The political economy of endogenous dual-sector model: public goods, labor markets and tax rates

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Abstract

Purpose – This paper studies the political economy of the endogenous urban–rural divide in two dimensions: labor market and provision of public goods.

Design/methodology/approach – This paper gives a dual-sector model endogenously depending on the consumption of public goods (club goods), the number of rural–urban migrants and the tax rate (transfer payments).

Findings – According to the research findings in this paper, the constraints on the participation of rural residents portray the rural residents' bargaining power, and in the game between the urban elites and the rural residents, tax rates depend on the preferences of the urban elites and the constraints urban elites and the rural residents jointly face. Therefore, the urban elites have to set tax rates deviating from the most preferred ones. The model in this paper can explain a series of empirical findings and yield new theoretical findings for empirical testing.

Originality/value – Significantly, the paper finds that the increase in agricultural productivity will lead to industrialization, accompanied by the disintegration of the dual-sector model. However, though the increase in industrial productivity can accelerate industrialization, it will further expand the urban–rural divide.

Keywords Congestion effect, Two-sector model, Urban bias, Political economy

Paper type Research paper

> The most significant conflict in underdeveloped countries today is not between labor and capital. Nor is it between foreign and national interests. It is between the rural classes and the urban classes — Michael Lipton

1. Introduction

Since Arthur Lewis (1954), the "dual-sector model" concept has had far-reaching effects on the researchers of development economics and policymakers and has remained the starting point

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for most economists in considering the economic issues of developing countries. According to Lewis's opinions, a dual-sector model of economic development exists in many developing countries, where a modern sector and a traditional sector coexist. The modern sector is economically advanced, with modern urban lifestyles and industries as well as advanced technology, while the traditional sector is associated with rural life, agricultural production and backward system and technology. The labor force in the traditional sector is utilized inefficiently, and as per Lewis's opinions, this labor force can be transferred to the modern sector without reducing the output of the traditional sector. The "problem of development" is how to move people and resources from the traditional sector (rural areas) to the modern sector (urban areas). Indeed, many developed countries have gone through urbanization and industrialization. The ongoing urbanization in China and other developing economies confirms Lewis's idea.

One policy implication of Lewis's idea is that by liberalizing labor moves and transferring rural residents from the rural sector to the urban sector, the urban–rural dual-sector model will be eliminated, and the economy will grow [1]. However, according to the history of global economic development, most developing countries have been mired in the dual-sector model of economic development for a long time. Thus, unlike Lewis's assumption that the dual-sector model is exogenously given, it endogenously depends on the political process in many countries.

Lipton (1977) noticed the urban-biased policies prevalent in developing countries very early: the urban elites pressure governments into making rules and policies biased towards them, such as accessing better public goods (e.g. healthcare and education) and more rights in the labor market. Also, Bates (1981) discovered that urban elites capture rents by distorting the prices in product and factor markets (e.g. by depressing the purchase price of agricultural products) [2]. This artificial dual-sector model of economic development affects efficiency, hinders economic development and creates extreme inequality. This indicates that the dual-sector model is an endogenous (equilibrium) phenomenon, and economists should understand the political economy that causes such kind of phenomena.

Although China has enjoyed remarkable economic growth since its opening up and reform, the Chinese society is now still a typical dual-sector society. China's urbanization rate has only reached 51%, and the dual-sector pattern has not fundamentally changed. The divide between urban and rural areas in China lies not only in space but also in access to social benefits. The urban residents (and their children) are entitled to social benefits to which rural residents (and their children) are not entitled regarding education, healthcare, social security and job opportunities. In the labor market, rural residents fail to integrate into the cities permanently but end up returning to their hometowns in the countryside as a floating population.

China's urban bias in the provision of public goods is noticeable. According to statistics about the divide between urban and rural residents in access to education and healthcare, in 1997, the enrollment of urban ordinary secondary and primary schools was 48.82 and 30.32% of the national total, respectively, while the educational expenditure of urban ordinary secondary and primary schools within the fiscal budget were 61.25 and 36.39% of the national total, respectively. Regarding educational expenditure per student in primary and secondary schools, the figure for urban areas was 1.79 times that for rural areas. In 2002, 40.63% of China's national educational funds allocated to primary and secondary schools went to rural areas. In 2000, 69% of China's urban population had access to sanitation facilities, while only 27% of the total rural population accessed sanitation facilities (Hou and Zhang, 2006). According to the data released by the World Health Organization in 2002, China ranked 188th (the fourth lowest) in the world regarding equity in the distribution of health resources. The urban residents, representing 30% of China's total population, had access to 80% of the nationwide health resources, while the rural residents, occupying 70% of China's total population, accessed only 20% of China's health resources.

This is accompanied by the gradual widening development gap in the urban and rural areas. In terms of labor productivity, if "comparative labor productivity" is used to evaluate the urban and rural labor productivity, the comparative labor productivity of the primary industry was always lower than that of the secondary and tertiary industries from 1978 to 2009. In the sense of comparative labor productivity, the labor productivity gap between urban and rural workers is significant (Gao, 2012). Regarding resident income, China's income gap is caused mainly by the urban–rural income gap. If the urban–rural income gap is significantly reduced, China's income gap problem will greatly improve (Wan, 2006).

The urban-biased household registration, education, healthcare and social security systems have severely restricted the transformation of China's dual-sector economic development model, fettered its economic growth potential and exacerbated the inequality and imbalance of China's development. According to Chen *et al.* (2010), one of the crucial causes of the urban–rural income gap is the urban–rural education gap. The difference in education level contributes 34.69% to the urban–rural income gap in China, and the urban–rural education gap tends to widen further. Though policymakers and many researchers argue that urbanization is a critical engine for China's economic development, it is undeniable that there are still many obstacles to China's urbanization, including huge pressure from the urban sector regarding the reform of the household registration system. Especially since the reform and opening up in 1978, the cyclical changes in the urban–rural gap have mainly originated from the pressure of the urban interest groups and the institutional factors inherited from the traditional system; in other words, there is a gap between the influence of different groups on policies (Cai and Yang, 2000).

Some studies have been conducted to explain the persistence of urban-biased policies and the dual-sector model from the political economy perspective. According to the theory of Majumdar *et al.* (2004), urban and rural residents differ in their access to information, and information enables residents to judge the government's ability to provide public goods by the quality and amount of the public goods observed. The superiority of urban residents in terms of access to information will likely lead to an urban bias in the allocation of public resources when the government's goal is to gain reelection. However, in their argument, this information advantage of urban residents stems from the factors such as higher levels of per capita wealth and education, as well as the concentrated coverage of various types of media in urban areas. However, we believe that these factors are the results and manifestations of urban bias and that treating them as the cause of urban bias misses the point. Chen and Lu (2008), on the other hand, explain the formation of the urban–rural dual-sector model from the perspective of capital accumulation.

Fergusson (2013) formulates a model of the conflict within the rural sector, indicating that the large landowners in the elites support the policies that weaken the peasants' property rights because the landowners rely on the peasants for labor. Fergusson explains the emergence of incomplete property rights regimes and provides an endogenous mechanism for the persistence of inefficient rural property rights regimes in the development process. However, the phenomenon researched in his study is not representative because, in most countries, dual-sector is manifested as a conflict between urban and rural areas; just as Lipton (1977) observed long ago, the most critical conflict in underdeveloped countries is not between labor and capital but between urban and rural areas. Therefore, Fergusson's research misses the point in regard to the persistence of the dual-sector model.

Pedersen (1997) also argues that the urban bias is caused mainly by government policies and furthermore, due to the uneven distribution of political influence. Other explanations focus on exploring the theory of political organization (Olson, 1971), arguing that peasants are generally the most decentralized political group, especially in most regions of Africa and Latin America, and that it is usually costly and thus much less efficient for peasants to form a pressure group (Bates, 1981; Binswanger and Deininger, 1997).

However, the above literature fails to note that in Asian developing countries, where the density of rural populations is very high, peasants can form an effective rural pressure group (In fact, peasants engaged in rice cultivation are the group with the most voters in many Asian countries). Moreover, in many East Asian countries or regions (Korea, Taiwan, Malaysia and Indonesia), the threat of peasant-induced insurgency has forced the authorities to especially consider the needs and interests of these peasants (Eastwood and Lipton, 2004; World Bank, 1993).

Other studies have highlighted that since the founding of New China, the urban–rural dual-sector model was born out of a strategy of prioritizing the development of heavy industry. For example, Lin and Liu (2003) argue that the allocation structure of production factor stocks formed under the catch-up strategy of prioritizing the development of heavy industry pursued since the founding of New China is not in line with the comparative advantage and is the main cause of regional income disparities. In addition, Chen and Lin (2010) theoretically demonstrate that, both from a static perspective and in a dynamic framework, a heavy industry-first development strategy will lead to a lower level of urbanization and a larger urban–rural wage gap; moreover, the greater the degree of catch-up, the lower the level of urbanization, the slower the urbanization process, the larger the urban–rural wage gap and the slower its reduction. Although the impact of this strategy has now weakened significantly and some of the corresponding institutional arrangements (e.g. the household registration system) are loosened, the urban–rural dual-sector model in China has not been fundamentally changed as mentioned above, and deeper causes need to be sought in theory.

We argue that the existing literature on political economy explaining the dual-sector model neglected two crucial dimensions. One is the general equilibrium effect of the labor market, i.e. how the move of rural labor influences the wage level in the urban sector and further influences the endogenous policies; the other dimension is the bargaining and compromise of the urban elites and the rural residents. However, these are not considered in the existing literature, and the fact is that the urban elites are not unconstrained in formulating the urban-biased policies – they must respect the potential revolutionary constraint (participation constraint) of the rural residents, namely, the retained utility of the rural residents cannot fall below a certain threshold, or else a potential revolution or social conflict will occur. The participation constraint determines the relative bargaining powers of the urban and rural sectors, the size of the cake they gain and the endogenous policies.

Our model will explicitly consider these two points. Our approach is closer to the political economy literature on social conflicts, such as Roemer (1998), Grossman (1991, 1994), Wintrobe (1998), Bueno de Mesquita *et al.* (2003) and Acemoglu and Robinson (2006). These works explicitly examine the games between the government and the masses. More specifically, since the political elites are under the pressure of social conflicts, they must make some compromises to the masses during policymaking, such as tax reduction and transfer payments. In our model, all these policy measures can be portrayed as tax rates.

Here we construct a game model between the urban elites with a small proportion of the total population and the rural residents with a large proportion in a nondemocratic society and embed the general equilibrium effects of the labor market in this game. In this model, the urban elites determine the tax rates and policies on population move and try to maximize their utility by formulating the best policy mix under the government's budget constraint and the rural residents' revolutionary or social conflict constraint (participation constraint).

In terms of urbanization, the urban elites face competition from the rural residents in two aspects. The first one is the public goods with congestion effect: more rural residents migrating to urban areas will lead to a decrease in the quality of the public goods (e.g. education, healthcare, etc.) enjoyed by the urban elites. The public goods here are a kind

of club goods with only a part of competition and exclusivity (Cornes and Sandler, 1996), i.e. not pure public goods but quasipublic goods with a certain congestion effect [3]. One of the characteristics of club products is the presence of congestion effect, which means that the quality of the public goods consumed by individuals decreases as the number of consumers increases. Club products produce congestion effects in a variety of ways, such as longer waiting time, slower service, longer travel time on highways and greater noise in public places. In this paper, we focus on the club products that can improve human capital, such as education and healthcare. The second is the labor market: the migrants from the rural sector and the existing residents of the urban sector will also compete in the labor market, which will reduce the balanced wage level.

If the industrial characteristics of different industries and the economic behavior of urban and rural residents are regarded as the "endogenous" factors leading to the dual-sector model of economic development and the government policies are the "exogenous" factors leading to the dual-sector model, a more convincing analytical framework will be able to endogenize both. We believe that it is an effective way to explore the causes and trends of the dual-sector economic model from the political economy perspective.

The rest of the paper is organized as follows: section 2 gives the basic setup of the model; section 3 portrays the economic equilibrium under a given policy combination; section 4 gives some results of comparative static analysis; section 5 portrays the political equilibrium and section 6 concludes the whole paper.

2. The model

We consider a two-sector economy with the total population normalized to 1. The rich (urban elites) in the urban sector (denoted by u) is $\alpha \in (0, 1)$, and the remaining population, denoted as $1-\alpha$, indicates the poor (rural residents) in the rural sector (denoted by r). These two sectors are described below with some basic notations.

(1) The rural sector: The technology of the rural sector is portrayed in the following function [4]: $Y_r = A_r F(t, L)$, where A_r is the total factor productivity, t the total amount of land and L the effective labor input into the rural sector. In particular, $L = \mu_r \overline{L}$, where μ_r, the selection variable of the rural residents (while μ_u denotes the selection variable of the urban residents accordingly), is the quality of the public goods consumed by the rural residents (such as education and healthcare, which can improve the level of human capital and production efficiency). Furthermore, $\overline{L} = 1-\alpha-m$ is the total rural–urban labor input into the rural sector, and m represents the number of rural migrants flowing to urban areas. We assume that the rural sector's production function F has constant returns to scale for the labor and land input and enjoys the basic properties of a typical concave function:

$$F_t > 0, F_u < 0, F_L > 0, F_{LL} < 0, F_{tL} > 0$$

We assume that the rural residents have no land ownership, and then each rural resident in $1-\alpha-m$ has to rent land for farming. In the equilibrium, all land is rented out and fully utilized. Suppose each rural resident is of the same quality and the land will be evenly distributed among all rural residents, then the amount of land allocated to each rural resident is $\frac{t}{1-\alpha-m}$. The net income of a representative rural resident is as follows:

$$y_r = pA_r F\left(\frac{t}{1-\alpha-m}, \mu_r\right) - \frac{\rho t}{1-\alpha-m}$$

where ρ is the rental price of land and is given, deemed by rural residents; p is the price of agricultural products in relation to industrial products. In the equilibrium, the rural residents maximize their net income by equaling the value of marginal products of the land to ρ, i.e. the rental price of the land. Therefore, the equilibrium rental price of the land is as follows:

$$\rho = pA_r F_t\left(\frac{t}{1-\alpha-m}, \mu_r\right) \tag{1}$$

Since the rural sector's production function has constant returns to scale, the net income of a representative rural resident is as follows:

$$y_r = pA_r F\left(\frac{t}{1-\alpha-m}, \mu_r\right) - \frac{\rho t}{1-\alpha-m} = \mu_r pA_r F_L\left(\frac{t}{1-\alpha-m}, \mu_r\right) \tag{2}$$

The above equation indicates that the net income of a representative rural resident equals the product of the value of the marginal products of his/her effective labor input and the quality of the public goods consumed by him/her.

(2) The urban sector: The wages earned by a worker in the urban sector are w_u. We assume that the wages of urban workers decrease with an increasing number of rural migrants flowing to urban areas. In addition, as the urban sector is perfectly competitive, the reward available to an urban laborer equals his marginal product. Based on the existing literature, we assume, without loss of generality, that the marginal product of the effective labor input of a representative rural resident is lower than that of an urban worker, i.e. $pA_r F_L\left(\frac{t}{1-\alpha-m}, \mu_r\right) < w_u$.

Another assumption is that the rural residents migrating to the urban sector cannot work in the rural sector meanwhile. In other words, the labor of each rural resident cannot be split. With the migration of rural residents to the urban area, the rural sector will lose one unit of labor. To simplify the analysis, we omit the specific form of the production function of the urban sector (industry or manufacturing sector), which does not affect the main results. We give the following functional form of wages:

$$w_u = A_u \omega(m) \tag{3}$$

where A_u is the total factor productivity of the urban sector. We assume that the function $\omega(\cdot)$ has the following properties: $\omega' < 0$ and $\omega'' > 0$. As mentioned, these properties mean that the urban wages decrease with an increase in the number of migrants m. Like the rural residents in the rural sector, the net income of an urban worker equals the product of the marginal product of his effective labor input (i.e. the wage rate per unit of labor input denoted by w_u) and the quality of the public goods consumed by him, μ_u. This can be summarized in the following equation:

$$y_u = \mu_u w_u \tag{4}$$

(3) Maximization of individual utility: Individual utility originates from the consumption of industrial products c, leisure and health. It is worth noting that we think the agricultural output is used to meet survival needs only. Therefore, we set the function of individual utility as follows:

$$U_i = c_i + Q(1-\mu_i)\, i = r, u$$

where the function Q has the properties of a concave function, i.e. $Q' > 0$ and $Q'' < 0$. This quasilinear form of the utility function is an excellent way to depict the "hierarchy of needs",

showing that the consumption of public goods takes precedence over industrial product consumption. In regard to public goods like education and healthcare, this form of utility function suggests that people will participate in certain training programs or health insurance before engaging in market-based production activities. In particular, a higher quality of education for personal consumption implies more input of effort and time is required, resulting in less leisure time and lower utility gained. Similarly, a higher quality of healthcare for personal consumption implies more treatment and care required, resulting in less time of staying healthy and lower utility gained. Without loss of generality, we normalize the upper bound (endowment) of the time for personal leisure or health to 1, and the utility function is set to the above form.

In terms of consumption, every person must first meet his basic survival needs, and it is assumed that every person consumes $\overline{S}$ unit(s) of agricultural output. When this need is met, the individual consumption is as follows: $\overline{c}_i = y_i - p\overline{S} - \tau\mu_i;\ i = r, u$ where τ is the tax rate determined at the first stage of the game, which will be discussed later, and is deemed given here. Hamilton (1975) argues that the property tax serves as "the price for public services." In other words, the property tax can be regarded as the "congestion fee" for the public goods because the property tax paid by residents equals the marginal effect of a new resident's cost for the public goods provided by the government at the existing level (Wilson, 1997).

With the quality of the public goods consumed denoted by μ_r as a selection variable, the utility maximization of a representative rural resident means that the following first-order condition can be obtained:

$$pA_r(F_L + \mu_r F_{LL}) - \tau = Q'(1 - \mu_r) \tag{5}$$

Likewise, the first-order condition of an urban worker is as follows:

$$w_u - \tau = Q'(1 - \mu_r) \tag{6}$$

Then we analyze the migration decisions of rural residents. We denote the maximum utility gained by rural residents staying in the rural sector or migrating to the urban sector as V_r and V_u, respectively. If the initial condition is $V_u > V_r$, then migration will last until $V_u = V_r$. It is possible that $V_u < V_r$ when the number of migrants $m = 0$. In such a case, the rural residents have no motives for migration. To sum up, we adopt the form of complementary slackness to unify all the above conditions of the migration decisions of rural residents:

$$m(V_u - V_r) = 0, m \geqslant 0, V_u - V_r \leqslant 0 \tag{7}$$

We did not give a specific functional form regarding the quality of the public goods consumed by the people initially, and now we take the sector size into account. For a given sector (club), we use $\mu = f(q, N)$ to denote the impact of the sector size on the quality of the public goods consumed by people, where q is a "composite public good" representing the total amount of public goods services provided by a sector (club) and N is the number of persons consuming public goods at the same time. According to the assumption adopted by Borcherding and Deacon (1972) and Bergstrom and Goodman (1973) that μ is proportionate to q [5], we rewrite the above function as follows:

$$\mu_u = g(m)q_u \tag{8}$$

where $g''(\cdot) < 0$. It is worth noting that our main consideration is the number of rural migrants flowing to urban areas rather than the total number of persons consuming the public goods at the same time. Also, we define the elasticity of the quality of the public goods consumed towards the number of migrants ("elasticity of sector size") as follows:

$$\varepsilon_m^u = \frac{\partial \mu_u}{\partial m} \cdot \frac{m}{\mu_u} \tag{9}$$

ε_m^u is adopted to measure the change in the quality of the public goods consumed by the urban population when the total amount of the public goods (i.e. the public services provided) remains unchanged and rural migrants flow into the urban area. This elasticity can easily portray three conditions, i.e. the network effect ($\varepsilon_m^u > 0$), congestion effect ($\varepsilon_m^u < 0$) and zero effect of migrant influx ($\varepsilon_m^u = 0$).

(4) The game problem: We will complete the description of the entire economic problem after discussing the government acts. Now we consider the following games:

- The urban elites decide the tax rates and transfer payments under the government's budget constraint and the rural residents' revolution constraint. Then the rural residents decide whether to start a revolution or not. If a revolution occurs, the game ends; if a revolution does not occur, the game continues.
- The urban elites decide whether to allow the migration of rural residents to cities or not. If the migration is not allowed, the game ends; if the migration is allowed, the game continues. The rural residents decide whether to migrate to cities or not by comparing the maximum utility available to them under the conditions of entering the urban areas and staying in the countryside, i.e. V_u and V_r.
- The rural residents who have not migrated choose μ_r to maximize the utility U_r, while the migrated rural residents and urban elites choose μ_u to maximize the utility U_u. The urban labor market is perfectly competitive.

For a given policy mix, the second and third stages of the game determine the model's economic equilibrium, which will be discussed in the following section. In the first stage of the game, the model's political equilibrium depends on the urban elites' policy selection. How political equilibrium impacts economic equilibrium will be discussed in the fourth section.

3. Economic equilibrium

When the migration of rural residents to urban areas is allowed, migration will persist until the utility obtained in the urban sector is equal to the utility obtained in the rural sector. As mentioned above, we assume that an individual cannot work in both sectors simultaneously, and then we can define the economic equilibrium as follows.

Definition 1. (economic equilibrium): Given certain economic state variables $(A_r, A_u, t, \alpha, \tau)$, economic equilibrium is the combination of a series of prices and resource allocations $\{p^*, \rho^*, w_u^*, m^*, \mu_r^*, \mu_u^*, q_u^*\}$, which meets the following conditions:

(1) Given p, ρ, W_u *and* m, the nonmigrated rural residents choose μ_r to maximize the utility U_r and the rural migrants and urban elites choose μ_u to maximize the utility U_u, satisfying the first-order conditions, i.e. Equations (5) and (6).

(2) It is worth noting that the agricultural output must be able to meet the survival needs of all people, for all people need to consume $\overline{S}$ units of agricultural output.

Therefore, the following equation can be obtained:

$$\overline{S} = A_r F(t, L) = A_r F\left(t, \mu_r^*(1 - \alpha - m^*)\right) \tag{10}$$

And $(p^*, \rho^*, w_u^*, m^*, q_u^*)$ satisfies this equation and Equations (1), (3), (7) and (8).

We notice that $\frac{\partial \mu_u}{\partial m} = g'(m)q_u$. Through Equation (8), the elasticity of sector size can be expressed as $\varepsilon_m^u = \frac{g'(m)m}{g(m)}$. Since $g''(\cdot) < 0$, there is a $\widehat{m}$ that makes $g'(\widehat{m}) = 0$. At this time, μ_u takes the maximum value (denoted as $\widehat{\mu}_u$), and $\varepsilon_m^u = 0$. However, it is generally possible that $\widehat{\mu}_u \neq \mu_u^*$ and $\widehat{m} \neq m^*$. Therefore, m^*, the number of migrants in the equilibrium state does not necessarily exert a congestion effect on the urban sector, which depends on the relationship between the sizes of m^* and $\widehat{m}$. If $m^* < \widehat{m}$, since $g''(\cdot) < 0$ and $g'(\widehat{m}) = 0$, $\varepsilon_m^u(m = m^*) > 0$, the number of migrants in the equilibrium state will produce a network effect. On the contrary, if $m^* > \widehat{m}$, the number of migrants in the equilibrium state will produce a congestion effect.

We can now prove that the dual-sector model will exist even if free migration of individuals between sectors is allowed. Therefore, we have the following proposition.

Proposition 1. In the equilibrium state, the quality of the public goods consumed by the urban workers is higher than that consumed by the rural residents, i.e. $\mu_{u>}^* \mu_r^*$. In this sense, the dual-sector model exists.

The conclusion is that the urban elites have access to better education and healthcare resources, which complies with economic intuition and reality. This may be because urban residents have more and easier access to these resources. However, based on our model, this is the result of individual rationality in equilibrium. By consuming higher-quality public goods, urban workers can accumulate more human capital.

Unlike other literature, we do not focus on the factors hindering the migration of rural residents, such as urban unemployment and the cost of migration. Our model attempts to explain the existence of the dual-sector model without introducing such exogenous costs.

Obviously, based on the model in this paper, when the migration of the rural residents to the urban sector is not allowed, i.e. $m = 0$, the wages of the urban workers are higher than the urban wages under free migration. This result can be obtained when $w_u = A_u\omega(m)$ and $\omega'(\cdot) < 0$. In addition, judging from the first-order condition of Equation (6), the higher the urban wages are, the higher the quality of the public goods consumed by the urban residents is. Furthermore, when the congestion effect predominates in the urban sector, the quality of the public goods consumed by the urban residents increases with a decline in the number of migrants. In other words, when the total amount of urban public goods is fixed, the migrants "dilute" the public goods in the urban sector. Therefore, when there is a congestion effect in the urban sector, the optimal strategy of the urban elites at the second stage of the game is to prohibit the migration of the rural residents to urban areas. However, when a network effect exists, the outcome becomes uncertain because the number of migrants acts in the opposite direction on urban wages and the quality of public goods consumed.

4. Comparative static analysis

With some comparative static analyses, our model also gives some interesting results about the evolution of the dual-sector model with the change in economic conditions. Here we assume that a perfectly competitive market for agricultural output and industrial products exists, where technological progress (other than particularly significant technological progress) has almost no effect on the prices of agricultural output and industrial products. To put it another way, p, the price of the agricultural output relative to the industrial products, will not change when A_r and A_u increase. Therefore, we have Proposition 2.

Proposition 2. (1) An increase in the total factor productivity of the rural sector A_r will result in an increase in the number of migrants m^*, a decline in the quality of the public goods consumed by the urban residents μ_u^* and a reduction in

the urban wages w_u^*. (2) An increase in the total factor productivity of the urban sector A_u will result in no changes in the number of migrants m^*, an improvement in the quality of the public goods consumed by the urban residents μ_u^* and an increase in the urban wages w_u^*.

With Proposition 2, we obtain not only some common results of the general two-sector model but also arrive at some other interesting conclusions. As agricultural technology advances, the rural sector no longer needs too much labor, and the rural labor is "pushed" into the urban sector. More migrants increase the labor supply in the urban sector, and the urban wages fall accordingly. In addition, the cities begin to become crowded: the classroom sizes in schools expand; the hospitals become more crowded with patients waiting to be treated and thoroughfares become increasingly congested. Consequently, the urban public goods are "diluted;" thus, the quality of the public goods consumed by the urban residents is lower than before.

On the contrary, the increase in urban productivity will result in a rise in the effective labor input into the urban sector. Such technological progress may require higher-level knowledge and more specialized and higher skills without more workers. Contrary to what happened before, the technological progress in cities leads to not only a rise in urban wages but also an increase in the quality of the public resources consumed by the urban residents, such as education and healthcare. We can also draw the following inferences about the dual-sector model.

Inferring the conclusion obtained from the given Proposition 2:

(1) An increase in total factor productivity in the agricultural sector A_r will cause a reduction in the quality gap (degree of urban bias) between the public goods consumed by the residents of the two sectors, denoted as $\mu_u^* - \mu_r^*$.

(2) An increase in total factor productivity in the industrial sector A_u will cause a widening of the quality gap (degree of urban bias) between the public goods consumed by the residents of the two sectors, denoted as $\mu_u^* - \mu_r^*$.

The above inference suggests that the type of technological progress is related to the long-run development of the economy. Similar to the general dual-sector model, the results suggest that the technological progress in agriculture will reduce the size of the rural sector, thus reducing the gap between the two sectors. In contrast, while industrial-technological progress will also help the economy achieve industrialization, it will at the same time widen the gap between the two sectors. In sum, our model shows that the agricultural-technological progress spurs the disintegration of the dual-sector model, accompanied by industrialization, which can be supported by the findings of Schultz (1964), Lipton (1977), Matsuyama (1992) and Laitner (2000), who also argue that the technological progress in agriculture and the increase in agricultural productivity can lead to the transformation of economic structure and that the transformation of traditional agriculture is an important way to promote the transformation of the urban–rural dual-sector model.

Using the cross-sectional and panel data of 62 developing countries (regions) from 1960 to 1990, Gollin *et al.* (2002) found that the agricultural productivity gains are critical in explaining per capita gross domestic product (GDP) growth, contributing to 54% of GDP growth directly. In addition, they found that the countries that had experienced agricultural productivity gains were able to release labor from the agricultural sector effectively, and this intersectoral transfer of labor further explains 29% of GDP growth, while the remaining 17% of GDP growth comes from growth in the nonagricultural sector. Since then, some scholars have also studied the relationship between agriculture and economic growth by using a

dynamic general equilibrium approach. For example, Yang and Zhu (2013) demonstrated by building a two-sector intertemporal model that without increasing agricultural productivity, a traditional economy cannot break through the constraints of natural resources and thus cannot support the whole process of economic growth. Regardless of the agricultural growth rate, stagnant agricultural production in the early stage of development will impede the structural transition from a traditional to a modern economy. Timmer (2005) also points out that the investments in promoting agricultural growth will contribute to the overall economic growth. The Asian Green Revolution [6] in the late 1960s and early 1970s also demonstrates the positive role of agricultural-technological advances in economic transformation. Remarkably, the advances in machinery and biotechnology in the agricultural sector play a significant role in overcoming factor endowments, especially land and labor scarcity.

It should be noted that there is different thinking about the transformation path of the dual-sector model. Friedmann (1966), Hansen and Prescott (2002) and Ngai and Pissarides (2004) emphasize the development of the urban sector as a priority, followed by the development of rural areas, i.e. urban-centered, urban first, followed by rural, for the transformation of the dual-sector model. Several empirical studies have supported this idea. For example, Henderson (2007) finds that with the continuous increase of urbanization rates, Korea largely eliminated the urban–rural income gap in 1994, and Taiwan Province of China reduced the urban–rural income ratio to below 1.4 in 1995. Verner (2005) also found that urbanization significantly reduced the income gap, based on a study on Mexico's urbanization process from 1992 to 2002. Based on these analyses, much of the domestic literature also emphasizes that the transformation of China's dual-sector model should be achieved mainly through urbanization (Cheng and Li, 2007). Wan and Zhu (2010) point out that the economies of scale generated by the agglomeration of production factors and the reduction of production costs brought about by the optimal allocation of resources make urbanization the most fundamental and effective way to narrow the urban–rural gap.

However, as mentioned above, there are also empirical studies showing that the urban–rural income gap has increased rather than decreased with the continuous advancement of urbanization. For example, Wang (2009) points out that since the founding of New China, the urban–rural economic gap has shown a tendency to rise amidst fluctuations, and if measured with the residential consumption indicators, the current urban–rural gap exceeds that of any period since the founding of New China. The above divergences precisely imply that agricultural development and agricultural technological progress are often neglected in the transformation of the urban–rural dual-sector model, and during urbanization, many problems are still to be solved, including improving the regulations on the labor market, capital market and property rights.

In the foregoing analysis, we considered the tax rate as a given, which is decided by the urban elites in the first stage of the game. In the next section, we will discuss the decision on this tax rate in detail. For now, we will first analyze how the urban elites affect the economic equilibrium through policy choices in the first stage of the game, that is, how the political equilibrium affects the economic equilibrium.

Proposition 3. An increase in the tax rate τ will lead to a decrease in the number of migrants, while the change in the quality of the public goods consumed by the urban residents is uncertain.

When the rural residents are taxed more, their incomes will decrease. As the price of public services or the "congestion charge" of public goods, the quality of the public goods consumed by the rural residents will naturally decrease when the tax rate τ increases. As a result, the rural–urban migrants will reduce so that there will be enough efficient labor input into agricultural production. However, the reduction in the number of migrants leads to an increase in urban wages. If the increase in urban wages exceeds the increase in the tax rate,

the urban residents will be able to consume higher-quality public goods because the increase of tax rate will be small, and the increased tax revenue will be used to provide more public goods such as schools and hospitals. If the opposite happens, then the urban residents will consume lower quality public goods because the tax rate is too high relative to the increase in wages, and the urban residents will have lower real incomes. These two conditions can also be equivalently regarded as when there is a congestion effect in the urban sector, the quality of public goods consumed by urban residents increases with the increase of "congestion cost", while when there is a network effect in the urban sectors, the conclusion is just the opposite.

5. Political equilibrium

In the previous sections, we analyzed the economic equilibrium of the dual-sector model, considering the second and third stages of the overall game. Now we return to the first stage of the game and delineate the political equilibrium. Since most developing countries (or dual-sector structured economies) are not a democracy fully or partially, we just consider the cases of non-democratic societies. The urban elites decide on a nonnegative tax rate, namely, $\tau \geq 0$, and adopt proportional taxation (that is, the tax levied occupies a certain percentage of the income). Then the tax collected is distributed in the form of a one-time transfer payment to the rural and urban residents T_r and T_u, respectively. In addition, we draw on the approach of Acemoglu and Robinson (2006) to consider another critical constraint in addition to the government's budget constraint – the revolutionary constraint of the rural residents, namely, the urban elites shall respect the participation constraint of the rural sector determined by social conflicts.

In this section, we consider the nominal income of the two sectors and denote them as I_r and I_u, respectively, different from the marginal products y_r and y_u, units of the effective labor input in the rural and urban sectors. We continue to use some of the notations adopted earlier. In a total population normalized to 1, the rural population with income I_r is $1-\alpha > \frac{1}{2}$ with the urban population with income I_u as α. The average income is denoted as $\bar{I}$. To portray the inequality of income distribution, we introduce another parameter β to denote the share of total income received by the urban elites. Thus, we have $I_r = \frac{(1-\beta)\bar{I}}{1-\alpha}$ and $I_u = \frac{\beta\bar{I}}{\alpha}$. It is worth noting that an increase in β represents an increase in inequality. Also, since we require $I_r < \bar{I} < I_u$, we have $\frac{(1-\beta)\bar{I}}{1-\alpha} < \frac{\beta\bar{I}}{\alpha}$ or $\beta > \alpha$.

We assume that taxation has a cost and that the cost of taxation at a tax rate τ is $C(\tau)\bar{I}$, where the total economic income (which is also the average income) $\bar{I}$ is introduced just as a normalization. With the increase in $\bar{I}$, the cost of taxation also increases. In particular, we assume $C:[0,1]\to R_+$ with the general properties of a convex function: $C(0) = 0, C'(\cdot) > 0, C''(\cdot) > 0, C'(0) = 0, C'(1) = 1$.

All individuals maximize the utility from their consumption, while the consumption equals their after-tax income. When the tax rate is τ, and the targeted transfer payment is $T_i (i = r, u)$, we denote the indirect utility and after-tax income of individual i as $V(I_i|\tau, T_i) = (1-\tau)I_i + T_i, i = r, u$.

Now we consider the threat of revolution (social conflict) as a constraint condition (participation constraint) on nondemocratic politics. To simplify the analysis, we assume that after the outbreak of a revolution, the θ component of the social resources is destroyed, and the remainder is distributed equally among the rural residents (θ can also be interpreted as the cost of rural residents for collective action). Since the total income available for distribution is $(1-\theta)\bar{I}$ and the number of rural residents is $1-\alpha$, the indirect utility received by each rural resident after the revolution is as follows:

$$V_R^{\tau}(\theta) = \frac{(1-\theta)\bar{I}}{1-\alpha} \tag{11}$$

where R denotes "after the revolution" and $V_R^{\tau}(\theta)$ denotes the income (i.e. utility) received by the rural residents after the revolution. Regarding the government's budget constraint, the targeted transfer payment implies: $(1-\alpha)T_r + \alpha T_u = \tau[(1-\alpha)I_r + \alpha I_u] - C(\tau)\bar{I} = (\tau - C(\tau))\bar{I}$. It can be seen from the above equation that given τ and T_u (or T_r), T_r (or T_u) can be determined by this government budget constraint. Obviously, the urban elites do not want any redistribution to the rural residents, so $T_r = 0$. Thus, the urban elites choose to maximize the tax rate τ:

$$V(I_u|\ \tau, T_u) = (1-\tau)I_u + T_u = (1-\tau)I_u + \frac{(\tau - C(\tau))\bar{I}}{\alpha}$$

The first-order condition on τ is $\alpha I_u = (1 - C'(\tau_u))\bar{I}$. This yields an optimal tax rate $\tau_u > 0$ and targeted transfer payment T_u^u and T_r^u, preferred by the urban elites. Substituting the expression for I_u, we can see that τ_u satisfies the equation: $\beta = 1 - C'(\tau_u)$. And because $T_r^u = 0$, under the government budget constraint, we have $T_u^u = \frac{(\tau_u - C(\tau_u))\bar{I}}{\alpha}$. At this point, the indirect utility of the rural residents is as follows:

$$V\left(I_r|\ \tau_u, T_r^u\right) = (1-\tau_u)I_r + T_r^u = (1-\tau_u)\frac{(1-\beta)\bar{I}}{1-\alpha} \tag{12}$$

We can see that for rural residents, it would be advantageous to start a revolution if the rural income $V_R^r(\theta)$ brought by the revolution is higher than the income resulting from no revolution, denoted as $V(I_r|\ \tau_u, T_r^u)$. That is, if Equation (11) is greater than Equation (12), or if $\frac{(1-\theta)\bar{I}}{1-\alpha} > (1-\tau_u)\frac{(1-\beta)\bar{I}}{1-\alpha}$, which is equivalent to

$$\beta > \frac{\theta - \tau_u}{1-\tau_u} \tag{13}$$

Then the rural residents will start a revolution. If Equation (13) about the revolutionary constraint takes an equal sign, in other words, there is no difference between the rural residents starting a revolution and being comfortable with the status quo, the rural residents will not start a revolution. Thus, the revolutionary constraint is binding. When the rural residents try to start a revolution, we assume that the revolution will always succeed (in rational expectations equilibrium), then they receive the incomes $V_R^r(\theta) = \frac{(1-\theta)\bar{I}}{1-\alpha}$ and $V_R^u(\theta) = 0$, respectively. In contrast, the urban elite gets nothing because the income of rural residents is stripped from the urban elite. What matters is not that the urban elites have nothing to gain but that they get so little that they want to avoid a revolution. We need to distinguish two conditions to analyze the solution of this game:

The first condition: The equation about the revolutionary constraint, Equation (13), is loosened. This means that even if the tax rate denoted as τ_u set by urban elites is most preferential to the urban elite, starting a revolution is not in the interest of the rural residents. Then, in the subgame perfect Nash equilibrium of this game, the urban elites will definitely set the most preferred tax rate τ_u as the revolution is expected never to happen.

The second condition: Equation (13) is tight. This is a more interesting condition. In this case, the urban elites will respect the participation constraint of the rural residents and make certain compromises during policymaking to prevent any revolution.

However, whether such a tax rate exists is similar to the process of obtaining τ_u, where we can obtain a tax rate τ_r, which is most preferential to the rural residents. Thus, to maximize the utility of the rural residents, urban elites have no other choice but to set the tax rate as τ_r. The question now becomes whether $V(I_r|\ \tau_r, T_r^r) = (1-\tau_r)I_r + \frac{(\tau_r - C(\tau_r))\overline{I}}{1-\alpha} \geq \frac{(1-\theta)\overline{I}}{1-\alpha}$ is tenable, or equivalently, substituting the expression for I_r. The question is whether the following equation holds:

$$\theta \geq \beta(1-\tau_r) + C(\tau_r) \tag{14}$$

As mentioned earlier, we assume that if Equation (13) takes an equal sign, i.e. if there is no difference between the rural residents' being comfortable with the status quo and starting a revolution, they will not start a revolution.

(1) If Equation (14) does not hold, even if the tax rate set is most preferential to the rural residents, it will not be sufficient to prevent a revolution. This may be due to the fact that the productive economic resource effectively used by the rural residents after the revolution, i.e. the value of θ, is relatively small or because the cost of taxation is relatively high, even the tax rate that is most favorable to the rural residents is not sufficient for redistribution. In this case, the only equilibrium is achieved by a revolution started by rural residents.

(2) If Equation (14) holds, the situation is more interesting. At this point, the urban elites can consider equalized transfer payment rather than targeted transfer payment. For a given tax rate set by the urban elites denoted as $\widehat{\tau}$, the following equations are obtained:

$$V\left(I_r|\ \widehat{\tau}, \widehat{T}\right) = (1-\widehat{\tau})I_r + \widehat{T} = I_r + \left[\widehat{\tau}\left(\overline{I} - I_r\right) - C(\widehat{\tau})\overline{I}\right]$$
$$V\left(I_u|\ \widehat{\tau}, \widehat{T}\right) = (1-\widehat{\tau})I_u + \widehat{T} = I_u + \left[\widehat{\tau}\left(\overline{I} - I_u\right) - C(\widehat{\tau})\overline{I}\right]$$

where $\widehat{T} = \widehat{\tau} - C(\widehat{\tau})\overline{I}$. If $V(I_r|\ \widehat{\tau}, \widehat{T}) \geq \frac{(1-\theta)\overline{I}}{1-\alpha}$, equivalently, $\theta \geq \beta - [\widehat{\tau}(\beta-\alpha) - (1-\alpha)C(\widehat{\tau})]$, the rural residents will not start a revolution. Therefore, there exists a tax rate τ^* given by the following equation:

$$\theta = \beta - [\tau^*(\beta-\alpha) - (1-\alpha)C(\tau^*)] \tag{15}$$

we have $V(I_r|\ \tau^*, T^*) = V_R^r(\theta)$.

In the above condition, urban elites achieve the only equilibrium of the game by setting a tax rate τ^* to prevent the revolution. It is worth noting that if the set tax rate τ is lower than τ^*, a revolution will occur; otherwise, it will not. The reason for this is that a proportional tax on income and equalized transfer payment will make the urban elites bear a heavier tax burden (note that the net transfer payment received by the urban elites at this point is $(\tau(\overline{I} - I_u) - C(\tau)\overline{I} < 0)$. Moreover, in Proposition 3, we obtain that when there is a congestion effect in the urban sector, the quality of the public goods consumed by the urban residents increases as the "congestion cost" increases. However, we also conclude that when there is a congestion effect in the urban sector, the optimal strategy of the urban elites in the second stage of the game is not to allow rural migration to cities. Therefore, an increase in the tax rate τ must lead to a decrease in the quality of the public goods consumed by the urban residents. When there is a "network effect" in the urban sector, the quality of the public goods consumed by the urban residents decreases with an increase in the tax rate, regardless of whether rural migration into urban areas is allowed. In sum, the urban elites prefer lower tax

rates while the rural residents prefer higher tax rates, and τ^* is the minimum tax rate that prevents any revolution.

Before giving the main results, we introduce some notations. $S_u = \{\tau\}$ denotes the action taken by the urban elites, which consists of a series of tax rates $\tau \in [0, 1]$. Similarly, $S_r = \{\alpha(\cdot)\}$ denotes the action taken by the rural residents, i.e. the decision whether to start a revolution $\alpha(\tau)$ ($\alpha = 1$ means starting a revolution). According to the sequence of events in the game set up by us, this decision of the rural residents depends on the behavior of the urban elites acting first. Thus, α is a function, α: $[0, 1] \to \{0, 1\}$. Now, we can summarize the above analysis and obtain the following proposition.

Proposition 4. The game has a unique subgame perfect Nash equilibrium $\{S_u^*, S_r^*\}$, which we also define as a political equilibrium of the game, satisfying the following conditions: if Equation (13) does not hold, then $\{S_u^*, S_r^*\} = \{\tau_u, \alpha(\tau) = 0 \text{ holds for all } \tau\}$; if Equation (13) holds but Equation (14) does not, then $\{S_u^*, S_r^*\} = \{\tau_u, \alpha(\tau) = 1 \text{ holds for all } \tau\}$ and if both Equation (13) and Equation (14) hold, then $\{S_u^*, S_r^*\} = \{\tau^*, \alpha(\tau) = 0 \text{ holds for } \tau \geq \tau^* \text{ and } \alpha(\tau) = 1 \text{ holds for } \tau < \tau^*\}$ under the condition of equalized transfer payment, where τ^* is given by Equation (15).

This proposition gives an idea of how the constraints faced by and preferences of the urban elites in nondemocratic politics determine policymaking in equilibrium. When these constraints are not binding, the preferences of the urban elites become the main influencing factor. When these constraints are binding, the margin for the urban elite's choices is limited. Interestingly, although the urban elites in nondemocratic societies hold full political power, they may also have to deviate from their most preferred tax rate τ_u and instead set a tax rate that redistributes resources in favor of the rural residents. This is because the rural residents outside the political power system pose an effective external threat to the urban elites, which forces the elites to make some concessions.

6. Conclusions

Economic development is a process of transcending the dual-sector model, where only a few countries have succeeded, while most countries or regions have been caught in the trap of the dual-sector model for a long time and cannot extricate themselves from it. The paper provides a political economy theory to understand how the dual-sector model is endogenously determined in the political process.

We construct a model of a game between the urban elites and the rural residents and embed the general equilibrium effects of the labor market in this game. The urban elites try to maximize their utility through formulating the optimal policy mix under the government's budget constraint and the rural residents' participation constraint (revolutionary or social conflict constraint). The urban elites face competition from the rural residents in two aspects. One is public goods where congestion effects exist – more rural residents migrating to cities will lead to a decrease in the quality of the public goods (e.g. education, healthcare, etc.) enjoyed by the urban elites, and the other is labor market – more rural residents moving to cities will lower the wages of the urban residents. The urban-biased policies and the dual-sector model are endogenously determined in the equilibrium after the above circumstances are considered.

By portraying the interplay between the endogenous economic model and the endogenous policies, our model not only provides a formal model analysis for the stylized facts in the previous descriptive studies on urban bias (Lipton, 1977; Bates, 1981) but also explains why the urban-biased policies and the dual-sector economic model persist over time and predicts under what conditions they will disappear. The paper's results of comparative static analysis (theoretical prediction) can be tested with cross-country data.

China is at the crossroad between urbanization and economic structural transformation, and the theory presented in the paper is instructive for China's current urbanization and urban–rural integration. Particularly, the model in this paper suggests that the technological improvement in agriculture leads to the disintegration of the dual-sector model while accompanying industrialization; in contrast, although the technological improvement in the industry leads to industrialization, it widens the gap between the industrial and agricultural sectors. This indicates that economic development and technological improvement in the rural sector are significant, both in an economic and political sense. The development of the agricultural sector reduces the urban sector's resistance to urban–rural integration and makes the urban-biased policies decrease, which greatly contributes to the integration of the urban–rural dual-sector model. Since the reform and opening-up, especially after the shift of the focus of China's reform to the urban sector in the early 1980s, the development of China's rural areas has actually lagged behind so far. Chinese leaders have recognized the importance of agricultural modernization and have proposed "supporting new urbanization with agricultural modernization" (Li, 2013), which is very insightful. The previous literature has placed too much emphasis on urban development and neglected the role of rural development in eliminating the dual-sector model.

This study shows that the dual-sector model is an equilibrium phenomenon caused by the interplay of economic and political forces. To eliminate the urban–rural dual-sector model, policymakers need to consider the interplay of economic and political forces and the substitutability and complementarity between corresponding policies and institutions. Many specific policy design issues in this regard deserve further in-depth discussion.

Lastly, it is essential to note that our model examines the relationship between the urban and rural sectors without considering the role of the central government. Under China's centralized political and decentralized fiscal system, the central government would play a more active role in eliminating the dual-sector model (urban–rural divide) to reduce the resistance of local governments and the urban sector during the reform. For example, the central government can provide global public goods in facilitating cross-regional population moves and take on more responsibility for social security, such as providing some compensation to those damaged in the urban sector. There are also many institutional design issues in this regard that deserve further in-depth research. The central government may consider these general equilibrium effects and the interplay processes in this paper during its design of systems and specific policies.

Notes

1. The "modern sector" and the "traditional sector" can also be called "urban sector" and "rural sector" or "manufacturing sector" and "agricultural sector". We use these terms herein for convenience.
2. Pan (2008) discussed the inefficiencies caused by the distortion of factor market prices by the urban elites, but not in the context of a dual-sector model.
3. Nevertheless, for the sake of narrative convenience, we use the term "public goods" in the following.
4. Capital will not be considered in this paper without prejudice to the main mechanisms of action and conclusions.
5. Refer to Reiter and Weichenrieder (1999) for a discussion of this point.
6. The "Green Revolution" refers to the technological innovations in the 1960s that led to increased food production in parts of Asia, Africa and South America through the spread of high-yielding cereal varieties and technologies in some developed Western countries.

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