market clear, $H_R^S + H_U^S = H_U^D + H_R^D$
   (c) Agricultural goods market clear, $Y_a = x_U + a_R + a_U$
   (d) Manufacturing goods market clear, $Y_R + Y_U = x_a + m_R + m_U$

6.6.1. Comparison with benchmark economy

Fig. 12 and Fig. 13 compare the output and welfare in two economies. The dash line represents the benchmark value and solid line is the result in frictionless economy. The agricultural output would be lower if there were no friction, while output in rural and urban enterprises, total output would be higher than baseline model. While the welfare in rural would be higher, it would be lower in urban and the total welfare would be also lower.

As shown in Fig. 12, the lower output of agricultural goods is mainly due to the less labor force although the land size and intermediate goods is higher. The higher level output in rural enterprise is due to more labor force, and higher output in urban is due to more active firms as shown in Fig. 13. In addition, the higher welfare in rural is due to the land rent in frictionless economy; the lower welfare in urban is due to the lower wage rate in urban. More precisely, Table 7 presents the results in 1978, and it shows that comparing to benchmark, the total output would be tripled, and the rural welfare would increase from −1.93 to 1.242, in terms of CE, it will increase by more than 23 times.

6.6.2. Growth and welfare

Previous results are also related to a long lasting discussion on the ultimate goal of economic growth: to increase GDP or to increase social welfare. Initially, DTS favors urban but hurts rural welfare, while as it activated the economic growth, it should benefit both rural and urban people. However, it depends on how much it will contribute to the growth and what the redistribution policy. In our case, while the net effect of abolishing DTS is positive for rural people, for urban people it is ambiguous. As shown in Fig. 13, even in the frictionless economy, urban welfare is still lower than benchmark. For the total social welfare, as the weight on urban is much higher than rural, it is still lower than benchmark. However, if we treat rural and urban with same weight, the aggregate social welfare will be much higher. As shown in Fig. 14, the right panel shows the weighted social welfare as in equation (8), while the left panel shows the social welfare when treating the rural and urban with same weight.

7. Alternative parameters

In the benchmark, we adopt ability distribution parameters directly from Adamopoulos et al. (2017). In this section, we conduct several robustness check. Firstly, we study the economy where the mean of abilities are normalized to 0 which is also used in Adamopoulos et al. (2020). In addition to normalize the mean, they also adjust co-variance as $\sigma_E = 0.65$, $\sigma_F = 1.3$, $\rho_{FE} = -0.15$ accordingly, then we will use both the mean and co-variance matrix as alternative parameters. Secondly, one may think the ability might be lower than that in Adamopoulos et al. (2017) because their data covers from 1993 to 2002 while we study the period between 1978 and 1992, then we study the economy when the mean or co-variance matrix vary by some proportion. In the following, we compare the economy with alternative parameters with the benchmark results and also conduct counterfactual analysis to see how sensitive the quantitative results rely on these parameters.

7.1. Comparison

We first compare the results under alternative ability parameter with benchmark results across years. Fig. 15 compares the DTS economy (bench) with economy under normalized ability parameters (counter), and Fig. 16 compares the benchmark market economy (bench) with the market economy under normalized ability parameters (counter). The results show that, under the alternative parameters, while both outputs and welfare are lower than benchmark value, the trends are quite similar.

To further study how the ability level affect results, we compare the benchmark economy with the economy where (μ_E, μ_F) are 80% of benchmark value in Fig. 17. And Fig. 18 compares the market economy under benchmark parameters (bench) and the market economy under alternative ability parameters (counter). Similarly, while both outputs and welfare are lower than benchmark value, the trends are quite similar.

Finally, we compute the results under other different scenarios in Appendix C, including adjusting mean and co-variance matrix of abilities. It shows that the outputs and welfare are higher (lower) than benchmark if the mean of abilities (μ_F, μ_E) are higher (lower) (Figure D.1 - Figure D.6). For the variance parameters (σ_F, σ_E), it is also similar (Figure D.7 - Figure D.14). Correlation parameter (ρ_{FE}) has relatively limited impact (Figure D.15 - Figure D.22). For all the cases, the trends are similar to benchmark economy.

7.2. Counterfactual analysis

To see how sensitive the quantitative results rely on these parameters, we conduct several counterfactual analysis in 1978. Table 8 presents the results under counterfactual cases. The column of “benchmark” lists benchmark results, column of “normalization” lists results where abilities are normalized, and each column under “counterfactual case (value)” list the results setting the parameter with 1992’s value while keeping others the same as in 1978; in the column of “market”, we set $\frac{\overline{P_a}}{P_a} = 1$ and $\overline{Q} = 0$. As all the exercises are conducted with normalized ability parameter, this counterfactual analysis can examine the impact of each channel under normalized ability parameter.

As mentioned in last subsection, comparing with benchmark value, outputs and welfare are lower under this alternative ability distribution as shown in Table 8. In addition, if the economy switched directly to market economy, aggregate output (Y) would be much lower than that under DTS (from 0.947 to 0.086), this change is consistent with results in Table 4 although the difference there is much smaller (from 2.408 to 2.299). Note we didn’t re-calibrate the model, given these normalized abilities ($\mu_F = \mu_E = 0$), in the benchmark economy, the abilities ($\mu_F = 0.16, \mu_E = 0.88$) are higher, hence the outputs under normalized abilities are lower. Finally, the welfare are higher under market economy than DTS. This result is slightly different from that in Table 4 where the welfare for urban people would be slightly lower under market economy. This may be because of the uneven change of abilities in the alternative case.

In another exercise, Table 9 presents the results where (μ_E, μ_F) are 80% of benchmark value. The column of “benchmark” lists benchmark results, column of “(μ_F, μ_E)” lists alternative results, and each column under “counterfactual case (value)” has same meaning as in Table 8. Comparing with benchmark value, outputs and welfare, except for agricultural goods production (Y_a), are lower under this alternative ability distribution. In addition, if the economy switched directly to market economy, aggregate output (Y) would be much lower than that under DTS (from 2.021 to 0.065), this is also consistent with result in Table 4 although the difference is much smaller. Similarly, the welfare are higher under market economy than DTS. This result is also slightly different from that in Table 4 where the welfare for urban people will be slightly lower under market economy.

8. Discussion

The model abstracts from both migration and capital for simplicity as it already had heterogeneity on both firms and workers. How would it affect our results? While it is believed that both capital and migration might have contributed to Chinese economic growth significantly for the past over 40 years, results from data and literature show that might not be the case from 1978 to 1992.

8.1. Migration

In reality, there is migration from rural to urban areas from 1978 to 1992; however, it is highly restricted under the “Hukou” system. In particular, the total number of migrants in 1978 and 1992 was 1.484 million and 1.6 million respectively, and rural population was 790 million and 848 million respectively, hence the migration rate was 0.19% in both years. This is pretty low given this ratio is 41.5% in 2016 (245 out of 589.73). In addition, no migration doesn’t mean rural people can only work on farmland, instead, we emphasize the role of TVEs in the rural. To absorb the surplus rural labor force, more TVEs were established, particularly after 1984. As shown in Figure E.25, both the number of TVEs and its employment share in rural areas had increased. In particular, as there was a large increase in the number of private TVEs in 1984, the output value share of which increased from 15% to 30%.

8.2. Capital

In the model, neither agricultural nor manufacturing goods production requires capital, which might contradict to the belief that the investment has played an important role in China’s development. However, there are some evidence showing that may not be the case from 1978 to 1992 and this assumption might not hurt our main result. First, the data shows that capital to labor ratio keep relatively constant from 1978 to 1992, and it surged only after 1997 (Brandt and Zhu, 2010). Second, the accounting exercise shows that the contribution of capital to output ratio to per capita GDP growth is only 0.51% from 1978 to 2007, whereas TFP contributes to 77.9% (Zhu, 2012). Therefore, as we focus on labor and agricultural goods allocation, we put everything else into the TFP, including the capital.

9. Conclusion

This paper studied the formation of market economy in China from 1978 to 1992. We built a model and analyzed allocation, prices, and welfare in China during this DTS period by emphasizing three main mechanisms. Firstly, as urban enterprises enjoy the quota benefit, the gross manufacturing output could be larger, which in turn increased the agricultural goods output as the intermediate goods supply increased. Secondly, procurement requirement played a role as screening machine–only rural people with relative high farming ability stayed as farmers. Thirdly, some low productive firms in urban can survive due to quota benefit, whereas firms with higher productivity in rural may not survive.

The quantitative analysis showed that directly switching to market economy in 1978 would decrease total output by 4.5% but increase rural welfare by 43.9% in equivalent consumption. That is to say, on the extensive margin, DTS has activated Chinese economy with scarifying rural’s welfare. On the other hand, on the intensive margin, from 1978 to 1992, the DTS has improved as procurement price is getting closer to market price. This change had contributed positively to total output by 4.4% and rural welfare by 14.1%, and it contributed negatively to agricultural output by 18.1% and total welfare by 11.3%. The quantitative results also confirmed that productivity improvement contributed mostly to Chinese economic growth.

Furthermore, in the economy with second-hand market, there is not much change in output of different sectors, but the welfare changed significantly. For example, comparing to benchmark in 1978, the total output would decrease by 6%, the rural welfare will decrease by 36%. However, in frictionless economy, the impact is much larger. The total output in 1978 would be tripled comparing to benchmark, and the rural welfare would increase by more than 23 times.

The current Chinese economy is still under transition, and internal markets are still partially open; some markets, such as the credit market, are still under DTS. Therefore, this framework can be easily applied to other scenarios, and the quantitative analysis could provide policy recommendations regarding market structure formation. Moreover, the question studied in this paper can be related to discussions about the role of industry policies and subsidies to infant industries, which is prevalent around the world especially in developing countries. The dual track system aims to protect urban enterprises as China went through the unprecedented episode. Therefore, a better understanding about the dual track system during this period would provide new empirical evidence about the impact of industry protection on the aggregate economy.

Authorship contribution

Rongsheng Tang and Yang Tang contribute to this manuscript equally.

Declaration of competing interest

I declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

A Mathematical details

A.1. Homogeneous model

To illustrate the activation effect, we simplify the model in the following way. Both worker's ability and firm's productivity are homogeneous, agricultural goods are produced in rural, enterprises are located only in urban, and there is no migration. Procurement is determined by the government to maximize the total welfare. In particular, we normalize the farmers' abilities and firms' productivity to be 1 in the production function, we also normalize $M_U = 1$.

A.1.1. Agricultural goods production. The agricultural production function is

$$y_a = A_a (Z_{RF}^{\eta})^{1-\alpha_a} x_a^{\alpha_a},$$

where $Z_{RF} = \frac{\overline{Z}}{L_R}$, and the total agricultural product is $Y_a = L_R y_a$. Farmer's problem is

$$\max_{x_a > 0, Q_a \geq \overline{Q} Z_{RF}} P_a A_a (Z_{RF}^{\eta})^{1-\alpha_a} x_a^{\alpha_a} - P_m x_a - (P_a - \overline{P}_a) Q_a.$$

A.1.2. Manufacturing goods production. Production function in urban enterprise is

$$y_U = A_U (H_U^{1-\alpha_U} x_U^{\alpha_U})^{1-\gamma_U},$$

and the total manufacturing goods production is $Y_U = M_U y_U$. Firm's problem is to maximize the profit

$$\pi_U(z) = \begin{cases} \max_{H_U, x_U} P_m y_U - w_U H_U - \overline{P}_a x_U - C_U & \text{if } x_U \leq \overline{q} \\ \max_{H_U, x_U} P_m y_U - w_U H_U - P_a x_U + (P_a - \overline{P}_a)\overline{q} - C_U & \text{if } x_U > \overline{q}. \end{cases}$$

A.1.3. Profit. Given agricultural goods price P_a, manufacturing goods price P_m, and labor supply in urban L_U, denote $\beta_j = 1 - \alpha_j, j = a, R, U$, solving the model we have

$$w_U = \begin{cases} \left(\frac{\overline{P}_a L_U^{\gamma_U}}{\alpha_a (1-\gamma_U) P_m A_U} \right)^{\frac{1}{\alpha_U (1-\gamma_U) - 1}} \frac{\beta_U}{\alpha_U} \overline{P}_a & \text{if } x_U \leq \overline{q} \\ \left(\frac{P_a L_U^{\gamma_U}}{\alpha_a (1-\gamma_U) P_m A_U} \right)^{\frac{1}{\alpha_U (1-\gamma_U) - 1}} \frac{\beta_U}{\alpha_U} P_a & \text{if } x_U > \overline{q} \end{cases},$$

$$x_U = \begin{cases} \frac{\alpha_U}{\beta_U} \frac{w_U}{\overline{P}_a} L_U & \text{if } x_U \leq \overline{q} \\ \frac{\alpha_U}{\beta_U} \frac{w_U}{P_a} L_U & \text{if } x_U > \overline{q} \end{cases},$$

output is

$$y_U = \begin{cases} A_U \left[\frac{\overline{P}_a}{\alpha_a (1-\gamma_U) P_m A_U} \right]^{\frac{\alpha_U (1-\gamma_U)}{\alpha_U (1-\gamma_U) - 1}} L_U^{1 + \frac{\gamma_U}{\alpha_U (1-\gamma_U) - 1}} & \text{if } x_U \leq \overline{q} \\ A_U \left[\frac{P_a}{\alpha_a (1-\gamma_U) P_m A_U} \right]^{\frac{\alpha_U (1-\gamma_U)}{\alpha_U (1-\gamma_U) - 1}} L_U^{1 + \frac{\gamma_U}{\alpha_U (1-\gamma_U) - 1}} & \text{if } x_U > \overline{q} \end{cases},$$

profit is

$$\pi_U = \begin{cases} \gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U} \frac{w_U}{\overline{P}_a} \right)^{\alpha_U (1-\gamma_U)} L_U^{1-\gamma_U} - C_U & \text{if } x_U \leq \overline{q} \\ \gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U} \frac{w_U}{P_a} \right)^{\alpha_U (1-\gamma_U)} L_U^{1-\gamma_U} - C_U + (P_a - \overline{P}_a)\overline{q} & \text{if } x_U > \overline{q} \end{cases}.$$

Total gross output of manufacturing goods is $Y_U = y_U$, hence Y_U is weakly decreasing in $\overline{P}_a$. The total profit is $\Pi_U = \pi_U$. Since there is no migration, $Z_{RF} = \frac{\overline{Z}}{L_R}$, the gross output of agricultural goods for each farmer is

$$y_a = A_a \left[\frac{\alpha_a P_a A_a}{P_m} \right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^{\eta} L_R^{-\eta},$$

total gross output is

$$Y_a = L_R y_a = A_a \left[\frac{\alpha_a P_a A_a}{P_m} \right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^{\eta} L_R^{1-\eta},$$

profit is

$$\pi_R = (1-\alpha_a)P_a y_a - (P_a - \overline{P}_a)\frac{\overline{QZ}}{L_R},$$

total profit is

$$\Pi_R = \pi_R L_R = (1-\alpha_a)P_a Y_a - (P_a - \overline{P}_a)\overline{QZ}$$

A.1.4. Workers. A worker's utility depends on consumption of agricultural goods (a) and manufacturing goods (m)

$$u(a,m) = \theta log(a-\overline{a}) + (1-\theta)log(m),$$

subject to budget constraint $P_a a + P_m m \le I$, where θ is the weight on agricultural goods; $\overline{a}$ is the subsistence level of agricultural goods; P_a, P_m are the market prices of agricultural and manufacturing goods, respectively, and I is worker's income. Then the indirect utility function is

$$V(I) = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log(I - P_a\overline{a}).$$

The income in rural is $I_R = \frac{\Pi_R}{L_R}$, and income in urban is $I_U = w_U + \frac{\Pi_U}{L_U}$.

Welfare in rural is

$$V_R = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log\left\{(1-\alpha_a)P_a y_a - \frac{\overline{QZ}}{L_R}(P_a - \overline{P}_a) - P_a\overline{a}\right\},$$

then V_R is decreasing in $\overline{Q}$ and increasing in $\overline{P}_a$. Welfare in urban is

$$V_U = \begin{cases} \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log\left[w_U + \frac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right]}{L_U} - P_a\overline{a}\right] \\ \text{if } x_U \le \overline{q} \\ \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log\left[w_U + \frac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right]}{L_U} \right. \\ \left. + \frac{(P_a - \overline{P}_a)\overline{QZ}}{L_U} - P_a\overline{a}\right] \\ \text{if } x_U > \overline{q} \end{cases},$$

then V_U is increasing in $\overline{Q}$ and decreasing in $\overline{P}_a$.

A.1.5. Government. Lastly, the government is to maximize weighted total welfare, that is,

$$\max_{\overline{q},\overline{Q}\ge 0} \chi_U L_U V_U(I_U) + (1-\chi_U)L_{RF}V_R(I_R)$$

$$s.t. min\{x_U, \overline{q}\} = \overline{QZ}.$$

In the case of $x_U > \overline{q}$, the objective function is

$$\max_{\overline{Q}\ge 0} \chi_U L_U log\left[w_U + \frac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right]}{L_U} + \frac{(P_a - \overline{P}_a)\overline{QZ}}{L_U} - P_a\overline{a}\right]$$

$$+ (1-\chi_U)L_R log\left[(1-\alpha_a)P_a y_a - \frac{\overline{QZ}}{L_R}(P_a - \overline{P}_a) - P_a\overline{a}\right].$$

Solving the problem implies

$$\overline{Q} = \frac{[(1-\alpha_a)P_a y_a - P_a\overline{a}] + \frac{1-\chi_U}{\chi_U}\left(w_U + \frac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right]}{L_U} - P_a\overline{a}\right)}{\left(\frac{1-\chi_U}{\chi_U}\frac{\overline{Z}}{L_U} + 1\right)(P_a - \overline{P}_a)},$$

then $\overline{Q}$ is increasing in χ_U. The following proposition summarizes the partial equilibrium results in the case of $x_U > \overline{q}$.

Proposition 3. *In the homogeneous model, the procurement quantity $\overline{Q}$ is increasing in χ_U; the gross output of manufacturing goods and labor productivity in urban are weakly decreasing in procurement price $\overline{P}_a$; the welfare of rural (urban) people is decreasing(increasing) in procurement level and increasing (decreasing) in procurement price.*

A.1.6. General equilibrium. Given $\overline{Q}$, the aggregate consumption for manufacturing goods are

$$m_U = \frac{(1-\theta)w_U L_U + (1-\theta)\Pi_U - (1-\theta)P_a \overline{a} L_U}{P_m},$$

$$m_R = \frac{(1-\theta)L_R(1-\alpha_a)P_a y_a - (1-\theta)(P_a - \overline{P}_a)\overline{QZ} + (1-\theta)\Pi_R - (1-\theta)P_a \overline{a} L_R}{P_m},$$

the aggregate consumption for agricultural goods are

$$a_U = \begin{cases} \theta \dfrac{w_U L_U + \left[\gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right]}{P_a} + (1-\theta)\overline{a}L_U & \text{if } x_U \le \overline{q} \\ \theta \dfrac{w_U L_U + \left[\gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U}\frac{w_U}{P_a}\right)^{\alpha_U(1-\gamma_U)} L_U^{1-\gamma_U} - C_U\right] + (P_a - \overline{P}_a)\overline{QZ}}{P_a} + (1-\theta)\overline{a}L_U & \text{if } x_U > \overline{q} \end{cases},$$

and

$$a_R = \frac{\theta(1-\alpha_a)P_a A_a \left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta} - \theta(P_a - \overline{P}_a)\overline{QZ} + (1-\theta)P_a \overline{a} L_R}{P_a},$$

and intermediate goods used in manufacturing goods production is

$$x_U = \begin{cases} \left(\dfrac{\overline{P}_a L_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U & \text{if } x_U \le \overline{q} \\ \left(\dfrac{P_a L_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U & \text{if } x_U > \overline{q} \end{cases},$$

market clear condition requires $Y_a - a_R = a_U + x_U$.

A.1.7. case of $x_U \le \overline{q}$. Denote $\frac{\overline{P}_a}{P_a} = \kappa_P$, and normalize $P_m = 1$, in the case of $x_U \le \overline{q}$, then the following equation will pin down equilibrium price P_a^D

$$\begin{aligned} &[1-\theta(1-\alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta} + \theta(1-\kappa_P)\overline{QZ} - [(1-\theta)\overline{a}]L_R \\ &= (1-\theta)\overline{a}L_U - \theta\frac{C_U}{P_a} + \left(\frac{\kappa_P P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \\ &\left\{1 + \theta\kappa_p\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]\right\}, \end{aligned} \tag{21}$$

such that $\left(\frac{\kappa_P P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \le \overline{QZ}$. Given the equilibrium price P_a^D, the gross outputs are

$$Y_a^D = A_a\left[\frac{\alpha_a P_a^D A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta},$$

$$Y_U^D = A_U\left[\frac{\kappa_P P_a^D}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} L_U^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}}.$$

On the other hand, the equilibrium condition in market economy implies

$$\begin{aligned} &[1-\theta(1-\alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta} - [(1-\theta)\overline{a}]L_R \\ &= (1-\theta)\overline{a}L_U - \theta\frac{C_U}{P_a} + \left(\frac{P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \\ &\left\{1 + \theta\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]\right\}, \end{aligned} \tag{22}$$

which will solve equilibrium price P_a^M, and gross outputs are

$$Y_a^M = A_a\left[\frac{\alpha_a P_a^M A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^\eta L_R^{1-\eta},$$

$$Y_U^M = A_U\left[\frac{P_a^M}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} L_U^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}}.$$

A.1.8. Proof of Proposition 1. First, we can show that $P_a^M > \kappa_P P_a^D$. Suppose not, the RHS of equation (21) is smaller than (22), however, in this case, LHS of equation (21) is larger than (22), this contradiction implies the only case is $P_a^M > \kappa_P P_a^D$. Then we should have $Y_U^M < Y_U^D$.

Second, suppose $P_a^D = P_a^M = P_a^*$ then equations (21) and (22) will pin down productivity A_a^*. In particular, and

$$A_a^* = \left\{ \frac{(1-\theta)\overline{a}(L_U + L_R) - \theta(1-\kappa_P)\overline{QZ} - \theta\frac{C_U}{P_a^*} + \left(\frac{\kappa_P P_a^*}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} L_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \left\{1 + \theta\kappa_p\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]\right\}}{[1-\theta(1-\alpha_a)]\overline{Z}^\eta L_R^{1-\eta}[\alpha_a P_a^*]^{\frac{\alpha_a}{1-\alpha_a}}} \right\}^{1-\alpha_a}$$

where

$$P_a^* = \frac{\alpha_a(1-\gamma_U)A_U}{\kappa_P L_U^{(\alpha_U-1)(1-\gamma_U)}} \left\{ \frac{\theta(1-\kappa_P)\overline{QZ}}{\left[(\kappa_P)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} - 1\right] + \left[(\kappa_P)^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} - 1\right]\theta\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]} \right\}^{\alpha_U(1-\gamma_U)-1},$$

and the compatibility condition implies

$$\frac{\theta(1-\kappa_P)}{\left[(\kappa_P)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} - 1\right] + \left[(\kappa_P)^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} - 1\right]\theta\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]} \le 1$$

this condition can be satisfied when κ_P is small enough. If $A_a < (>)A_a^*$, as the RHS of equation (21) is steeper than equation (22), then $P_a^M < (>)P_a^D$, then $Y_a^M < (>)Y_a^D$.

In sum, we conclude: 1) In the equilibrium, there always exists $P_a^M > \kappa_P P_a^D$; 2) the manufacturing goods under DTS is always higher than that in market economy; 3) when κ_P and A_a are small enough, the agricultural goods under DTS is higher than that in market economy. Q.E.D.

A.2. Homogeneous model with migration

To illustrate the activation effect, we simplify the model in the following way. Both worker's ability and firm's productivity are homogeneous, agricultural goods are produced in rural, enterprises are located only in urban, and there is migration between rural and urban. Procurement is determined by the government to maximize the total welfare. In particular, we normalize the farmers' abilities and firms' productivity to be 1 in the production function, we also normalize $M_U = 1$.

A.2.1. Agricultural goods production. The agricultural production function is

$$y_a = A_a(Z_{RF}^\eta)^{1-\alpha_a}x_a^{\alpha_a},$$

where $Z_{RF} = \frac{Z}{H_R}$, and the total agricultural product is $Y_a = H_R y_a$. Farmer's problem is

$$\max_{x_a>0, Q_a \ge \overline{Q}Z_{RF}} P_a A_a(Z_{RF}^\eta)^{1-\alpha_a}x_a^{\alpha_a} - P_m x_a - (P_a - \overline{P}_a)Q_a.$$

A.2.2. Manufacturing goods production. Production function in urban enterprise is

$$y_U = A_U(H_U^{1-\alpha_U}x_U^{\alpha_U})^{1-\gamma_U},$$

and the total manufacturing goods production is $Y_U = M_U y_U$. Firm's problem is to maximize the profit

$$\pi_U(z) = \begin{cases} \max_{H_U, x_U} P_m y_U - w_U H_U - \overline{P}_a x_U - C_U & \text{if } x_U \le \overline{q} \\ \max_{H_U, x_U} P_m y_U - w_U H_U - P_a x_U + (P_a - \overline{P}_a)\overline{q} - C_U & \text{if } x_U > \overline{q}. \end{cases}$$

A.2.3. Profit. Given agricultural goods price P_a, manufacturing goods price P_m, and labor supply in urban H_U, denote $\beta_j = 1 - \alpha_j, j = a, R, U$, solving the model we have

$$w_U = \begin{cases} \left(\frac{\overline{P}_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} \frac{\beta_U}{\alpha_U}\overline{P}_a & \text{if } x_U \le \overline{q} \\ \left(\frac{P_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} \frac{\beta_U}{\alpha_U}P_a & \text{if } x_U > \overline{q} \end{cases},$$

$$x_U = \begin{cases} \frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}H_U & \text{if } x_U \le \overline{q} \\ \frac{\alpha_U}{\beta_U}\frac{w_U}{P_a}H_U & \text{if } x_U > \overline{q} \end{cases},$$

output is

$$y_U = \begin{cases} A_U\left[\dfrac{\overline{P}_a}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} H_U^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}} & \text{if } x_U \le \overline{q} \\ A_U\left[\dfrac{P_a}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} H_U^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}} & \text{if } x_U > \overline{q} \end{cases},$$

profit is

$$\pi_U = \begin{cases} \gamma_U P_m A_U\left(\dfrac{\alpha_U}{\beta_U}\dfrac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U & \text{if } x_U \le \overline{q} \\ \gamma_U P_m A_U\left(\dfrac{\alpha_U}{\beta_U}\dfrac{w_U}{P_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U + (P_a - \overline{P}_a)\overline{q} & \text{if } x_U > \overline{q} \end{cases}.$$

Total gross output of manufacturing goods is $Y_U = y_U$, hence Y_U is weakly decreasing in $\overline{P}_a$. The total profit is $\Pi_U = \pi_U$. Since there is no migration, $Z_{RF} = \frac{\overline{Z}}{H_R}$, the gross output of agricultural goods for each farmer is

$$y_a = A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^{\eta} H_R^{-\eta},$$

total gross output is

$$Y_a = H_R y_a = A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \overline{Z}^{\eta} H_R^{1-\eta},$$

profit is

$$\pi_R = (1-\alpha_a)P_a y_a - (P_a - \overline{P}_a)\frac{\overline{QZ}}{H_R},$$

total profit is

$$\Pi_R = \pi_R H_R = (1-\alpha_a)P_a Y_a - (P_a - \overline{P}_a)\overline{QZ}.$$

A.2.4. Workers. A worker's utility depends on consumption of agricultural goods (a) and manufacturing goods (m)

$$u(a,m) = \theta log(a - \overline{a}) + (1-\theta)log(m),$$

subject to budget constraint $P_a a + P_m m \le I$, where θ is the weight on agricultural goods; $\overline{a}$ is the subsistence level of agricultural goods; P_a, P_m are the market prices of agricultural and manufacturing goods, respectively, and I is worker's income. Then the indirect utility function is

$$V(I) = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log(I - P_a\overline{a}).$$

The income in rural is $I_R = (1-\alpha_a)P_a y_a - \frac{\overline{QZ}}{L_R}(P_a - \overline{P}_a)$, and income in urban is $I_U = w_U + \frac{\Pi_U}{H_U}$.

Welfare in rural is

$$V_R = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log\left\{(1-\alpha_a)P_a y_a - \frac{\overline{QZ}}{H_R}(P_a - \overline{P}_a) - P_a\overline{a}\right\},$$

then V_R is decreasing in $\overline{Q}$ and increasing in $\overline{P}_a$. Welfare in urban is

$$V_U = \begin{cases} \left[\theta log\left(\dfrac{\theta}{P_a}\right) + (1-\theta)log\left(\dfrac{1-\theta}{P_m}\right)\right] + log\left[w_U + \dfrac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right]}{H_U} - P_a\overline{a}\right] \\ \text{if } x_U \le \overline{q} \\ \left[\theta log\left(\dfrac{\theta}{P_a}\right) + (1-\theta)log\left(\dfrac{1-\theta}{P_m}\right)\right] + log\left[w_U + \dfrac{\left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{P_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right]}{H_U} \right. \\ \left. + \dfrac{(P_a - \overline{P}_a)\overline{QZ}}{H_U} - P_a\overline{a}\right] \quad \text{if } x_U > \overline{q} \end{cases},$$

then V_U is increasing in $\overline{Q}$ and decreasing in $\overline{P}_a$.

A.2.5. Migration. In this setting, labor are free mobile, then in the equilibrium, the following condition will hold $V_R = V_U$ that is

$$(1-\alpha_a)P_a y_a - \frac{\overline{QZ}}{H_R}(P_a - \overline{P}_a) = \begin{cases} w_U + \dfrac{\left[\gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right]}{H_U} \\ \quad \text{if } x_U \le \overline{q} \\ w_U + \dfrac{\left[\gamma_U P_m A_U \left(\frac{\alpha_U}{\beta_U}\frac{w_U}{P_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right]}{H_U} \\ \quad + \dfrac{(P_a - \overline{P}_a)\overline{QZ}}{H_U} \quad \text{if } x_U > \overline{q} \end{cases},$$

where

$$w_U = \begin{cases} \left(\dfrac{\overline{P}_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} \dfrac{\beta_U}{\alpha_U}\overline{P}_a & \text{if } x_U \le \overline{q} \\ \left(\dfrac{P_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} \dfrac{\beta_U}{\alpha_U}P_a & \text{if } x_U > \overline{q} \end{cases}.$$

A.2.6. General equilibrium in DTS. Given $\overline{Q}$, the aggregate consumption for manufacturing goods are

$$m_U = \frac{(1-\theta)w_U H_U + (1-\theta)\Pi_U - (1-\theta)P_a\overline{a}H_U}{P_m},$$

$$m_R = \frac{(1-\theta)H_R(1-\alpha_a)P_a y_a - (1-\theta)(P_a - \overline{P}_a)\overline{QZ} + (1-\theta)\Pi_R - (1-\theta)P_a\overline{a}H_R}{P_m},$$

aggregate consumption for agricultural goods are

$$a_U = \begin{cases} \theta\dfrac{w_U H_U + \left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{\overline{P}_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right]}{P_a} + (1-\theta)\overline{a}H_U & \text{if } x_U \le \overline{q} \\ \theta\dfrac{w_U H_U + \left[\gamma_U P_m A_U\left(\frac{\alpha_U}{\beta_U}\frac{w_U}{P_a}\right)^{\alpha_U(1-\gamma_U)} H_U^{1-\gamma_U} - C_U\right] + (P_a - \overline{P}_a)\overline{QZ}}{P_a} + (1-\theta)\overline{a}H_U & \text{if } x_U > \overline{q} \end{cases},$$

and

$$a_R = \frac{\theta(1-\alpha_a)P_a A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^\eta H_R^{1-\eta} - \theta(P_a - \overline{P}_a)\overline{QZ} + (1-\theta)P_a\overline{a}H_R}{P_a},$$

and intermediate goods used in manufacturing goods production is

$$x_U = \begin{cases} \left(\dfrac{\overline{P}_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} H_U & \text{if } x_U \le \overline{q} \\ \left(\dfrac{P_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} H_U & \text{if } x_U > \overline{q} \end{cases},$$

goods market clear condition requires

$$Y_a - a_R = a_U + x_U,$$

labor market clear condition implies

$$H_R + H_U = L_R + L_U.$$

A.2.7. case of $x_U \le \overline{q}$. Denote $\frac{\overline{P}_a}{P_a} = \kappa_P$, and normalize $P_m = 1$, in the case of $x_U \le \overline{q}$, the following equation will solve labor allocation H_R^D, H_U^D

$$(1-\alpha_a)A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^\eta H_R^{-\eta} - \frac{\overline{QZ}}{H_R}(1-\kappa_P)$$
$$= \left(\frac{\overline{P}_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} \kappa_P\left[\frac{\beta_U}{\alpha_U} + \frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right] - \frac{C_U}{P_a H_U}, \quad (23)$$

such that

$$H_R + H_U = L_R + L_U.$$

The following equation will pin down equilibrium price P_a^D

$$[1-\theta(1-\alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^{\eta}H_R^{1-\eta} + \theta(1-\kappa_P)\overline{QZ} - [(1-\theta)\overline{a}]H_R$$
$$= (1-\theta)\overline{a}H_U - \theta\frac{C_U}{P_a} + \left(\frac{\kappa_P P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} H_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}$$
$$\left\{1+\theta\kappa_p\left[\frac{\beta_U}{\alpha_U}+\frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]\right\}, \tag{24}$$

such that $(\frac{\kappa_P P_a}{\alpha_a(1-\gamma_U)A_U})^{\frac{1}{\alpha_U(1-\gamma_U)-1}} H_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}} \le \overline{QZ}$. Given the equilibrium price P_a^D, the gross outputs are

$$Y_a^D = A_a\left[\frac{\alpha_a P_a^D A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^{\eta}(H_R^D)^{1-\eta},$$

$$Y_U^D = A_U\left[\frac{\kappa_P P_a^D}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}(H_U^D)^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}}.$$

On the other hand, the labor market clear condition in market economy solves labor allocations H_R^M, H_U^M

$$(1-\alpha_a)A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^{\eta}H_R^{-\eta}$$
$$= \left(\frac{P_a H_U^{\gamma_U}}{\alpha_a(1-\gamma_U)P_m A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}}\left[\frac{\beta_U}{\alpha_U}+\frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right] - \frac{C_U}{P_a H_U} \tag{25}$$

such that

$$H_R + H_U = L_R + L_U,$$

and goods market clear condition

$$[1-\theta(1-\alpha_a)]A_a[\alpha_a P_a A_a]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^{\eta}H_R^{1-\eta} - [(1-\theta)\overline{a}]H_R$$
$$= (1-\theta)\overline{a}H_U - \theta\frac{C_U}{P_a} + \left(\frac{P_a}{\alpha_a(1-\gamma_U)A_U}\right)^{\frac{1}{\alpha_U(1-\gamma_U)-1}} H_U^{\frac{(\alpha_U-1)(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}$$
$$\left\{1+\theta\left[\frac{\beta_U}{\alpha_U}+\frac{\gamma_U}{\alpha_a(1-\gamma_U)}\right]\right\} \tag{26}$$

will solve equilibrium price P_a^M, and gross outputs are

$$Y_a^M = A_a\left[\frac{\alpha_a P_a^M A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}}\overline{Z}^{\eta}(H_R^M)^{1-\eta},$$

$$Y_U^M = A_U\left[\frac{P_a^M}{\alpha_a(1-\gamma_U)P_m A_U}\right]^{\frac{\alpha_U(1-\gamma_U)}{\alpha_U(1-\gamma_U)-1}}(H_U^M)^{1+\frac{\gamma_U}{\alpha_U(1-\gamma_U)-1}}.$$

A.3. Heterogeneous ability

In this setting, we assume enterprises are only located in urban, and migration between rural and urban is allowed. Farmers choose intermediate input to maximize the net value of agricultural goods production, that is,

$$\max_{x_a} P_a A_a (Z_{RF}^{\eta} h_F^{1-\eta})^{\beta_a} x_a^{\alpha_a} - P_m x_a,$$

then the demand function is

$$x_a(h) = \left(\frac{\alpha_a P_a}{P_m}\right)^{\frac{1}{1-\alpha_a}}[A_a(Z_{RF}^{\eta} h_F^{1-\eta})^{\beta_a}]^{\frac{1}{1-\alpha_a}},$$

and output can be rewritten as

$$y_a(h) = \left(\frac{\alpha_a P_a}{P_m}\right)^{\frac{\alpha_a}{1-\alpha_a}}[A_a(Z_{RF}^{\eta} h_F^{1-\eta})^{\beta_a}]^{\frac{1}{1-\alpha_a}},$$

hence $y_a(h)$ is increasing in $\frac{P_a}{P_m}$. In the rural, land is equally distributed among farmers, that is, $Z_{RF} = \frac{\overline{Z}}{L_{RF}}$, and as long as $P_a > \overline{P}_a$, farmers will only satisfy the procurement requirement, $Q_a = \overline{Q}Z_{RF}$. For the worker choosing to work on farmland, the net income is

$$I_{RF}(h) = P_a((1-\alpha_a)y_a(h) - \overline{Q}Z_{RF}) + \overline{P}_a\overline{Q}Z_{RF},$$

the income for workers in urban is $I_U(h) = w_U h_E$. Given the indirect utility function is

$$V(I) = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log(I - P_a\overline{a}),$$

maximizing utility is equivalent to maximize the total income. The margin profile for occupational choice is

$$h_E = L(h_F) = \frac{1}{w_U}\left[(1-\alpha_a)P_a\left(\frac{\alpha_a P_a}{P_m}\right)^{\frac{\alpha_a}{1-\alpha_a}}[A_a(Z_{RF}^{\eta}h_F^{1-\eta})^{\beta_a}]^{\frac{1}{1-\alpha_a}} - (P_a - \overline{P}_a)\overline{Q}Z_{RF}\right].$$

Then, the ability profile of a worker in urban is $UE = \{h : h_E > L(h_F)\}$ and that of a farmer is $RF = \{h : h_E < L(h_F)\}$.

In addition, given $H_U = L_R\int_{RU} h_E dG(h) + L_U\int h_E dG(h)$, the total human capital in urban can be solved as

$$H_U = L_R\frac{\theta_F\theta_E}{\theta_E-1}\frac{1}{\theta_F-(1-\eta)(1-\theta_E)}h_{min}^{\theta_E+(1-\eta)(1-\theta_E)}\left[\frac{L_R - \frac{\overline{Z}}{Z_{RF}}}{L_R\frac{\theta_F}{\theta_F+\theta_E(1-\eta)}}h_{min}^{-\eta\theta_E}\right]^{\frac{\theta_E-1}{\theta_E}},$$

hence H_U is increasing in $\overline{Q}$ and decreasing in $\overline{P}_a$. Since Y_U is increasing in H_U, the gross output of manufacturing goods Y_U is increasing in procurement level $\overline{Q}$ and decreasing in $\overline{P}_a$.

Finally, the regional welfare are

$$V_R = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + \frac{1}{L_R}\left\{\int_{RF} log[P_a(1-\alpha_a)y_a(h) - (P_a - \overline{P}_a)\overline{Q}Z_{RF}(h) - P_a\overline{a}]dG(h) + \int_{RE} log[(1-\tau)w_U h_E - P_a\overline{a}]dG(h)\right\}$$

$$V_U = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + \frac{1}{L_U}\int_U log\left[w_U h_E + \frac{\Pi_U}{L_U} - P_a\overline{a}\right]dG(h)$$

A.4. Heterogeneous productivity

In this setting, we assume enterprises are only located in urban, and migration between rural and urban is not allowed.

A.4.1. Enterprises in urban areas. Intermediate goods producers maximize the profit, and at $x_U = \overline{q}$, there is a jump of the marginal cost of x_U from $\overline{P}_a$ to P_a. Then, given $P_m = 1$, the profit is

$$\pi_U(z) = \begin{cases} max\ y_U(z) - w_U H_U - \overline{P}_a x_U - C_U & \text{if } x_U \le \overline{q} \\ max\ y_U(z) - w_U H_U - P_a(x_U - \overline{q}) - \overline{P}_a\overline{q} - C_U & \text{if } x_U > \overline{q} \end{cases}.$$

If $x_U(z) < \overline{q}$, the margin price is $\overline{P}_a$, denote $x_U(z) = x_L(z)$, then $x_L(z) = \frac{\alpha_U(1-\gamma_U)y_U^L(z)}{\overline{P}_a}$, $H_U^L(z) = \frac{\beta_U(1-\gamma_U)y_U^L(z)}{w_U}$, $\pi_U^L(z) = \gamma_U y_U^L(z) - C_U$ and $y_U^L(z) = z\overline{y}_U^L$ where

$$\overline{y}_U^L = A_U^{\frac{1}{\gamma_U}}\left\{\left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U}\left[\frac{\alpha_U(1-\gamma_U)}{\overline{P}_a}\right]^{\alpha_U}\right\}^{\frac{1-\gamma_U}{\gamma_U}},$$

then the entry-level productivity is $z_U^* = \frac{C_U}{\gamma_U\overline{y}_U^L}$, and the mass of active firms is $M_U^* = M_U(\frac{z_{U,min}}{z_U^*})^{\theta_U}$. In this case, the procurement has a direct impact on this cutoff, which is summarized in the following Lemma In urban area, the entry level productivity z_U^* is increasing in C_U, $\overline{P}_a$, w_U and decreasing in A_U. In addition, if procurement price is lower, more urban enterprises, particularly those with low productivity will enter the market.

If $x_L(z_L;\overline{P}_a) = \overline{q}$, it will pin down a cutoff $z_L = \frac{\overline{P}_a\overline{q}}{\alpha_U(1-\gamma_U)\overline{y}_U^L}$ such that the interior solution satisfies $x_U(z) < \overline{q}$, substituting $\overline{y}_U^L$ we rewrite it as

$$z_L = \frac{\overline{P}_a\overline{q}}{\alpha_U(1-\gamma_U)A_U^{\frac{1}{\gamma_U}}\left\{\left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U}\left[\frac{\alpha_U(1-\gamma_U)}{\overline{P}_a}\right]^{\alpha_U}\right\}^{\frac{1-\gamma_U}{\gamma_U}}},$$

and the following proposition states features of this cutoff In urban area, the cutoff z_L is increasing in $\overline{P}_a$, $\overline{q}$, w_U and decreasing in A_U.

If firms tend to purchase agricultural goods above the quota level, the marginal cost (price) of agricultural goods will jump from $\overline{P}_a$ to P_a; hence, firms with productivity slightly higher than z_L may not be able to cover this cost and then stick to the quota level. In other words, there is another cutoff productivity z_H such that, if firm productivity is lower than z_H, then it is profitable to purchase agricultural goods at quota level. Denoted $\pi_U^H(z)(\pi_U^M(z))$ the profit functions when firm purchases intermediate goods more than (same as) quota level.

If $x_U = \overline{q}$ (binding), then $H_U^M(z) = \frac{\beta_U(1-\gamma_U)y_U^M(z)}{w_U}$, and

$$\pi_U^M(z) = [1 - \beta_U(1-\gamma_U)]y_U^M(z) - \overline{P}_a\overline{q} - C_U,$$

and $y_U^M(z) = z^{\frac{\gamma_U}{1-\beta_U(1-\gamma_U)}}\overline{y}_U^M$ where

$$\overline{y}_U^M = \left\{ A_U \overline{q}^{\alpha_U(1-\gamma_U)} \left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U(1-\gamma_U)} \right\}^{\frac{1}{1-\beta_U(1-\gamma_U)}}.$$

If $x_U(z) > \overline{q}$, then the margin price is P_a, and $x_U(z) = x_H(z)$, then $x_H(z) = \frac{\alpha_U(1-\gamma_U)y_U^H(z)}{P_a}$, $H_U^H(z) = \frac{\beta_U(1-\gamma_U)y_U^H(z)}{w_U}$,

$\pi_U^H(z) = \gamma_U y_U^H(z) + (P_a - \overline{P}_a)\overline{q} - C_U$,

and $y_U^H(z) = z\overline{y}_U^H$ where

$$\overline{y}_U^H = A_U^{\frac{1}{\gamma_U}} \left\{ \left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U} \left[\frac{\alpha_U(1-\gamma_U)}{P_a}\right]^{\alpha_U} \right\}^{\frac{1-\gamma_U}{\gamma_U}}.$$

Then the condition $\pi_U^H(z) = \pi_U^M(z)$ implies

$$\gamma_U z\overline{y}_U^H + P_a\overline{q} = [1-\beta_U(1-\gamma_U)]z^{\frac{\gamma_U}{1-\beta_U(1-\gamma_U)}}\overline{y}_U^M, \tag{27}$$

and it will pin down another cutoff $z_H(> z_L)$ such that if $z > z_H$ then $x(z) > \overline{q}$, the following Lemma shows there is an unique solution to equation (27). In the domain $\{z : z > z_L\}$, there is an unique solution to equation (27).

Prof: Define function $f(z) = \pi_U^M(z) - \pi_U^H(z)$ in the domain of $\{z : z \geq 0\}$, note that $\pi_U^M(z)$ is concave in z, $f(z)$ is concave, $f(0) < 0$, $f(+\infty) < 0$, since at $z = z_L$, those staying with quota level enjoy lower agricultural prices, then $f(z_L) > 0$; thus, there are two solutions to equation (27), one is larger than z_L and the other is smaller than z_L.

Since both sides of equation (27) increase in quota level $\overline{q}$, its impact on z_H is ambiguous. As the price of agricultural goods input jumps from $\overline{P}_a$ to P_a at point $x = \overline{q}$, it will motivate a positive measure of the mass of firms that purchase agricultural goods at the level $x = \overline{q}$.

In sum, there are three cutoffs of firm productivity in urban areas, z_U^*, z_L, z_H, such that

$$x_U(z) = \begin{cases} 0 & z \leq z_U^* \\ x_L(z) & z_U^* < z \leq z_L \\ \overline{q} & z_L < z \leq z_H \\ x_H(z) & z > z_H \end{cases}, \text{ and } \pi_U(z) = \begin{cases} 0 & z \leq z_U^* \\ \pi_L(z) & z_U^* < z \leq z_L \\ \pi_M(z) & z_L < z \leq z_H \\ \pi_H(z) & z > z_H \end{cases}$$

the total profit is

$$\Pi_U = M_U \left[\int_{z_U^*}^{z_L} \pi_L(z)dF(z) + \int_{z_L}^{z_H} \pi_M(z)dF(z) + \int_{z_H}^{\infty} \pi_H(z)dF(z) \right],$$

the aggregate output in urban area is

$$Y_U = M_U \left[\int_{z_U^*}^{z_L} z\overline{y}_U^L dF(z) + \int_{z_L}^{z_H} z^{\frac{\gamma_U}{1-\beta_U(1-\gamma_U)}}\overline{y}_U^M dF(z) + \int_{z_H}^{\infty} z\overline{y}_U^H dF(z) \right]$$

Let $\widetilde{\gamma}_U = 1-\beta_U(1-\gamma_U) > \gamma_U$, then given Pareto distribution,

$$\begin{aligned} Y_U =& M_U \underline{z}_U^{\theta_U} \left\{ \overline{y}_U^L \frac{\theta_U}{\theta_U - 1}[z_U^{*-(\theta_U-1)} - z_L^{-(\theta_U-1)}] + \overline{y}_U^M \frac{\theta_U}{\theta_U - \frac{\gamma_U}{\widetilde{\gamma}_U}} \right. \\ & \left. \left[z_L^{-\left(\theta_U - \frac{\gamma_U}{\widetilde{\gamma}_U}\right)} - z_H^{-\left(\theta_U - \frac{\gamma_U}{\widetilde{\gamma}_U}\right)} \right] + \overline{y}_U^H \frac{\theta_U}{\theta_U - 1} z_H^{-(\theta_U-1)} \right\} \end{aligned}$$

The demand for human capital in urban enterprises is $H_U^D = \frac{\beta_U(1-\gamma_U)}{w_U}Y_U$.

A.4.2. Labor productivity. The labor productivity in rural is

$$LP_a = (1-\alpha_a)A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} \frac{\overline{Z}}{L_R},$$

and labor productivity in urban is

$LP_m = (1-\alpha_U)Y_U/L_U$.

A.4.3. Welfare. The regional welfare are

$$\begin{aligned} V_R =& \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] \\ & + log\left\{ P_a(1-\alpha_a)A_a\left[\frac{\alpha_a P_a A_a}{P_m}\right]^{\frac{\alpha_a}{1-\alpha_a}} Z_{RF} - \overline{Q}Z_{RF}(P_a - \overline{P}_a) - P_a\overline{a} \right\} \end{aligned}$$

and

$$V_U = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log\left[w_U + \frac{\Pi_U}{L_U} - P_a\overline{a}\right],$$

where the total profit is

$$\Pi_U = M_U\left[\int_{z_U^*}^{z_L}\pi_L(z)dF(z) + \int_{z_L}^{z_H}\pi_M(z)dF(z) + \int_{z_H}^{\infty}\pi_H(z)dF(z)\right],$$

then we have following Lemma.

Welfare $V_R(V_U)$ is decreasing(increasing) in $\overline{Q}$.

A.5. Quantitative model

This section solves the benchmark model in section 3. The behavior for urban enterprises is the same as the model in Appendix A.4, then we only discuss others in the following.

A.5.1. Enterprises in rural. As the rural enterprises do not have the benefit of quotas, the price of agricultural goods is P_a, the profit is

$$\pi_R(z) = max\ y_R(z) - w_R H_R - P_a x_R - C_R,$$

then solving the problem implies $x_R(z) = \frac{\alpha_R(1-\gamma_R)y_R(z)}{P_a}$, $H_R(z) = \frac{\beta_R(1-\gamma_R)y_R(z)}{w_R}$, $\pi_R(z) = \gamma_R y_R(z) - C_R$, and $y_R(z) = z\overline{y}_R$ where

$$\overline{y}_R = A_R^{\frac{1}{\gamma_R}}\left\{\left[\frac{\beta_R(1-\gamma_R)}{w_R}\right]^{\beta_R}\left[\frac{\alpha_R(1-\gamma_R)}{P_a}\right]^{\alpha_R}\right\}^{\frac{1-\gamma_R}{\gamma_R}}.$$

The entry-level productivity is $z_R^* = \frac{C_R}{\gamma_R\overline{y}_R}$ and the mass of active firms is $M_R^* = M_R(\frac{z_{R,min}}{z_R^*})^{\theta_R}$. The aggregate output in rural is $Y_R = M_R\int_{z_R^*}^{\infty} z\overline{y}_R dF(z)$ or

$$Y_R = M_R \underline{z}_R^{\theta_R}\overline{y}_R\frac{\theta_R}{\theta_R - 1}z_R^{*-(\theta_R-1)}.$$

The aggregate profit in rural enterprises is $\Pi_R = M_R\int_{z_R^*}^{\infty}\pi_R(z)dF(z)$, and it will be redistributed across all people in rural. The demand for human capital in rural enterprises is $H_R^D = \frac{\beta_R(1-\gamma_R)}{w_R}Y_R$ or

$$H_R^D = M_R\frac{\beta_R(1-\gamma_R)}{w_R}\underline{z}_R^{\theta_R}\overline{y}_R\frac{\theta_R}{\theta_R-1}z_R^{*-(\theta_R-1)}.$$

The following proposition describes features related to. z_R^*

Proposition 4. *In the rural areas, the entry-level productivity z_R^* is increasing in C_R, P_a, w_R and decreasing in A_R; however, neither procurement price nor quantity affect this cutoff directly.*

A.5.2. Workers in rural. Farmers face the same problem as in heterogeneous ability model. For the worker choosing to work on farmland, the net income is

$$I_{RF}(h) = P_a[(1-\alpha_a)y_a(h) - \overline{Q}Z_{RF}] + \overline{P}_a\overline{Q}Z_{RF} + \frac{\Pi_R}{L_R},$$

the income for workers in rural enterprises is $I_{RE}(h) = w_R h_E + \frac{\Pi_R}{L_R}$. Given the indirect utility function is

$$V(I) = \left[\theta log\left(\frac{\theta}{P_a}\right) + (1-\theta)log\left(\frac{1-\theta}{P_m}\right)\right] + log(I - P_a\overline{a}),$$

maximizing utility is equivalent to maximize the total income. The margin profile for occupational choice is

$$h_E = L(h_F) = \frac{1}{w_R}\left\{(1-\alpha_a)P_a\left(\frac{\alpha_a P_a}{P_m}\right)^{\frac{\alpha_a}{1-\alpha_a}}[A_a(Z_{RF}^{\eta}h_F^{1-\eta})^{\beta_a}]^{\frac{1}{1-\alpha_a}} - (P_a - \overline{P}_a)\overline{Q}Z_{RF}\right\}.$$

Then, the ability profile of a worker in rural enterprises is $RE = \{h : h_E > L(h_F)\}$ and that of a farmer is $RF = \{h : h_E < L(h_F)\}$. The total number of farmers is $L_{RF} = L_R\int_{RF}dG(h)$, and total supply of human capital is $H_R^S = L_R\int_{RE}h_E dG(h)$.

A.5.3. Government. Government is to maximize weighted total welfare, that is,

$$\max_{\overline{q},\overline{Q}\geq 0} V(\overline{q},\overline{Q}) = \chi_U L_U\int_U V_U(I_U(h))dG(h) + (1-\chi_U)L_R \left[\int_{RF}V_R(I_{RF}(h))dG(h) + \int_{RE}V_R(I_{RE}(h))dG(h)\right]$$

$$s.t. M_U\int_U min\{x_U(z),\overline{q}\}dF(z) = \overline{QZ}.$$

Given urban income level $I_U(h) = w_U h_E + \frac{\Pi_U}{L_U}$ where

$$\Pi_U = M_U \left\{ \int_{z_U^*}^{z_L} \pi_L(z)dF(z) + \int_{z_H}^{\infty} [\gamma_U y_U^H(z)]dF(z) + \overline{q}^{\frac{\alpha_U(1-\gamma_U)}{1-\beta_U(1-\gamma_U)}} \int_{z_L}^{z_H} [1-\beta_U(1-\gamma_U)]z^{\frac{\gamma_U}{1-\beta_U(1-\gamma_U)}} \right.$$

$$\left. \left\{ A_U \left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U(1-\gamma_U)} \right\}^{\frac{1}{1-\beta_U(1-\gamma_U)}} dF(z) \ + \overline{q}\left[P_a \int_{z_H}^{\infty} dF(z) - \overline{P}_a \int_{z_L}^{\infty} dF(z)\right] \right\}$$

we have $\frac{\partial I_U(h)}{\partial \overline{q}} = \frac{1}{L_U}\frac{\partial \Pi_U}{\partial \overline{q}}$ where

$$\frac{\partial \Pi_U}{\partial \overline{q}} = M_U \left\{ \frac{\alpha_U(1-\gamma_U)}{1-\beta_U(1-\gamma_U)} \overline{q}^{\frac{(\alpha_U+\beta_U)(1-\gamma_U)-1}{1-\beta_U(1-\gamma_U)}} \int_{z_L}^{z_H} [1-\beta_U(1-\gamma_U)]z^{\frac{\gamma_U}{1-\beta_U(1-\gamma_U)}} \right.$$

$$\left. \left\{ A_U \left[\frac{\beta_U(1-\gamma_U)}{w_U}\right]^{\beta_U(1-\gamma_U)} \right\}^{\frac{1}{1-\beta_U(1-\gamma_U)}} dF(z) \ + \left[P_a \int_{z_H}^{\infty} dF(z) - \overline{P}_a \int_{z_L}^{\infty} dF(z)\right] \right\}.$$

In addition,

$$I_{RF}(h) = (1-\alpha_a)P_a y_a(h) + \frac{\Pi_R}{L_R} - (P_a - \overline{P}_a)\overline{Q}Z_{RF},$$

then $\frac{\partial I_{RF}(h)}{\partial \overline{Q}} = -(P_a - \overline{P}_a)Z_{RF}$, and $I_{RE}(h) = w_R h_E + \frac{\Pi_R}{L_R}$ is independent on procurement level $\overline{Q}$, then $\frac{\partial I_{RE}(h)}{\partial \overline{Q}} = 0$. From the procurement budget

$$\overline{QZ} = M_U \left\{ \int_{z_U^*}^{z_L} x_L(z)dF(z) + \int_{z_L}^{\infty} \overline{q}dF(z) \right\},$$

we have $\frac{\partial \overline{q}}{\partial \overline{Q}} = \frac{\overline{Z}}{M_U \int_{z_L}^{\infty} dF(z)}$. Then $\frac{\partial V}{\partial \overline{Q}} = 0$ solves $\overline{Q}$. In particular, given $V'(I) = \frac{1}{I - P_a \overline{a}}$ the following equations will solve $\{\overline{q}, \overline{Q}\}$

$$\overline{QZ} = M_U \left\{ \int_{z_U^*}^{z_L} x_L(z)dF(z) + \int_{z_L}^{\infty} \overline{q}dF(z) \right\}$$

$$0 = \chi_U \frac{\partial \Pi_U}{\partial \overline{q}} \frac{\overline{Z}}{M_U \int_{z_L}^{\infty} dF(z)} \left[\int_U \frac{1}{I_U(h,\overline{q}) - P_a\overline{a}} dG(h)\right]$$

$$- (1-\chi_U)(P_a - \overline{P}_a)\frac{L_R \overline{Z}}{L_{RF}} \left[\int_{RF} \frac{1}{I_{RF}(h,\overline{Q}) - P_a\overline{a}} dG(h)\right]$$

A.5.4. Markets clear. Agricultural goods

Intermediate goods in rural enterprises is $x_R = \frac{\alpha_R(1-\gamma_R)}{P_a} Y_R$, intermediate goods in urban enterprises are

$$x_L = M_U \frac{\alpha_U(1-\gamma_U)\overline{y}_U^L}{\overline{P}_a} \frac{\theta_U}{\theta_U - 1} \underline{z}_U^{\theta_U} [z_U^{*-(\theta_U-1)} - z_L^{-(\theta_U-1)}],$$

$$x_M = M_U \overline{q} \underline{z}_U^{\theta_U} [z_L^{-\theta_U} - z_H^{-\theta_U}],$$

and

$$x_H = M_U \frac{\alpha_U(1-\gamma_U)\overline{y}_U^H}{P_a} \frac{\theta_U}{\theta_U - 1} \underline{z}_U^{\theta_U} z_H^{-(\theta_U-1)},$$

and agricultural goods consumption is $a_i(h) = \frac{\theta I_i(h) + (1-\theta)P_a\overline{a}}{P_a}, i = RF, RE, UE$. Denote a_U and $a_R = a_{RF} + a_{RE}$ the aggregate consumption of agricultural goods in urban and rural respectively, then

$$a_U = \frac{\theta w_U L_U \int_U h_E dG(h) + \theta \Pi_U + (1-\theta)P_a \overline{a} L_U}{P_a},$$

$$a_{RE} = \frac{\theta w_R L_R \int_{RE} h_E dG(h) + \theta \Pi_R \frac{L_{RE}}{L_R} + (1-\theta)P_a \overline{a} L_{RE}}{P_a},$$

$$a_{RF} = \frac{\theta L_R \int_{RF} (1-\alpha_a)P_a y_a(h)dG(h) - \theta(P_a - \overline{P}_a)\overline{QZ} + \theta \Pi_R \frac{L_{RF}}{L_R} + (1-\theta)P_a \overline{a} L_{RF}}{P_a}.$$

The total supply for agricultural goods is $Y_a^S = L_R \int_{RF} y_a(h)dG(h)$, and the total demand for agricultural goods is

$$Y_a^D = x_R + x_L + x_M + x_H + a_R + a_U.$$

Then market clear implies $Y_a^D = Y_a^S$.

Manufacturing goods

Manufacturing goods consumption is

$$m_i(h) = \frac{(1-\theta)I_i(h) - (1-\theta)P_a\overline{a}}{P_m}, i = RF, RE, UE,$$

then the aggregate demand for manufacturing goods in consumption is

$$m_U = \frac{(1-\theta)w_U L_U \int_U h_E dG(h) + (1-\theta)\Pi_U - (1-\theta)P_a \overline{a} L_U}{P_m},$$

$$m_{RE} = \frac{(1-\theta)w_R L_R \int_{RE} h_E dG(h) + (1-\theta)\Pi_R \frac{L_{RE}}{L_R} - (1-\theta)P_a \overline{a} L_{RE}}{P_m},$$

$$m_{RF} = \frac{(1-\theta)L_R \int_{RF}(1-\alpha_a)P_a y_a(h)dG(h) - (1-\theta)(P_a - \overline{P}_a)\overline{QZ} + (1-\theta)\Pi_R \frac{L_{RF}}{L_R} - (1-\theta)P_a \overline{a} L_{RF}}{P_m}.$$

In addition, the demand for manufacturing goods as intermediate goods is $x_a = L_R \int_{RF} x_a(h)dG(h)$, and the total demand for manufacturing goods is $Y_m^D = x_a + m_{RE} + m_{RF} + m_U$.

The total supply of manufacturing goods is $Y_m^S = Y_U + Y_R$. Market clear implies $Y_m^S = Y_m^D$. Human capital market clear requires $H_j^S = H_j^D, j = R, U$. Finally, quota and procurement budget balance requires

$$M_U \int_U min\{x_U(z), \overline{q}\} dF(z) = \overline{QZ}.$$

B. Simulation

In calibration, we simulate the model to minimize the error between simulated moment and data moment as in Lagakos and Waugh (2013) and solve the equilibrium by following the path described in Chen (2017).

1. Let $\Theta = \{\theta_i : \theta_i > \theta_{i,min}, \theta_i < \theta_{i,max}\}$ the set of parameters needs to be calibrated.
2. Guess a group of θ from Θ, simulate the model, and solve equilibrium.
   (a) Draw workers in both rural and urban $h = (h_F, h_E)$, and the two types of abilities follow log normal distribution as in Adamopoulos et al. (2017).
   (b) Draw firms in rural (z_R) and urban (z_U) areas that follow Pareto distribution as in Brandt et al. (2018).
   (c) In a simulated economy, all the agents make an occupational choice, and the equilibrium is solved by clearing all the markets.
   (d) Compute the moments in the simulated economy, and then, compute the distance to the data moments.
3. Repeat step 2 with different guesses in step 1, and pick up the parameters θ that give the lowest error.

C. Tables and Figures

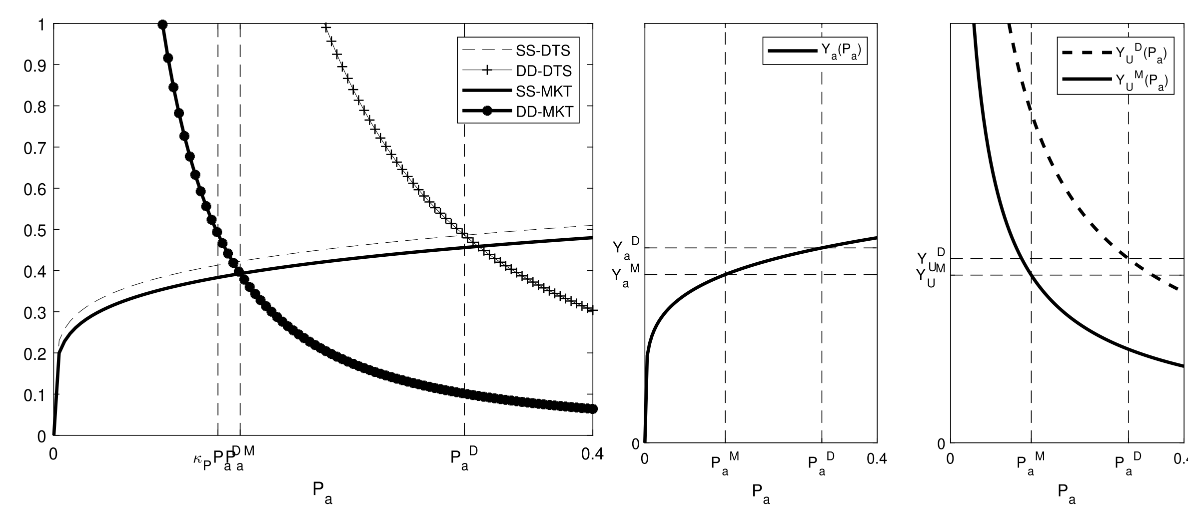

Fig. 1 Activation effect. **Note**: This figure compares the equilibrium in homogeneous model under DTS and market economy. Left panel illustrates the equilibrium prices, SS-DTS and SS-MKT is the agricultural goods supply in urban ($Y_a - a_R$) under DTS and market economy respectively; DD-DTS and DD-MKT is the agricultural goods demand in urban ($a_U + x_U$) under DTS and market economy respectively. Right and middle panel illustrate the equilibrium outputs. The middle panel is agricultural goods gross output, and the function forms are the same under DTS and market economy. The right panel is manufacturing goods gross output under DTS ($Y_U^D(P_a)$) and market economy ($Y_U^M(P_a)$).

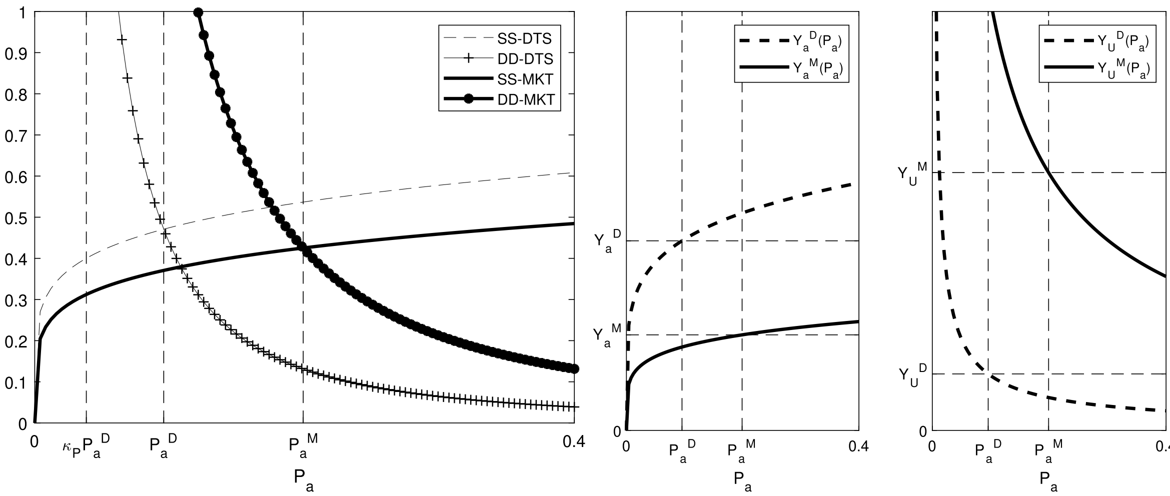

Fig. 2 Activation effect with migration. **Note**: This figure compares the equilibrium under DTS and market economy in homogeneous model with migration. The parameters are the same as those used in Fig. 1. Left panel illustrates the equilibrium prices, SS-DTS and SS-MKT is the agricultural goods supply in urban ($Y_a - a_R$) under DTS and market economy respectively; DD-DTS and DD-MKT is the agricultural goods demand in urban ($a_U + x_U$) under DTS and market economy respectively. Right and middle panel illustrate the equilibrium outputs. The middle panel is agricultural goods gross output under DTS ($Y_a^D(P_a)$) and market economy ($Y_a^M(P_a)$). The right panel is manufacturing goods gross output under DTS ($Y_U^D(P_a)$) and market economy ($Y_U^M(P_a)$).

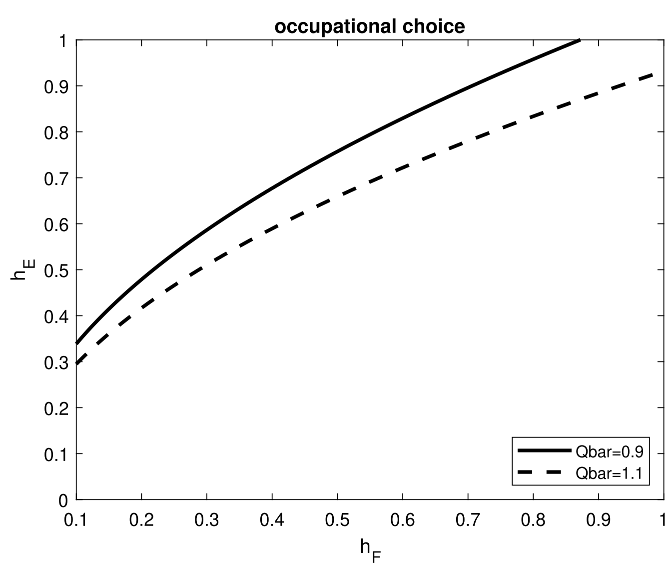

Fig. 3 Selection effect. **Note**: This figure illustrates the response of occupational choice as procurement level changes, with abilities below the line people will choose to work on farmland, while for those of abilities above the line will choose to work in enterprises.

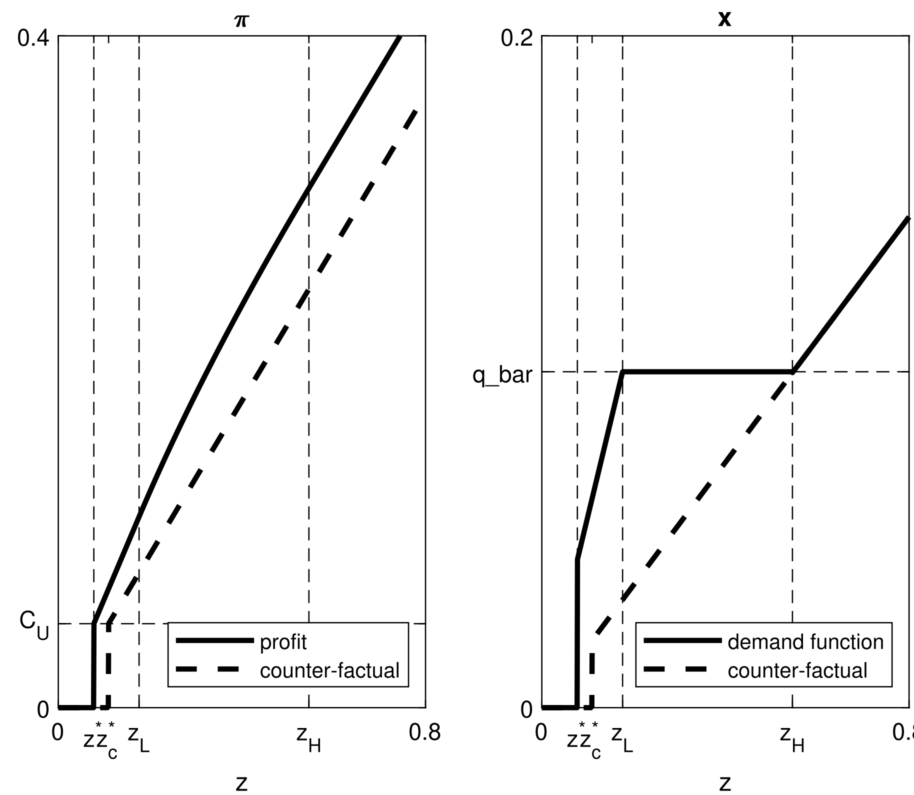

Fig. 4 Misallocation effect. **Note**: This figure illustrates the firm's decision. The solid line represents the profit function in left panel and intermediate goods demand function in the right panel, while the dash line represent the result of removing the quota benefit and the intermediate goods is under the market price.

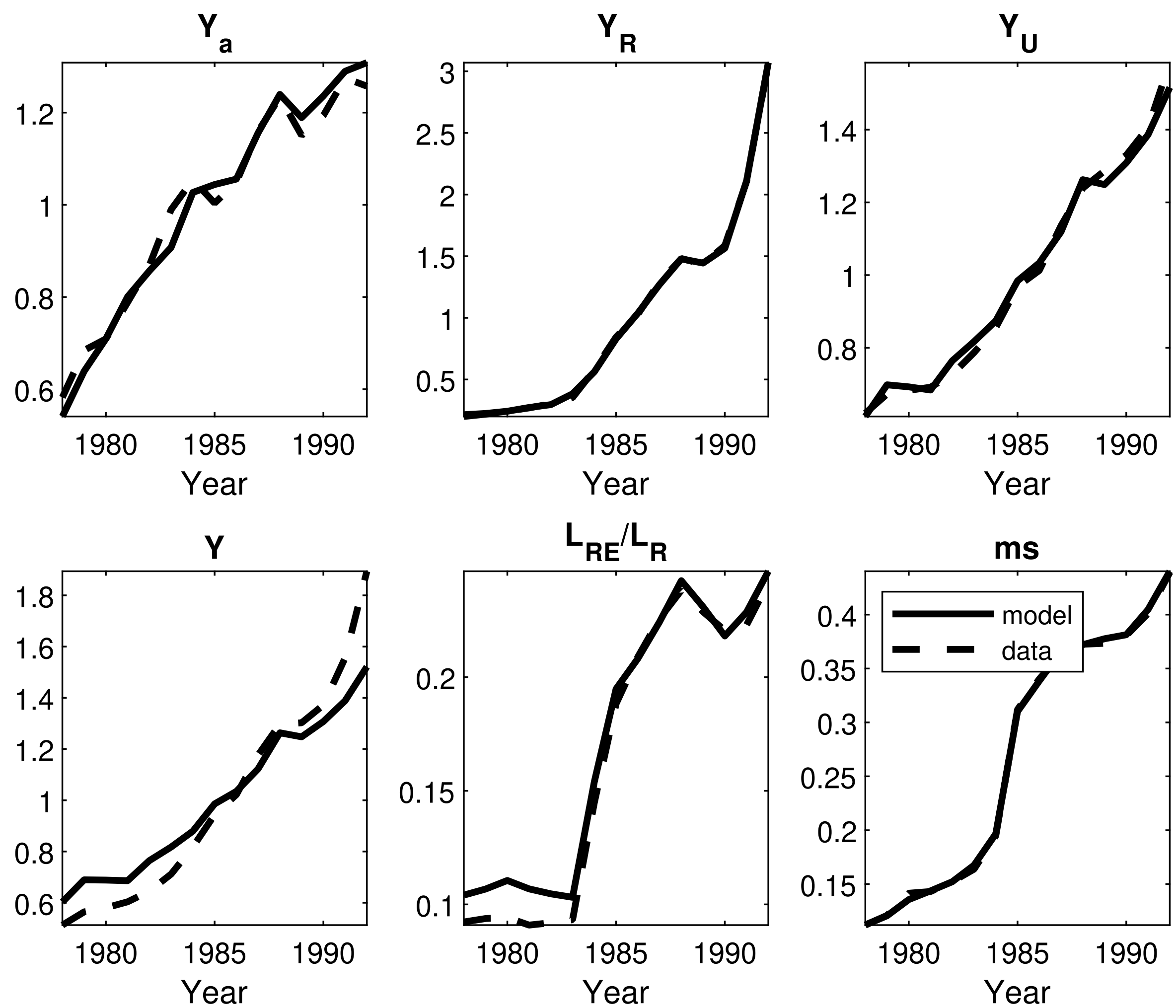

Fig. 5 Model fit: targeted moments. **Note**: This figure compares the model with data for targeted moments. The dash line is data and the solid line is model. The output Y_a, Y_R, Y_U are normalized as 1 in average for both the data and the model.

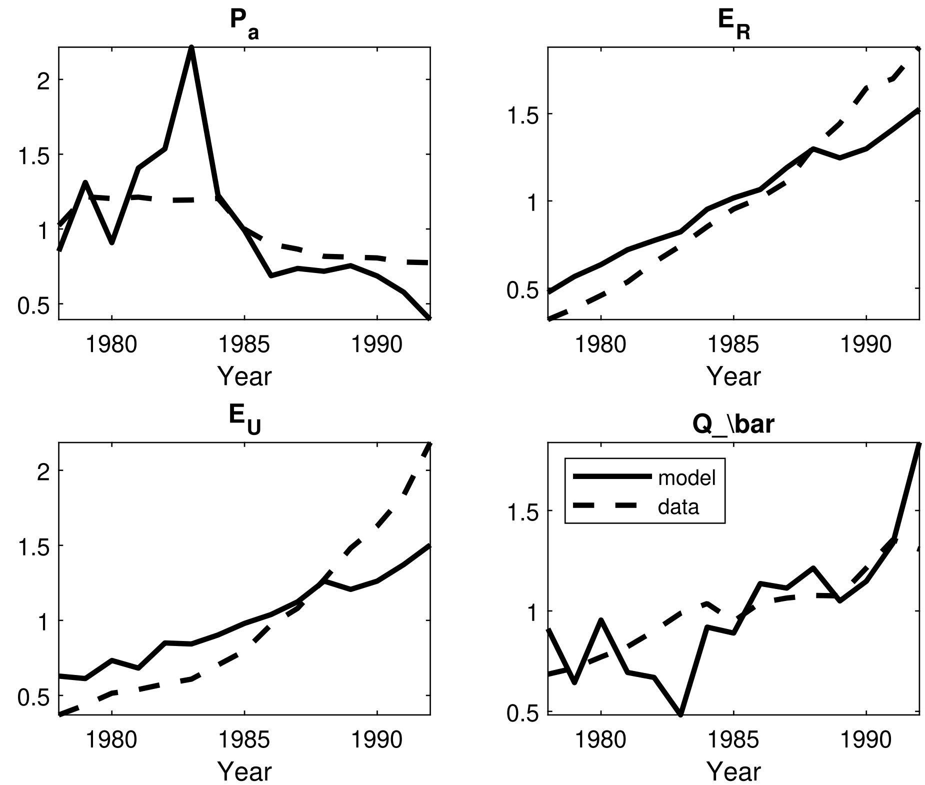

Fig. 6 Model fit: untargeted moments. **Note**: This figure compares the model with data for untargeted moments: agricultural goods price (P_a), average earning in rural and urban (E_R, E_U), procurement level ($\overline{Q}$). The dash line is data and the solid line is model. All the variables are normalized as 1 in average value for both the data and the model.

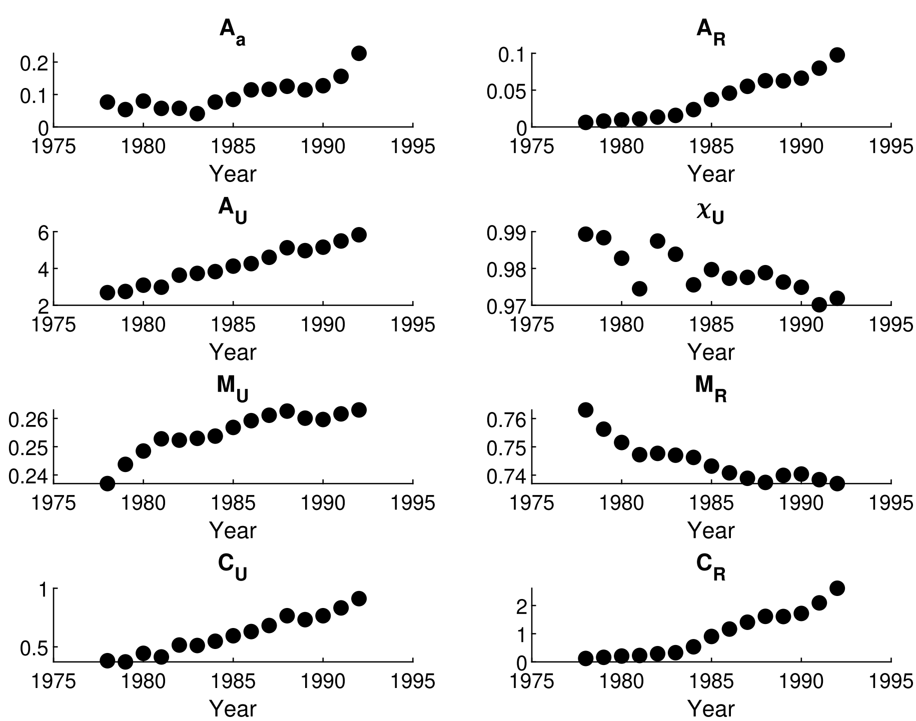

Fig. 7 Parameters. **Note**: This figure presents parameters across years: agricultural productivity (A_a), rural productivity (A_R), urban productivity (A_U), weight on urban in social welfare (χ_U), number of potential entrant in urban and rural (M_U, M_R), entry costs in urban and rural (C_U, C_R).

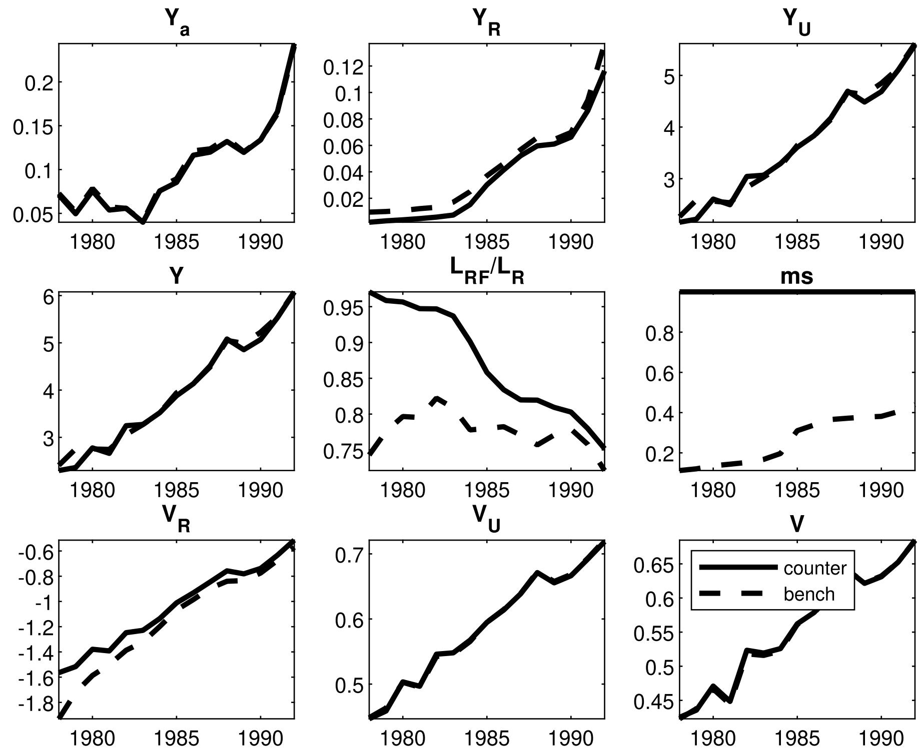

Fig. 8 Counterfactual result: market economy. **Note**: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results in market economy. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, L_{RF}/L_R, ms are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

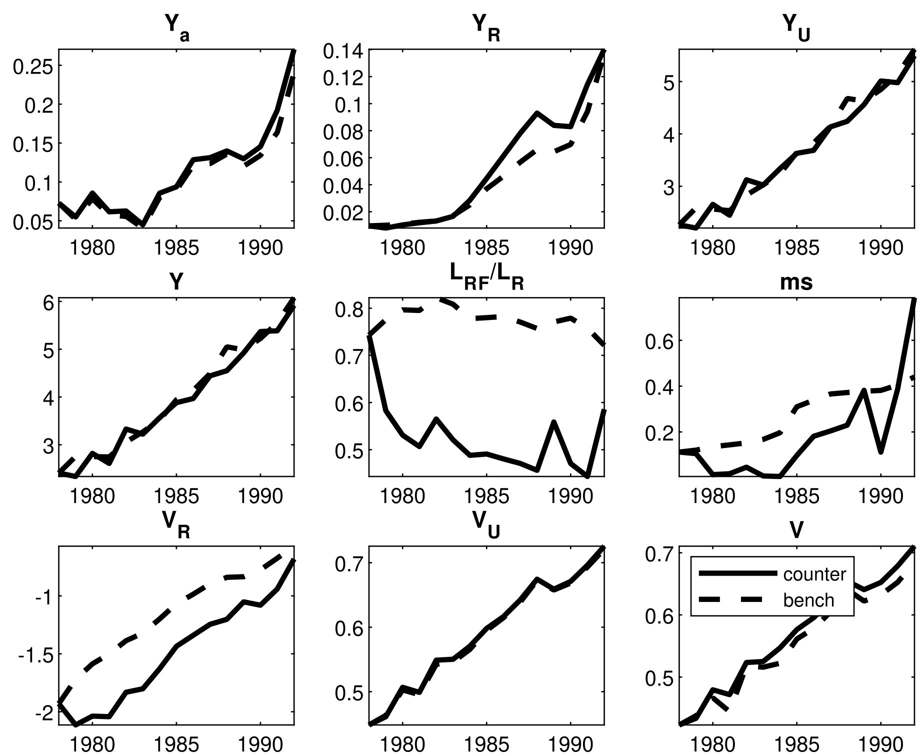

Fig. 9 Counterfactual result: DTS. **Note**: The dash line represents the results of benchmark economy, and the solid line represents the counterfactual results by setting $\frac{\overline{P}_a}{P_a}$ and χ_U in 1978's values. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, L_{RF}/L_R, ms are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

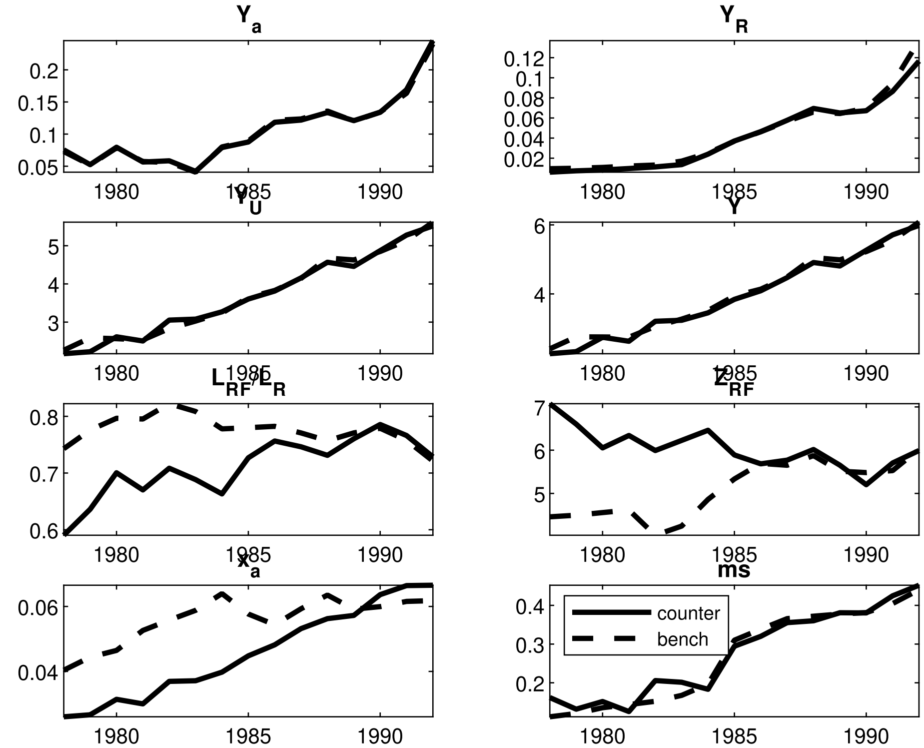

Fig. 10 Counterfactual result: second-hand market. **Note**: This figure compares output in benchmark economy and second-hand economy, the dash line is the value for benchmark model, and the solid line is for second-hand economy. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, Z_{RF}, x_a, ms$ are employment ratio of farmer in rural, average land size, intermediate good in agricultural goods production and market share respectively.

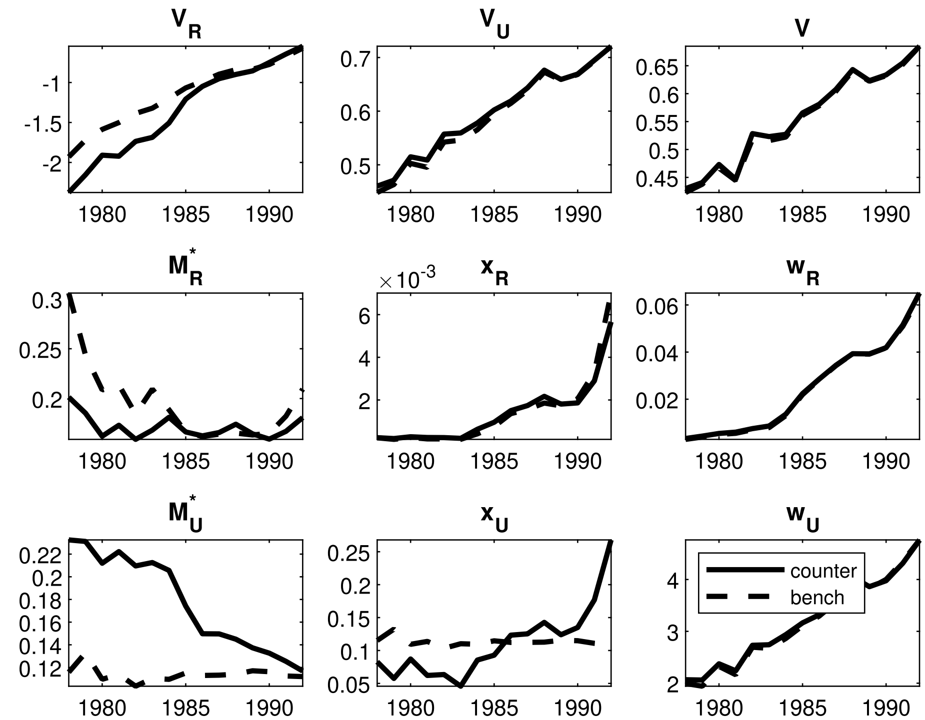

Fig. 11 Counterfactual result: second-hand market. **Note**: This figure compares welfare in benchmark economy and second-hand economy, the dash line is the value for benchmark model, and the solid line is for second-hand economy. V_R, V_U, V are welfare of rural, urban and total welfare respectively, $M_R^*, x_R, w_R, M_U^*, x_U, w_U$ are number of active firms in rural, intermediate goods in TVE, wage rate in rural, number of active firms in urban, intermediate goods in urban enterprises and wage rate in urban respectively.

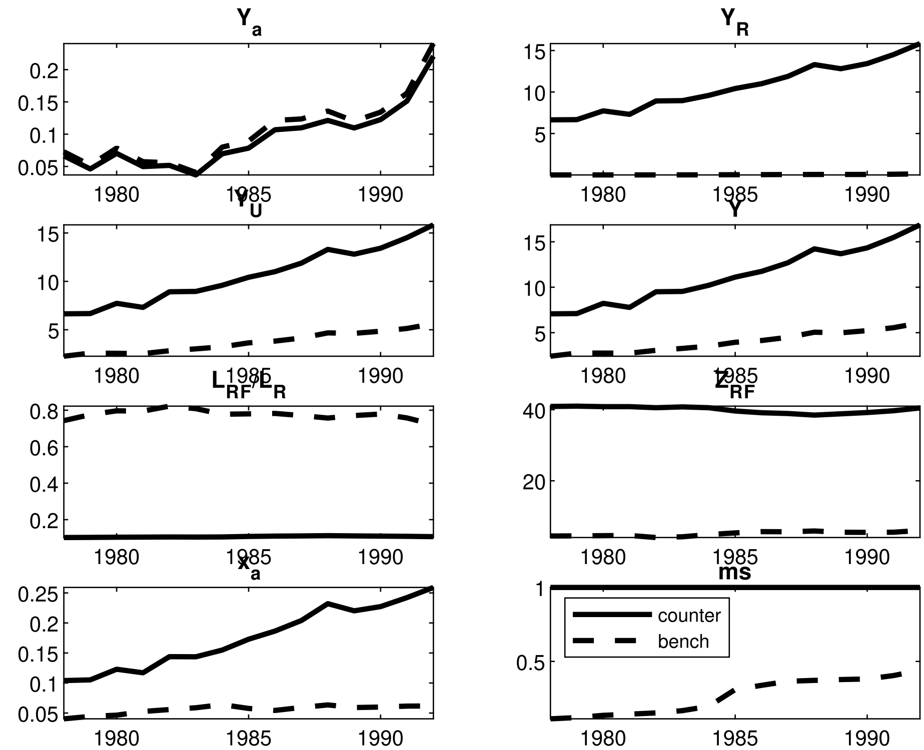

Fig. 12 Counterfactual result: frictionless economy. **Note**: This figure compares results in benchmark economy and frictionless economy, the dash line is the value for benchmark model, and the solid line is for frictionless economy. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, Z_{RF}, x_a, ms$ are employment ratio of farmer in rural, average land size, intermediate good in agricultural goods production and market share respectively.

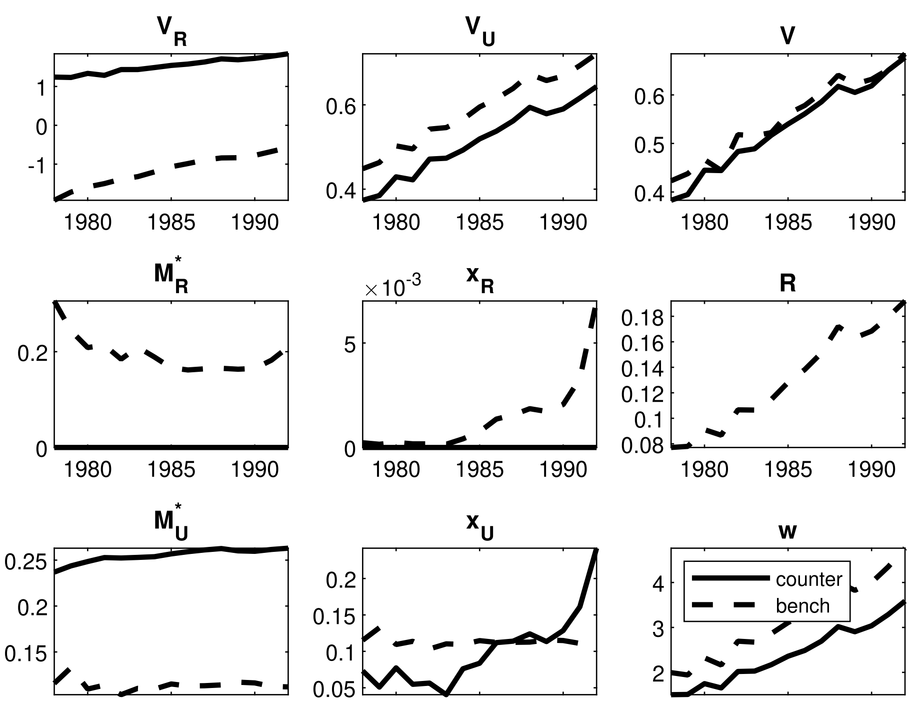

Fig. 13 Counterfactual result: frictionless economy. **Note**: This figure compares the welfare in benchmark economy and frictionless economy, the dash line is the value for benchmark model, and the solid line is for frictionless economy. V_R, V_U, V are welfare of rural, urban and total welfare respectively, $M_R^*, x_R, R, M_U^*, x_U, w$ are number of active firms in rural, intermediate goods in TVE, land rent, number of active firms in urban, intermediate goods in urban enterprises and wage rate respectively.

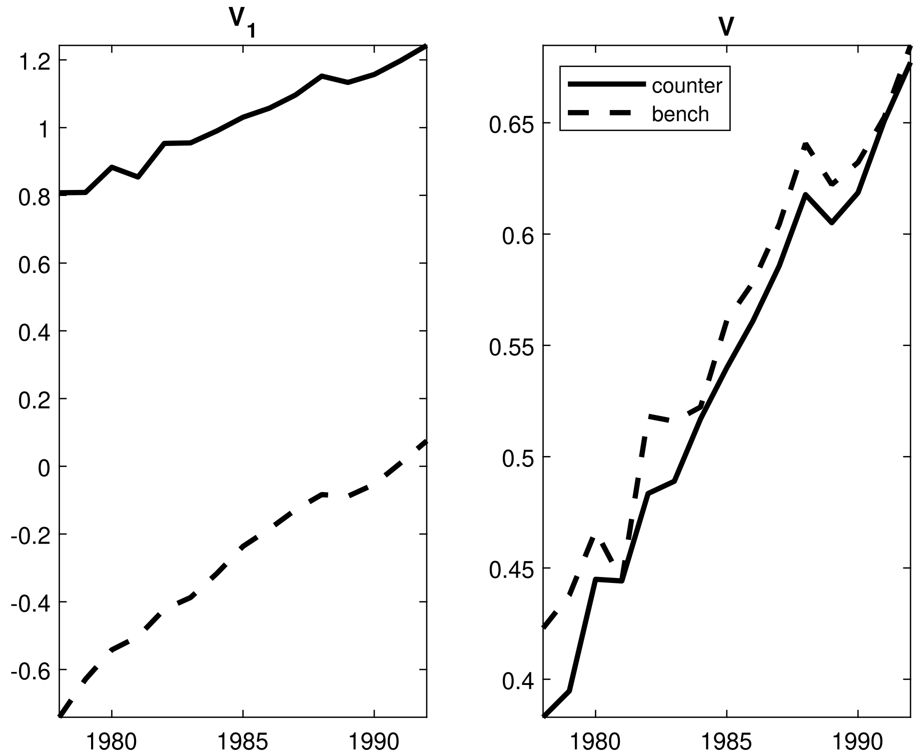

Fig. 14 Welfare: frictionless economy. **Note**: This figure compares the welfare in benchmark economy and frictionless economy, the dash line is the value for benchmark model, and the solid line is for frictionless economy. The right panel shows the weighted social welfare as in equation (8), while the left panel shows the social welfare when treating the rural and urban with same weight.

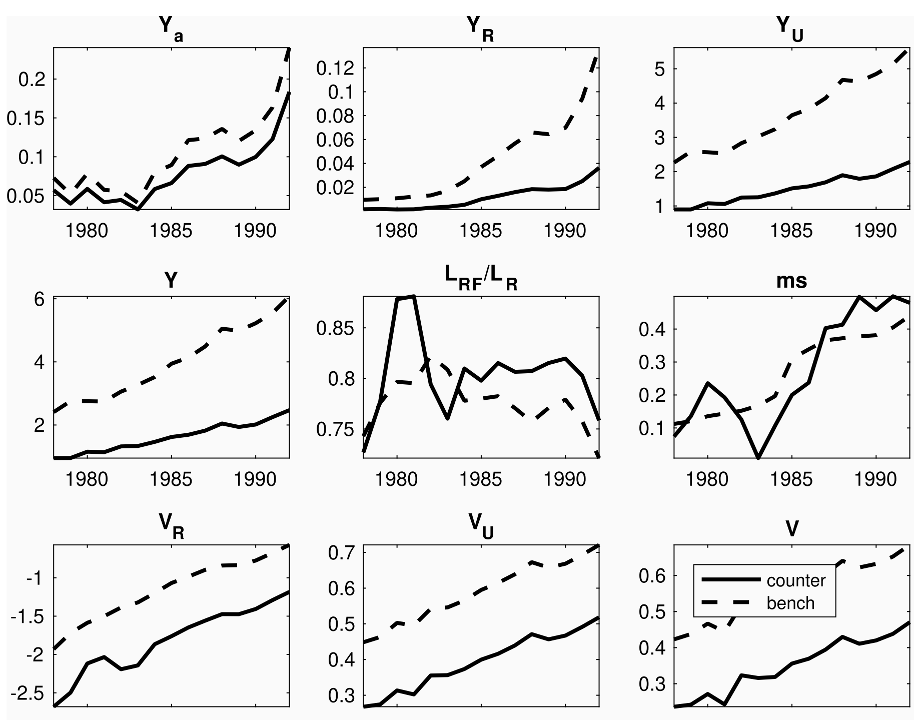

Fig. 15 Alternative ability distribution: normalization. **Note**: The dash line represents the results in benchmark economy (bench), and the solid line represents the results with normalized ability parameters (counter). Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

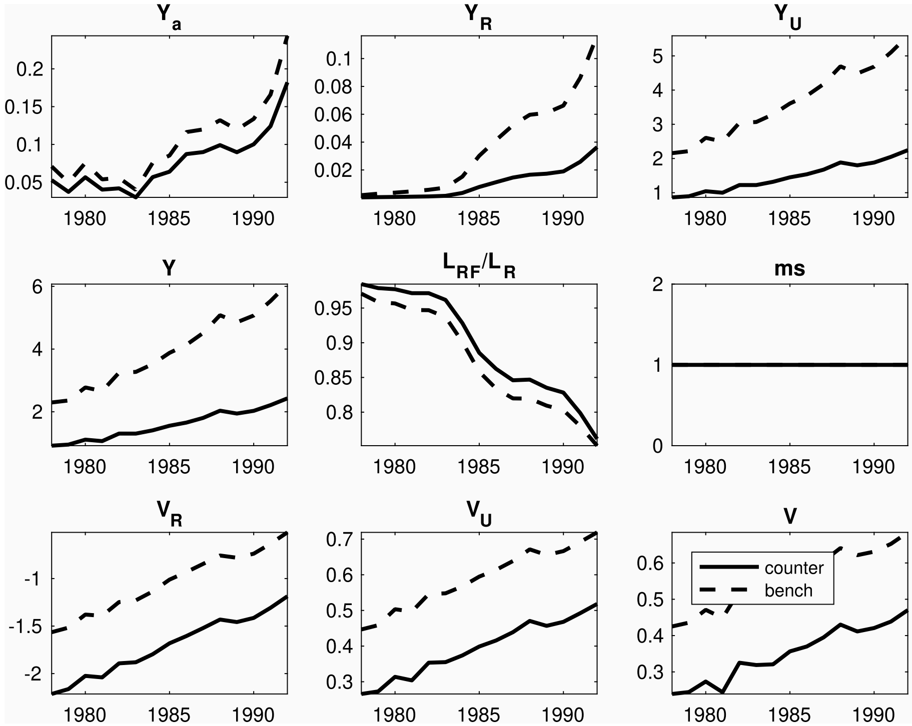

Fig. 16 Alternative ability distribution: normalization. **Note**: The dash line represents the results in market economy under benchmark parameters (bench), and the solid line represents the counterfactual results in market economy with normalized ability parameters (counter). Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

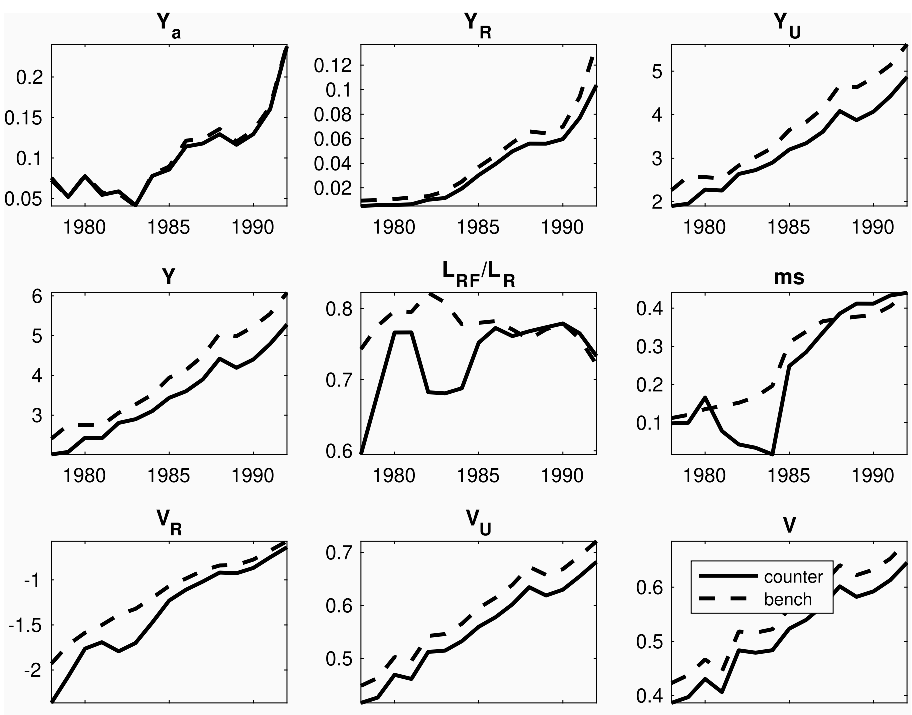

Fig. 17 Alternative ability distribution: (μ_E, μ_F). **Note**: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (μ_E, μ_F) are 80% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

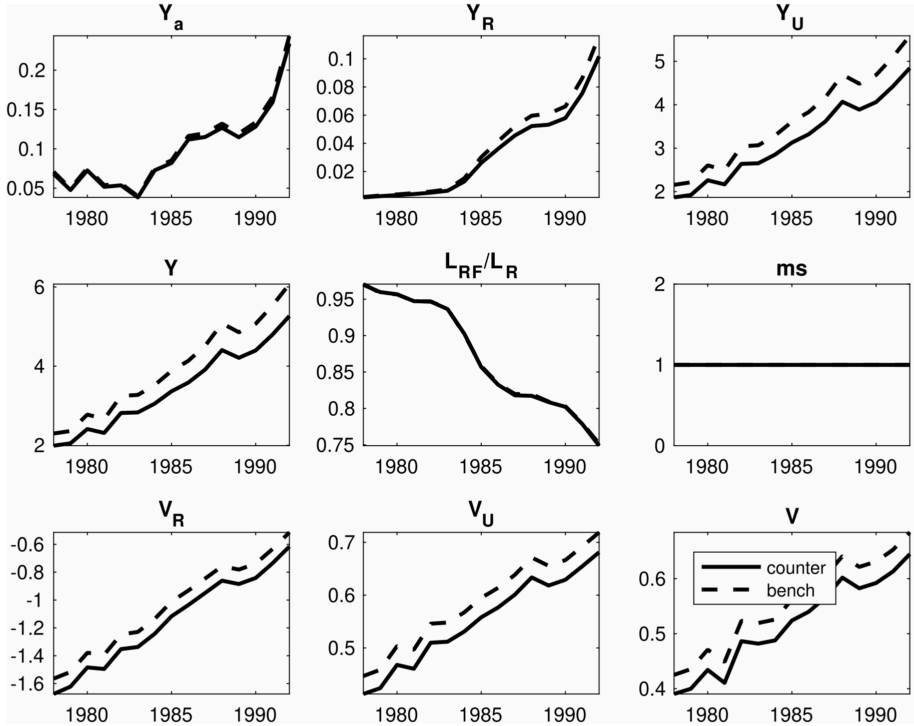

Fig. 18 Alternative ability distribution: (μ_E, μ_F). **Note**: The dash line represents the results in market economy under benchmark parameters (bench), and the solid line represents the counterfactual results in market economy where (μ_E, μ_F) are 80% of benchmark value (counter). Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

Table 1
Parameters without solving model.

parameters	value	target or source
α_j	$\alpha_R = \alpha_U = 0.078, \alpha_a = 0.157$	Input-Output table
η	0.439	Adamopoulos et al. (2017)
γ_R, γ_U	0.15	Brandt et al. (2018)
$\mu_F, \mu_E, \sigma_F, \rho_{FE}, \sigma_E$	$\mu_F = 0.16, \mu_E = 0.88, \sigma_F = 1.48, \rho_{FE} = -0.35, \sigma_E = 0.95$	Adamopoulos et al. (2017)
θ_R, θ_U	1.05	Brandt et al. (2018)
θ	0.005	Chen (2017)

Note: This table lists the parameters calibrated without solving the model. $\alpha_j, j = a, R, U$, η, γ_R, γ_U are the share in production function calculated from the Input-Output table and the literature (Adamopoulos et al., 2017; Brandt et al., 2018), $\mu_F, \mu_E, \sigma_F, \rho_{FE}, \sigma_E$ are the parameters of productivity distribution adopted from Adamopoulos et al. (2017), θ_R, θ_U are the parameters of ability distribution from Brandt et al. (2018), θ is the preference parameter (Chen, 2017).

Table 2
Parameters in average.

parameters	description	value	target	model	data
A_a	agricultural productivity	0.0418	Y_R/Y_a	1.2243	1.4653
A_R	TVE productivity	0.2184	Y_U/Y_R	3.9809	4.1039
χ_U	welfare weight	0.9178	ms	0.3139	0.2674
$\overline{a}$	subsistence level	0.0106	L_{RE}/L_R	0.3595	0.1651
C_R	entry cost in rural	0.0166	$H_R(z_R^*) = 1$		
C_U	entry cost in urban	0.1041	$H_U(z_U^*) = 1$		
M_R	potential entrant	0.1226	L_{RE}	0.1226	0.1226
M_U	potential entrant	0.2550	L_U	0.2550	0.2550
$\overline{Z}$	total land size	3.1810	E_U/E_R	2.9317	2.2174

Note: This table lists the parameters calibrating targets in average value from 1978 to 1992. A_a, A_R are productivities, χ_U is welfare weight on urban household, $\overline{a}$ is subsistence level in utility function, C_R, C_U are the entry cost in rural and urban, M_R, M_U are the potential entrant in rural and urban, $\overline{Z}$ is the total land size.

Table 3
Parameters across years.

parameters	description	target
A_a	agriculture productivity	Y_a
A_R	TVE productivity	Y_R
A_U	urban productivity	Y_U
M_R	potential entrant in rural	L_{RE}
M_U	potential entrant in urban	L_U
χ_U	welfare weight in urban	ms
$\overline{a}$	subsistence level of agricultural goods	L_{RE}/L_R
C_R	entry cost in rural	$H_R(z_R^*) = 1$
C_U	entry cost in urban	$H_U(z_U^*) = 1$

Note: This table lists the parameters calibrating targets year by year. A_a, A_R, A_U are productivity, M_R, M_U are the potential entrants in rural and urban, χ_U is welfare weight on urban household, $\overline{a}$ is subsistence level in utility function, C_R, C_U are the entry costs. All the parameters are calibrated year by year.

Table 4
Counterfactual analysis in 1978.

variable	benchmark	counterfactual result (value)					
		A_a	A_R	A_U	$\overline{P}_a/P_a$	χ_U	market
Y_a	0.073	0.227	0.085	0.087	0.073	0.072	0.071
Y_R	0.01	0.004	0.166	0.004	0.002	0.003	0.002
Y_U	2.264	2.374	2.228	4.788	2.126	2.211	2.159
L_{RF}/L_R	0.743	0.793	0.392	0.704	0.955	0.898	0.971
ms	0.112	0.464	0.809	0.188	0.156	0.529	1
Y	2.408	2.528	2.51	5.084	2.251	2.415	2.299
x_a	0.04	0.038	0.024	0.085	0.023	0.05	0.026
M_R^*	0.306	0.147	0.763	0.151	0.082	0.093	0.069
M_U^*	0.116	0.128	0.129	0.237	0.101	0.114	0.102
V_R	−1.93	−1.806	−0.981	−1.689	−1.681	−1.458	−1.566
V_U	0.448	0.467	0.455	0.636	0.449	0.444	0.447
V_{total}	0.423	0.443	0.439	0.611	0.426	0.39	0.425

Note: The column of "benchmark" lists results in 1978, and each column under "counterfactual case (value)" list the results setting the parameter with 1992's value while keeping others the same as in 1978; in the column of "market", we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$.

Table 5
Counterfactual analysis: activation effect.

variable	benchmark	market	$A_U = A_R, C_U = C_R$	
			DTS	market
Y_a	0.073	0.071	0.0755	0.0873
Y_R	0.01	0.002	0.0115	0.0129
Y_U	2.264	2.159	0.0001	0.0001
L_{RF}/L_R	0.743	0.971	0.7358	0.9926
ms	0.112	1	0.2052	1
Y	**2.408**	**2.299**	**0.1491**	**0.2419**
x_a	0.04	0.026	0.0397	0.0426
M_R^*	0.306	0.069	0.3637	0.4055
M_U^*	0.116	0.102	0.0001	0.0001
V_R	−1.93	−1.566	−1.9562	−1.1887
V_U	0.448	0.447	0.3475	0.3746
V_{total}	0.423	0.425	0.3229	0.3579

Note: The column of "benchmark" lists results under DTS in 1978, and in the column of "market", we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$. And each column under "$A_U = A_R, C_U = C_R$" list the results further setting productivity and entry costs in the urban same as that in the rural.

Table 6
Decomposition.

variable	model (1978)	model (1992)	(A_a, A_R, A_U)	$(\chi_U, \frac{\overline{P}_a}{P_a})$	(M_U, M_R)	(L_U, L_R)	(C_U, C_R)	residue
Y_a	0.073	0.24	1.021	−0.181	−0.043	−0.038	−0.043	0.285
Y_R	0.01	0.137	1.065	−0.026	0.129	0.083	0.117	−0.367
Y_U	2.264	5.617	0.944	0.036	0.034	0.146	−0.002	−0.159
Y	2.408	6.079	0.936	0.044	0.026	0.133	−0.007	−0.133
Z_{RF}	4.459	6.024	1.04	−0.858	0.104	0.184	0.082	0.448
V_R	−1.93	−0.571	0.712	0.141	−0.054	0.024	−0.066	0.242
V_U	0.448	0.721	0.873	−0.019	0.022	0.275	−0.009	−0.143
V_{total}	0.423	0.685	0.955	−0.113	0.018	0.28	−0.015	−0.124

Note: In this table, column “model (1978)” and “model (1992)” are the benchmark values in these two years, and the column “(A_a, A_R, A_U)”, “$(\chi_U, \frac{\overline{P}_a}{P_a})$”, “$(M_U, M_R)$”, “$(L_U, L_R)$” and “$(C_U, C_R)$” report the contribution of each channel, $ct_i = \frac{X_{1992}-X_i}{X_{1992}-X_{1978}} / \sum \frac{X_{1992}-X_i}{X_{1992}-X_{1978}}$,where X_i is the counterfactual result, and X_{1978} and X_{1992} are the benchmark results in 1978 and 1992 respectively, and column “residue” is $1 - \sum \frac{X_{1992}-X_i}{X_{1992}-X_{1978}}$, which captures the impact from all the other factors in the model and out of the model.

Table 7
Counterfactual analysis in 1978: second-hand and frictionless economy.

variable	benchmark	second-hand	frictionless
Y_a	0.073	0.075	0.066
Y_R	0.01	0.006	6.646
Y_U	2.264	2.173	6.646
L_{RF}/L_R	0.743	0.59	0.102
ms	0.112	0.162	1
Y	2.408	2.268	7.073
V_R	−1.93	−2.376	1.242
V_U	0.448	0.46	0.374
V_{total}	0.423	0.43	0.383

Note: In this table, the column “benchmark” presents benchmark results in 1978, “second-hand” presents counterfactual results in economy with second-hand market, “frictionless” presents counterfactual results in frictionless economy.

Table 8
Alternative ability distribution: normalization.

variable	benchmark	normalization	counterfactual result (value)					
			A_a	A_R	A_U	$\overline{P}_a/P_a$	χ_U	market
Y_a	0.073	0.057	0.229	0.022	0.023	0.053	0.022	0.05
Y_R	0.01	0.001	0	0.283	0	0	0	0
Y_U	2.264	0.892	0.011	0.011	3.143	0.006	0.041	0.014
Y	2.408	0.947	0.273	0.26	3.107	0.082	0.006	0.086
V_R	−1.93	−2.584	−1.183	−1.566	−2.05	−1.671	−1.933	−1.665
V_U	0.448	0.268	0.383	0.389	0.481	0.393	0.333	0.365
V_{total}	0.423	0.237	0.366	0.368	0.454	0.371	0.269	0.343

Note: The column of “benchmark” lists benchmark results in 1978, column of “normalization” lists results where the ability parameters are normalized, and each column under “counterfactual case (value)” list the results setting the parameter with 1992’s value while keeping others the same as in 1978; in the column of “market”, we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$.

Table 9
Alternative ability distribution: (μ_F, μ_E).

variable	benchmark	(μ_F, μ_E)	counterfactual result (value)					
			A_a	A_R	A_U	$\overline{P}_a/P_a$	χ_U	market
Y_a	0.073	0.075	0.233	0.032	0.025	0.052	0.024	0.044
Y_R	0.01	0.005	0	0.161	0	0	0	0
Y_U	2.264	1.909	0.011	0.04	7.257	0.018	0.017	0.012
Y	2.408	2.021	0.24	0.172	7.22	0.083	0.032	0.065
V_R	−1.93	−2.291	−0.953	−1.255	−1.456	−1.35	−1.432	−1.296
V_U	0.448	0.417	0.551	0.497	0.646	0.523	0.534	0.54
V_{total}	0.423	0.388	0.535	0.478	0.623	0.503	0.479	0.521

Note: The column of “benchmark” lists benchmark results in 1978, column of “(μ_F, μ_E)” lists results where (μ_F, μ_E) are 80% of benchmark value, and each column under “counterfactual case (value)” list the results setting the parameter with 1992’s value while keeping others the same as in 1978; in the column of “market”, we set $\frac{\overline{P}_a}{P_a} = 1$ and $\overline{Q} = 0$.

D. Robustness

Figure D.1 - Figure D.3 compare benchmark economy and economy with alternative ability distribution: (μ_E, μ_F). Figure D.4 - Figure D.6 compare market economy with benchmark parameters and market economy with alternative ability distribution: (μ_E, μ_F). Figure D.7 - Figure D.10 compare benchmark economy and economy with alternative ability distribution: (σ_E, σ_F). Figure D.11 - Figure D.14 compare market economy with benchmark parameters and market economy with alternative ability distribution: (σ_E, σ_F). Figure D.15 - Figure D.18 compare benchmark economy and economy with alternative ability distribution: ρ_{FE}. Figure D.19 - Figure D.22 compare market economy with benchmark parameters and market economy with alternative ability distribution: ρ_{FE}.

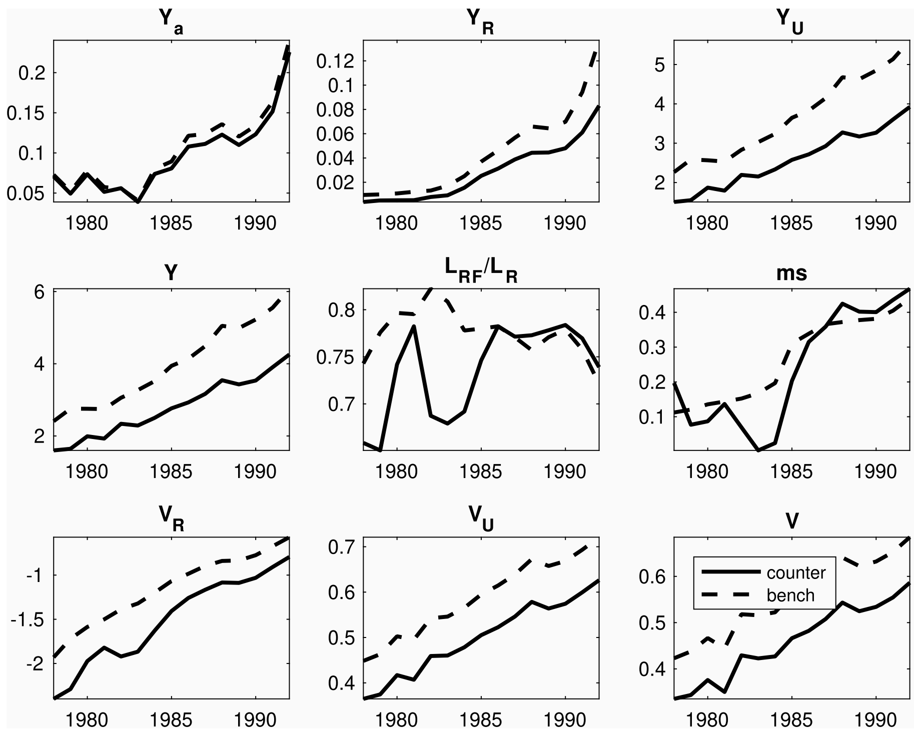

Fig. D.1 Robustness check: (μ_E, μ_F)
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (μ_E, μ_F) are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

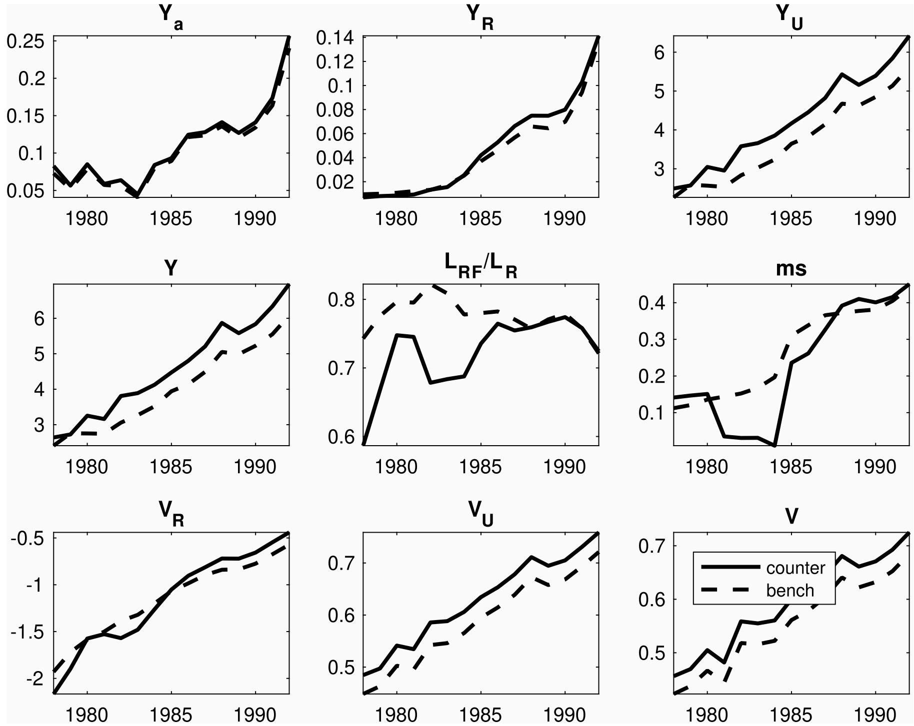

Fig. D.2 Alternative ability distribution: (μ_E, μ_F)

Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (μ_E, μ_F) are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

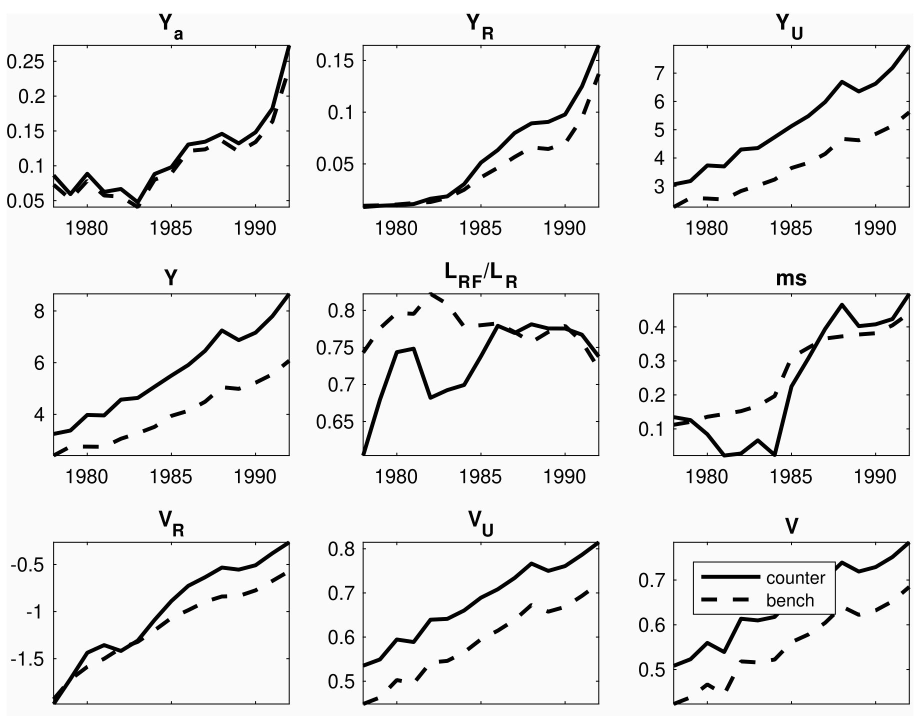

Fig. D.3 Alternative ability distribution: (μ_E, μ_F)

Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (μ_E, μ_F) are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

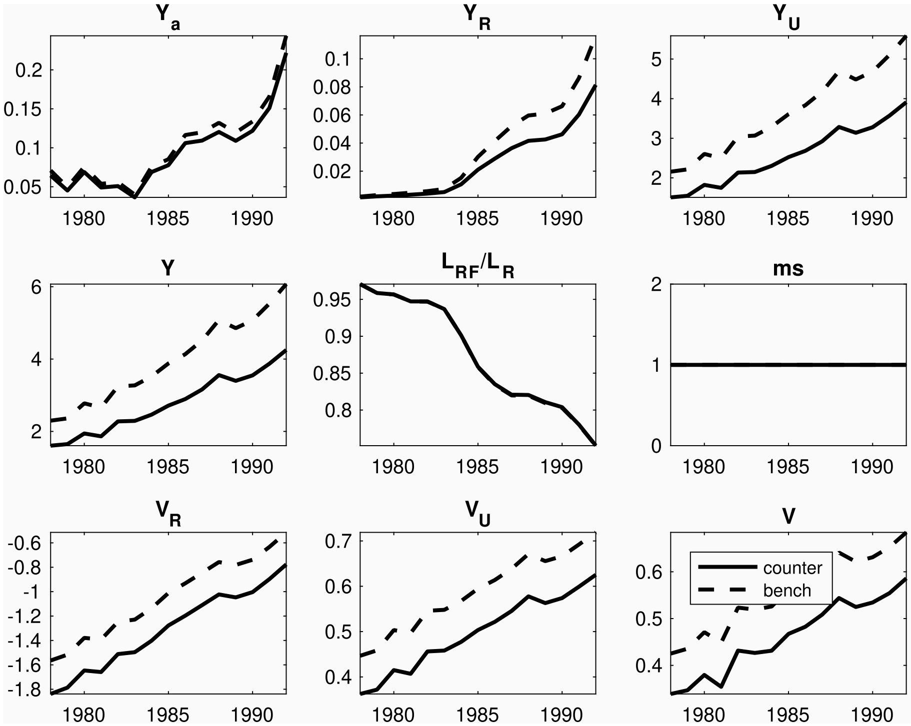

Fig. D.4 Alternative ability distribution: (μ_E, μ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (μ_E, μ_F) are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

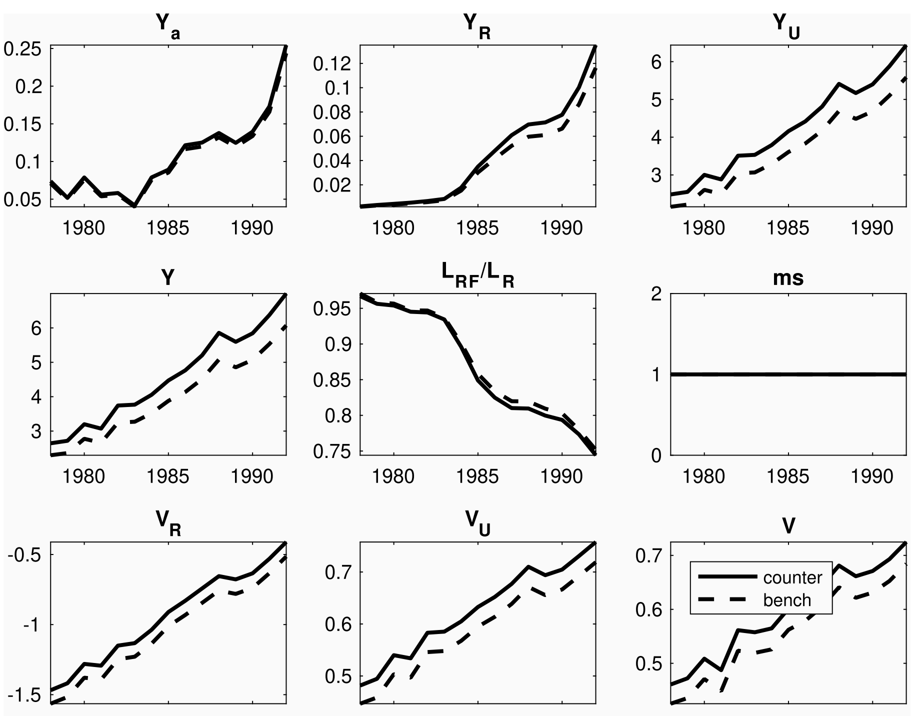

Fig. D.5 Alternative ability distribution: (μ_E, μ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (μ_E, μ_F) are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

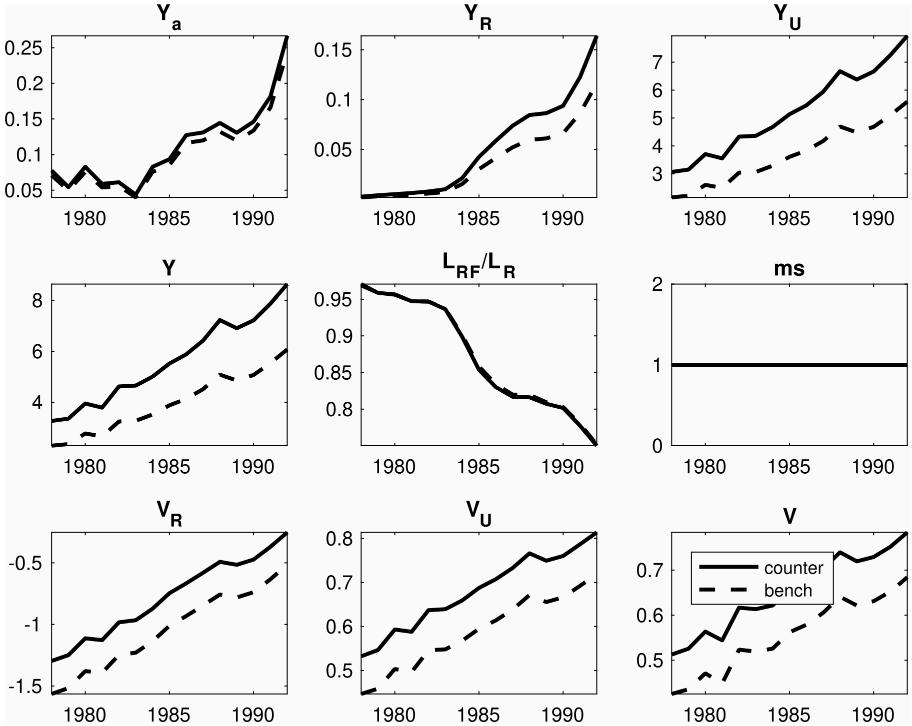

Fig. D.6 Alternative ability distribution: (μ_E, μ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (μ_E, μ_F) are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

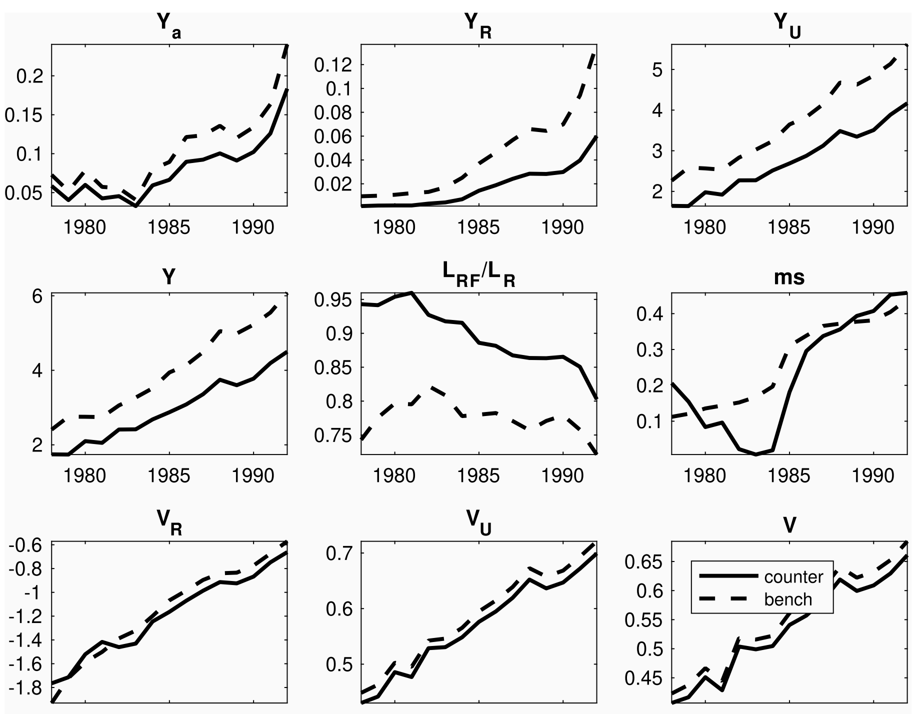

Fig. D.7 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (σ_E, σ_F) are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

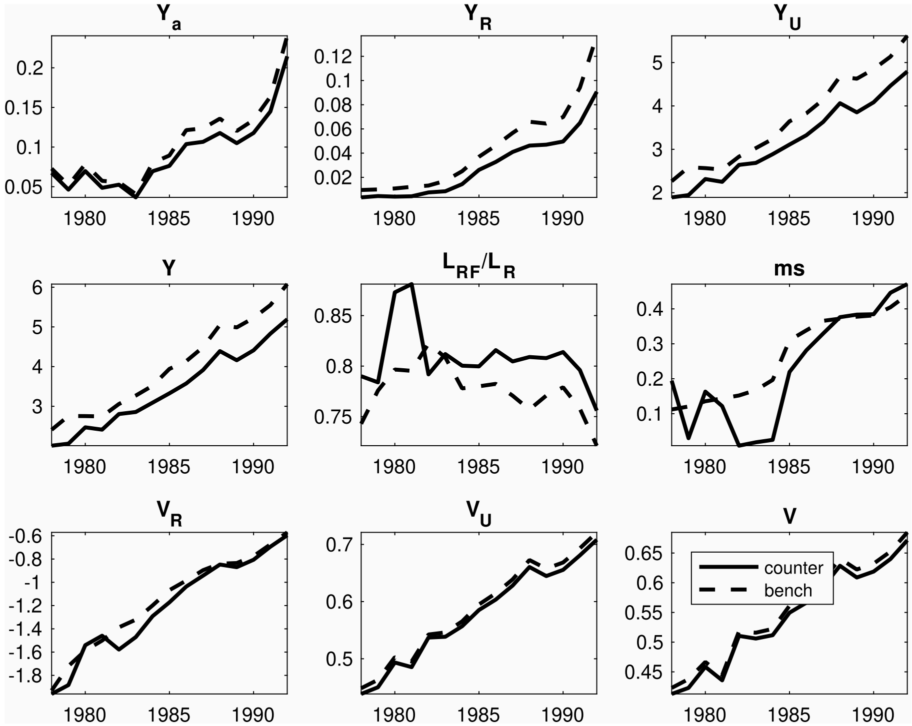

Fig. D.8 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (σ_E, σ_F) are 80% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

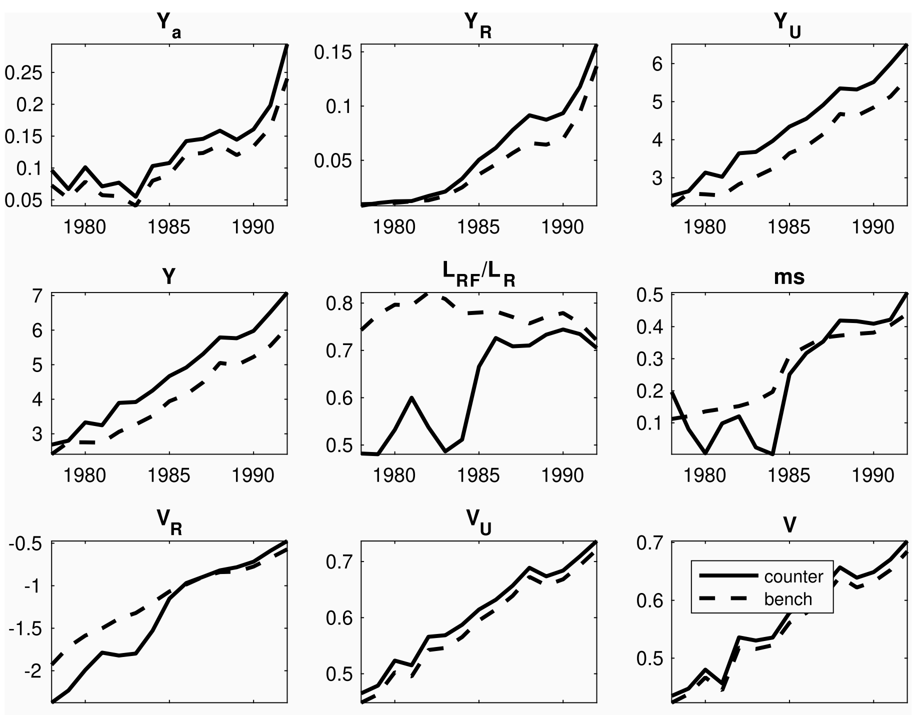

Fig. D.9 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (σ_E, σ_F) are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

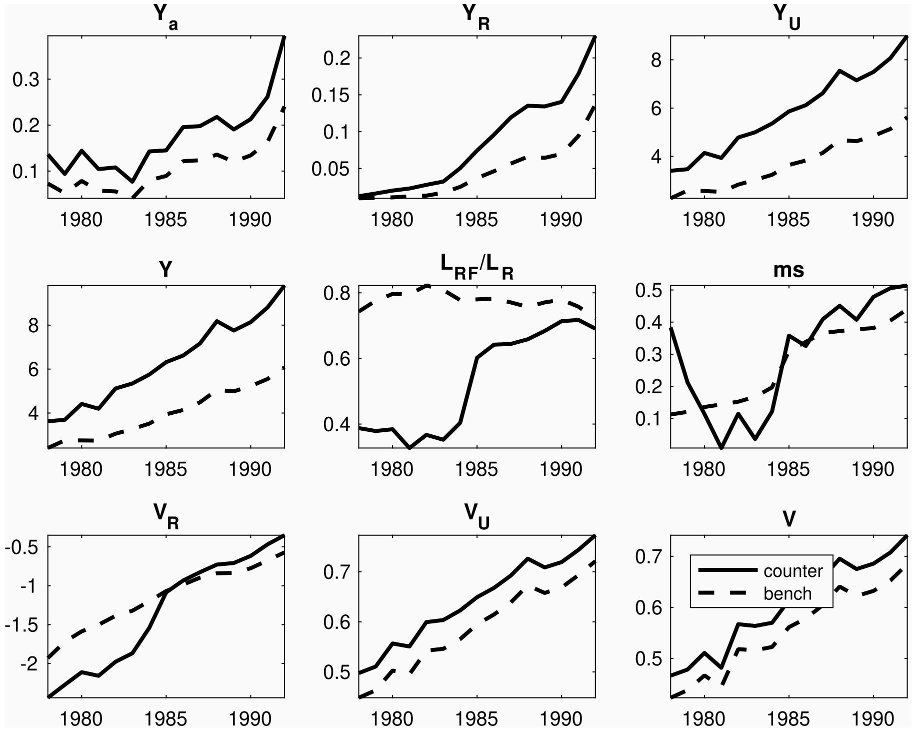

Fig. D.10 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where (σ_E, σ_F) are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

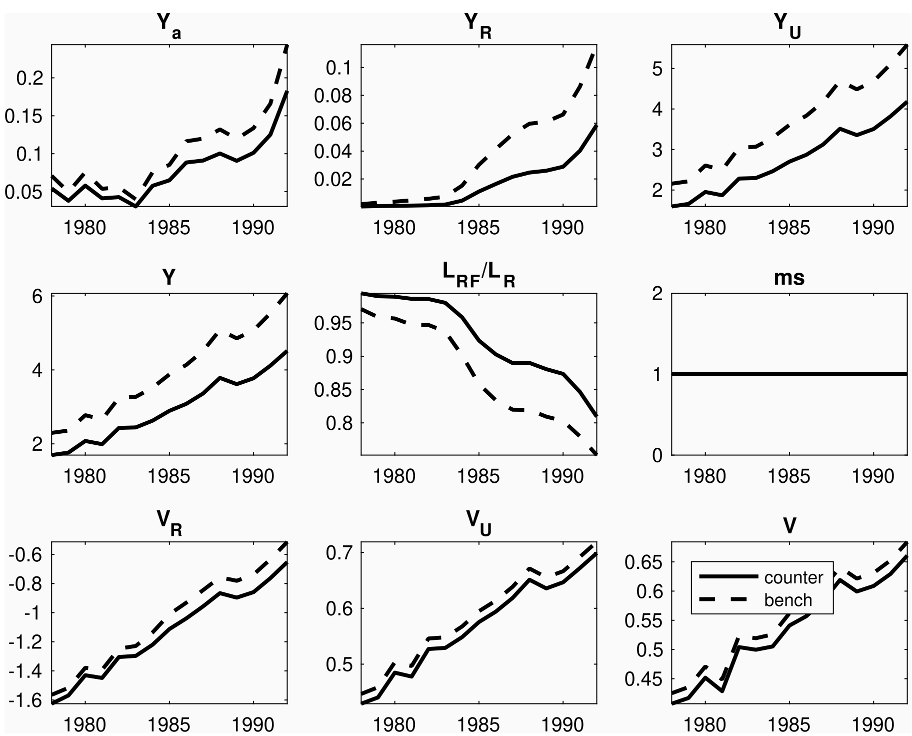

Fig. D.11 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (σ_E, σ_F) are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

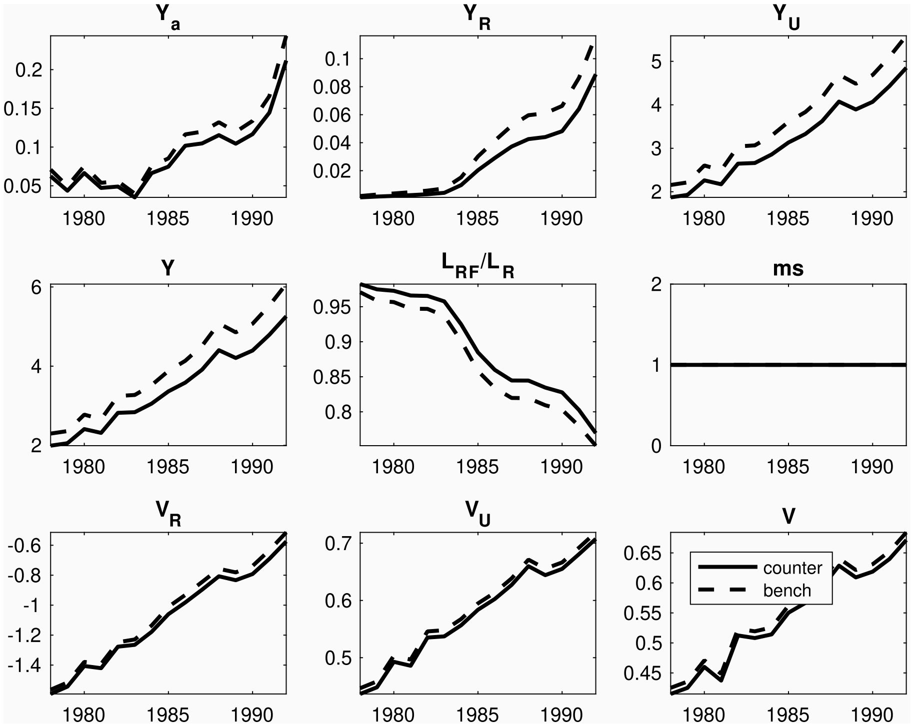

Fig. D.12 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (σ_E, σ_F) are 80% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

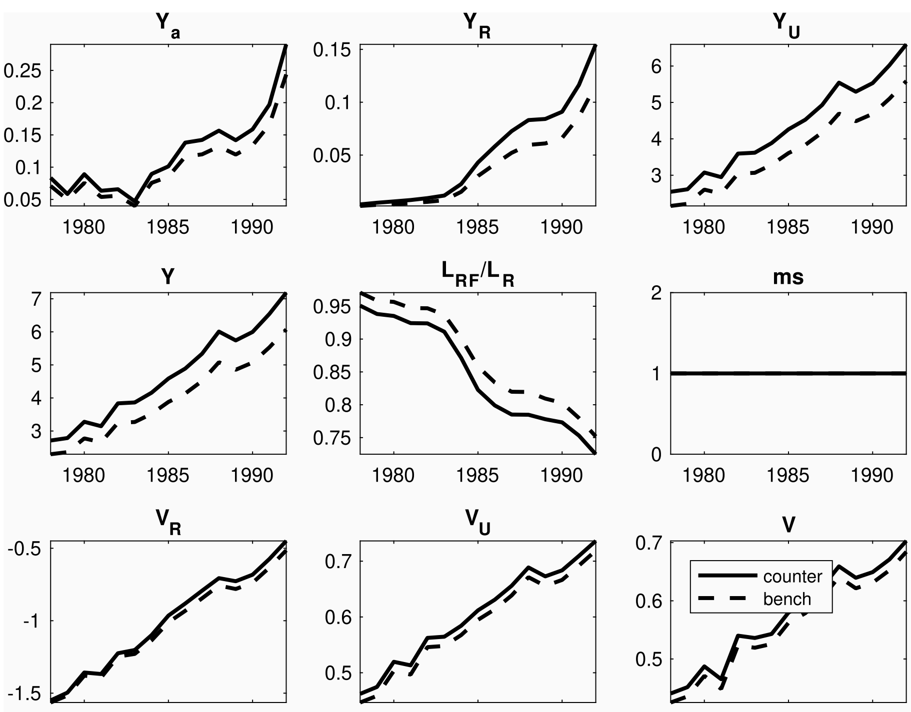

Fig. D.13 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (σ_E, σ_F) are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

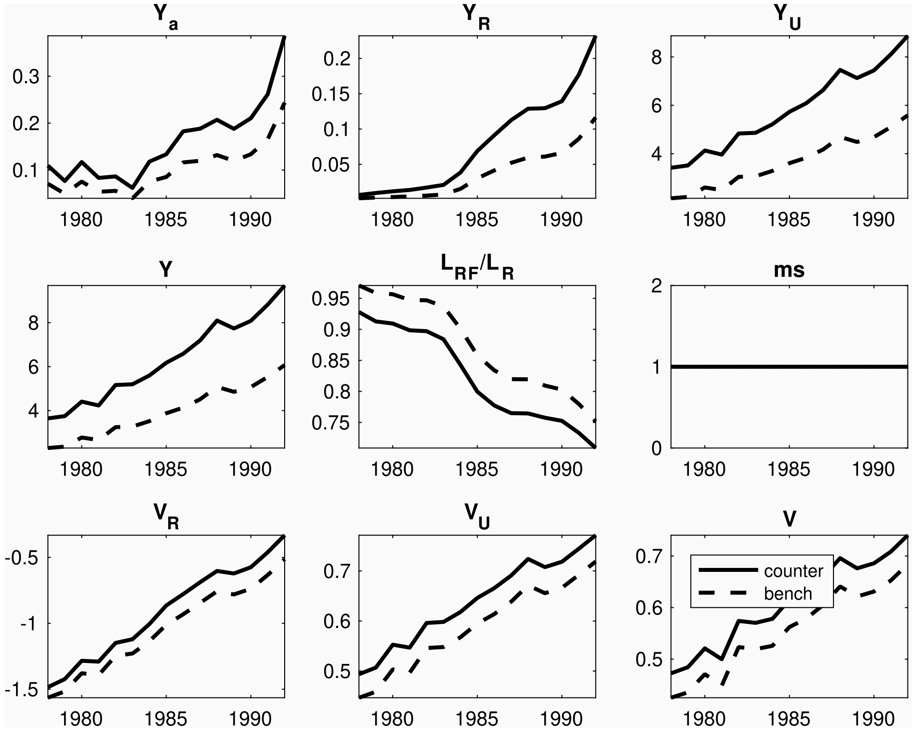

Fig. D.14 Alternative ability distribution: (σ_E, σ_F)
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where (σ_E, σ_F) are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

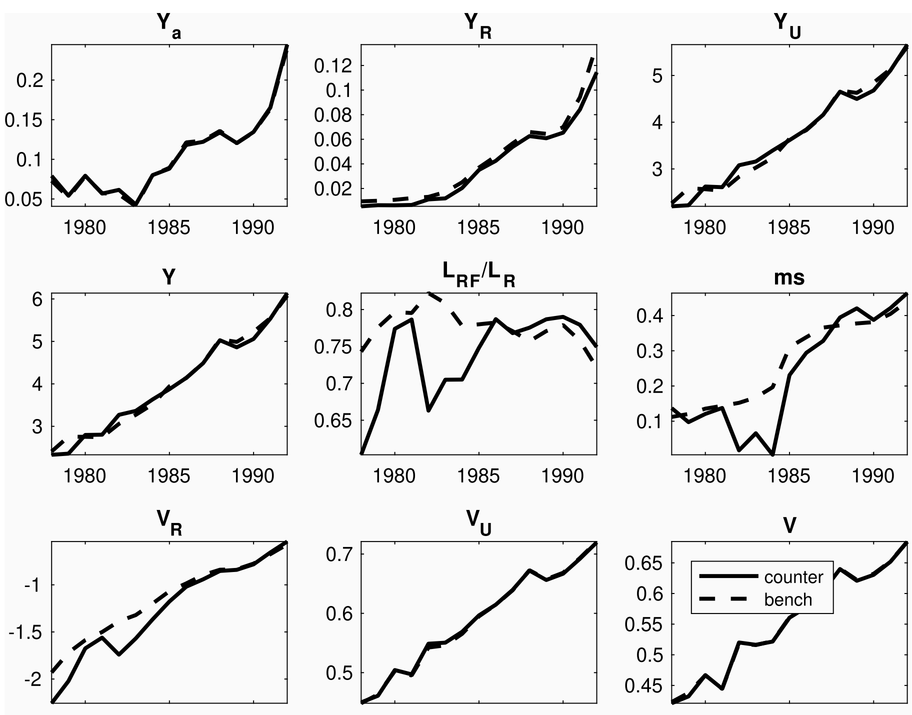

Fig. D.15 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where ρ_{FE} are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

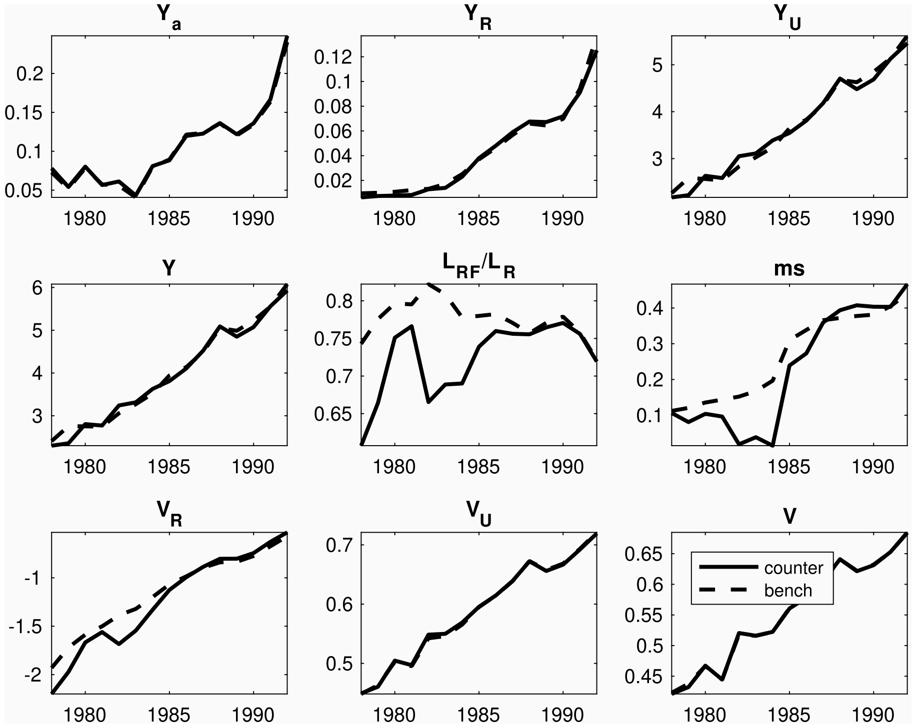

Fig. D.16 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where ρ_{FE} are 80% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

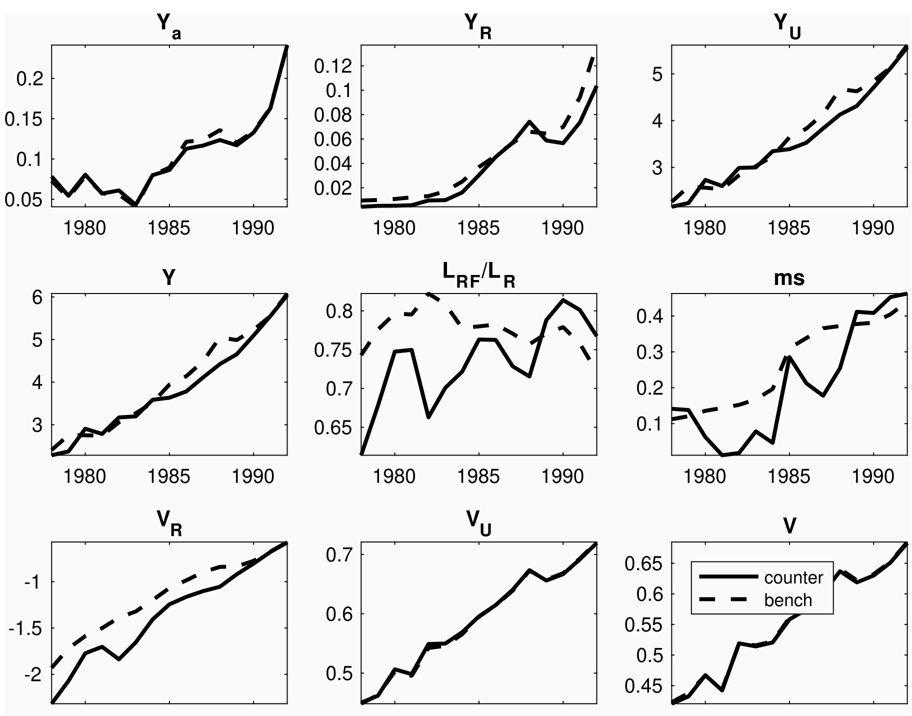

Fig. D.17 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where ρ_{FE} are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

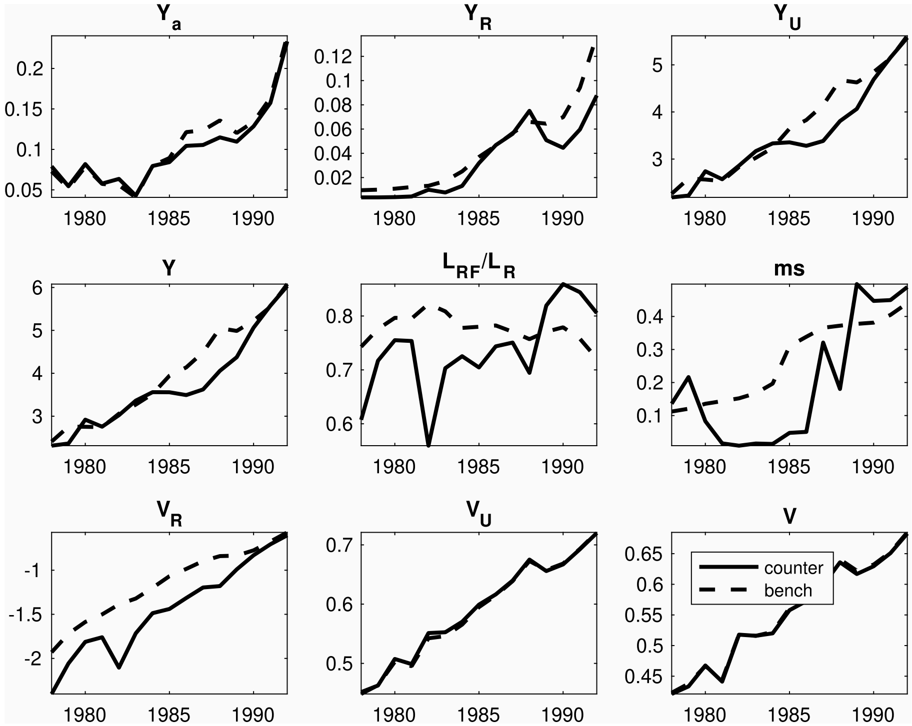

Fig. D.18 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in benchmark economy, and the solid line represents the counterfactual results where ρ_{FE} are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

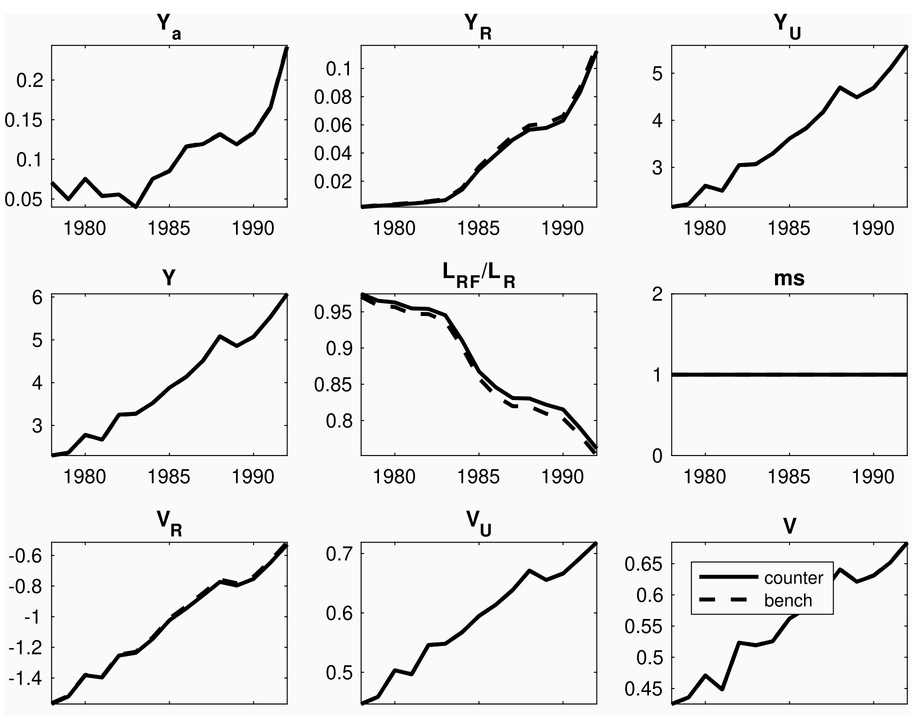

Fig. D.19 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where ρ_{FE} are 50% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

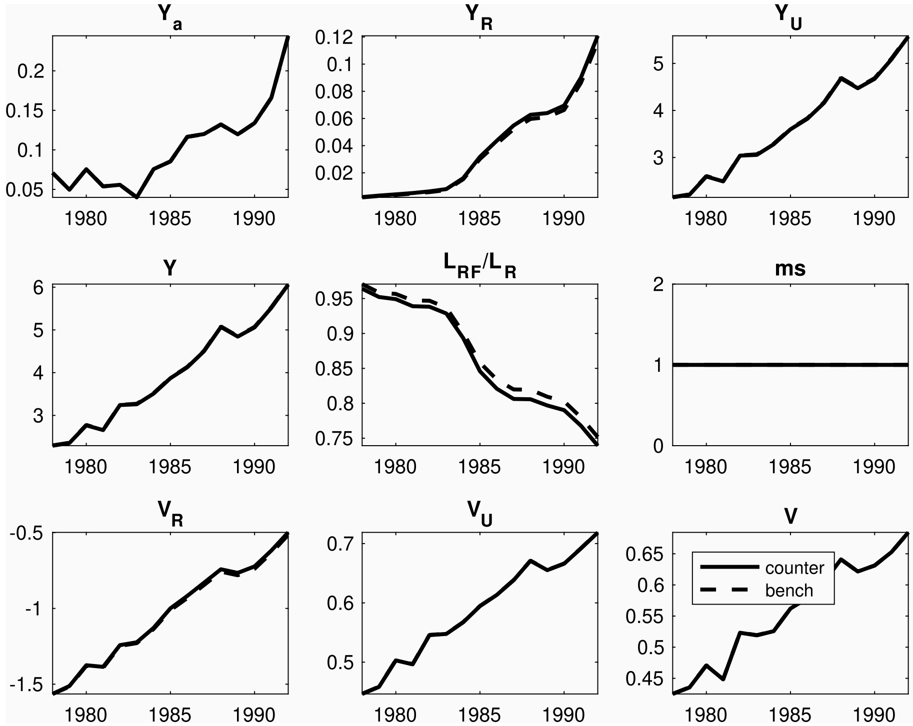

Fig. D.20 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where ρ_{FE} are 80% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

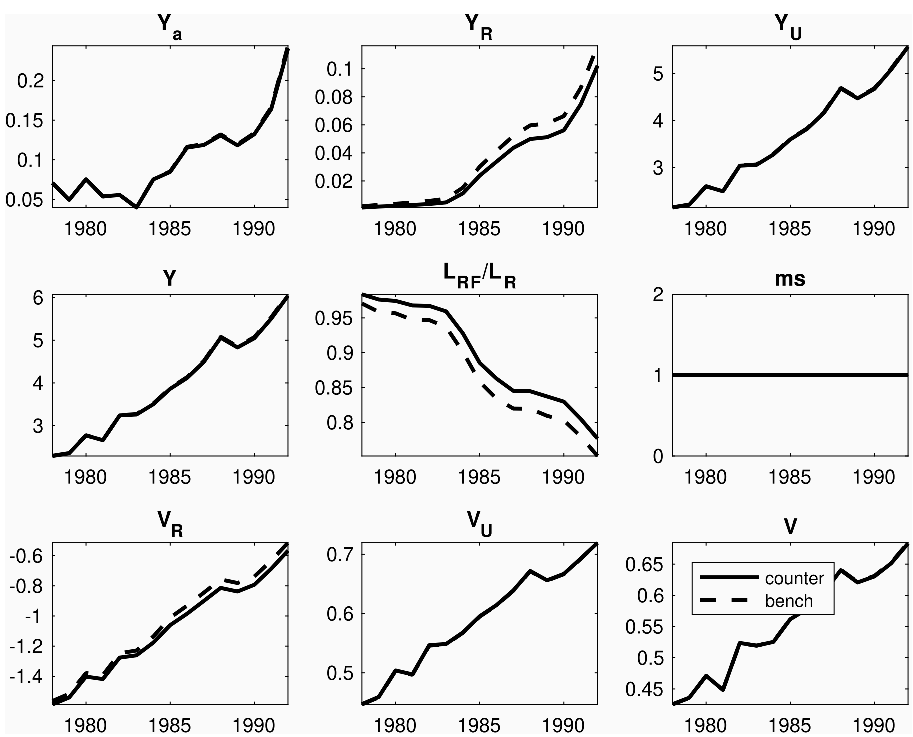

Fig. D.21 Alternative ability distribution: ρ_{FE}
Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where ρ_{FE} are 120% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

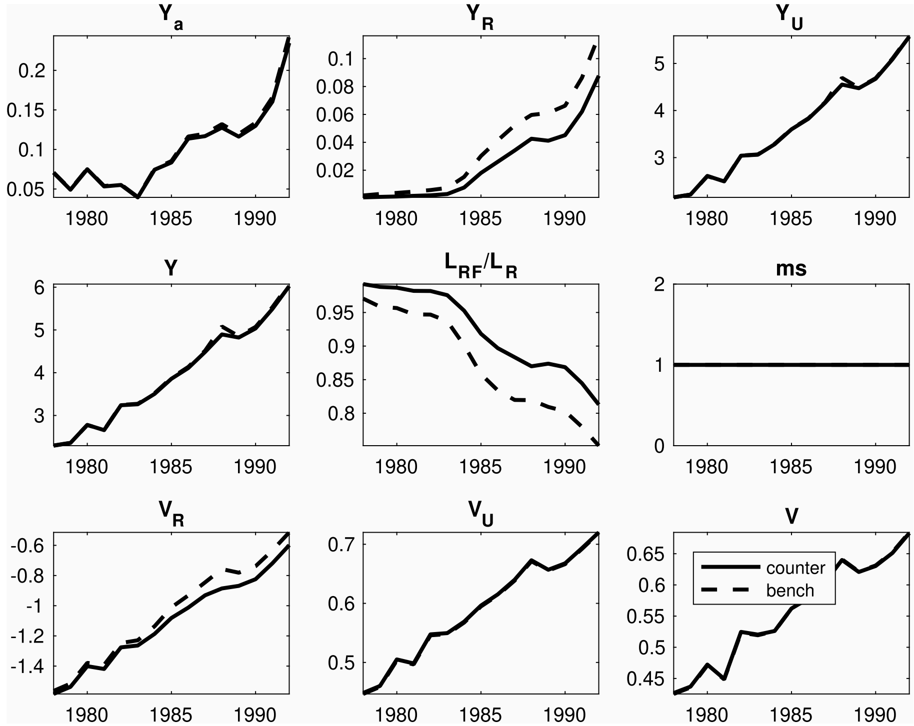

Fig. D.22 Alternative ability distribution: ρ_{FE}

Note: The dash line represents the results in market economy with benchmark parameters, and the solid line represents the counterfactual results in market economy where ρ_{FE} are 150% of benchmark value. Y_a, Y_R, Y_U, Y are output of agriculture, rural enterprises, urban enterprises and total output respectively, $L_{RF}/L_R, ms$ are employment ratio of farmer in rural and market share respectively, V_R, V_U, V are welfare of rural, urban and total welfare respectively.

E. Additional Tables and Figures

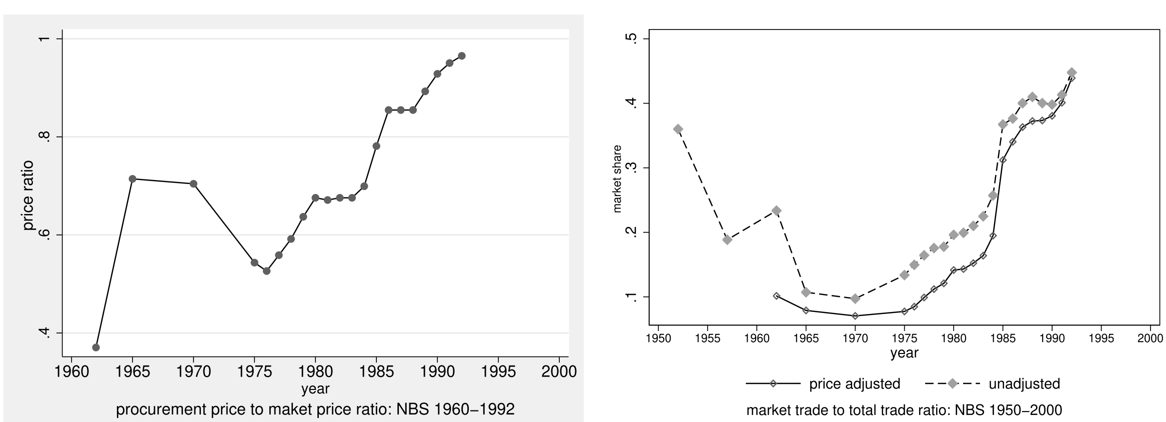

Fig. E.23 Procurement price and market share

Note: The left panel presents the ratio of procurement price to market price for composite agricultural products between 1962 and 1992, and the right panel shows the trend of market share from 1953 to 1992 under adjusted and unadjusted price.

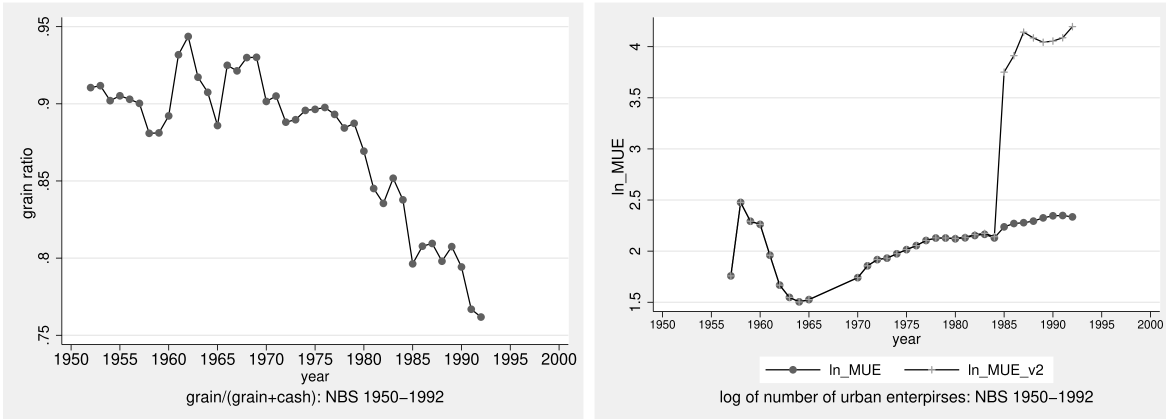

Fig. E.24 Ratio of grain and number of urban enterprises

Note: The left panel presents the share of grain crop to the total amount of grain and cash crop representing the total amount of agricultural production. The Right panel presents the number of urban enterprises. The dot line includes data only from SOEs, and the solid line includes four components: SOE, private, mixed, and others, including foreign enterprises. As only SOE data is available for the period before 1984, the jump in the figure is attributable to the inclusion of private enterprises after 1984.

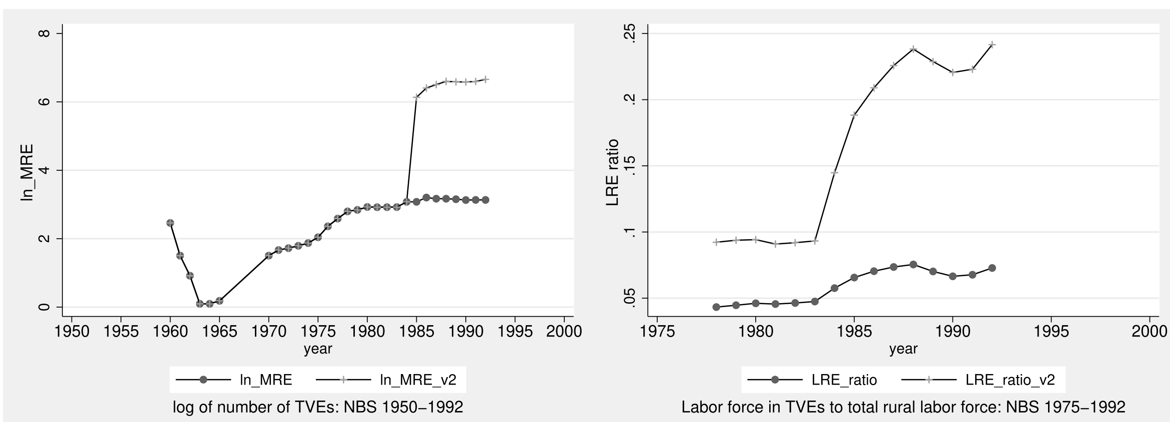

Fig. E.25 Number and employment share of TVEs

Note: This figure presents the number of TVEs (left) and the employment share of TVEs (right). The dot line only has township enterprises, and the solid line (v2) has township, villages, private, and mixed enterprises. In 1984, there was a large increase in the number of private TVEs; therefore, the jump in 1984 was mainly the result of adding private TVEs to the data.

Table E.1
Intermediate goods share. **Source**: China Industrial Productivity (CIP) and author's calculation. The column "Y_n in Y_a" is the share of nonagricultural goods as intermediate goods to the total agricultural output. The column "Y_a in Y_n" is the share of agricultural goods as intermediate goods to the total output of non-agricultural goods. The row "average" is the average share weighted by output across years.

year	Y_n in Y_a	Y_a in Y_n
1981	0.132	0.07
1982	0.124	0.076
1983	0.132	0.078
1984	0.137	0.078
1985	0.155	0.067
1986	0.165	0.066
1987	0.173	0.068
1988	0.188	0.06
1989	0.198	0.056
1990	0.183	0.066
1991	0.202	0.057
1992	0.219	0.049
average	0.157	0.066

Table E.2
Agricultural goods share as intermediate inputs

YEAR	AGR	CLM	PTM	MEM	NMM	FB	TBC	TEX	WEA	LEA	WF	PP	PET	CHE	RP	BUI	MET	MEP
1981	**0.53**	0.01	0.01	0.01	0.01	**0.84**	**0.65**	**0.22**	**0.09**	**0.27**	**0.07**	**0.30**	0.01	**0.09**	**0.22**	0.05	0.00	0.01
1982	**0.56**	0.02	0.01	0.01	0.01	**0.80**	**0.60**	**0.25**	**0.10**	**0.30**	**0.18**	**0.29**	0.01	**0.11**	**0.20**	0.04	0.00	0.01
1983	**0.55**	0.03	0.01	0.02	0.01	**0.77**	**0.56**	**0.27**	**0.12**	**0.30**	**0.22**	**0.25**	0.01	**0.11**	**0.19**	0.03	0.00	0.01
1984	**0.55**	0.04	0.01	0.02	0.01	**0.75**	**0.52**	**0.27**	**0.12**	**0.30**	**0.23**	**0.22**	0.00	**0.11**	**0.17**	0.03	0.00	0.01
1985	**0.51**	0.04	0.00	0.02	0.01	**0.68**	**0.45**	**0.24**	**0.10**	**0.24**	**0.22**	**0.17**	0.00	**0.09**	**0.15**	0.02	0.00	0.00
1986	**0.49**	0.04	0.00	0.02	0.01	**0.65**	**0.42**	**0.23**	**0.10**	**0.22**	**0.22**	**0.15**	0.00	**0.09**	**0.13**	0.02	0.00	0.00
1987	**0.48**	0.05	0.00	0.02	0.01	**0.62**	**0.39**	**0.22**	**0.10**	**0.21**	**0.22**	**0.14**	0.00	**0.09**	**0.13**	0.02	0.00	0.00
1988	**0.44**	0.05	0.00	0.02	0.01	**0.62**	**0.37**	**0.20**	**0.08**	**0.17**	**0.21**	**0.12**	0.00	**0.07**	**0.12**	0.02	0.00	0.00
1989	**0.43**	0.05	0.00	0.02	0.01	**0.62**	**0.37**	**0.18**	**0.08**	**0.14**	**0.21**	**0.12**	0.00	**0.06**	**0.12**	0.02	0.00	0.00
1990	**0.47**	0.05	0.00	0.02	0.01	**0.67**	**0.40**	**0.23**	**0.10**	**0.16**	**0.23**	**0.14**	0.00	**0.06**	**0.13**	0.02	0.00	0.00
1991	**0.43**	0.05	0.00	0.02	0.01	**0.64**	**0.37**	**0.20**	**0.08**	**0.13**	**0.21**	**0.13**	0.00	**0.05**	**0.12**	0.02	0.00	0.00
1992	**0.40**	0.04	0.00	0.01	0.01	**0.62**	**0.35**	**0.18**	**0.08**	**0.10**	**0.18**	**0.12**	0.00	**0.05**	**0.10**	0.02	0.00	0.00
YEAR	MCH	ELE	ICT	INS	TRS	OTH	UTL	CON	SAL	HOT	TS	PT	FIN	REA	BUS	ADM	EDU	HEA
1981	0.01	0.01	0.00	0.00	0.00	**0.19**	0.00	**0.10**	0.03	**0.14**	0.00	0.00	0.00	0.00	**0.13**	0.00	0.01	0.02
1982	0.01	0.01	0.00	0.00	0.00	**0.19**	0.00	**0.10**	0.04	**0.23**	0.00	0.00	0.00	0.01	**0.13**	0.01	0.01	0.02
1983	0.01	0.01	0.00	0.00	0.00	**0.18**	0.00	**0.09**	0.05	**0.30**	0.00	0.00	0.00	0.01	**0.12**	0.01	0.01	0.02
1984	0.00	0.01	0.00	0.00	0.00	**0.16**	0.00	**0.08**	0.05	**0.35**	0.00	0.00	0.00	0.01	**0.11**	0.01	0.01	0.02
1985	0.00	0.01	0.00	0.00	0.00	**0.13**	0.00	**0.06**	0.05	**0.34**	0.00	0.00	0.00	0.01	**0.08**	0.01	0.01	0.02
1986	0.00	0.01	0.00	0.00	0.00	**0.11**	0.00	**0.06**	0.05	**0.36**	0.00	0.00	0.00	0.01	**0.08**	0.01	0.01	0.02
1987	0.00	0.01	0.00	0.00	0.00	**0.10**	0.00	**0.05**	0.05	**0.35**	0.00	0.00	0.00	0.01	**0.07**	0.01	0.01	0.02
1988	0.00	0.00	0.00	0.00	0.00	**0.09**	0.00	**0.05**	0.03	**0.36**	0.00	0.00	0.00	0.02	**0.06**	0.00	0.01	0.01
1989	0.00	0.00	0.00	0.00	0.00	**0.09**	0.00	**0.05**	0.02	**0.36**	0.00	0.00	0.00	0.02	**0.06**	0.00	0.01	0.01
1990	0.00	0.00	0.00	0.00	0.00	**0.11**	0.00	**0.05**	0.02	**0.41**	0.00	0.00	0.00	0.02	**0.06**	0.00	0.01	0.02
1991	0.00	0.00	0.00	0.00	0.00	**0.10**	0.00	**0.04**	0.02	**0.37**	0.00	0.00	0.00	0.02	**0.06**	0.00	0.01	0.02
1992	0.00	0.00	0.00	0.00	0.00	**0.09**	0.00	**0.03**	0.01	**0.35**	0.00	0.00	0.00	0.02	**0.05**	0.00	0.01	0.01

Source: China Industrial Productivity (CIP). Each column represents an industry, the value is the ratio of the share of agricultural goods to the total intermediate goods in this industry.

Table E.3
Intermediate goods to output ratio

Industry	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
ADM	0.46	0.46	0.43	0.41	0.40	0.38	0.36	0.38	0.40	0.35	0.43	0.52
AGR	0.28	0.28	0.30	0.31	0.31	0.32	0.33	0.34	0.34	0.34	0.36	0.37
BUI	0.55	0.55	0.56	0.57	0.57	0.58	0.59	0.60	0.62	0.64	0.65	0.65
BUS	0.55	0.55	0.56	0.57	0.58	0.58	0.59	0.58	0.56	0.57	0.54	0.51
CHE	0.65	0.65	0.65	0.66	0.66	0.66	0.67	0.67	0.68	0.69	0.70	0.71
CLM	0.42	0.42	0.41	0.41	0.41	0.40	0.40	0.44	0.48	0.54	0.55	0.56
CON	0.74	0.74	0.73	0.73	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.70
EDU	0.51	0.51	0.49	0.47	0.46	0.44	0.43	0.41	0.38	0.40	0.34	0.28
ELE	0.66	0.66	0.67	0.68	0.69	0.70	0.70	0.71	0.72	0.73	0.74	0.75
F&B	0.78	0.78	0.79	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.80	0.80
FIN	0.33	0.33	0.26	0.20	0.16	0.11	0.06	0.11	0.17	0.07	0.27	0.48
HEA	0.69	0.69	0.67	0.65	0.65	0.63	0.62	0.61	0.61	0.61	0.59	0.57
HOT	0.71	0.71	0.72	0.72	0.72	0.72	0.72	0.71	0.69	0.70	0.65	0.60
ICT	0.67	0.67	0.68	0.69	0.70	0.71	0.72	0.72	0.73	0.74	0.74	0.75
INS	0.52	0.52	0.54	0.55	0.55	0.56	0.57	0.60	0.62	0.66	0.66	0.66
LEA	0.70	0.70	0.71	0.71	0.72	0.72	0.73	0.74	0.75	0.75	0.77	0.80
MCH	0.61	0.61	0.62	0.63	0.63	0.64	0.64	0.66	0.67	0.69	0.70	0.72
MEM	0.43	0.43	0.44	0.46	0.46	0.47	0.48	0.51	0.53	0.57	0.59	0.61
MEP	0.65	0.65	0.66	0.66	0.67	0.67	0.68	0.69	0.71	0.71	0.74	0.76
MET	0.67	0.67	0.67	0.67	0.67	0.68	0.68	0.69	0.70	0.74	0.73	0.72
NMM	0.35	0.35	0.37	0.38	0.39	0.40	0.41	0.44	0.48	0.52	0.56	0.61
OTH	0.62	0.62	0.63	0.63	0.64	0.64	0.65	0.67	0.70	0.74	0.75	0.75
P&P	0.64	0.64	0.65	0.66	0.66	0.67	0.68	0.69	0.70	0.70	0.72	0.73
P&T	0.46	0.46	0.40	0.35	0.32	0.28	0.24	0.26	0.28	0.32	0.32	0.31
PET	0.56	0.56	0.57	0.57	0.57	0.57	0.58	0.60	0.63	0.65	0.69	0.72
PTM	0.29	0.29	0.28	0.26	0.26	0.25	0.24	0.27	0.30	0.35	0.36	0.38
R&P	0.67	0.67	0.68	0.69	0.69	0.70	0.71	0.72	0.72	0.73	0.74	0.75
REA	0.50	0.50	0.46	0.41	0.39	0.36	0.32	0.31	0.30	0.31	0.28	0.25
SAL	0.55	0.55	0.51	0.47	0.45	0.42	0.39	0.42	0.46	0.55	0.54	0.53
SER	0.31	0.31	0.32	0.33	0.33	0.34	0.35	0.38	0.41	0.45	0.48	0.51
T&S	0.43	0.43	0.42	0.40	0.40	0.39	0.38	0.39	0.40	0.41	0.43	0.44
TBC	0.23	0.23	0.26	0.28	0.29	0.31	0.33	0.34	0.36	0.34	0.39	0.44
TEX	0.72	0.72	0.72	0.73	0.73	0.74	0.74	0.75	0.76	0.77	0.78	0.79
TRS	0.67	0.67	0.68	0.69	0.69	0.70	0.70	0.71	0.71	0.72	0.73	0.73
UTL	0.66	0.66	0.67	0.67	0.68	0.68	0.69	0.70	0.70	0.72	0.72	0.73
W&F	0.65	0.65	0.66	0.67	0.67	0.68	0.68	0.69	0.70	0.71	0.73	0.75
WEA	0.69	0.69	0.69	0.70	0.70	0.70	0.71	0.72	0.73	0.74	0.76	0.78

Source: China Industrial Productivity (CIP). Each row represents an industry, and the value is the ratio of intermediate goods to output in this industry.

Table E.4
Industry code description

Description	Industry
Agriculture, forestry, animal husbandry & fishery	AGR
Coal mining	CLM
Oil & gas excavation	PTM
Metal mining	MEM
Non-metallic minerals mining	NMM
Food and kindred products	F&B
Tobacco products	TBC
Textile mill products	TEX
Apparel and other textile products	WEA
Leather and leather products	LEA
Sawmill products, furniture, fixtures	W&F
Paper products, printing & publishing	P&P
Petroleum and coal products	PET
Chemicals and allied products	CHE
Rubber and plastics products	R&P
Stone, clay, and glass products	BUI
Primary & fabricated metal industries	MET
Metal products (excluding rolling products)	MEP
Industrial machinery and equipment	MCH
Electric equipment	ELE
Electronic and telecommunication equipment	ICT
Instruments and office equipment	INS
Motor vehicles & other transportation equipment	TRS
Miscellaneous manufacturing industries	OTH
Power, steam, gas, and tap water supply	UTL
Construction	CON
Wholesale and retail trades	SAL
Hotels and restaurants	HOT
Transport, storage & post services	T&S
Information & computer services	P&T
Financial Intermediations	FIN
Real estate services	REA
Leasing, technical, science & business services	BUS
Government, public administration, and political and social organizations, etc.	ADM
Education	EDU
Healthcare and social security services	HEA
Cultural, sports, and entertainment services; residential and other services	SER

Source: China Industrial Productivity (CIP).

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