Advances

Jiancai Pi* and Yu Zhou

Rural Property Rights, Migration, and Welfare in Developing Countries

Abstract: Two-sector general equilibrium models are built to investigate how the quality of rural property rights influences rural-urban migration and national welfare in developing countries. In the basic model where the urban wage rate is exogenously given, the impacts of strengthened rural property rights on rural-urban migration and national welfare are determined by comparisons of the rent-gaining effect and the productivity-enhancing effect. Specifically, if the rent-gaining effect dominates the productivity-enhancing effect, strengthened rural property rights will increase the number of rural-urban migrants and reduce national welfare. Otherwise, the opposite impacts are exerted if the productivity-enhancing effect dominates the rent-gaining effect. When we extend the basic model by considering the endogenously determined urban minimum wage rate, the urban minimum wage determination mechanism is also of great importance in determining the outcomes of the basic model. When we extend the basic model by introducing an urban informal sector, the value of labor's marginal product of the urban informal sector also plays a role in determining the impact of strengthened rural property rights on national welfare. In addition, urban unemployment is also taken into account by the basic and extended models.

Keywords: rural property rights, rural-urban migration, national welfare, urban unemployment, developing countries

JEL Classification: O15, P26, R13

DOI 10.1515/bejeap-2014-0062

*Corresponding author: Jiancai Pi, Department of Economics, Nanjing University, 22 Hankou Road Nanjing 210093, P. R. China, E-mail: pi2008@nju.edu.cn

Yu Zhou, Department of Economics, Nanjing University, 22 Hankou Road, Nanjing 210093, P. R. China, E-mail: zhouyu_0105@hotmail.com

1 Introduction

It is well-known that the quality of rural property rights plays a certain role in both agricultural and urban development in developing countries.¹ This can be attributed to the facts that rural property rights are closely related to rural-urban migration and that rural-urban migration can reduce rural poverty and stimulate the urbanization process.

Nevertheless, how rural property rights influence rural-urban migration is empirically controversial. Conventional wisdom contends that strong rural property rights will increase peasants' incomes and thus tie them to rural areas, because there exists a positive relationship between rural property rights and agricultural productivity (or the peasants' incentive to conduct land investment) and exists a negative relationship between agricultural productivity and rural migration. These two relationships have been explored by one strand of empirical studies like Besley (1995), Kabubo-Mariara (2003), Goldstein and Udry (2005), Markussen (2008), and Giles and Mu (2012), etc. However, another strand of empirical literature (e.g., Field 2007; Mullan, Grosjean, and Kontoleon 2011; Chernina, Dower, and Markevich 2013) contends that the protection of rural property rights stimulates rural-urban migration since strong rural property rights mean less expropriation. It is not hard to find that the first strand of literature mainly highlights the positive impact of strengthened rural property rights on increasing peasants' incomes, while the second strand of literature basically emphasizes the positive impact of secured rural property rights on reducing the peasants' migration cost. Can these two strands of empirical results be integrated into a unified theoretical framework? Do strengthened rural property rights encourage rural-urban migration, reduce urban unemployment, and raise national welfare? We cannot find answers to these questions from the existing theoretical studies. This inspires us to conduct the present study.

In order to fill the theoretical research gap, we establish two-sector general equilibrium models with a dual economy to investigate how strengthened rural property rights influence rural-urban migration, urban unemployment, and national welfare. The protection of rural property rights in our paper can influence both rural productivity and land rent expropriation, which is similar

¹ Although the concept of rural property rights is very comprehensive, in our paper such a concept particularly refers to rural land property rights, which are composed of a bundle of rights, i.e., the right to use land, the right to earn income from land, the right to transfer land to others, and the right to enforce these property rights. In many developing countries, some rights are restricted or impaired by the governments and local conventions, which results in weak rural property rights.

to Fergusson (2013), but our setting is more general. That is, our setting grasps the essence and is also in accord with the existing two strands of empirical literature. In the basic model where the urban wage rate is exogenously given, the relation between strengthened rural property rights and rural-urban migration, as well as national welfare, is determined by comparisons of two effects exerted by the improvement of rural property rights, i.e., the rent-gaining effect and the productivity-enhancing effect. The former effect reduces the rural-urban migration cost, and the latter effect raises the rural wage rate. If the productivity-enhancing effect dominates the rent-gaining effect, strengthened rural property rights will reduce rural-urban migration and urban unemployment, but raise national welfare. However, if the opposite occurs, strengthened rural property rights will increase rural-urban migration and urban unemployment, but possibly reduce national welfare. Our findings on the relation between strengthened rural property rights and rural-urban migration theoretically support the validity of the aforementioned two strands of empirical literature. What's more, our results concerning the relation between the quality of rural property rights and national welfare are also in line with Harris and Todaro (1970), and Todaro's (1997) important idea that agricultural development is crucial for economic development and national welfare. When we extend the basic model by considering the endogenously determined urban minimum wage rate, the urban minimum wage determination mechanism is of great importance in determining the outcomes of the basic model. When we extend the basic model by introducing an urban informal sector, the main findings are almost the same as those in the basic model, but the value of labor's marginal product of the urban informal sector plays a role in determining the impact of strengthened rural property rights on national welfare. In a word, in the extended models, the economic mechanisms behind our results are much more complex than those in the basic model.

It is worth noting that Fergusson (2013) is based on an agricultural economy with rural-urban migration satisfying Lewis' equilibrium condition, which indicates that a typical peasant will continue to move to an urban area until the income he gets from rural production is equal to that he obtains from urban production, and meanwhile there is no urban unemployment (see Lewis 1954). In Fergusson's (2013) model, rural property rights are endogenously determined by the rural elite and the exogenously determined urban wage rate plays an important role in determining the peasants' migration decision. But in our models, we adopt the modified Harris–Todaro migration equilibrium condition. The benefits of our method are that we can take the whole economy containing both rural and urban areas into account, and at the same time accommodate urban unemployment in our model. Originally, the Harris–Todaro migration

equilibrium condition shows that a typical peasant will not stop migrating until the wage rate he gets from the rural production is equal to the expected wage rate (i.e., the probability of getting a job multiplying the corresponding wage rate) he obtains in an urban area (see Harris and Todaro 1970). In our paper, we argue that a typical peasant will stop moving to an urban area when the expected income (e.g., wage, land revenue and expropriated land revenue from other migrants) he obtains in a rural area is equal to the corresponding expected income (e.g., expected wage rate and unexpropriated land revenue) he gets in an urban area. We call this the modified Harris–Todaro rural-urban migration equilibrium condition. On the basis of such a condition, we find that the endogenously determined urban wage rate matters for the rural people's migration decision.

Another point worthy of mention is the relation between strengthened rural property rights and urban unemployment. In the basic and extended models, we argue that under some conditions strengthened rural property rights can effectively reduce urban unemployment, which more or less indicates that the solution to reduce urban unemployment lies in the rural sector and the development of rural areas. Our results are parallel to existing findings obtained in the Harris–Todaro framework. Beladi and Naqvi (1988) use a two-sector model to find that the improvement in the agricultural production technique can reduce the urban unemployment rate. Gupta (1997b) constructs a three-sector model to show that the rise of the agricultural output price can decrease the urban unemployment rate. Chaudhuri (2000) builds a three-sector model to demonstrate that wage and price subsidies to the rural sector can effectively decrease urban unemployment. Yabuuchi and Beladi (2001) construct a different three-sector model from Chaudhuri (2000) to argue that the wage subsidy to the rural sector will reduce urban unemployment. Chaudhuri and Banerjee (2010) contend that FDI on the agricultural land can decrease urban unemployment through constructing a three-sector model. In addition to these rural development policies, other development policies (e.g., wage and price subsidies to urban sectors, tariff reductions on manufacturing products, international factor mobility policies) can also unambiguously or conditionally reduce urban unemployment in the presence or absence of the Harris–Todaro framework (see Basu 1980; Gupta 1993, 1994, 1995b; Chaudhuri 2006; Chaudhuri, Yabuuchi, and Mukhopadhyay 2006; Chaudhuri 2007; Chaudhuri and Yabuuchi 2010; Gupta and Dutta 2011; Pi and Zhou 2012). Our result concerning urban unemployment complements these findings.

This paper also contributes to the existing literature in other two respects. The first and main aspect is anchored in the study of rural-urban migration. Since the publication of Harris and Todaro's (1970) classic paper, the Harris–Todaro model

has been widely used by many development economists. As this model has very good policy implications, numerous theoretical studies have investigated the impacts exerted by development policies, trade policies, and production factors accumulation in such a framework.² Here we just briefly introduce some of them. For example, Stiglitz (1974), Bhagwati and Srinivasan (1974), Calvo (1978), Basu (1980), Beladi and Naqvi (1988), Gupta (1995a, 1995b), Beladi and Marjit (1996), and Zenou (2011) explore the economic and social impacts of development policies (e.g., price and wage subsidies, tariff reductions and export promoting policies, international factor mobility and tax policies) and the formation of labor unions. By adding an informal sector to the economy, Fields (1975), Quibria (1988), Grinols (1991), Gupta (1993, 1997b), Chandra and Khan (1993), Chaudhuri (2000), Chaudhuri, Yabuuchi, and Mukhopadhyay (2006) investigate the economic and welfare effects of development policies (e.g., price and wage subsidies, tariff reductions and export promoting policies, international factor mobility and tax policies). Considering distortions of capital markets (i.e., segmentations of urban and rural formal and informal capital markets), Khan and Naqvi (1983), Chao and Yu (1992), and Gupta (1993, 1997b) investigate how reductions of capital market distortions and other development policies influence the whole economy and social welfare. By dividing labor into skilled and unskilled types, Chaudhuri and Yabuuchi (2007), Beladi, Chaudhuri, and Yabuuchi (2008), Beladi, Chakrabarti, and Marjit (2010), Chaudhuri (2008), Pi and Zhou (2012, 2014), and Pan and Zhou (2013) study how development policies and other factors (e.g., public infrastructure provisions, global production, labor market reforms) influence the skilled-unskilled wage gap, urban unemployment and social welfare. Some scholars also reconsider the socioeconomic impacts of development policies and economic growth by incorporating the land market, the special economic zone (e.g., the free-duty zone), and the dualism of agricultural sectors into the Harris–Todaro framework (e.g., Miyagiwa 1993; Gupta 1997a; Krichel and Levine 1999; Yabuuchi and Beladi 2001; Chaudhuri 2006; Chaudhuri and Banerjee 2010; Chaudhuri and Yabuuchi 2010).³ However, just as mentioned above, although empirical studies have emphasized the close relation between rural property rights and rural-urban migration, such a relation is rarely explored within the Harris–Todaro framework. To the best of our knowledge, this paper is the first one to incorporate rural property rights into the Harris–Todaro framework.

² A survey of the studies on the Harris–Todaro framework can be referred to Khan (2007).

³ As for other issues (e.g., the environmental issues and technical process issues), scholars also address them in the Harris–Todaro framework, we do not mention them here in order to save space.

The second aspect mainly rests on our theoretical methodology. When the issue related to rural property rights is addressed, the game-theoretical or contractual approach is commonly employed (see, e.g., Baker 2003; Tassel 2004). However, the game-theoretical or contractual approach usually treats the factor prices as given and ignores the interactions among markets to some degree. Such limitations of partial equilibrium analysis cannot tell us the whole story when we discuss the impacts of improved rural property rights. Just as Acemoglu (2010, p. 22) puts it, “Depending on magnitudes of various effects, general equilibrium interactions can offset or even reverse sensible partial equilibrium conclusions Economic theory nonetheless provides some guidance in assessing the importance of general equilibrium effects.” To fill the gap, our analytical approach highlights the market interactions and develops full scenarios for the assumed economy. We establish a unified and open theoretical framework with a general equilibrium approach to investigate the issue concerning the quality of rural property rights.

The rest of this paper is organized as follows. The basic theoretical model is established in Section 2. We analyze how the quality of rural property rights influences rural-urban migration and national welfare in Section 3. In Section 4, we extend the basic model and examine the validity of findings obtained in Section 3. Section 5 provides some concluding remarks.

2 The theoretical model

Consider a small open dual economy consisting of two sectors, the urban sector and the rural sector. The outputs of these two sectors are internationally tradable. The urban sector uses labor and capital as factors of production, and the rural sector uses labor and land. Capital and land are sector specific to the urban and rural sectors, respectively. In urban areas, workers are often protected by minimum wage laws or receive a contractual wage rate. If the minimum wage is high enough, urban unemployment will persist (e.g., Calvo 1978; Gupta 1997a; Zenou 2011). In this section, we assume that the urban minimum wage rate is downwards rigid and exogenously given. This assumption will be relaxed in Section 4. In rural areas, labor can be fully employed due to the rural flexible wage rate. It is worth noting that labor in urban areas is composed of the urban initial labor force and the rural-urban migrants. We further assume that all the goods and factor markets are perfectly competitive, and the output of the rural sector is numeraire.

The urban sector's production function is described by:

$$M = F^M(L_M, \bar{K}_M), \quad [1]$$

where M is the output of the urban sector. L_M and $\bar{K}_M$ are labor and capital used by the urban sector, respectively. F^M is the urban production function: it is strictly concave and linearly homogenous.

The profit maximization conditions of the urban sector yield:

$$p_M F_L^M(L_M, \bar{K}_M) = \bar{w}, \quad [2]$$

$$p_M F_K^M(L_M, \bar{K}_M) = r, \quad [3]$$

where p_M is the output price of the urban sector, $\bar{w}$ is the urban minimum wage rate, r is the interest rate of capital, and $F_j^i = \partial F^i / \partial j$ ($i = M$, and $j = L, K$).

In this paper, the key variable is the quality of rural property rights. Following Fergusson (2013), the quality of rural property rights is denoted by a parameter μ , where $\mu \in [0, 1]$. When $\mu = 0$, there is no rural property rights protection at all. When $\mu = 1$, the rural property rights protection is complete. The larger the value of μ , the better the quality of rural property rights. In this paper, we focus our attention on the case where rural property rights are incomplete, that is, $\mu \in (0, 1)$. In accord with the above-mentioned empirical literature, the quality of rural property rights has two impacts, one impact on the rural productivity and the other impact on land rent expropriation. These two impacts will be demonstrated in details as below.

First, let us take a close look at the relation between the quality of rural property rights and rural production. In our assumed economy, rural production not only relies on the production inputs but also on the quality of rural property rights. μ influences rural production by way of changing the rural productivity. The larger the value of μ , the higher the rural productivity. Therefore, the rural sector can produce more output if rural property rights are better protected.

The production activities are described by:

$$R = A(\mu) F^R(L_R, \bar{T}), \quad [4]$$

where R is the output of the urban and rural sector. L_R and $\bar{T}$ are labor and land used by the rural sector, respectively. F^R is the rural production function: it is strictly concave and linearly homogenous with respect to production factors. A represents rural productivity, which is a function of the quality of rural property rights (i.e., μ). $A(\mu)$ is a strictly concave function, indicating that strengthened rural property rights improve rural productivity at a decreasing marginal ratio. We further assume that $A(0) = 0$ and $A(1) = 1$. Our setting of $A(\mu)$ follows the spirit of Fergusson (2013), but here our expression (i.e., eq. [4]) is more general in the sense that we do not explicitly show the relation between the quality of rural property rights and rural production factors. The causal mechanisms behind $A(\mu)$ have been considered by Feder and Noronha (1987), Feder and

Feeny (1991), and Migot-Adholla et al. (1991). Besides, eq. [4] also captures the essence of the first strand of the empirical literature, that is, better protection of rural property rights indicates higher rural productivity.

The profit maximization conditions of the rural sector yield:

$$A(\mu)F_L^R(L_R, \bar{T}) = w_R, \quad [5]$$

$$A(\mu)F_T^R(L_R, \bar{T}) = \tau, \quad [6]$$

where w_R is the flexible rural wage rate, τ is the rental rate of land, and $F_j^i = \partial F^i / \partial j$ ($i = R$, and $j = L, T$).

We now consider how the quality of rural property rights influences land rent expropriation. Our setting of the relationship between rural property rights and land rent expropriation also follows the spirit of Fergusson (2013), but we incorporate the relationship into the Harris–Todaro rural-urban migration equilibrium condition. All of the details will be shown below.

We assume that each rural household is endowed with one unit of labor. For simplicity, each rural household is represented by one peasant, either working in agricultural production or migrating to an urban area. The initial rural labor endowment of all the rural households is denoted as $\bar{L}_R$. The number of rural-urban migrants is denoted as L_{TR} . Furthermore, we assume that L_{UN} is the number of urban unemployed and $\bar{L}_U$ is the initial urban labor endowment. Different from Fergusson (2013), who assumes that the rural elite owns most of the land and each peasant has the same amount of land, here we suppose that all the land belongs to rural households, and they equally own a certain amount of land. Specifically, each family has the same land endowment $\bar{T} / \bar{L}_R$. Although such an assumption is realistic in some developing countries (e.g., China and Vietnam) and unrealistic in others (e.g., some Latin American countries), the focus of our paper is on migration and rural property rights instead of the political economy of rural property rights, and such a treatment helps us to capture the main mechanisms in the purest way. Our assumption is beneficial to simplify analyses and concentrate on the main effects. With the process of urbanization and industrialization, some rural workers will transfer from rural areas to urban areas. If a peasant chooses to stay in a rural area, he can not only get his labor income w_R , but also get his own land rent income $\tau(\bar{T} / \bar{L}_R)$. In addition, due to weak rural property rights, the peasant staying in a rural area can also get a chance to expropriate other migrant families' land rent income (i.e., $\tau(1 - \mu)(\bar{T} / \bar{L}_R)L_{TR}$). We assume that each peasant has equal probability to expropriate the other migrants' land rent incomes and hence he can get $\tau(1 - \mu)(\bar{T} / \bar{L}_R)(L_{TR} / L_R)$. Thus, the expected income of a typical peasant staying in a rural area is

$$w_R + \tau \frac{\bar{T}}{\bar{L}_R} + \tau(1 - \mu) \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R}.$$

But if the peasant moves to an urban area, he can earn an expected wage rate (i.e., $(L_M/(L_M + L_{UN}))\bar{w}$) and an unexpropriated land rent income (i.e., $\tau\mu(\bar{T}/\bar{L}_R)$).⁴ Therefore, if the peasant migrates to an urban area, he can earn

$$\frac{L_M}{L_M + L_{UN}} \bar{w} + \tau\mu \frac{\bar{T}}{\bar{L}_R}.$$

In the spirit of Harris and Todaro (1970), the rural-urban migration equilibrium condition in our paper can be described as follows: a typical peasant will stop moving to an urban area when the expected income of staying in a rural area (i.e., $w_R + \tau(\bar{T}/\bar{L}_R) + \tau(1 - \mu)(\bar{T}/\bar{L}_R)(L_{TR}/L_R)$) is equal to that of working in an urban area (i.e., $(L_M/(L_M + L_{UN}))\bar{w} + \tau\mu(\bar{T}/\bar{L}_R)$). Here, we call it the modified Harris–Todaro rural-urban migration equilibrium condition. Formally, it can be described as:

$$w_R + \tau \frac{\bar{T}}{\bar{L}_R} + \tau(1 - \mu) \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} = \frac{L_M}{L_M + L_{UN}} \bar{w} + \tau\mu \frac{\bar{T}}{\bar{L}_R}. \quad [7]$$

In Fergusson (2013), rural-urban migration satisfies the Lewis' equilibrium condition. That is, a peasant will stop migrating when the income he obtains from agricultural production is equal to that he earns in an urban area. There is no unemployment in urban areas and one can get a job in urban areas for sure if he chooses to migrate. However, in our paper, the rural-urban migration equilibrium satisfies the modified Harris–Todaro equilibrium condition. This is one of the most significant differences between this paper and Fergusson (2013).

To close the model, the labor market-clearing condition is stated as:⁵

$$L_M + L_{UN} = \bar{L}_U + L_{TR}, \quad [8]$$

$$L_R + L_{TR} = \bar{L}_R. \quad [9]$$

⁴ Here, we do not consider the case where land can be cultivated by the rest members of migrant's family, as we assume that each rural family is represented by one peasant. Generally speaking, in many developing economies (e.g., China and some African countries), for a typical rural family, the young and strong males choose to migrate from rural to urban areas. Only the elders, children and women are left in rural areas, whose abilities to conduct agricultural production and protect land rents are relatively limited. Due to weak property rights, their land rents will be expropriated. In fact, this is in accord with our assumption.

⁵ It is worth noting that eq. [8] reflects the important empirical fact that increased rural-urban migration plays a dominant role in explaining the growing urban population in developing economies like African and South American countries (see Todaro 1997; Beladi, Chakrabarti, and Marjit, 2010).

In our model, capital and land are sector-specific factors to the urban and rural sectors. For the sake of simplicity, we do not demonstrate the market clearing conditions for the capital and land markets.

So far, the theoretical model has been built. Equations [1]–[9] determine nine endogenous variables, M , R , L_M , L_{UN} , L_R , L_{TR} , r , w_R , and τ . μ is the exogenous variable. Others are parameters.

3 The general equilibrium analysis

Before conducting the comparative static analysis, firstly we would like to totally differentiate eqs [5]–[7]. This step will strengthen our understanding of how the quality of rural property rights influences rural-urban migration.

By totally differentiating eqs [5]–[7] and combining with the help of the remaining equations, we can get:

$$AF_{LL}^R dL_{TR} + dw_R = A'F_L^R d\mu, \quad [10]$$

$$AF_{TL}^R dL_{TR} + d\tau = A'F_T^R d\mu, \quad [11]$$

$$dw_R + \frac{(1-\mu)\bar{T}}{L_R} d\tau + \left[\frac{(1-\mu)\bar{T}}{L_{TR}^2} + \frac{L_M \bar{w}}{(L_M + L_{UN})^2} \right] dL_{TR} = \left(\tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} \right) d\mu, \quad [12]$$

where $F_{jl}^i = \partial^2 F^i / \partial j \partial l$ ($i = M, R$, $j = L, K, T$, and $l = L, K, T$), and $A' = dA/d\mu$.

The established economic system can be reduced to a subsystem, namely eqs [10]–[12], which explicitly show how the protection of rural property rights influences rural-urban migration. On the one hand, according to eqs [10] and [11], the improvement of rural property rights raises the marginal productivities of labor and land (i.e., $A'F_L^R$ and $A'F_T^R$), therefore influencing rural-urban migration. On the other hand, from the migration equilibrium condition (i.e., eq. [12]), the protection of rural property rights also exerts an impact on the migration decision by way of changing the migration benefit in terms of the potential land rent income (i.e., $\tau(\bar{T}/\bar{L}_R)(L_{TR}/L_R) + \tau(\bar{T}/\bar{L}_R)$).

It is not hard to get the following equations system:

$$\begin{pmatrix} AF_{LL}^R & 1 & 0 \\ AF_{TL}^R & 0 & 1 \\ \left[\frac{(1-\mu)\bar{T}\tau}{L_R^2} + \frac{L_M \bar{w}}{(L_M + L_{UN})^2} \right] & 1 & \frac{(1-\mu)\bar{T}}{L_R} \end{pmatrix} \begin{pmatrix} dL_{TR} \\ dw_R \\ d\tau \end{pmatrix} = \begin{pmatrix} A'F_L^R \\ A'F_T^R \\ \left(\tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} \right) \end{pmatrix} d\mu. \quad [13]$$

The determinant of the coefficient matrix of the above equations system is denoted as Δ . It is easy to find that

$$\Delta = \frac{(1-\mu)\bar{T}\tau}{L_R^2} + \frac{L_M\bar{W}}{(L_M + L_{UN})^2} - A\mu F_{LL}^R > 0.$$

In order to intuitively understand the impacts of the quality of rural property rights, we try to demonstrate the propositions and corollaries without using mathematical notation in this section and the following section. However, when providing the economic intuition behind these propositions and corollaries, we use the simplest mathematical notation in order to avoid unnecessary misunderstandings.

Proposition 1 is established to show how the quality of rural property rights influences rural-urban migration.

Proposition 1: If the rent-gaining effect dominates the productivity-enhancing effect, strengthened rural property rights will increase the number of rural-urban migrants; and if the productivity-enhancing effect is larger than the rent-gaining effect, strengthened rural property rights will decrease the number of rural-urban migrants.

Proof: See Appendix A-1.

Proposition 1 implies that the quality of rural property rights exerts an ambiguous impact on rural-urban migration. On the one hand, strong rural property rights will raise the migrant's land rent income (i.e., $\tau(\bar{T}/\bar{L}_R)$) and at the same time decrease land rent expropriation (i.e., $\tau(\bar{T}/\bar{L}_R)(L_{TR}/L_R)$). This will stimulate a peasant to migrate to an urban area (i.e., $(1/\Delta)(\tau(\bar{T}/\bar{L}_R)(L_{TR}/L_R) + \tau(\bar{T}/\bar{L}_R)) > 0$). We call this effect (i.e., $\tau(\bar{T}/\bar{L}_R)(L_{TR}/L_R) + \tau(\bar{T}/\bar{L}_R)$) the rent-gaining effect. On the other hand, strong rural property rights will also raise the peasant's income in a rural area. This is because strengthened rural property rights will not only raise the marginal product of labor (i.e., $A'(F_L^R)$), but will also increase the net land rent income of a peasant staying in a rural area (i.e., $((1-\mu)\bar{T}/L_R)F_T^R$). This will cause a peasant to remain in a rural area (i.e., $-(1/\Delta)A'(F_L^R) + (((1-\mu)\bar{T})/L_R)F_T^R < 0$). We call this effect (i.e., $A'(F_L^R) + (((1-\mu)\bar{T})/L_R)F_T^R$) the productivity-enhancing effect. The final migration decision depends on which effect dominates. If the former effect dominates the latter, strengthened rural property rights will increase rural-urban migration. However, if the former effect is dominated by the latter, the opposite will occur.

Our theoretical results support the findings of both the first and the second strands of empirical literature. If the protection of rural property rights only means the protection of agricultural output and the rise of the rural productivity,

that is, there is no $\tau(\bar{T}/\bar{L}_R)(L_{TR}/L_R) + \tau(\bar{T}/\bar{L}_R)$, then strengthened rural property rights will tie peasants to rural areas, which supports the results obtained by the first strand of empirical literature (e.g., Kabubo-Mariara 2003; Giles and Mu 2012). However, if the protection of rural property rights only results in less land rent expropriation, that is, $A' = 0$, then strengthened rural property rights will increase rural-urban migration, which confirms the findings of the second strand of empirical literature (e.g., Field 2007; Mullan, Grosjean, and Kontoleon 2011; Chernina, Dower, and Markevich 2013).

Based on Proposition 1, we use Corollary 1 to summarize the impact of strengthened rural property rights on urban unemployment.

Corollary 1: If the rent-gaining effect dominates the productivity-enhancing effect, the improvement of the quality of rural property rights will increase urban unemployment; and if the productivity-enhancing effect is larger than the rent-gaining effect, strengthened rural property rights will decrease urban unemployment.

Proof: See Appendix A-2.

Combining Proposition 1 with Corollary 1, we see that changes in urban unemployment and rural-urban migration move in the same direction. That is to say, if strengthened rural property rights stimulate peasants to migrate to urban areas, increased migration will unambiguously raise urban unemployment. But if strengthened rural property rights tie peasants to agricultural activities, the number of rural-urban migrants will decline and urban unemployment will shrink. The economic explanation for above demonstrations can be attributed to the fact that the urban sector has a relatively constant scale. One may wonder whether the positive relation between the number of rural-urban migrants and the scale of urban unemployment can be empirically supported. The answer is yes. For example, Todaro (1997) and Potts (2000) empirically confirm that in many African countries, increased urban unemployment can be largely attributed to the growing number of rural-urban migrants.

Now, we can use Figure 1 to intuitively show the contents of Proposition 1 and Corollary 1. For simplicity, we only use straight lines to show the relations among variables.⁶ L_M is determined by eq. [2], which is independent of μ . Replacing w_R and L_{UN} in eq. [7] by eqs [5] and [8], we can get the relation between L_{TR} and τ shown by eq. [7], which is depicted by Line *a*. Line *b* represents the relation between L_{TR} and τ described by eq. [6]. Line *c* indicates the relation between L_{TR} and L_{UN} implied by eq. [8]. *o* is the original point. τ^* ,

⁶ In order to save space, we do not give detailed process about how we derive the lines depicted by Figure 1.

Figure 1: Impacts of strengthened rural property rights on migration and unemployment.

L_{TR}^* , and L_{UN}^* are set as the initial equilibrium values. Now, consider the case where the quality of rural property rights is improved, i.e., μ increases. By eq. [6], an increase in μ will make Line b move leftwards to b' . However, an increase of μ may either make Line a move leftwards or rightwards to a' . When

$$\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} > A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right],$$

that is, the rent-gaining effect dominates the productivity-enhancing effect (denoted as Condition I), Line a will largely move leftwards. Combined with the movement of Line b , such a movement of Line a will lead to an increase in L_{TR} . By Line c , the amount of L_{UN} also increases. This demonstrates the first parts of Proposition 1 and Corollary 1. When

$$\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right],$$

that is, the productivity-enhancing effect dominates the rent-gaining effect (denoted as Condition II), Line a will slightly move leftwards or move rightwards,⁷ which leads to a reduction of L_{TR} . By Line c , L_{UN} decreases. This demonstrates the second parts of Proposition 1 and Corollary 1.

Now, let us focus our attention on how the quality of rural property rights generates an impact on national welfare.

The balance of the national expenditure and income is stated as:

$$E(p_M, U) = \bar{w}L_M + r\bar{K}_M + w_R L_R + \tau \bar{T}, \quad [14]$$

where E is the minimum expenditure function, and U is the social utility level which depicts national welfare. Investigating national welfare by considering the

⁷ To clearly show the case where L_{TR} decreases, we only need to show the situation where Line a moves rightwards. Obviously, if Line a moves slightly leftwards, we can see that L_{TR} will also decrease.

balance of the national expenditure and income is widely used by many development economists (e.g., Grinols 1991; Chandra and Khan 1993; Gupta 1997a).

Now we can obtain Proposition 2.

Proposition 2: If the rent-gaining effect is dominated by the productivity-enhancing effect, strengthened rural property rights will increase national welfare; and if the productivity-enhancing effect is dominated by the rent-gaining effect, strengthened rural property rights will decrease national welfare.

Proof: See Appendix A-3.

The economic mechanism behind Proposition 2 is as follows. On the one hand, strengthened rural property rights will directly increase rural production output (i.e., $A'F^R$). On the other hand, it will also indirectly affect national welfare by exerting an impact on rural-urban migration. If strengthened rural property rights decrease rural-urban migration (i.e., $dL_{TR}/d\mu < 0$), then from eq. [8] we know that more peasants will stay in rural areas, which definitely increases rural output (i.e., $-AF_L^R(dL_{TR}/d\mu) > 0$). In this situation, strengthened rural property rights will increase national welfare. However, if strengthened rural property rights stimulate rural-urban migration to a certain degree (i.e., $dL_{TR}/d\mu > A'F^R/(AF_L^R)$), that is, the increase in rural output (i.e., $A'F^R$) is less than the loss of rural output due to increased rural-urban migration, then national welfare will decrease.

Proposition 2 implies that the change in national welfare is determined by the change in urban unemployment (i.e., rural employment). The reason behind this is that the urban sector has a fixed size in the basic model. Less urban unemployment (i.e., more rural employment) expands the rural sector, increasing agricultural output and national welfare. Proposition 2 highlights the role that the rural sector plays in economic development. With the help of such a simple model, our argument is parallel to Jorgenson (1967) and Harris and Todaro (1970) who also contend that rural development is of great importance for economic development in a dual economy.

We should point out that such a finding highly depends on the fixed size of the urban sector. However, when the urban sector size is flexible, the impacts of the quality of rural property rights on national welfare are more complex, which will be explored in Section 4.

4 Extension and discussion

Section 4 extends Sections 2 and 3. We will make the following two extensions. The first one is to relax the assumption of the urban exogenous minimum wage

rate by endogenizing it. Such an extension is made to further investigate the role that the urban sector plays. The second one is to introduce an urban informal sector to the basic model, since such a sector plays a crucial role in economic development of developing countries.⁸

4.1 Endogenous determination of urban minimum wage

In Fergusson (2013), the urban exogenous wage rate plays an important role in the rural-urban migration decision, but in our paper, especially in Section 3, the urban exogenous wage rate does not influence rural people's transfer decision at all. Thus, we would like to explore whether the urban endogenous minimum wage rate matters for rural-urban migration, urban unemployment, and national welfare. It is well known that the labor union's lobbying activities and bargaining activities are the main sources affecting the urban minimum wage rate. Similar to Pi and Zhou (2012), the urban endogenous minimum wage rate is stated as:

$$w^* = w^*(w_R, \lambda, U^L), \quad [15]$$

$$\lambda = \frac{L_{UN}}{L_M}, \quad [16]$$

where λ is the Harris–Todaro unemployment rate. U^L is a positive parameter that reflects the labor union's bargaining power. The larger the value of U^L is, the more bargaining power the labor union has. Furthermore, we have $w_1^* = \partial w^* / \partial w_R > 0$ ($(\partial w^* / \partial w_R)(w_R / w^*) < 1$), $w_2^* = \partial w^* / \partial \lambda < 0$, and $w_3^* = \partial w^* / \partial U^L > 0$. The mechanism for the endogenous urban minimum wage rate here is closely related to the existing theoretical literature (e.g., Stiglitz 1974; Calvo 1978; Chaudhuri and Yabuuchi 2007). The urban endogenous minimum wage rate in Stiglitz (1974) can be regarded as a special case of this paper if we set $w_1^* = 0$ and $U^L = 0$. In the situation where $w_2^* = 0$, our setting can be reduced to that used by Calvo (1978) and Chaudhuri and Yabuuchi (2007).

Equations [2] and [7] are rewritten as:

$$p_M F_L^M(L_M, \bar{K}_M) = w^*, \quad [17]$$

$$w_R + \tau \frac{\bar{T}}{\bar{L}_R} + \tau(1 - \mu) \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} = \frac{L_M}{L_M + L_{UN}} w^* + \tau \mu \frac{\bar{T}}{\bar{L}_R}. \quad [18]$$

⁸ We would like express our thanks to a reviewer who encourages us to introduce an informal sector to the basic model.

The economic intuition behind eq. [18] is the same as that of eq. [7]. To save space, here we do not give detailed explanations.

So far, the extended model has been established, which consists of eqs [1], [17], [3], [4], [5], [6], [18], [8], [9], and [16]. Ten equations determine ten endogenous variables, M , R , L_M , L_{UN} , L_R , L_{TR} , r , w_R , τ , and λ . μ is an exogenous variable as before. Others are parameters.

Now we consider how the quality of rural property rights influences rural-urban migration, which is stated as Proposition 3.⁹

Proposition 3: In the situation where the urban sector's wage elasticity of labor demand is elastic, the condition for stimulating rural peasants to migrate shown in Proposition 1 will be weakened and that for tying peasants to rural areas will be strengthened; and in the situation where the urban sector's wage elasticity of labor demand is inelastic, the condition for encouraging rural-urban migration depicted by Proposition 1 will be strengthened and that for tying peasants to rural areas will be weakened.

Proof: See Appendix B-2.

From the economic analysis of Proposition 1, the improvement of rural property rights exerts two effects, the rent-gaining effect and the productivity-enhancing effect. The former effect pushes peasants to migrate, and the latter effect attracts peasants to remain in rural areas. When the urban minimum wage is endogenously determined, strengthened rural property rights will indirectly influence rural-urban migration by way of the productivity-enhancing effect, hence affecting the urban minimum wage. Strengthened rural property rights will raise the rural wage rate via the productivity-enhancing effect. The increased rural wage rate will also lead to an increase of the wage rate of the urban sector, encouraging peasants to migrate. But at the same time, the growing urban wage rate will reduce urban employment, which impedes rural-urban migration. When the wage elasticity of labor demand in urban sector is inelastic (i.e., $-1 < e_{wL}^M < 0$), the effect exerted by the growing urban wage rate will dominate the effect generated by decreasing urban employment and become another pushing force to inspire peasants to migrate to urban areas. Therefore, the condition for stimulating rural migration shown in Proposition 1 will be weakened and that for tying peasants to rural areas will be strengthened. This explains the first situation stated by Proposition 3. We can explain the second part of Proposition 3 in a similar way.

⁹ In line with the denotations in Section 3, the rent-gaining effect and the productivity-enhancing effect in Section 4 also refer to $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R}$ and $A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right]$, respectively.

We will further analyze how the quality of rural property rights influences urban unemployment. Corollary 2 is established to show the sufficient conditions for the change in urban unemployment due to strengthened rural property rights.

Corollary 2: If (i) the productivity-enhancing effect is sufficiently larger than the rent-gaining effect and (ii) the positive rural wage impact induced by the rural employment change on the urban wage rate is larger than the sum of the negative urban unemployment impact and the negative rural wage impact induced by the rural wage rate change on the urban wage rate, strengthened rural property rights will decrease urban unemployment. Otherwise, if (iii) the rent-gaining effect largely dominates the productivity-enhancing effect and (iv) the positive urban unemployment impact on the urban wage rate is less than the sum of the negative rural wage impact induced by the rural wage rate and the negative rural wage impact induced by the rural employment change on the urban wage rate, strengthened rural property rights will increase urban unemployment.

Proof: See Appendix B-3.

The economic intuition behind the first part (i.e., conditions (i) and (ii)) of Corollary 2 is demonstrated as follows. When the productivity-enhancing effect is sufficiently larger than the rent-gaining effect, the improvement of rural property rights will definitely raise rural employment, reducing the number of rural-urban migrants. The change in rural employment will produce two effects. The first effect is that increased rural employment will reduce the rural marginal productivity, thus decreasing the rural wage rate. This will contribute to a decrease of the urban wage rate and an increase of employment in the urban sector, that is,

$$\frac{-AF_{LL}^R L_M W_1^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} \right) \right] > 0.$$

We call the first effect the positive rural wage impact induced by the rural employment change on the urban wage rate. The second effect is that the reduction of migration will decrease urban unemployment, hence increasing the urban wage rate and reducing employment in urban areas, that is,

$$\frac{w_2^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} \right) \right] < 0.$$

We call the second effect the negative urban unemployment impact. On the other hand, the improvement of rural property rights will directly exert a positive

impact on the rural wage rate, the consequence of which is to raise the urban wage rate and reduce employment in urban areas, that is,

$$-\frac{A' F_L^R w_1^*}{\Phi} \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] < 0.$$

We call such an effect the negative rural wage impact induced by the rural wage rate change on the urban wage rate. It is not hard to see that when the rural wage impact induced by the rural employment change on the urban wage rate dominates the sum of the urban unemployment impact and the rural wage impact induced by the rural wage rate change on the urban wage rate, employment in urban areas will increase. Thus, in this situation, strengthened rural property rights will increase employment in both rural and urban sectors, hence reducing urban unemployment. Similarly, we can explain the second part (i.e., conditions (iii) and (iv)) of Corollary 2.

Remark 1: As suggested by the above analysis, under some conditions, strengthened rural property rights can reduce urban unemployment, and the solution to urban unemployment lies in the rural sector. As for the endogenous determination of minimum wage, it is also worth discussing whether labor market reforms will be an alternative way to reduce urban unemployment, which can be captured by a reduction of the labor union's bargaining power U^L .¹⁰ We find that labor market reforms can conditionally decrease urban unemployment. When the wage elasticity of labor demand in the urban sector is not very inelastic i.e., ($e_{wL}^M < -\lambda/(1+\lambda)$), labor market reforms will reduce urban unemployment. However, when the wage elasticity of labor demand in the urban sector is pretty much inelastic (i.e., $-\frac{\lambda}{1+\lambda} + \frac{(1+\lambda)L_M}{w^*} \left(\frac{(1-\mu)\bar{T}\tau}{L_R^2} - \mu A F_{LL}^R \right) < e_{wL}^M < 0$), labor market reforms will raise urban unemployment. Our findings are in line with Chaudhuri (2006, 2008), who argues that labor market reforms can conditionally decrease urban unemployment when we consider the endogenous minimum wage in the Harris–Todaro framework.

Similar to eq. [14], the balance of the national expenditure and income in this section is described by:

$$E(p_M, U) = w^* L_M + r \bar{K}_M + w_R L_R + \tau \bar{T}. \quad [19]$$

¹⁰ The conditions concerning how urban unemployment changes with labor market reforms are sufficient ones. One can derive them with the help of eq. [19] and Appendix B-1. Here, we do not give detailed derivations.

Lastly, Proposition 4 is built to summarize the relation between the quality of rural property rights and national welfare.

Proposition 4: Under conditions (i) and (ii) given by Corollary 2, strengthened rural property rights will raise national welfare. However, under conditions (iii) and (iv) given by Corollary 2, strengthened rural property rights will decrease national welfare.

Proof: See Appendix B-4.

In our extended model, the improvement of rural property rights affects national welfare through different ways, namely enhancing rural productivity and changing rural and urban employment (see Appendix B-4). For the first part of Proposition 4, under conditions (i) and (ii) described by Corollary 2, strengthened rural property rights will improve rural productivity and increase rural and urban employment, hence raising national welfare. For the second part of Proposition 4, strengthened rural property rights will increase rural-urban migration, reducing labor available for rural production. Such a negative effect offsets the positive effect of the rural productivity improvement on rural production, eventually leading to a reduction of total rural output. Meanwhile, urban employment will also decrease, finally reducing total urban output. National welfare will fall due to reductions in both rural and urban outputs.

Here, we would like to point out that if we set $w_1^* = 0$ and $w_2^* = 0$, the extended model in this section will be reduced to the basic model in Section 3, which is just an exogenous urban minimum wage case.

4.2 Introduction of an urban informal sector

The importance of the urban informal sector has been studied and emphasized by a large amount of literature (e.g., Grinols 1991; Gupta 1993, 1997a; Chandra and Khan 1993; Chaudhuri 2000; Chaudhuri, Yabuuchi, and Mukhopadhyay 2006). Generally speaking, the urban informal sector consists of peddlers, small business owners, informal housekeepers, and others. When rural migrants cannot enter the urban formal sector (i.e., the manufacturing sector in this paper), they will enter the urban informal sector, in order to cover their own daily expenses and support their rural family members if possible. Here, we assume that the informal sector absorbs all of the urban unemployment and there is no urban unemployment. Rural migrants who cannot find jobs in the urban formal sector (i.e., the manufacturing sector) will enter the informal sector

or go back to rural areas. Such an assumption is in line with Grinols (1991), Chandra and Khan (1993), Gupta (1997a, 1997b), and others.¹¹ Besides, in accord with the above-mentioned literature, we assume that the urban informal sector is perfectly competitive.

The urban informal sector is represented as:

$$I = F^I(L_I, \bar{K}_I), \quad [20]$$

where I is the output of the informal sector. L_I and $\bar{K}_I$ are labor and capital used by that sector, respectively. F^I is the production function: it is strictly concave and linearly homogenous.

The profit maximization conditions of the urban informal sector yield:

$$p_I F_L^I(L_I, \bar{K}_I) = w_I, \quad [21]$$

$$p_I F_K^I(L_I, \bar{K}_I) = r_I, \quad [22]$$

where p_I is the output price of the informal sector, w_I is the flexible wage rate of that sector ($w_I < \bar{w}$), r_I is the interest rate of capital used in the informal sector, and $F_j^i = \partial F^i / \partial j$ ($i = I$, and $j = L, K$). Equations [7] and [8] will be replaced by:

$$w_R + \tau \frac{\bar{T}}{\bar{L}_R} + \tau(1 - \mu) \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} = \frac{L_M}{L_M + L_I} \bar{w} + \frac{L_I}{L_M + L_I} w_I + \tau \mu \frac{\bar{T}}{\bar{L}_R}, \quad [23]$$

$$L_M + L_I = \bar{L}_U + L_{TR}. \quad [24]$$

So far, the extended model in this subsection has been established, which consists of eqs [1], [2], [3], [20], [21], [22], [4], [5], [6], [23], [24], and [9]. Twelve equations determine twelve endogenous variables, M , I , R , L_M , L_I , L_R , L_{TR} , w_I , r , w_R , r_I , and τ . μ is still an exogenous variable. Others are parameters.

Then, we can get Proposition 5.

Proposition 5: In the situation where an urban informal sector is introduced, (i) the impact of strengthened rural property rights on rural-urban migration is the same as that in Proposition 1; (ii) if we replace urban unemployment by employment of the urban informal sector, the impact of strengthened rural property rights on employment in the urban informal sector is the same as that in Corollary 1.

¹¹ Some scholars also consider the situation where urban unemployment and the informal sector coexist, such as Chaudhuri (2000) and Chaudhuri, Yabuuchi, and Mukhopadhyay (2006). This may also be a good extension of our established model, but here we ignore such a case.

Proof: See Appendix B-5.

The economic intuitions are similar to Proposition 1 and Corollary 1. In order to save space, here we do not give detailed explanations.

In this case, eq. [14] is rewritten as:

$$E(p_M, p_I, U) = \bar{w}L_M + r\bar{K}_M + r_I\bar{K}_I + w_IL_I + w_RL_R + \tau\bar{T}. \quad [25]$$

Now the welfare impact of strengthened rural property rights is shown by the following proposition in the sense of sufficient conditions.¹²

Proposition 6: In the situation where an urban informal sector is introduced: (i) when the value of labor's marginal product of the urban informal sector is less than that of the rural sector, if the rent-gaining effect is dominated by the productivity-enhancing effect, strengthened rural property rights will increase national welfare; however, if the productivity-enhancing effect is largely dominated by the rent-gaining effect, strengthened rural property rights will reduce national welfare; (ii) when the value of labor's marginal product of the urban informal sector is larger than that of the rural sector, if the productivity-enhancing effect is dominated by the rent-gaining effect, strengthened rural property rights will raise national welfare; however, if the rent-gaining effect is largely dominated by the productivity-enhancing effect, strengthened rural property rights will decrease national welfare.

Proof: See Appendix B-6.

The economic explanations behind Proposition 6 are as follows. From eq. [2], we know that employment in the manufacturing sector is invariant. In the situation where the value of labor's marginal product of the urban informal sector is less than that of the rural sector, according to Proposition 5, if the rent-gaining effect is dominated by the productivity-enhancing effect, rural migrants will decrease, and employment of the urban informal sector will fall and that of the rural sector will rise. However, the decreased output value of the urban informal sector will be offset by the increased output value of the rural sector, leading to an increase in national welfare. If the productivity-enhancing effect is largely dominated by the rent-gaining effect, urban-rural migration will increase, and employment of the urban informal sector will rise, but employment of the rural sector will fall. In this case, the decreased output value of the rural sector due to increased

¹² Here we only consider the case where $\mu \in (0, 1)$, and hence we have the establishment of Proposition 6(ii).

urban-rural migration cannot be offset by the sum of the increased output value of the urban informal sector and the increased marginal output value induced by strengthened rural property rights. Therefore, national welfare will be reduced. Similarly, Proposition 6(ii) can be explained.

To fully investigate the urban informal sector, we should also consider the case where capital can move freely between the informal sector and the manufacturing sector. We find that outcomes in such a case are similar to those obtained in the urban capital market segmentation case.¹³

5 Concluding remarks

This paper provides a unified theoretical framework and employs the general equilibrium approach to investigate the impacts of the quality of rural property rights on rural-urban migration and national welfare in developing countries. We pay much attention to the empirical debate concerning how the quality of rural property rights influences the rural-urban migrants. In the basic model where the urban wage rate is exogenously given, the impacts of strengthened rural property rights on rural-urban migration and national welfare are determined by the rent-gaining effect and the productivity-enhancing effect. Our theoretical results are in line with the existing empirical literature. For the sake of generality and completeness, we extend the basic model. When we extend the basic model by considering the endogenously determined urban minimum wage rate, the urban minimum wage determination mechanism is also of great importance in determining the findings obtained by the basic model. When we extend the basic model by introducing an urban informal sector, the value of labor's marginal product of the urban informal sector is crucial for determining the impact of strengthened rural property rights on national welfare.

Future studies can extend our analysis as follows. Firstly, the urban informal sector could be vertically integrated with the urban formal sector. However, this paper does not take it into account. Secondly, the global increase in skilled-unskilled wage inequality in developing countries has captured the attention of many economists. Will strengthened rural property right alleviate or worsen the wage inequality? Thirdly, the studies of rural property rights are mostly analyzed by the empirical or game-theoretical or contractual approach. Much theoretical

¹³ When capital can move freely between the urban formal and informal sectors, calculations are much more complex, but findings are analogous. In order to save space, here we do not give detailed derivations, which are on request if needed.

work could be done through the employment of the general equilibrium approach. Fourthly, this paper assumes that when a peasant migrates, his family's land rent may be expropriated. But in some situations, the family members can effectively protect their land from expropriation by changing their migration choices.¹⁴ Hence, relaxing our assumption by considering changing the choice of migration decisions is worthy of being investigated in the future research. Fifthly, it may be important to relate the structural transformation within a country (i.e., contraction of the rural sector and the expansion of the urban sector) to the wage convergence between the two sectors.

Acknowledgment: We would like to thank the editor Till Requate for his sincere help and encouragement. We are very grateful to two anonymous reviewers for their insightful comments and detailed suggestions on improving this paper. Pi acknowledges the financial support provided by the Program for New Century Excellent Talents in University and the Fundamental Research Funds for the Central Universities. Any remaining errors are ours.

Appendix A: Proofs of Section 3

Appendix A-1: Proof of Proposition 1

Using Cramer's rule to solve eq. [13], we have:

$$\frac{dL_{TR}}{d\mu} = \frac{1}{\Delta} \left\{ \underbrace{\left(\tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} \right)}_{\text{the rent-gaining effect}} - \underbrace{A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right]}_{\text{the productivity-enhancing effect}} \right\},$$

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} > A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{TR}}{d\mu} > 0;$$

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{TR}}{d\mu} < 0.$$

¹⁴ For example, they may let some less strong males migrate and leave the stronger male to stay at home to grow crops and protect land rents.

Appendix A-2: Proof of Corollary 1

From eq. [8], we can obtain:

$$\frac{dL_M}{d\mu} + \frac{dL_{UN}}{d\mu} = \frac{dL_{TR}}{d\mu}.$$

From eq. [2], it is not hard to see that $dL_M/d\mu = 0$. Thus, we have: $dL_{UN}/d\mu = dL_{TR}/d\mu$. From the proof of Proposition 1, we can get:

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} > A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{UN}}{d\mu} > 0;$$

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{UN}}{d\mu} < 0.$$

Appendix A-3: Proof of Proposition 2

Totally differentiating eq. [14] yields:

$$E_U \frac{dU}{d\mu} = A' F^R - A F_L^R \frac{dL_{TR}}{d\mu}.$$

From the proof of Proposition 1, we have:

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dU}{d\mu} > 0;$$

$$\text{If } \tau \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{\bar{L}_R} - A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right] > \frac{A' F^R \Delta}{A F_L^R}, \text{ then } \frac{dU}{d\mu} < 0.$$

Appendix B: Proofs of Section 4

Appendix B-1: Dynamic adjustment process of eq. [19]

The basic idea of the dynamic adjustment process is to build the excess demand function and our approach employed here is similar to that in Funatsu (1988),

Beladi, Chaudhuri, and Yabuuchi (2008)), Pi and Zhou (2013), and Pi and Zhou (2014). The dynamic adjustment process for equations system [19] can be demonstrated as follows:

$$\dot{L}_M = d_1[p_M F_L^M(L_M, \bar{K}_M) - \bar{w}], \quad [26]$$

$$\dot{L}_R = d_2[A(\mu)F_L^R(L_R, \bar{T}) - w_R], \quad [27]$$

$$\dot{w}_R = d_3[L_M(1 + \lambda) + L_R - (\bar{L}_U + \bar{L}_R)], \quad [28]$$

$$\dot{\lambda} = d_4 \left[\frac{1}{1 + \lambda} w^* + \tau \mu \frac{\bar{T}}{\bar{L}_R} - w_R - \tau \frac{\bar{T}}{\bar{L}_R} - \tau(1 - \mu) \frac{\bar{T}}{\bar{L}_R} \frac{L_{TR}}{L_R} \right], \quad [29]$$

where d_i ($i = 1, 2, 3, 4$) is the positive adjustment speed. The dot “.” denotes differentiation of the variable with respect to time. The Jacobian matrix of eqs [26]–[29] is denoted by J , which can be stated as:

$$J = \begin{pmatrix} p_M F_{LL}^M & 0 & -w_1^* & -w_2^* \\ 0 & A F_{LL}^R & -1 & 0 \\ 1 + \lambda & 1 & 0 & L_M \\ 0 & \frac{(1 - \mu) \bar{T}(\tau - A F_{TL}^R L_R)}{L_R^2} & \frac{w_1^* - (1 + \lambda)}{1 + \lambda} & \frac{(1 + \lambda) w_2^* - w^*}{(1 + \lambda)^2} \end{pmatrix}.$$

The determinant of the above matrix is denoted as $|J|$. From the Routh–Hurwitz Theorem, we know that the local stability can be achieved if the elements of the principal diagonal of the Jacobian matrix are negative or zero and the sign of $|J|$ is $(-1)^m$, where m describes the row of the Jacobian matrix. In our situation, the elements of the principal diagonal of the above Jacobian matrix are negative or zero, and $m = 4$, hence $|J| > 0$. By calculation, we have that $\Phi = |J| > 0$.

Appendix B-2: Proof of Proposition 3

By totally differentiating eqs [1], [17], [3], [4], [5], [6], [18], [8], [9], and [16], we can see that the established economic system can be reduced to the following new one:

$$\begin{pmatrix} p_M F_{LL}^M & 0 & -w_1^* & -w_2^* \\ 0 & A F_{LL}^R & -1 & 0 \\ 1+\lambda & 1 & 0 & L_M \\ 0 & \frac{(1-\mu)\bar{T}(\tau - A F_{TL}^R L_R)}{L_R^2} & \frac{w_1^* - (1+\lambda)}{1+\lambda} & \frac{(1+\lambda)w_2^* - w^*}{(1+\lambda)^2} \end{pmatrix} \begin{pmatrix} dL_M \\ dL_R \\ dw_R \\ d\lambda \end{pmatrix} \\
= \begin{pmatrix} 0 \\ -A' F_L^R \\ 0 \\ \frac{\bar{T}[(1-\mu)A' F_T^R - \tau]}{L_R} \end{pmatrix} d\mu$$

[30]

The determinant of the coefficient matrix of the above equations system is denoted as Φ . However, the sign of Φ is ambiguous by the direct calculation. From the dynamic adjustment process (see Appendix B-1), we can know that the sign of Φ is positive (i.e., $\Phi > 0$).

Using Cramer's rule to solve eq. [30], we have:

$$\begin{aligned} \frac{dL_R}{d\mu} = \frac{1}{\Phi} & \left\{ -H \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] \right. \\ & \left. + \frac{w_1^*}{1+\lambda} (p_M F_{LL}^M L_M + w^*) A' F_L^R \right\}, \end{aligned}$$

where $H = p_M F_{LL}^M L_M + (1+\lambda)w_2^* < 0$.

From eq. [9], we know that $dL_{TR}/d\mu = -dL_R/d\mu$. That is,

$$\begin{aligned} \frac{dL_{TR}}{d\mu} = \frac{1}{\Phi} & \left\{ -H \left[\left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) - A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) \right] \right. \\ & \left. - \frac{w_1^* A' F_L^R}{1+\lambda} (p_M F_{LL}^M L_M + w^*) \right\}. \end{aligned}$$

Furthermore, we know that

$$p_M F_{LL}^M L_M + w^* = p_M F_{LL}^M L_M \left(1 + \frac{\partial L_M / L_M}{\partial w^* / w^*} \right).$$

It is not hard to verify that $(\partial L_M / L_M) / (\partial w^* / w^*)$ is the wage elasticity of labor demand in urban areas, which is denoted as e_{wL}^M , where $e_{wL}^M < 0$. The term

$$-\frac{w_1^* A' F_L^R}{1+\lambda} (p_M F_{LL}^M L_M + w^*) \text{ is equal to } -\frac{p_M F_{LL}^M L_M w_1^*}{1+\lambda} (1 + e_{wL}^M) A' F_L^R.$$

When $-1 < e_{wL}^M < 0$, we can get $-\frac{p_M F_{LL}^M L_M w_1^*}{1+\lambda} (1 + e_{wL}^M) A' F_L^R > 0$.

If $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} + \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R > A' [F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R]$, then $\frac{dL_{TR}}{d\mu} > 0$;

If $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} + \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R < A' [F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R]$, then $\frac{dL_{TR}}{d\mu} < 0$.

When $e_{wL}^M < -1$, we can obtain $-\frac{p_M F_{LL}^M L_M w_1^*}{1+\lambda} (1 + e_{wL}^M) A' F_L^R < 0$.

If $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} > A' [F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R] - \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R$, then $\frac{dL_{TR}}{d\mu} > 0$;

If $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} < A' [F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R] - \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R$, then $\frac{dL_{TR}}{d\mu} < 0$.

Appendix B-3: Proof of Corollary 2

Using Cramer's rule to solve eq. [30], we have:

$$\frac{dL_M}{d\mu} = \frac{1}{\Phi} \left\{ [-AF_{LL}^R L_M w_1^* + w_2^*] \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] \right. \\ \left. - \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] A' F_L^R w_1^* \right\}$$

From the proof of Proposition 3, we can get:

$$\frac{dL_R}{d\mu} = \frac{1}{\Phi} \left\{ -H \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] \right. \\ \left. + \frac{w_1^*}{1+\lambda} (p_M F_{LL}^M L_M + w^*) A' F_L^R \right\}.$$

If $A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) > \max \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R, 0 \right\}$, then

$\frac{dL_R}{d\mu} > 0$. Also on the condition that $A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) >$

$\max \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R, 0 \right\}$, we have:

$$\frac{-AF_{LL}^R L_M w_1^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] > 0,$$

$$\frac{w_2^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] < 0,$$

$$-\frac{A' F_L^R w_1^*}{\Phi} \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] < 0.$$

Therefore, when

$$\begin{aligned} & (-AF_{LL}^R L_M w_1^* + w_2^*) \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right], \\ & - \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] A' F_L^R w_1^* > 0 \end{aligned}$$

we have $\frac{dL_M}{d\mu} > 0$.

Furthermore, from eqs [8] and [9], we have $\frac{dL_{UN}}{d\mu} = -\left(\frac{dL_M}{d\mu} + \frac{dL_R}{d\mu}\right)$.

Therefore, we can get $\frac{dL_{UN}}{d\mu} < 0$.

Furthermore, if $A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) < \min \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R, 0 \right\}$, then $\frac{dL_R}{d\mu} < 0$.

Also on the condition that $A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) < \min \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R, 0 \right\}$, we have:

$$\begin{aligned} & \frac{-AF_{LL}^R L_M w_1^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] < 0, \\ & \frac{w_2^*}{\Phi} \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] > 0, \\ & - \frac{A' F_L^R w_1^*}{\Phi} \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] < 0. \end{aligned}$$

Hence, when

$$\begin{aligned} & (-AF_{LL}^R L_M w_1^* + w_2^*) \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right], \\ & - \left[\frac{L_M(1-\mu)\tau\bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] A' F_L^R w_1^* < 0 \end{aligned}$$

we have $\frac{dL_M}{d\mu} < 0$. Furthermore, we can obtain $\frac{dL_{UN}}{d\mu} > 0$.

Appendix B-4: Proof of Proposition 4

By totally differentiating eq. [19], we have:

$$E_U \frac{dU}{d\mu} = A' F^R + A F_L^R \frac{dL_R}{d\mu} + F_L^R \frac{dL_M}{d\mu}.$$

On the following two conditions given by the proof of Corollary 2:

$$(i) \quad A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) > \max \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R, 0 \right\}; \text{ and}$$

$$(ii) \quad \begin{aligned} & (-A' F_{LL}^R L_M w_1^* + w_2^*) \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] \\ & - \left[\frac{L_M (1-\mu) \tau \bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] A' F_L^R w_1^* > 0 \end{aligned},$$

we can obtain $\frac{dL_R}{d\mu} > 0$ and $\frac{dL_M}{d\mu} > 0$. Thus, $\frac{dU}{d\mu} > 0$.

When the conditions shown in the proof of Corollary 3 are strengthened by:

$$(i) \quad \begin{aligned} & A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \\ & < \min \left\{ \frac{p_M F_{LL}^M L_M w_1^*}{(1+\lambda)H} (1 + e_{wL}^M) A' F_L^R - \frac{A' F^R \Phi}{H A F_L^R}, 0 \right\}, \text{ and} \end{aligned}$$

$$(ii) \quad \begin{aligned} & (-A' F_{LL}^R L_M w_1^* + w_2^*) \left[A' \left(F_L^R + \frac{1-\mu}{L_R} \bar{T} F_T^R \right) - \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) \right] \\ & - \left[\frac{L_M (1-\mu) \tau \bar{T}}{L_R^2} + \frac{\mu L_M \bar{T} A}{L_R} F_{TL}^R + \frac{w^*}{(1+\lambda)^2} \right] A' F_L^R w_1^* < 0, \end{aligned}$$

we can obtain $\frac{dL_R}{d\mu} < -\frac{A' F^R}{A F_L^R}$ and $\frac{dL_M}{d\mu} < 0$. Thus, $\frac{dU}{d\mu} < 0$.

Appendix B-5: Proof of Proposition 5

By totally differentiating eqs [1], [2], [3], [20], [21], [22], [4], [5], [6], [23], [24], and [9], we can see that the established economic system can be reduced to:

$$\begin{pmatrix} A' F_{LL}^R & 1 & 0 \\ A' F_{TL}^R & 0 & 1 \\ \left[\frac{(1-\mu) \bar{T} \tau}{L_R^2} + \frac{L_M (\bar{w} - w_I)}{(L_M + L_I)^2} - \frac{L_I p_I F_{LL}^I}{L_M + L_I} \right] & 1 & \frac{(1-\mu) \bar{T}}{L_R} \end{pmatrix} \begin{pmatrix} dL_{TR} \\ dw_R \\ d\tau \end{pmatrix} = \begin{pmatrix} A' F_L^R \\ A' F_T^R \\ \tau \frac{\bar{T}}{L_R} \end{pmatrix} d\mu. \quad [31]$$

The determinant of the coefficient matrix of the above equations system is denoted as Ω . Similar to equations system [13], it is not hard to see that $\Omega > 0$.

Using Cramer's rule to solve eq. [31], we have:

$$\frac{dL_{TR}}{d\mu} = \frac{1}{\Omega} \left\{ \left(\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} \right) - A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right] \right\}.$$

Hence, if

$$\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} > A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{TR}}{d\mu} > 0; \text{ and if}$$

$$\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right], \text{ then } \frac{dL_{TR}}{d\mu} < 0.$$

By eqs [2] and [24], we have $\frac{dL_L}{d\mu} = \frac{dL_{TR}}{d\mu}$.

Hence, if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} > A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right]$, then $\frac{dL_L}{d\mu} > 0$; and if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right]$, then $\frac{dL_L}{d\mu} < 0$.

Appendix B-6: Proof of Proposition 6

From eq. [25], we can get $E_U \frac{dU}{d\mu} = A' F^R + (p_I F_L^I - A F_L^R) \frac{dL_{TR}}{d\mu}$.

From the proof of Proposition 5, we have the following results.

When $p_I F_L^I < A F_L^R$, if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} < A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right]$, then $\frac{dU}{d\mu} > 0$; and if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} - A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right] > \frac{A' F^R \Omega}{A F_L^R - p_I F_L^I}$, then $\frac{dU}{d\mu} < 0$.

When $p_I F_L^I > A F_L^R$, if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} - A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right] > 0$, then $\frac{dU}{d\mu} > 0$; and if $\tau \frac{\bar{T}}{L_R} \frac{L_{TR}}{L_R} + \tau \frac{\bar{T}}{L_R} - A' \left[F_L^R + \frac{(1-\mu)\bar{T}}{L_R} F_T^R \right] < \frac{A' F^R \Omega}{p_I F_L^I - A F_L^R}$, then $\frac{dU}{d\mu} < 0$.

References

- Acemoglu, D. 2010. "Theory, General Equilibrium, and Political Economy in Development Economics." *Journal of Economic Perspectives* 24 (3):17–32.
- Baker, M. J. 2003. "An Equilibrium Conflict Model of Land Tenure in Hunter-Gatherer Societies." *Journal of Political Economy* 111 (1):124–73.
- Basu, K. 1980. "Optimal Policies in Dual Economies." *Quarterly Journal of Economics* 95 (1):187–96.
- Beladi, H., A. Chakrabarti, and S. Marjit. 2010. "Skilled-Unskilled Wage Rate Inequality and Urban Unemployment." *Economic Inquiry* 48 (4):997–1007.
- Beladi, H., S. Chaudhuri, and S. Yabuuchi. 2008. "Can International Factor Mobility Reduce Wage Rate Inequality in a Dual Economy?." *Review of International Economics* 16 (5):893–903.
- Beladi, H., and S. Marjit. 1996. "An Analysis of Rural-Urban Migration and Protection." *Canadian Journal of Economics* 29 (4):930–40.

- Beladi, H., and N. Naqvi. 1988. "Urban Unemployment and Non-Immiserizing Growth." *Journal of Development Economics* 28:365–76.
- Besley, T. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy* 103 (5):903–37.
- Bhagwati, J. N., and T. N. Srinivasan. 1974. "On Reanalyzing the Harris-Todaro Model: Policy Rankings in the Case of Sector-Specific Sticky Wages." *American Economic Review* 64 (3):502–8.
- Calvo, G. A. 1978. "Urban Unemployment and Wage Determination in LDC's: Trade Unions in the Harris-Todaro Model." *International Economic Review* 19 (1):65–81.
- Chandra, V., and M. A. Khan. 1993. "Foreign Investment in the Presence of an Informal Sector." *Economica* 60 (237):79–103.
- Chao, C. C., and E. Yu. 1992. "Capital Markets, Urban Unemployment and Land." *Journal of Development Economics* 38 (2):407–13.
- Chaudhuri, S. 2000. "Rural-Urban Migration, Informal Sector, Urban Unemployment, and Development Policies: A Theoretical Analysis." *Review of Development Economics* 4 (3):353–64.
- Chaudhuri, S. 2006. "Labour Market Reform, Welfare and Urban Unemployment in a Small Open Economy." *Keio Economic Studies* 43 (2):1–17.
- Chaudhuri, S. 2007. "Foreign Capital, Welfare and Urban Unemployment in the Presence of Agricultural Dualism." *Japan and the World Economy* 19 (2):149–65.
- Chaudhuri, S. 2008. "Wage Inequality in a Dual Economy and International Mobility of Factors: Do Factor Intensities Always Matter?" *Economic Modelling* 25:1155–64.
- Chaudhuri, S., and D. Banerjee. 2010. "FDI in Agricultural Land, Welfare and Unemployment in a Developing Economy." *Research in Economics* 64 (4):229–39.
- Chaudhuri, S., and S. Yabuuchi. 2007. "Economic Liberalization and Wage Inequality in the Presence of Labor Market Imperfection." *International Review of Economics and Finance* 16 (4):592–603.
- Chaudhuri, S., and S. Yabuuchi. 2010. "Formation of Special Economic Zone, Liberalized FDI Policy and Agricultural Productivity." *International Review of Economics and Finance* 19 (4):779–88.
- Chaudhuri, S., S. Yabuuchi, and U. Mukhopadhyay. 2006. "Inflow of Foreign Capital and Trade Liberalization in a Model with an Informal Sector and Urban Unemployment." *Pacific Economic Review* 11 (1):87–103.
- Chernina, E., P. C. Dower, and A. Markevich. 2013. "Property Rights, Land Liquidity, and Internal Migration." *Journal of Development Economics* 110:191–215.
- Feder, G., and D. Feeny. 1991. "Land Tenure and Property Rights: Theory and Implications for Development Policy." *World Bank Economic Review* 5 (1):135–53.
- Feder, G., and R. Noronha. 1987. "Land Rights Systems and Agricultural Development in Sub-Saharan Africa." *World Bank Research Observer* 2 (2):143–69.
- Fergusson, L. 2013. "The Political Economy of Rural Property Rights and the Persistence of the Dual Economy." *Journal of Development Economics* 103:167–81.
- Field, E. 2007. "Entitled to Work: Urban Property Rights and Labor Supply in Peru." *Quarterly Journal of Economics* 122 (4):1561–602.
- Fields, G. S. 1975. "Rural-Urban Migration, Urban Unemployment and Underemployment, and Job-Search Activity in LDCs." *Journal of Development Economics* 2 (2):165–87.
- Funatsu, H. 1988. "A Note on the Stability of the Harris-Todaro Model with Capital Mobility." *Economica* 55 (217):119–21.

- Giles, J., and R. Mu. 2012. "Village Political Economy, Land Tenure Insecurity and the Rural to Urban Migration Decision: Evidence from China." Available at: [aeaweb.org. http://www.aeaweb.org/aea/2013conference/program/retrieve.php?pdfid=455](http://www.aeaweb.org/aea/2013conference/program/retrieve.php?pdfid=455)
- Goldstein, M., and C. Udry. 2005. The profits of power: land rights and agricultural investment in Ghana. Center Discussion Paper No. 929, Economic Growth Center, Yale University.
- Grinols, E. 1991. "Unemployment and Foreign Capital: The Relative Opportunity Costs of Domestic Labour and Welfare." *Economica* 58 (229):107–21.
- Gupta, M. R. 1993. "Rural-Urban Migration, Informal Sector and Development Policies: A Theoretical Analysis." *Journal of Development Economics* 41 (1):137–51.
- Gupta, M. R. 1994. "Duty-Free Zone, Unemployment, and Welfare: A Note." *Journal of Economics* 59 (2):217–36.
- Gupta, M. R. 1995a. "Foreign Capital, Income Inequality and Welfare in a Harris-Todaro Model." *Journal of Development Economics* 45 (2):407–14.
- Gupta, M. R. 1995b. "Tax on Foreign Capital Income and Wage Subsidy to the Urban Sector in the Harris-Todaro Model." *Journal of Development Economics* 47 (2):469–79.
- Gupta, M. R. 1997a. "Foreign Capital and the Informal Sector: Comments on Chandra and Khan." *Economica* 64 (254):353–63.
- Gupta, M. R. 1997b. "Informal Sector and Informal Capital Market in a Small Open Less-Developed Economy." *Journal of Development Economics* 52 (2):409–28.
- Gupta, M. R., and P. B. Dutta. 2011. "Skilled-Unskilled Wage Inequality and Unemployment: A General Equilibrium Analysis." *Economic Modelling* 28 (4):1977–83.
- Harris, R., and M. Todaro. 1970. "Migration, Unemployment, and Development: A Two Sector Analysis." *American Economic Review* 60 (1):126–42.
- Jorgenson, D. W. 1967. "Surplus Agricultural Labour and the Development of a Dual Economy." *Oxford Economic Papers* 19 (3):288–312.
- Kabubo-Mariara, J. 2003. "The Linkages Between Property Rights, Migration, and Productivity: The Case of Kajiado District, Kenya." *Environment and Development Economics* 8 (4):621–36.
- Khan, M. A., and S. N. H. Naqvi. 1983. "Capital Markets and Urban Unemployment." *Journal of International Economics* 15 (3–4):367–85.
- Khan, M. A. 2007. "The Harris-Todaro Hypothesis." *PIDE Working Papers* 2007–16.
- Krichel, T., and P. Levine. 1999. "The Welfare Economics of Rural-to-Urban Migration: The Harris-Todaro Model Revisited." *Journal of Regional Science* 39 (3):429–47.
- Lewis, W. A. 1954. "Economic Development with Unlimited Supplies of Labour." *Manchester School* 22 (2):139–91.
- Markussen, T. 2008. "Property Rights, Productivity, and Common Property Resources: Insights From Rural Cambodia." *World Development* 36 (11):2277–96.
- Migot-Adholla, S., P. Hazell, B. Blarel, and F. Place. 1991. "Indigenous Land Rights Systems in Sub-Saharan Africa: A Constraint on Productivity?." *World Bank Economic Review* 5 (1):155–75.
- Miyagiwa, K. 1993. "The Locational Choice for Free-Trade Zones: Rural Versus Urban Options." *Journal of Development Economics* 40 (1):187–203.
- Mullan, K., P. Grosjean, and A. Kontoleon. 2011. "Land Tenure Arrangements and Rural-Urban Migration in China." *World Development* 39 (1):123–33.
- Pan, L., and Y. Zhou. 2013. "International Factor Mobility, Environmental Pollution and Skilled-Unskilled Wage Inequality in Developing Countries." *Economic Modelling* 33:826–31.

- Pi, J., and Y. Zhou. 2012. "Public Infrastructure Provision and Skilled-Unskilled Wage Inequality in Developing Countries." *Labour Economics* 19 (6):881–7.
- Pi, J., and Y. Zhou. 2013. "Institutional Quality and Skilled-Unskilled Wage Inequality." *Economic Modelling* 35:356–63.
- Pi, J., and Y. Zhou. 2014. "Foreign Capital, Public Infrastructure, and Wage Inequality in Developing Countries." *International Review of Economics and Finance* 29:195–207.
- Potts, D. 2000. "Urban Unemployment and Migrants in Africa: Evidence From Harare 1985–1994." *Development and Change* 31 (4):879–910.
- Quibria, M. G. 1988. "Migration, Trade Unions, and the Informal Sector: A Note on Calvo." *International Economic Review* 29 (3):557–63.
- Stiglitz, J. 1974. "Alternative Theories of Wage Determination and Unemployment in LDCs." *Quarterly Journal of Economics* 88 (2):194–227.
- Tassel, E. V. 2004. "Credit Access and Transferable Land Rights." *Oxford Economic Papers* 56 (1):151–66.
- Todaro, M. 1997. "Urbanization, Unemployment and Migration in Africa: Theory and Policy." Policy Research Division Working Paper No. 104, Population Council, New York.
- Yabuuchi, S., and H. Beladi. 2001. "Urban Unemployment, Informal Sector and Development Policies." *Journal of Economics* 74 (3):301–14.
- Zenou, Y. 2011. "Rural-Urban Migration and Unemployment: Theory and Policy Implications." *Journal of Regional Science* 51 (1):65–82.