Why Doesn't India Industrialize?—A Dynamic General Equilibrium Approach—*†

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*This version: September 26th, 2010

†This paper is based on my master's thesis submitted to the University of Tokyo, and an earlier version was circulated under the title "Quantifying the role of low labor barrier in India—A dynamic general equilibrium approach—." I would like to thank Toni Braun, Julen Esteban-Pretel, Fumio Hayashi, and Yasuyuki Sawada for their useful comments and discussions. The remaining errors are my own.

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Abstract

India's relative GDP per capita to the U.S. was 7.4 % in 2004 and has not caught up with the U.S. We address the question of why India has shown poor economic performance. We argue that the important factors were the labor barrier in the organized sector, the low spatial mobility rate, and the government policy against the agricultural sector. In a three-sector neoclassical growth model, we find that these factors prevented the agricultural labor from moving out to a more productive organized sector, which resulted in economic underperformance. We also show that without the labor constraint in the organized sector, labor would have flowed from the agricultural sector and the relative GDP per capita would have risen significantly up to 30% in 2004. We argue that this barrier is due to the caste system or labor regulation.

Keywords: Three-sector growth model, Structural change, India.

JEL Classification: E1, O1, O4, N3

1 Introduction

For 44 years, India has stagnated and has not caught up with the U.S. In fact, the actual data shows that India's relative GDP per capita to the U.S. was 6.8 % in 1961 and in 2004, it had risen only to 7.4%. This difference of a factor of 16 in living standards is enormous. More interestingly, all countries that are almost as large as India do not necessarily face the same situation. One of the counterexamples is China. According to the data, the relative GDP per capita of China in 2004 was about 3.5 times as high as that in 1961. Why did not such high economic growth happen in India? This problem of economic development, which means "the problem of accounting for the observed pattern across countries and across time, in levels of growth of per capita income" (Lucas(1988)) is a major task facing economists.

In this paper, we attempt to account for the gap between India and the U.S. One explanation is that the share of employment in the agricultural sector was very high in India. In many cases, catching up has been associated with a huge decline in the agricultural sector. The high share of agricultural employment in India has already been argued by Virmani (2005), Bosworth, Collins, and Virmani (2007), and Bosworth, and Collins (2008). However, none of them explores why. Therefore, we need to consider how this could occur. In this case, we decompose economic activity into the three sectors; the agricultural, organized, and unorganized sectors. In this paper, the organized sector comprises the subsectors of the non-agricultural sector defined in the National Statistics Account provided by the government of India, and the rests of the non-agricultural sectors are classified under the unorganized sector. In a unique decomposition, we find three remarkable facts. The first fact is that since 1980, the TFP (Total Factor Productivity) series in the agricultural sector have started to rise and those in the non-agricultural sector have risen sharply. In particular, the TFP in the organized sector has increased dramatically. The second fact is that a small amount of labor has flowed from the agricultural sector. In 1980, the share of employment in the agricultural sector started to decrease, but this speed was quite slow. The third fact is that the share of employment in the organized sector was constant at approximately 8% over 44 years. Besides these points, India has two other characteristics. One is that the spatial mobility rate in India was low over our sample period, and the other is that India's sectoral policy regime had a positive or negative agriculture bias. The last three facts strongly suggest that there were forces that prevented labor in the agricultural sector from moving. This is just what Ngai (2004) argues. She claims that some countries are poor because barriers to technology adoption and capital accumulation delay the transition from land-intensive technology (the Malthus technology) to constant-to-scale technology with labor and capital (the Solow technology) described by Hansen, and Prescott (2002). We are certain that these three factors correspond to the barrier, which had an important quantitative effect on India's economic underperformance.

We shed light on the issue using a neoclassical growth model that addresses the structural transformation. This model can explain that once the productivity of the agricultural sector reaches the level needed to meet the food requirements, labor and capital begin to move out of the agricultural sector into the non-agricultural sector, which is highly productive owing to Engel's law. This transformation results in high GDP per capita. We build such a model to take into account the Indian economy. In particular, in this paper, we employ a three-sector model. The three sectors represent the agricultural, organized, and unorganized sectors. In recent years, some papers have addressed the structural transformation by using a three-sector model.[1] Echeverria (1997), Konsgsamut, Rebelo, and Xie (2001), and Duarte, and Restuccia (2010) are the recent papers.[2] Unlike the previous literature, our model considers the case where the labor barrier is superimposed. This method is developed by Hayashi, and Prescott (2008), who consider a two-sector model and incorporate a binding lower bound for agricultural employment. In addition to the labor barrier, we need to consider other assumptions. The first assumption is related to the low spatial mobility rate. Munshi, and Rosenzweig (2009) argue that such a mobility rate is due to the fact that there is a caste-based network in rural areas. This does not enable people living in rural areas to move to urban areas. To incorporate this fact, we assume that people living in urban areas incur a flow cost due to a lack of community or network. We model this in a reduced form way followed by Acemoglu (2008). Second, we assume that there is distortion to capital input in the agricultural sector. This is because sectoral policy should reflect the cost of intermediate inputs, as Restuccia, Yang, and Zhu (2008) argue.

When we conduct a simulation based on our model, we can show that our model can mostly reproduce the slow transformation from the agricultural sector, which has resulted in India's underperformance. Next, we perform the three stages as counterfactual simulations. The first stage is to eliminate distortion to the agricultural capital. The second stage is the case where half of flow cost is subsidized by the government. Finally, we try to lift the labor barrier in the organized sector. These simulations enable us to investigate how India's economy would have performed in the absence of each factor. The results are as follows. Even if we had got rid of the barrier on the agricultural capital or the government had supported the urban population, the transformation would not have been affected. However, if the labor constraint had been eliminated, more labor would have flowed from the agricultural sector since 1980 and the share of employment in the organized sector would have risen. As a result, the relative GDP per capita to the U.S. would have increased up to 30% in 2004. Hence, our model can show that the labor barrier in the organized sector was the major factor behind India's poor performance.

The remainder of this paper is organized as follows. In the next section, we document facts about India's economic development. Section 3 explains a three-sector growth model and its equilibrium conditions that match with the

[1] In addition to a three-sector model, some use a two-sector neoclassical growth model. Matsuyama (1992), Laitner (2000), Gollin, Parente, and Rogerson (2002,2007), and Esteban-Pretel, and Sawada (2009) are examples of this.

[2] Note that the definition of "three sectors" in the above literature is different from ours. In the literature, the three sectors are the agricultural, industrial, and service sectors.

data. In Section 4, we present the calibration procedure. Section 5 shows the simulation and counterfactual simulation results. In Section 6, we discuss why the labor barrier in the organized sector exists. Finally, we state the conclusion and direction for future research in Section 7.

2 India's Economy from 1961 to 2004

In this section, we show that India stands out as a case of relative underperformance over the period 1961–2004. Next, we decompose the aggregate economy into the agricultural, organized, and unorganized sectors to gain additional insights into underperformance. We use data from the various sources described in the Data Appendix.

2.1 Lack of Catch-Up

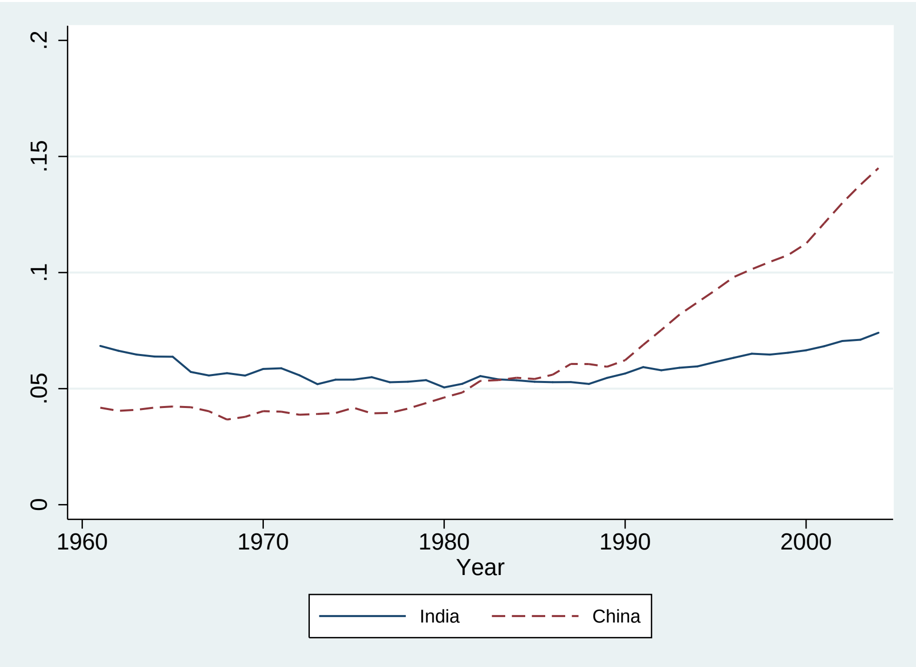

Figure 1: GDP per Capita Relative to the U.S. in India and China

In Figure 1, we present the trend of the relative GDP per capita to the U.S. in India. In order to stress India's underperformance, we choose China, which is almost as large as India.

There are two noteworthy features in Figure 1. The first feature is that the relative GDP per capita of India was higher than that of China in the initial period. In 1961, India's relative GDP per capita was 0.068 and China's relative GDP per capita was 0.042. The second feature is that this relation has reversed after 44 years. In 2004, India's relative GDP per capita had risen only to 0.074. On the other hand, the relative GDP per capita of China was 0.145.

In summary, India has shown no evidence of catching up, which resulted in the huge gap with respect to China.

2.2 Relation between the Agricultural Sector and Economic Performance

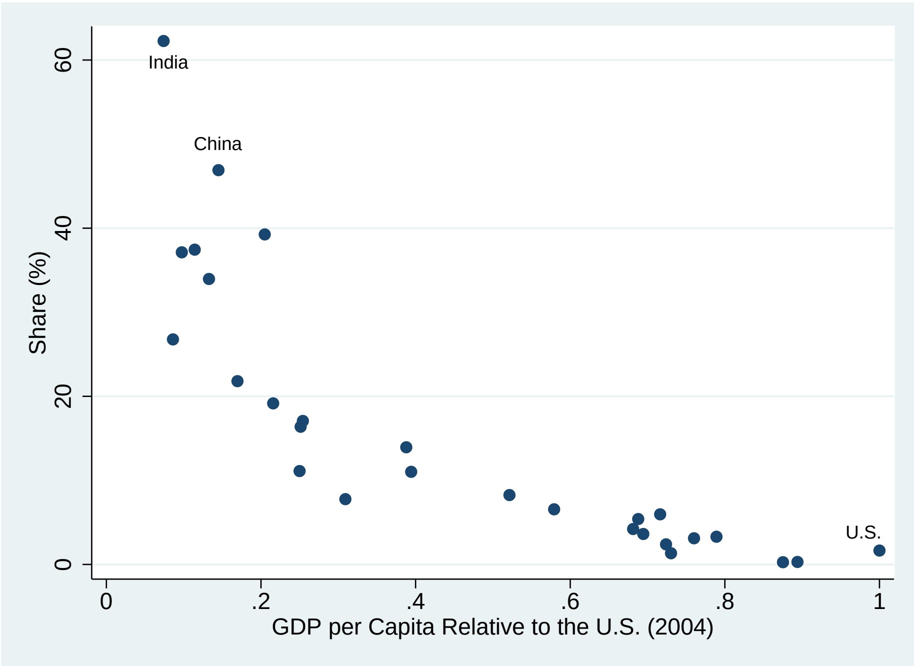

Figure 2: Relation between the Agricultural Sector and GDP per Capita

To explore reasons why India has not caught up with the U.S., we first observe the relation between the agricultural sector and the relative GDP per capita. Figure 2 plots the share of employment in the agricultural sector against the relative GDP per capita to the U.S. in 2004 for selected countries.[3] Figure 2 shows that in poor countries, more people tend to be employed in the agricultural sector than in rich countries. Figure 2 also points out where the three countries (i.e., India, China, and the U.S.) are located. As we can see, the

[3]Note that Japan and Bolivia reported the relation in 2003. We used these data because the employment share of the agricultural sector of the two countries in 2004 is not available.

share of employment in the agricultural sector in India in 2004 was very high as compared to the other two countries.

We conclude from the analysis that India's relative underperformance problem can be explained in a different way. Why was the share of employment in the agricultural sector in India so large? Next, we decompose India's aggregate economy into the three sectors: the agricultural, organized, and unorganized sectors.

2.3 The Sectoral Perspective

How are the organized and unorganized sectors defined? The National Account Statistics provided by the government of India describes the coverage of the organized sector. It defines the organized sector a sector that includes the formal public or private sector of every activity. For example, the organized agricultural sector covers the irrigation system established by the government, non-departmental enterprises, and crop production in the private corporate sector. In addition, the organized manufacturing sector consists of factories that are registered under the Factories Act.[4]. In this paper, "the organized sector" comprises the sub-sectors of the non-agricultural sector defined in the National Account Statistics. In contrast, "the unorganized sector" comprises the sub-sectors of the non-agricultural sector that are not included in the organized sector. Bosworth, Collins, and Virmani (2007) present that the unorganized sector accounts for 44% of the GDP of the non-agricultural sector in 2000. We have the annual employment data of each sector; however, we do not have complete data on the capital stock and output of both the sectors. Accordingly, we calculate the output and capital stock of the organized and unorganized sectors using the limited data. Additional details are provided in the Data Appendix.

On the basis of the above classification, we discuss the following two perspectives: the TFPs and employment. Ideally, we should use the corresponding data of China for comparison. However, we cannot calculate the TFPs of China owing to the unavailability of data on capital. Therefore, we compare the growth of India's TFPs with that of China's TFPs calculated by Dekle and Vandenbroucke (2004).

2.3.1 The TFP of Each Sector

We first consider the TFPs. Figure 3(a) indicates the evolution of the TFP of the agricultural and non-agricultural sectors in India. Note that each TFP level in 1961 is normalized to 100. Figure 3(a) shows that for the first twenty years in India, the TFP of the agricultural sector has stagnated and that of the non-agricultural sector has increased slightly. In this period, the TFP growth in the agricultural and non-agricultural sectors averaged -0.33% and 1.35% respectively from 1961 to 1980. However, since 1980, the TFP series in the agricultural sector have increased significantly and those in the non-agricultural sector have

[4]With regard to the other organized sectors, Section 2 of "National Accounts Statistics, Factor Incomes" provides detailed explanations.

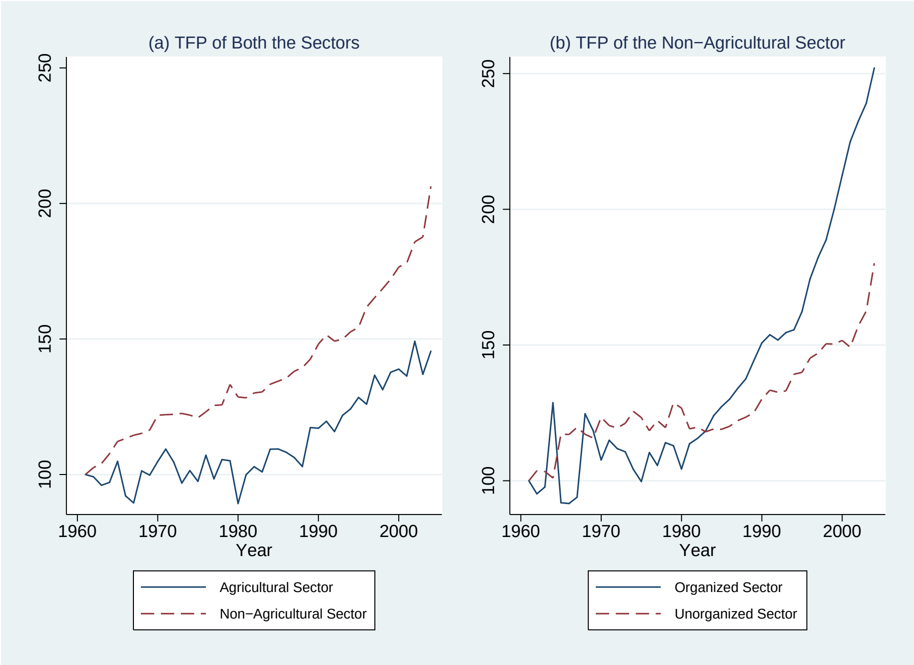

Figure 3: The TFP of Each Sector in India

increased further. In fact, the TFP growth in both the sectors were 2.20% and 2.01%, respectively from 1981 to 2004. The trends during this period are not inferior to those of China. According to Dekle and Vandenbroucke (2004), the TFP growth of China in the agricultural and non-agricultural sectors averaged 3.5% and 1.9% respectively between 1978 and 2003, when the country's relative GDP per capita had increased dramatically shown in Figure 1. These trends are similar to those of India; this indicates that there is no remarkable difference between India and China in terms of the TFPs.

Figure 3(b) shows the TFP of the organized and unorganized sectors. Similar to the trends of the agricultural and non-agricultural sectors, the TFP of both the sectors have started to increase since 1980; in particular, the increase in the TFP of the organized sector was quite large. The TFP growth of the organized and unorganized sectors were 3.77% and 1.52% per annum respectively between 1981 and 2004.

2.3.2 Employment Share in Each Sector

We turn to the employment share. Figure 4(a) and Figure 4(b) show the share of employment in the agricultural sector in India and China. Figure 4(a) indicates that labor flowed slightly from the agricultural sector into the non-agricultural

Figure 4: Employment Share of Each Sector in Two Countries

sector. The share of employment in the agricultural sector has started to decrease since 1980. However, this share has decreased only by 10% (from 72% in 1980 to 62% in 2004). On the other hand, the share of employment in the same sector has decreased by 22% (from 69% in 1980 to 47% in 2004) in China (Figure 4(b)). As compared to the China, the percentage in India was relatively low.

Next, we consider the employment share of the organized and unorganized sectors in India (Figure 4(c)). Remarkably, the share of employment in the organized sector remained unchanged. In fact, this share was constant at approximately 8% over 44 years.[5] Alternatively, the share of employment in the unorganized sector has started to rise since 1980. Concretely, it has increased by 13% (from 18% in 1980 to 31% in 2004).

2.4 Other Perspectives

As final stylized facts, we present two important points. They are related to the spatial mobility rate and economy-wide policies on agricultural incentives.

[5] Sakthivel and Joddar (2006) make the same observation.

2.4.1 Spatial Mobility Rate from Rural to Urban Areas

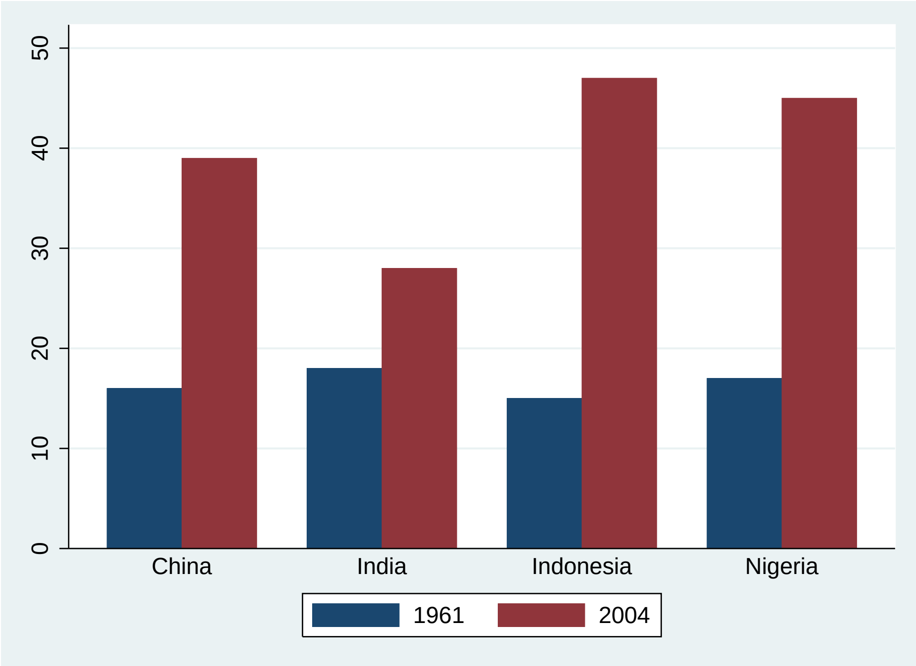

Figure 5: Share of Population Living in Urban Areas

Figure 5 plots the share of the population living in urban areas in terms of four countries. This figure has two features. The first feature is that there was a huge difference between China and India in 2004. Concretely, the share of the population living in urban areas in India and China were 18% and 16% in 1961 and 28% and 39% in 2004. The second feature is that this low mobility rate in India is remarkable even when we compare it with that of other countries that are almost as large as India. Urbanization in India declined as compared to that of other developing countries such as Indonesia and Nigeria in 2004, while their mobility rates were identical in 1961. It implies that the low spatial mobility rate in India was very crucial, as Munshi, and Rosenzweig (2009) suggest.

2.4.2 Policies on Agricultural Incentives

Figure 6 reports the estimates of the relative rate of assistance (RRA) from 1965 to 2004 in India provided by Anderson, and Velenzuela (2008). This is estimated by the following formula:

$$\frac{1 + NR_{ag}}{1 + NR_{non-ag}} - 1,$$

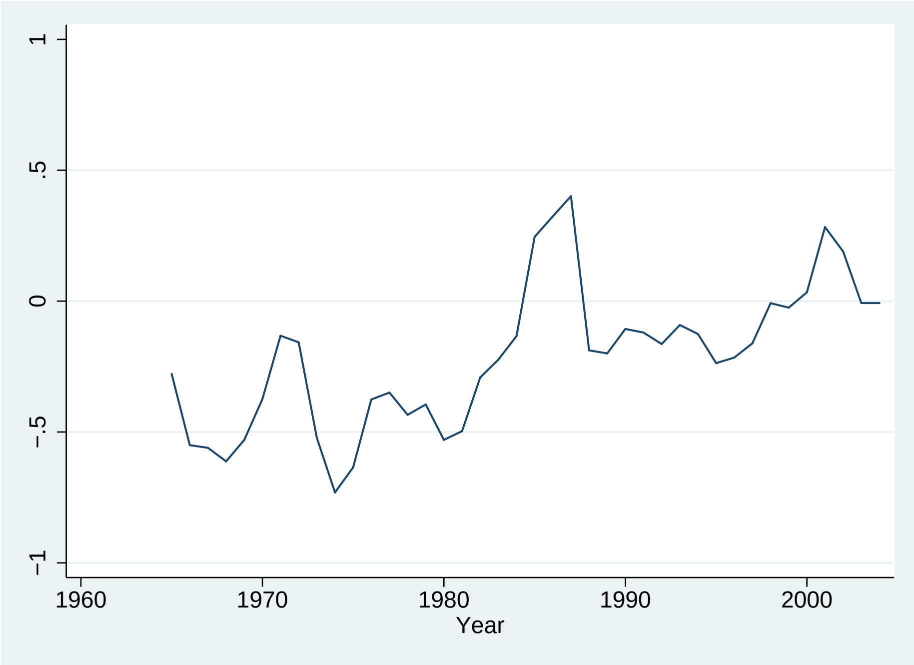

Figure 6: Relative Rate of Assistance in India

where NR_{ag} represents the nominal rate of assistance to the agricultural sector and NR_{non-ag} denotes the nominal rate of assistance to the non-agricultural sector. This calculation can capture the gap between the domestic relative price of the agricultural sector and free market price normalized to 1.[6] If this gap is positive, it indicates that the government exhibits varying degrees of protection toward the agricultural sector. On the contrary, if it is negative, it implies that the government discriminates against the agricultural sector. Figure 6 shows that the value of RRA is negative for most years. Therefore, India mostly has had an anti-agricultural bias.

3 The Model

In this section, we develop a simple model of the structural transformation of the closed economy capable of capturing the facts presented in the previous section. The model is a neoclassical growth model, in the style of Cass-Koopmans. In our paper, we consider the three sectors: the agricultural, organized, and unorganized sectors.

[6]Kruger, Schiff, and Valdes (1988) presented the first paper, which uses the RRA to quantify how the government policies affect agricultural incentives in developing countries.

3.1 Household

There is a representative household in the economy, and in every period, the household decides how much to consume and how much to save. Moreover, the household takes total employment E_t as given and decides how it is divided between employment in the agricultural sector E_{at}, the organized sector E_{ot}, and the unorganized sector E_{ut}. A worker in sector j works h_{jt} hours per unit period ($j = a, o, u$). Hours worked (h_{at},h_{ot},h_{ut}) are exogenously given to the household.

In this model, we consider the case where there is a barrier on labor mobility requiring employment in the organized sector. This is followed by the stylized facts mentioned in the previous section. This case is given by

$$s_{eot} \leq \bar{s_{eot}} \text{ i.e., } E_{ot}/E_t \equiv s_{eot} \leq \bar{s_{eot}} \equiv \bar{E_{ot}}/E_t, \tag{1}$$

where s_{eot} denotes the share of employment supplied to the organized sector and $\bar{s_{eot}}$ represents the fixed share of employment in the organized sector that is assumed to be an exogenous variable.

In addition, we make an assumption that is related to the low spatial mobility rate. Munshi, and Rosenzweig (2009) explore the reason for this occurrence. They claim that it is due to the caste-based network that exists in rural areas.[7] A remarkable feature of this network is that it reforms an important function of providing informal loans. These loans are useful in smoothing consumption and meeting contingencies because they are interest free. This facility is not available in other types of loans such as those provided by banks and money lenders. Thus, Munshi, and Rosenzweig (2009) argue that the caste-based networks impedes the migration of people from rural areas to urban areas.

On this basis, we assume that there are two locations in the model, a rural area, where the agricultural sector's firms are located, and an urban area, where the organized and unorganized sectors' firms operate.[8] Then, we assume that a rural area has a comparative advantage over an urban area in the sense that the network exists. We represent this advantage in a reduced form way. When the household decides to assign a worker to the agricultural sector, she incurs nothing. However, when the household assigns a worker to the organized or unorganized sectors, she must incur the cost owing to the lack of community enforcement. This idea is followed by Acemoglu (2008). In this paper, we assume that this cost per worker of living in an urban area is in proportion to the unorganized wage.

The household earns an income from three sources: income from labor by its workers, from renting capital to firms, and rent earned from land, an input in production in the agricultural sector. Note that unlike labor, we assume no

[7] The caste system of India will be explained in Section 6.

[8] Evidence from Chapter 32 of National Accounts Statistics of India shows that 93% of the NDP in the agricultural sector is produced in rural areas, and 68% of the NDP in the non-agricultural sector is operated in urban areas. Therefore, this assumption is plausible.

barrier to capital mobility among the sectors. Therefore, the rental rate does not depend on which sector rent capital.

The problem of the representative household is to choose

$$(\{c_{at}, c_{ot}, c_{ut}, K_{t+1}, s_{eat}, s_{eot}, s_{eut}, s_{kat}, s_{kot}, s_{kut}\}_{t=0}^{\infty})$$

to maximize

$$\sum_{t=0}^{\infty} \beta^t N_t u(c_{at}, c_{ot}, c_{ut})$$

$$\text{s.t. } p_t C_{at} + C_{ot} + q_t C_{ut} + K_{t+1} - (1-\delta)K_t = w_{at}h_{at}s_{eat}E_t + (w_{ot}h_{ot} - \xi_t w_{ut}h_{ut})s_{eot}E_t + (w_{ut}h_{ut} - \xi_t w_{ut}h_{ut})s_{eut}E_t + r_t K_t + \Pi_t + TR_t$$

$$\text{and } s_{eot} \leq \bar{s_{eot}},$$

where $\beta \in (0, 1)$ is the discount factor; N_t is the working-age population in the economy; $c_{at} \equiv C_{at}/N_t$, $c_{ot} \equiv C_{ot}/N_t$, and $c_{ut} \equiv C_{ut}/N_t$ are the consumption per capita of the agricultural, organized, and unorganized goods; p_t and q_t are the relative prices of the agricultural and unorganized goods; Π_t is the return on land, which is one of the factors of production in the agricultural sector; TR_t represents the lump-sum transfers to the household; K_t is aggregate stock of capital, which depreciates at δ, and is supplied to the agricultural, organized, and unorganized firms with shares s_{kat},s_{kot}, and s_{kut} respectively; s_{eat} and s_{eut} are the share of employment supplied to the agricultural and unorganized sectors; w_{at},w_{ot}, and w_{ut} are the wages per hour; and r_t is the return on capital. $\xi_t w_{ut}h_{ut}$ denotes the flow cost of living in an urban area. This cost involves the wages of the organized and unorganized sectors. We assume Engel's law and impose the Stone-Geary utility function $u(c_{at}, c_{nt}, c_{ut}) \equiv \mu_a log(c_{at} - \bar{a}) + \mu_o log c_{ot} + \mu_u log c_{ut}$, where μ_a,μ_o,μ_u, and $\bar{a}$ are nonnegative parameters.

The household chooses a fraction of the employment,s_{eat},s_{eot}, and s_{eut}, so that sectoral income is equated. In our paper, we consider two cases. In the first case, $\bar{s_{eot}}$ is high enough to prevent the labor constraint from binding, and s_{eat}, s_{eot}, and s_{eut} are chosen so that the following condition holds:

$$w_{at}h_{at} = w_{ot}h_{ot} - \xi_t w_{ut}h_{ut} = w_{ut}h_{ut} - \xi_t w_{ut}h_{ut}. \tag{2}$$

In the second case, where s_{eot} thus obtained does not satisfy the labor barrier (i.e., if $s_{eot} \geq \bar{s_{eot}}$), we impose $s_{eot} = \bar{s_{eot}}$. It follows that the rests of the variables are chosen to satisfy

$$w_{at}h_{at} = w_{ut}h_{ut} - \xi_t w_{ut}h_{ut}. \tag{3}$$

The savings and consumption decision for the households deliver the following optimal conditions:

$$\frac{\partial u(c_{at}, c_{ot}, c_{ut})}{\partial c_{at}} = \frac{p_t}{\lambda_t}, \tag{4}$$

$$\frac{\partial u(c_{at}, c_{ot}, c_{ut})}{\partial c_{ot}} = \frac{1}{\lambda_t}, \tag{5}$$

$$\frac{\partial u(c_{at}, c_{ot}, c_{ut})}{\partial c_{ut}} = \frac{q_t}{\lambda_t}, \tag{6}$$

$$\lambda_{t+1} = \beta \lambda_t (1 + r_{t+1} - \delta), \tag{7}$$

$$\nu_t(\bar{s_{eot}} - s_{eot}) = 0, \tag{8}$$

where λ_t and ν_t are the Lagrange multipliers associated with the households' budget constraint and labor constraint in the organized sector respectively. Given the Stone-Geary utility function presented above, (4),(5), and (6) deliver the following three Frisch demand equations:

$$c_a(p_t, \lambda_t) = \mu_a \frac{\lambda_t}{p_t} + \bar{a}, \tag{9}$$

$$c_o(\lambda_t) = \mu_o \lambda_t, \tag{10}$$

$$c_u(q_t, \lambda_t) = \mu_u \frac{\lambda_t}{q_t}. \tag{11}$$

3.2 Firms

Before discussing the firm's problem in each sector, we incorporate one assumption about agricultural incentives. Restuccia, Yang, and Zhu (2008) suggest that discrimination against or protection to the agricultural sector reflects the cost of intermediate inputs. Considering this situation, we incorporate the impact of distortions to capital of the agricultural sector. This barrier can take the form of tax (τ_{at}).

3.2.1 Firms in the Agricultural Sector

A firm in the agricultural sector rents capital and hires labor to maximize its profits.[9] Therefore, in every period, the firm chooses ($\{K_{at}, L_{at}\}$) to maximize

$$p_t Y_{at} - (1 + \tau_{at}) r_t K_{at} - w_{at} L_{at} \tag{12}$$

[9]The production function of the agricultural firms also includes land as a factor, but since it is assumed to be fixed, it can be ignored in the problem.

$$\text{s.t. } Y_{at} = A_{at} K_{at}^{\alpha_a} L_{at}^{\eta}, \quad (13)$$

where p_t is the relative price of the agricultural good; Y_{at} is the agricultural output; A_{at} is the TFP in this sector; K_{at} is the agricultural capital, L_{at} is the labor input of the agricultural firm, which is a combination of hours and employees; and α_a, $\eta \in (0, 1)$, with $\alpha_a + \eta < 1$.

The optimal conditions for this problem deliver the equilibrium factor prices:

$$r_t = \frac{\alpha_a p_t A_{at} K_{at}^{\alpha_a - 1} L_{at}^{\eta}}{1 + \tau_{at}}, \quad (14)$$

$$w_{at} = \eta p_t A_{at} K_{at}^{\alpha_a} L_{at}^{\eta - 1}. \quad (15)$$

3.2.2 Firms in the Organized Sector

Similarly, a firm in the organized sector chooses ($\{K_{ot}, L_{ot}\}$) to maximize

$$Y_{ot} - r_t K_{ot} - w_{ot} L_{ot} \quad (16)$$

$$\text{s.t.} Y_{ot} = A_{ot} K_{ot}^{\alpha_o} L_{ot}^{1-\alpha_o}, \quad (17)$$

where Y_{ot}, A_{ot}, K_{ot}, and L_{ot} are respectively output, the TFP, capital, and labor input in the organized sector; and $\alpha_o \in (0, 1)$.

The factor prices for this firm are obtained from the optimal conditions of the previous problem:

$$r_t = \alpha_o A_{ot} K_{ot}^{\alpha_o - 1} L_{ot}^{1-\alpha_o}, \quad (18)$$

$$w_{ot} = (1 - \alpha_o) A_{ot} K_{ot}^{\alpha_o} L_{ot}^{-\alpha_o}. \quad (19)$$

3.2.3 Firms in the Unorganized Sector

Finally, a firm in the unorganized sector chooses ($\{K_{ut}, L_{ut}\}$) to maximize[10]

$$q_t Y_{ut} - r_t K_{ut} - w_{ut} L_{ut} \quad (20)$$

$$\text{s.t.} Y_{ut} = A_{ut} K_{ut}^{\alpha_u} L_{ut}^{1-\alpha_u}, \quad (21)$$

[10]Some might point out that a firm in the unorganized sector should rely only on labor. That is because informal firms are basically assumed to hire only on labor. In fact, the model of Gupta (1994) and Ihrig and Moe (2004) follow this assumption. However, we assume that a firm in the unorganized sector rents capital as well as hires a labor. There are two reasons for this. First, the definition of the unorganized sector encompasses broader activities than the informal sector (Bosworth, Collins, and Virmani (2007)). Moreover, the assumption that a firm in the unorganized sector only hires labor makes the model difficulut to deterend.

where q_t, Y_{ut}, A_{ut}, K_{ut}, and L_{ut} are respectively the relative price, output, the TFP and capital and labor input in the unorganized sector; and $\alpha_u \in (0, 1)$.

The factor prices for this firm are derived from the optimal conditions of the previous problem:

$$r_t = \alpha_u q_t A_{ut} K_{ut}^{\alpha_u - 1} L_{ut}^{1-\alpha_u}, \tag{22}$$

$$w_{ut} = (1 - \alpha_u) q_t A_{ut} K_{ut}^{\alpha_u} L_{ut}^{-\alpha_u}. \tag{23}$$

3.3 Equilibrium

A competitive equilibrium, given K_0 and the sequence of the exogenous variables $\{E_t, h_{at}, h_{ot}, h_{ut}, \xi_t, \Pi_t, TR_t, A_{at}, A_{ot}, A_{ut}, \tau_{at}\}_{t=0}^{\infty}$ is a set of allocation for the households

$$\{c_{at}, c_{ot}, c_{ut}, K_{t+1}, s_{eat}, s_{eot}, s_{eut}, s_{kat}, s_{kot}, s_{kut}\}_{t=0}^{\infty}$$

and for the firms $\{Y_{at}, Y_{ot}, Y_{ut}, K_{at}, K_{ot}, K_{ut}, L_{at}, L_{ot}, L_{ut}\}_{t=0}^{\infty}$ and a price system $\{p_t, q_t, w_{at}, w_{ot}, w_{ut}, r_t, \}_{t=0}^{\infty}$ such that agents optimize and markets clear. Agents optimize on two sides: first, given prices, the allocations solve the households' maximization problem, whose solution is characterized by (2) to (8). Second, given prices, allocations solve the profit maximization of the firms in each sector, whose solution is characterized by equations (14), (15), (18), (19), (22), and (23). Seven markets clear: the agricultural, organized, and unorganized goods, the capital market, and the three labor markets:

$$Y_{at} = N_t c_{at}, \tag{24}$$

$$Y_{ot} - \xi_t w_{ut} h_{ut} s_{eot} E_t = N_t c_{ot} + K_{t+1} - (1 - \delta) K_t, \tag{25}$$

$$q_t Y_{ut} - \xi_t w_{ut} h_{ut} s_{eut} E_t = N_t q_t c_{ut}, \tag{26}$$

$$K_{at} + K_{ot} + K_{ut} = K_t, \tag{27}$$

$$L_{at} = h_{at} s_{eat} E_t, \tag{28}$$

$$L_{ot} = h_{ot} s_{eot} E_t, \tag{29}$$

$$L_{ut} = h_{ut} s_{eut} E_t. \tag{30}$$

We have three remarks about the market-clearing conditions. The first remark is that the agricultural and unorganized goods are only used for consumption purposes, while the organized good is used for investment as well as consumption. The second remark is that the supplies of the organized and unorganized goods are $Y_{ot} - \xi_t w_{ut} h_{ut} s_{eot} E_t$ and $q_t Y_{ut} - \xi_t w_{ut} h_{ut} s_{eut} E_t$ respectively, because of resource dissipation when labor is moved from the households to the organized or unorganized goods. The final remark is that the government budget constraint holds period by period because the lump-sum transfers are endogenously determined.

3.4 Transformed Economy Equilibrium

The equilibrium explained above is non-stationary since the TFP of the three sectors and population grow over time. We now define the three trends, detrend the model, and reduce it to a dynamic system of the two equations.

Following Hayashi, and Prescott (2008), we define

$$X_{Yt} = A_{ot}^{\frac{1}{1-\alpha_o}} \frac{h_{ot}E_t}{N_t},$$

$$X_{Pt} = A_{at}^{-1}(h_{at}E_t)^{-\eta} A_{ot}^{\frac{1-\alpha_a}{1-\alpha_o}} (h_{ot}E_t)^{(1-\alpha_a)},$$

and

$$X_{Qt} = A_{ut}^{-1}(h_{ut}E_t)^{-1+\alpha_u} A_{ot}^{\frac{1-\alpha_u}{1-\alpha_o}} (h_{ot}E_t)^{(1-\alpha_u)}.$$

X_{Pt} is the trend of the relative price of the agricultural good, p_t; X_{Qt} is the trend of the relative price of the unorganized good, q_t; X_{Yt} is the trend of the organized sector per capita variable and that of λ_t; $\frac{X_{Yt}}{X_{Pt}}$ is the trend of the agricultural sector per capita variable; and $\frac{X_{Yt}}{X_{Qt}}$ is the trend of the unorganized sector per capita variable. Hence, we can define the following detrended variables:

$$\tilde{k_t} = \frac{K_t}{X_{Yt}N_t}, \tilde{y_{ot}} = \frac{Y_{ot}}{X_{Yt}N_t}, \tilde{c_{ot}} = \frac{c_{ot}}{X_{Yt}N_t}, \tilde{p_t} = \frac{p_t}{X_{Pt}}, \tilde{q_t} = \frac{q_t}{X_{Qt}}, \text{ and } \tilde{\lambda_t} = \frac{\lambda_t}{X_{Yt}},$$

$$\text{where } \tilde{y_{ot}} = \tilde{k_t}^{\alpha_o}(s_{kot})^{\alpha_o}(s_{eot})^{1-\alpha_o}.$$

Likewise, we can define

$$\tilde{p_t}\tilde{y_{at}} = \frac{p_t Y_{at}}{X_{Yt}N_t}, \tilde{p_t}\tilde{c_{at}} = \frac{p_t C_{at}}{X_{Yt}N_t}, \tilde{q_t}\tilde{y_{ut}} = \frac{q_t Y_{ut}}{X_{Yt}N_t}, \tilde{q_t}\tilde{c_{ut}} = \frac{q_t C_{ut}}{X_{Yt}N_t},$$

$$\text{where } \tilde{y_{at}} = \tilde{k_t}^{\alpha_a}(s_{kat})^{\alpha_a}(s_{eat})^{\eta}, \tilde{y_{ut}} = \tilde{k_t}^{\alpha_u}(s_{kut})^{\alpha_u}(s_{eut})^{1-\alpha_u}.$$

Using these definitions in the equilibrium conditions and plugging the factor prices into Euler equation (7) and into the organized market-clearing condition (25), we can reduce the equilibrium into a system of two equations in $\tilde{k_t}$ and $\tilde{\lambda_t}$:

$$\frac{N_{t+1}}{N_t}\frac{X_{Y_{t+1}}}{X_{Yt}}\tilde{k_{t+1}} - (1-\delta)\tilde{k_t} = \tilde{y_{ot}} - \frac{\tilde{q_t}(1-\alpha_u)\xi_t s_{eot}}{s_{eut}}\tilde{y_{ut}} - \frac{c_{ot}(\tilde{\lambda_t}, X_{Yt})}{X_{Yt}}, \quad (31)$$

$$\frac{X_{Y_{t+1}}}{X_{Yt}}\tilde{\lambda_{t+1}} = \beta\tilde{\lambda_t}\{1 + \alpha_o\frac{\tilde{y_{ot+1}}}{s_{kot+1}\tilde{k_{t+1}}} - \delta\}. \quad (32)$$

The other variables (s_{kat},s_{kot},s_{kut},s_{eat},s_{eot},s_{eut},p_t,q_t) can be found using the equilibrium conditions once we have solved for $\tilde{k_t}$ and $\tilde{\lambda_t}$. The market equilibrium conditions for the agricultural good (24), unorganized good (25) and equality of the marginal products of capital among the three sectors (implied by (14), (18), (22)) can be written as

$$\frac{\tilde{p_t} c_{at}(\tilde{p_t} X_{Pt}, \tilde{\lambda_t} X_{Yt})}{X_{Yt}} = \tilde{p_t}\tilde{y_{at}}, \tag{33}$$

$$\frac{\tilde{q_t} c_{ut}(\tilde{q_t} X_{Qt}, \tilde{\lambda_t} X_{Yt})}{X_{Yt}} = \tilde{q_t}\tilde{y_{ut}} - (1-\alpha_u)\xi_t \tilde{q_t}\tilde{y_{ut}}, \tag{34}$$

$$\alpha_a \frac{\tilde{p_t}\tilde{y_{at}}}{(1+\tau_{at}) s_{kat}\tilde{k_t}} = \alpha_o \frac{\tilde{y_{ot}}}{s_{kot}\tilde{k_t}}, \tag{35}$$

$$\alpha_u \frac{\tilde{q_t}\tilde{y_{ut}}}{s_{kut}\tilde{k_t}} = \alpha_o \frac{\tilde{y_{ot}}}{s_{kot}\tilde{k_t}}. \tag{36}$$

Furthermore, when the labor barrier in the organized sector (s_{eot}) satisfies $s_{eot} < \bar{s_{eot}}$, we have $w_{at}h_{at} = w_{ot}h_{ot} - \xi_t w_{ut}h_{ut} = w_{ut}h_{ut} - \xi_t w_{ut}h_{ut}$, which can be reduced to

$$\eta \frac{\tilde{p_t}\tilde{y_{at}}}{s_{eat}} = \frac{(1-\alpha_o)\tilde{y_{ot}}}{s_{eot}} - q_t\xi_t \frac{(1-\alpha_u)\tilde{y_{ut}}}{s_{eut}} = q_t \frac{(1-\alpha_u)\tilde{y_{ut}}}{s_{eut}} - q_t\xi_t \frac{(1-\alpha_u)\tilde{y_{ut}}}{s_{eut}}. \tag{37}$$

For each t, given $(\tilde{k_t},\tilde{\lambda_t})$, we can solve (33), (34), (35), (36), and (37) for $(s_{kat},\ s_{kot},\ s_{kut},s_{eat},s_{eot},\ s_{eut},p_t,q_t)$.

On the other hand, if s_{eot} does not satisfy the labor barrier (i.e., $s_{eot} \geq \bar{s_{eot}}$), then we set $s_{eot} = \bar{s_{eot}}$. In that case, we solve (s_{eat}, s_{eut}) by

$$\eta \frac{\tilde{p_t}\tilde{y_{at}}}{s_{eat}} = q_t \frac{(1-\alpha_u)\tilde{y_{ut}}}{s_{eut}} - q_t\xi_t \frac{(1-\alpha_u)\tilde{y_{ut}}}{s_{eut}} \tag{38}$$

as well as (33), (34), (35), (36) for $(s_{kat},s_{kot},s_{kut},s_{eat},s_{eut},p_t,q_t)$.

4 Calibration and Simulation Procedure

To simulate the model, we need to calibrate the model by providing values for the parameters of the model and for the exogenous variables. The complete description of the data can be found in the Data Appendix. This section explains the calibration and describes the exogenous variables and parameters for the following simulation.

4.1 Calibration

We utilize Indian data for the period from 1961 to 2004 to calibrate the model parameters.

As we have explained in the previous section, the period utility function is of a Stone-Geary type having the form

$$u(c_{at}, c_{ot}, c_{ut}) \equiv \mu_a log(c_{at} - \bar{a}) + \mu_o log c_{ot} + \mu_u log c_{ut},$$

where $\bar{a}$ is the agricultural good subsistence level. From Ogaki and Zhang (2001) and Zhang and Ogaki (2004), we set $\bar{a}$ to 46.5% of the average per capita consumption of the agricultural good in 1976–1981.[11] This target implies $\bar{a} = 0.2868$. Incorporating the three Frisch demand equations (9),(10), and (11) we can obtain the following relation between μ_a, μ_o, μ_u, and $\bar{a}$:

$$\frac{\mu_a}{\mu_o} = \frac{(c_{at} - \bar{a})p_t}{c_{ot}}, \tag{39}$$

$$\frac{\mu_u}{\mu_o} = \frac{c_{ut}q_t}{c_{ot}}. \tag{40}$$

We normalize $\mu_a + \mu_o + \mu_u = 1$ and given $\bar{a}$, we choose μ_a and μ_u to satisfy (39) and (40) in order to obtain the average between 1961 and 2004, and set it to $\mu_a = 0.29$, $\mu_o = 0.3$, and $\mu_u = 0.41$ respectively.

The parameters in the technology function of the three sectors are set as follows. Data are available on the disaggregated factor income of the organized and unorganized sectors from 1981 to 2004 at current prices. The factor income of the organized sector has two components: the compensation of employees and the operating surplus. On the other hand, the factor income of the unorganized sector has different components: the compensation of employees and the mixed income. We can calculate the labor share of the organized sector $(1 - \alpha_o)$ as the ratio of the compensation of employees to output. However, the labor share of the unorganized sector $(1 - \alpha_u)$ cannot be calculated from this source since the mixed income basically includes the compensation of income to some degree.[12] Alternatively, we calculate this share by subtracting the compensation of employees in the organized sector from that in the non-agricultural sector. The labor share of the non-agricultural sector can be obtained from Sivasubramonian (2004). On the basis of this calculation, we set the average values of α_o and α_u to 0.42 and 0.57 respectively.[13] Moreover, Sivasubramonian (2004) reports the labor share of the agricultural sector and the land share of aggregate economy from 1950 to 2000. Assuming that the land is used only in the agricultural sector, we can easily calculate the land share of the agricultural sector. Its average values between 1961 and 2000 —0.23 and 0.21— respectively are the capital share of the agricultural sector (α_a) and the land share of the agricultural sector. The residual, 0.56, is taken as the labor share of the agricultural sector (η).

[11] Zhang and Ogaki (2004) report the average food consumption in the three districts: Aurepalle, Shirapur, and Kanzara from 1976 to 1981. Ogaki and Zhang (2001) estimate the subsistence level of food consumption on the basis of the above data. With regard to the percentage of the average total food consumption for the period 1976–1981, the subsistence level is 58% (Aurepalle), 41% (Shirapur), and 47% (Kanzara).

[12] According to the U.N. System of National Accounts, the employee compensation is the total compensation of people who work as employees. Therefore, the income of the self-employee is not counted as the employee compensation, but a mix of capital and labor income. Gollin (2002) claims that the calculation of the labor shares makes an error without accounting for the income of the self-employee.

[13] Note that we take the average value of α_o and α_u from 1981 to 2000. That is, because we can obtain the labor share of the non-agricultural sector up to 2000.

Finally, the parameter values for β and δ are set to 0.96 and 0.4, which are the standard values for a calibration to annual data. To summarize, Table 1 presents the values of the calibrated parameters.

Parameter	Value
β(preferences discount factor)	0.96
δ(capital depreciation rate)	0.04
$\bar{a}$(the agricultural good subsistence level)	0.2868
μ_a(asymptotic consumption share of the agricultural good)	0.29
μ_o(asymptotic consumption share of the organized good)	0.3
μ_u(asymptotic consumption share of the unorganized good)	0.41
α_a(the capital share of the agricultural sector)	0.23
η (the labor share of the agricultural sector)	0.56
α_o(the capital share of the organized sector)	0.42
α_u(the capital share of the unorganized sector)	0.57

Table 1: Parameters of the Model

4.2 Exogenous Variables

In order to compute equilibrium, we need to assign values to the exogenous variables in all periods. The exogenous variables are the TFP of the three sectors, A_{at}, A_{ot}, and A_{ut}; the population, N_t; the aggregate employment, E_t; hours in each sector, h_{at},h_{ot},h_{ut}; the flow cost of living in an urban area, ξ_t; distortionary tax levied on capital stock of the agricultural sector, τ_{at}; and the upper bound, $s_{\bar{eot}}$.

The Data Appendix explains the sources and construction of these variables for the sample from 1961 to 2004. After the final year of the simulation, 2004, we assume that these variables, except s_{eot}, remain constant at the 2004 level. The reason why s_{eot} is excluded is that we cannot reach steady state if $s_{\bar{eot}}$ is constant. To overcome this problem, we assume that the sum of the employment level in the agricultural and unorganized sectors is constant after 2004. This method is basically followed by Hayashi, and Prescott (2008).

Given the exogenous variables and the parameters we have mentioned above, we use a perfect foresight shooting algorithm to find the path of the variables in the model from the initial condition of India's economy in 1961 to the steady state. The method is the same as that used in Hayashi, and Prescott (2008).

5 Results

With the model calibrated, given the path of the exogenous variables, the parameters, and the initial conditions, we consider the two questions. How closely does the model track the actual data? What would India's performance have been if (1) distortion to the agricultural capital had been eliminated, (2) the flow cost had been subsidized by the government, and (3) there had been no labor barrier in the organized sector?

We now proceed to explain the performance of the model in terms of these constraints. Next, we present the effects of counterfactual simulations to understand the role played by these constraints.

5.1 Simulation Results

Figure 7: Result of the Baseline Model for Selected Variables

Figure 7 (a)–(f) shows the simulation results for "capital share in the agricultural sector (s_{kat})", "labor share in the agricultural sector (s_{eat})", "labor share in the organized sector (s_{eot})", "relative price of the agricultural sector to the non-agricultural sector", "aggregate capital per capita", and "relative output per capita to the U.S" respectively. We choose these variables because they are directly obtained in the actual data from 1961 to 2004, except for s_{kat} and k_t (1961–1980). As explained in the Data Appendix, these are calculated on the basis of the fixed capital stock obtained directly in the actual data. Four remarks must be made before discussing the result. The first remark is that we undo the detrending by multiplying $(\tilde{k_t},\tilde{\lambda_t})$ by X_{Yt}, $\tilde{p_t}$ by X_{Pt}, and $\tilde{q_t}$ by X_{Qt} to back out the solution (k_t,λ_t,p_t,q_t) in order to calculate the aggregate capital per capita or the relative output per capita. The second remark is that the level of the aggregate capital per capita in 1961 is normalized to 100. The third remark is that the relative price of the agricultural sector to the non-agricultural sector is calculated using the formula

$$\frac{p_t}{\frac{q_t y_{ut}+y_{ot}}{y_{ut}+y_{ot}}},$$

where p_t, q_t, y_{ut}, and y_{ot} are the variables utilized in our model.[14] This price is normalized to 1 in 2000. The final remark concerns the relative GDP per capita to the U.S. Since the relative price of the agricultural sector in the data and from the simulation can and do differ (see Figure 7(d)), we need to do a PPP (purchasing power parity) calculation to make the relative GDP per capita in the data and from the simulation comparable.

We now comment on the simulation results. Recall that the constraint setting with the upper bound on the organized sector employment is binding. Therefore, the graph of s_{eot} is completely matched with the data in Figure 7 (c). As we can see, our model is able to capture the actual time series data of most of the variables. Particularly, in terms of labor share of the agricultural sector (Figure 7 (b)), we can observe that it decreased slowly after 1980 (although this rate is lower (5 %) in our model than in the actual data (10%)). That affected India's relative GDP per capita significantly (Figure 7 (f)). However, the capital share of the agricultural sector and the relative price of the agricultural sector do not fit the data appropriately. The possible reasons behind this are mentioned as follows. First, the distortion to the agricultural capital (π_{at}) shown in Figure 11 of the Data Appendix might not capture the real one.[15] Second, our model does not consider the share of agricultural and non-agricultural export or import goods. According to Table 2 in Pursell, Gulati, and Gupta (2007), the net exports ratios of the manufacturing sector, which is a sub-sector of the non-agricultural sector, were 2.8% and 2.2% of the value of the manufacturing production in 2000 and 2004 respectively. However, before 1990, this ratio was negative. Concretely, the net exports ratios of the manufacturing sector were -5.8%, -0.8%, -1.5%, and -0.2% in 1960, 1970, 1980, and 1990, respectively. On the other hand, the net exports of the agricultural sector were stable over 44 years. Therefore, the share of agricultural and non-agricultural export or import goods had an impact on Indian economy. However, our model is assumed to be a closed economy. Hence the divergences with regards to the capital share of the agricultural sector and the relative price of the agricultural sector emerge.

In summary, we can show that our model can mostly reproduce the Indian economy. It indicates that the three constraints prevented labor from the agricultural sector from moving, which led to India's poor performance.

[14]We also calculate this variable in the actual data for comparison. See the Data Appendix for details.

[15]In the simulation, we do not use the RRA because it may not directly correspond to τ_{at}. Imrohoroglu, Imrohoroglu, and Ungor (2010) also mention this and do not use the RRA in the simulation that investigates whether distortions faced in the agricultural sector reflect the Turkish economy.

5.2 Counterfactual Simulations

5.2.1 Case 1: No Distortion to the Agricultural Capital

Figure 8: Result of Counterfactual 1 for Selected Variables

In this case, we investigate how India would have been without distortion to capital of the agricultural sector. In this case, our model is modified as $\pi_{at} = 0$ for every t. Figure 8 shows the result. Note that CF1 represents "the result of case 1 of the counterfactual simulations." This result shows that none of the variables would have remained unchanged, except for the capital share of the agricultural sector. Since distortion to the agricultural capital vanishes, this share is stable over time at approximately 15%.

Therefore, the Indian economy would not have changed if there had been no distortion to the agricultural capital.

5.2.2 Case 2: Flow Cost is Subsidized by the Government

Next, we turn to the case where the government helps people living in urban areas with the cost ξ_t. In particular, we perform a countefactual experiment where the government covers a fraction of the cost, and set the fraction to be 30%. Figure 9 presents the result of this counterfactual simulation.

The result shows a decline in the labor share of the agricultural sector;

Figure 9: Result of Counterfactual 2 for Selected Variables

however, the decline was not significant. Concretely, employment share of the agricultural sector would have decreased by 6% in 1961, but after that, this share would have been stable. This is due to the labor constraint in the organized sector. Therefore, if the government had subsidized the flow cost for people living in urban areas, there would have been no significant transformation in the labor share of the agricultural sector, which would not have affected the other variables greatly.

5.2.3 Case 3: No Labor Constraint in the Organized Sector

Finally, we consider the result of the counterfactual simulation in which the labor barrier in the organized sector was eliminated. We find a striking feature in Figure 10. First, s_{eat} would have decreased by 37% and s_{eot} would have increased by approximately 50% (Figure 10(b) and (c)) in 1961, which would make the relative GDP per capita 0.13 (Figure 10(f)). However, the share of employment in the agricultural sector would not have decreased for the first twenty years. It implies that the labor transformation from the agricultural sector would not have been found during that term. Therefore, the relative output per capita would have been constant. On the contrary, after 1980, the labor transformation would have occurred. In fact, s_{eat} would have decreased

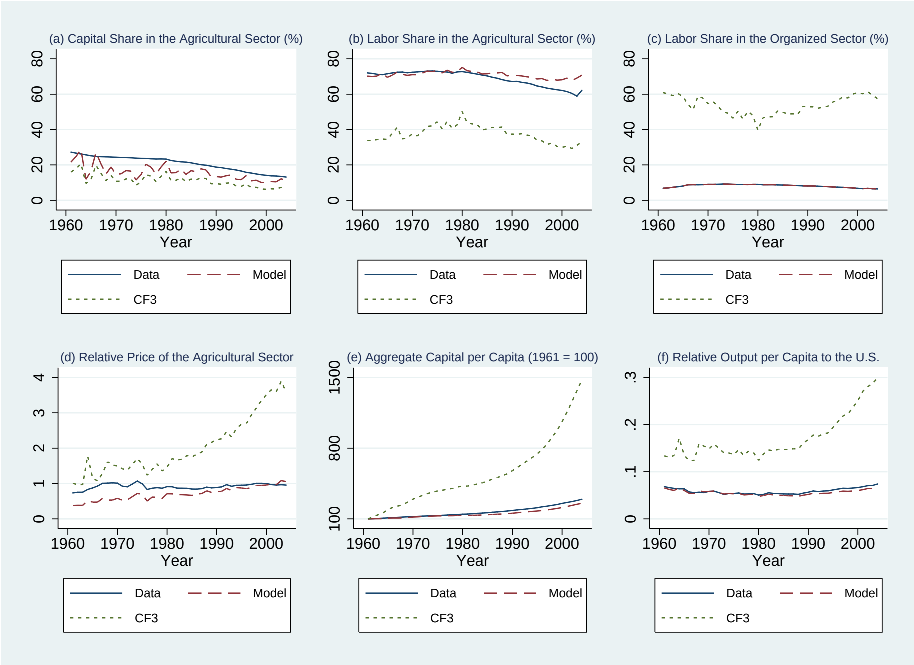

Figure 10: Result of Counterfactual 3 for Selected Variables

dramatically (from 50% in 1980 to 33% in 2004) and s_{eot} would have increased more (from 39% in 1980 to 57% in 2004). This would have affected the other variables such as the relative price of the agricultural sector and the aggregate capital per capita. As a result, this transformation would have led to a catch-up with the U.S. and the relative output per capita would have increased to 0.3 in 2004 from 0.12 in 1980. Thus, India would have experienced a process of the structural transformation after 1980 without a labor constraint in the organized sector.

6 What is the Labor Barrier Proxying for?

In this section, we explore the reasons for the labor barrier in the organized sector, which we have taken for granted thus far. We argue that this barrier is related to two factors: the caste system and labor regulation.

6.1 The Caste System

The caste system has a long history in India. The caste can be defined as a small and named group of persons characterized by marriage within a group, hereditary membership, and a specific style of life, such as ritual status or a particular occupation. According to Hindu religious texts, the caste system divided Hindu society into Brahmins (the highest class), Kshatriyas, Vaisyas, Sudras, and scheduled castes/tribes (the lowest class). The Census of India in 2001 finds that the share of scheduled castes/tribes in the total population was approximately 25%.

Is the caste system related to labor market in India? Banerjee et al (2009) explicitly find that there is labor discrimination on the basis of the caste system.[16] In the field experiment, they sent resumes to software companies and call centers, which are India's new economic sectors.[17] Since the last names of applicants are related to their caste group, companies can identify the class they belong to. Therefore, Banerjee et al (2009) could examine whether discrimination against non-upper caste people (e.g.,scheduled castes/tribes) exists. They found significantly different call back rates between upper-caste and non upper-caste applicants in the case of call centers, however, they did not find such differences with regard to software companies. Banerjee et al (2009) points out that this difference is due to what the two companies demand. Call centers demand "soft skills", such as familiarity with telephone etiquette. However, these elements are not evident from resumes. On the other hand, software companies demand technical skill, and these can be observed in resumes.

This indicates that call centers have no choice but to assess an applicant on the basis of his or her social background, which creates labor discrimination. However, in the case of software companies, even low castes can be employed as long as they have sufficient skills. In spite of this, few of them can obtain such skills because caste networks also affect schooling choice. Munshi, and Rosenzweig (2006) show that high-caste boys can receive English education, which increases the likelihood of obtaining a white-collar job, while medium or low-caste boys have greater chance of receiving local language education, which increases the likelihood of obtaining a working-class job.[18] Therefore, caste also plays an role in shaping schooling choices, which miss the opportunity for low cates to acquire sufficient skills.[19]

We claim that owing to such reasons, the caste-based network locks most groups of individuals in the agricultural or unorganized sectors.

6.2 Labor Regulation

Industrial labor regulation in India is an important issue. In particular, the laws that deal with retrenching workers and the closure of establishments are

[16]In this paper, the term "labor market discrimination" represents job discrimination, not wage discrimination. In terms of these discriminations, Banerjee and Knight (1985) and Borooah et al (2007) examine which factor dominates.

[17]These firms can be considered to be part of the organized sector.

[18]Munshi, and Rosenzweig (2006) classify unskilled manual, skilled manual, and organized blue-collar as working-class occupation. On the other hand, they categorize clerical, business, and professional as white-collar occupation.

[19]By contrast, girls can now receive English education regardless of their social background. Munshi, and Rosenzweig (2006) claim that the reason for this is that historically, few girls have a caste-based network to constrain them.

the most controversial points. According to these laws, layoff, retrenchment, and closure are illegal for all firms with more than 100 workers without permission from the government. Permission to retrench or to close is rarely granted and unapproved separations carry a potential punishment of both a fine and a prison sentence for the employer.

Does labor regulation affect a firm's behavior ? Some works have discussed this issue. One example is Besely, and Burgess (2004). They suggest that labor regulation lowers employment as well as output, investment, and productivity in the organized manufacturing sector. Another example is Aghion et al (2008). They investigate whether labor regulation is associated with the performance of the manufacturing sector after delicensing was carried out in the 1980s.[20] They point out that the effect of delicensing was unequal across Indian states, which depends on the level of labor regulation. Finally, Amin (2009) finds that employment in India's retail sector is strongly negatively affected by the power of labor regulation.

Hence, we claim that labor regulation prevents employees from flowing to the organized sector.

7 Conclusion

In this paper, we investigate why the relative GDP per capita to the U.S. in India has stagnated for 44 years. One of the explanations for this is that the share of employment in the agricultural sector was very high. When we consider the reasons for this, we find three main factors: the labor barrier in the organized sector, the low spatial mobility rate from rural to urban areas, and the government policy against the agricultural sector. To examine whether these are major causes, we build a three-sector model and calibrate it. As a result, our model can mostly capture the actual time series data for the Indian economy. Moreover, two findings emerge from the counterfactual simulations. First, if there had been no government policy against the agricultural sector or the mobility rate had increased through government assistance, the structural transformation would not have improved. Second, if the labor constraint in the organized sector had been eliminated, the transformation from the agricultural sector would have occurred after 1980, which would have increased the relative GDP per capita to 0.3. It indicates that the labor barrier in the organized sector had a big impact on the aggregate growth performance of India.

There are, however, other perspectives to study. In one such perspective, the TFP growth in the three sectors is assumed to be exogenous. In other words, we assume that the TFP of the agricultural or organized sectors increased significantly since 1980. However, we need to identify the reason behind the rapid TFP growth in this period. We argue that the key factor is the education

[20] Until the 1980s, the Indian government controlled industries in the organized manufacturing sector via licensing. This license was required to establish a new plant or change location. However, after the 1980s, a movement toward delicensing has gradually begun and in 1991, licensing was effectively abolished.

level of the labor force. According to Table 8 in Bosworth, Collins, and Virmani (2007), in 2004, 20% of the workers had at least secondary education. This number is twice as large as that twenty years ago. Therefore, the increase of human capital owing to a high education level must be related to the rapid TFP growth. To consider this, our model should be modified such that the TFP of the three sectors are endogenized.

Another perspective is that our model ignores the changes in the policy by the Indian government. Many previous studies (e.g., Ahluwalia (2002), Rodorik, and Subramanian (2002), Kochhar et al (2006), and Aghion et al (2008)) explore the economic reforms of India, beginning in the early 1980s. The key features of these reforms are the liberalization of imports, extension of export incentives through the tax system, and financial sector liberalization as well as the abolition of industrial licensing, which is mentioned in the footnote in the previous section. In short, the policy changes mainly focused on the trade and financial sectors. However, our model does not incorporate these changes. To assess whether the government's policy changes influenced the Indian economy, we would need to extend the model to an open economy instead of limiting it to a closed one and include the financial sector in our model. We leave this task as the next step for future research on the Indian economy.

A Data Appendix

This appendix describes the sources and construction of the variables used in the analysis. The first part covers the Indian data. In the second part, the data used in Section 2 are covered.

A.1 Indian Data

The data and variables we create are explained below. Note that in this paper, the definition of a sector is based on the International Standard Industrial Classification (ISIC) Revision 3. The broad sector "the agricultural sector" includes ISIC division 1–5 (Agriculture, Hunting and Forestry, Fishing). The broad sector "the non-agricultural sector" includes ISIC division 10-99, i.e., the rest of the economy.

- Y_t (aggregate output), Y_{at} (output of the agricultural sector): We can obtain them at 1999–2000 prices from "National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000)" and "National Accounts Statistics 2008."

- Y_{ot} (output of the organized sector), Y_{ut} (output of the unorganized sector): First, we explain the calculation of the output of the organized sector from 1981 to 2004. For this period, we calculate this variable assuming that the GDP ratio of the organized sector to the non-agricultural sector is the same as the NDP ratio of the organized sector.[21] We source the data on the NDP of the organized and unorganized sectors from "National Accounts Statistics, Factor Incomes", and National Accounts Statistics 2008.[22] Next, we show the calculation from 1961 to 1980. From Sivasubramonian (2004), we can get the NDP share of the organized sector, which includes the organized agricultural sector. Therefore, we derive the GDP of the organized sector with the organized agricultural sector making the same assumptions in the case of 1981–2004. Then, we need to exclude the organized agricultural sector, but this variable is not available. Alternatively, we calculate it assuming that the ratio of the organized agricultural sector to the overall agricultural sector is the same as that in 1981. This ratio can be obtained from National Accounts Statistics, Factor Incomes.

  We obtain the output of the unorganized sector by subtracting the agricultural, and organized outputs from the aggregate output.

- L_t (aggregate labor), L_{at} (labor of the agricultural sector): We can directly obtain them from the "10-sector Database" provided by the Groningen Growth and Development Centre.

[21] From National Accounts Statistics, Factor Incomes, we can obtain both the GDP and the NDP of the organized and unorganized manufacturing sectors. Using this data, we find that the GDP ratio of the organized manufacturing sector is almost identical to the corresponding NDP ratio. Thus, this assumption is valid.

[22] Although the organized and unorganized agricultural sectors are included in these data, we ignore them in this paper.

- L_{ot} (labor of the organized sector), L_{ut} (labor of the unorganized sector): The "Economic Survey" annually provided by the Ministry of Finance, Government of India, reports the estimates of employment in the organized public and private sectors. Therefore, L_{ot} is measured as the sum of the organized public and private sectors.[23] L_{ut} can be calculated by $L_{ut} = L_t - L_{at} - L_{ut}$.

- K_t (aggregate capital stock): We use the aggregate net capital stock at 1999–2000 prices. We can obtain it from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. However, it is not available from 1961 to 1980. Accordingly, we use the following formula for calculation in this period:

$$K_{t+1} = (1-\delta)K_t + I_t,$$

where δ represents the depreciation rate and I_t denotes investment in the current period. Since the fixed capital stock (it corresponds to $(1-\delta)K_t$) from 1962 to 1981 is available in the same source, we can calculate the net capital stock in the rest of the period by assuming $\delta = 0.04$ used in the calibration.

- K_{at} (the agricultural capital stock); We use the net capital stock of the agricultural sector at 1999–2000 prices. We can obtain it from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. Like the aggregate capital stock, it is available only from 1981 to 2004. Hence, we use the same method as that for the derivation of the aggregate capital stock from 1961 and 1980.

- K_{ot} (capital stock of the organized sector), K_{ut} (capital stock of the unorganized sector): For 1981–2004, we can obtain the compensation of the employees of the organized sector at current prices from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. Then, we can calculate the compensation of the employees of the unorganized sector by subtracting that of the organized sector from that of the non-agricultural sector. Recall that we cannot obtain the labor share of the non-agricultural sector from 2001 to 2004 as mentioned in the footnote in Section 4. Therefore, for 2001–2004, we assume that this labor share is the same as that of 2000. Using them, we obtain the capital income of both sectors by subtracting the compensation of the employees from the GDP. Since in our model, the rental rates of the organized and unorganized sectors are assumed to be identical, we can easily calculate the capital stock of each sector on the basis of this assumption.

  Next, we explain the derivation of these variables from 1961 to 1980. It is more complicated than the derivation of the variables from 1981 to 2004

[23] This measurement corresponds to the definition of the organized sector mentioned in Section 2. In fact, it is identical to the level of employment in the organized sector shown in Sakthivel and Joddar (2006).

because the compensation of the employees of each sector is not available. Alternatively, we calculate them in the following way. First, we assume that the labor share of the unorganized sector from 1961 to 1980 is the same as that of 1981.[24] Then on the base of this assumption, we can derive the compensation of the employees of the organized sector, since Sivasubramonian (2004) provides that of the non-agricultural sector. After obtaining these data, we calculate each capital stock in the same way as that from 1981–2004.

- h_{at} (hours in the agricultural sector), h_{ot} (hours in the organized sector), h_{ut} (hours in the unorganized sector): Since we do not have annual data on the hours in the three sectors, $h_{at} = h_{ot} = h_{ut}$ for every t. Since the Factories Act regulates that people employed in the organized sector have to work at least 48 hours in a week, we set $h_{at} = h_{ot} = h_{ut} = 48$.

- A_{at} (TFP of the agricultural sector), A_{ot} (TFP of the organized sector), A_{ut} (TFP of the unorganized sector): We use the production functions of the three sectors—(13),(17), and (21), and data on output, capital, employment, and hours in each sector to calculate the TFPs as the Solow residual:

$$A_{at} = \frac{Y_{at}}{(K_{at}^{\alpha_a})(E_{at}h_{at})^{\eta}},$$

$$A_{ot} = \frac{Y_{ot}}{(K_{ot}^{\alpha_o})(E_{ot}h_{ot})^{1-\alpha_o}},$$

$$A_{ut} = \frac{Y_{ut}}{(K_{ut}^{\alpha_u})(E_{ut}h_{ut})^{1-\alpha_u}}.$$

- p_t (relative price of the agricultural sector), q_t (relative price of the unorganized sector): First, we calculate the deflator of the three sectors. The implicit deflator of each sector is the ratio of the nominal output to the real counterpart. The nominal output of the agricultural sector is obtained from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. Next, the nominal outputs of the organized and unorganized sectors are calculated using the same method as that for the derivation of Y_{ot} and Y_{ut}. Using these deflators, we derive p_t and q_t by the following formula:

$$p_t = \frac{\text{the deflator of the agricultural sector}}{\text{the deflator of the organized sector}},$$

[24] The reason why we set such an assumption is that the labor share in the unorganized sector is almost constant from 1981 to 2004 in comparison with the one in the organized sector.

$$q_t = \frac{\text{the deflator of the unorganized sector}}{\text{the deflator of the organized sector}}.$$

- (relative price of the agricultural sector to the non-agricultural sector): The implicit deflator of the non-agricultural sector is the ratio of the nominal output of the non-agricultural sector to the real counterpart. These data are obtained from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. Using this deflator, the relative price of the agricultural sector to the non-agricultural sector is calculated as the ratio of the deflator of the agricultural sector to that of the non-agricultural sector.

- C_t (aggregate consumption): We can directly obtain this at current prices and 1999–2000 prices from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008.

- C_{at} (consumption of the agricultural sector), C_{ot} (consumption of the organized sector), C_{ut} (consumption of the unorganized sector): Since we do not have data on any of these factors, we calculate the consumption of the agricultural and unorganized sectors from (24) and (26). C_{ot} is derived by subtracting C_{at},C_{ot} from C_t.

- N_t (working-age population): The population aged 15 or older is calculated by multiplying the total population by the share of the population age 15–64. Both are available in the "World Development Indicators" provided by the World Bank.

- ξ_t (flow cost of living in an urban area), τ_{at} (distortion to the agricultural capital): First, since ξ_t is not available in the actual data, we obtain this variable from the equalization of sectoral income:

  $$w_{at}h_{at} = w_{ut}h_{ut} - \xi_t w_{ut}h_{ut},$$

  which implies

  $$\xi_t = 1 - \frac{w_{at}h_{at}}{w_{ut}h_{ut}}.$$

  This approach is similar to the methodology used by Chari et al (2007) and Restuccia, Yang, and Zhu (2008).

  Next, the RRA mentioned in Section 2 may not correspond to τ_{at}. Therefore, we use the gap between the rental price of the agricultural sector and that of the organized or unorganized sectors calculated from the actual data. Note that since the labor and the land share of the agricultural sector are not available from 2001 to 2004, we assume that these shares are the same as those of 2000.

  The trends of ξ_t and τ_{at} are shown in Figure 11. We find that ξ_t is stable over our sample period and τ_{at} can mostly capture the trend of RRA (Figure 6), although it fluctuates more.

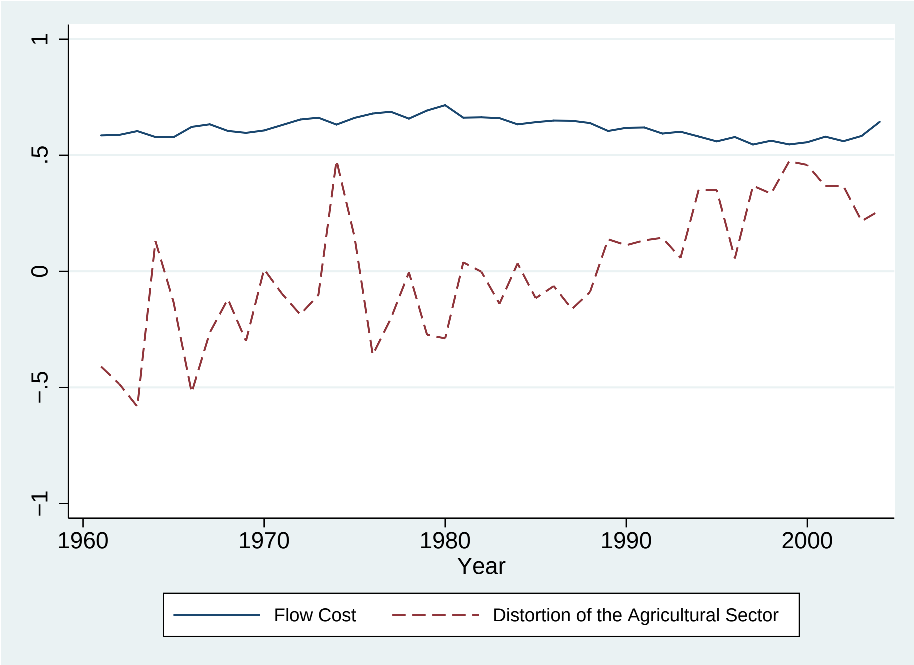

Figure 11: ξ_t and τ_{at}

A.2 Data Source Used in Section 2

In this section, we describe the data sources utilized in Figures in Section 2.

- Figure 1: The relative GDP per capita of India to the U.S. is calculated using PPP for comparison in our model. To calculate this, we need the U.S. GDP, the population of the U.S., and the India and U.S GDPs in millions dollars for 1998 in 1990 prices. These variables are obtained from "National Economic Accounts" provided by U.S. Department of Commerce, World Development Indicators, and Madison (2001).

  We calculate the relative GDP per capita of China, on the basis of Penn World Table 6.3. It provides "China Version 1" and "China Version 2." [25] In our paper, we use China Version 2 rather than China Version 1 since authors of the Penn World Table suggest that China Version 2 be more consistent with the recent economic history of China.

- Figure 2: Barring China and the U.S, the selected countries except are

[25]The difference between China Version 1 and China Version 2 is as follows. The former uses the official growth rates for the whole period, as in Penn World Table 6.2. On the other hand, the latter utilizes the recent modifications of official Chinese growth rates for the period before 1990, and applies the modification of the official rate from 1995–2000 to the official rate after 2000.

Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru, Venezuela, Denmark, Spain, France, Italy, the Netherlands, Sweden, and the United Kingdom. The share of employment in the agricultural sector in every country, except China, can be obtained from the 10-sector Database, and that of China is available from "Chinese Statistical Yearbook." In terms of the relative GDP per capita of other countries, we calculate it using Penn World Table 6.3.

- Figure 3: When we calculate the TFP of the non-agricultural sector, we use the following equation,

$$A_{not} = \frac{Y_{not}}{(K_{not}^{\alpha_{no}})(E_{not}h_{not})^{1-\alpha_{no}}},$$

  where A_{not}, Y_{not}, K_{not}, E_{not}, h_{not} are respectively the TFP, output, capital, employment, and hours in the non-agricultural sector; and $\alpha_{no} \in (0, 1)$. These data are available from National Accounts Statistics Back Series 2007 (1950-51 to 1999-2000) and National Accounts Statistics 2008. In this paper, we set α_{no} and h_{not} to 0.49 and 48 for every t, respectively.

- Figure 4: The trend of employment share in the agricultural sector in China is obtained from the Chinese Statistical Yearbook.

- Figure 5: The data are obtained from the World Development Indicator.

- Figure 6: RRA can be downloaded from the World Bank.

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