Urban bias and the political economy of rural land policy in China*

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Abstract

The property rights of rural land remain significantly restricted in China. Given its implications for broad swaths of the economy, rural land reform remains a central policy issue in China. This paper presents a political economy model of rural land policy, taking some salient characteristics of China's context into account. We consider an urban-biased political regime that faces the conflicting motives of industrializing the economy and controlling rural–urban migration. The model shows that while a higher level of urbanization provides stronger incentives in favor of land reform, an increase in the productivity of the urban sector has a counteracting effect. These effects are mediated by the labor elasticity of urban output, the income share of labor in the rural sector, and the political power of urban residents. The model delivers theoretical predictions that are consistent with the observed evolution of China's policy toward rural-urban migration and land policy. The model also sheds light on how the modernization of China's economy could affect the prospects for rural land reform.

JEL Code: R1, P26, H13, O53
Key-words: *urban bias; land policy; China.*

1 Introduction

Property rights are considered crucial to structuring incentives in political, economic, and social exchanges (North, 1990; Jacoby, Li, and Rozelle, 2002; Besley and Persson, 2011). Rural land ownership rights are particularly important in developing countries because of the dominant share of the rural sector.[1] The rural land

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[1] See, e.g., Binswanger, Deininger, and Feder (1995); Besley and Burgess (2000); Bardhan et al. (2014); Chernina, Castañeda Dower, and Markevich (2014); Keswell and Carter (2014); Besley et al. (2016); Chari et al. (2017).

policy during the early periods of the People's Republic of China (PRC), dating back more than half a century, restricted farmers' rights to engage in land markets. Notwithstanding the extensive liberalization reforms across broad swaths of China's economy over the past four decades, ownership rights regarding rural land remain restricted. Land within a village is collectively owned and allocated to peasants based on largely egalitarian criteria, namely household size (Brandt et al., 2002; Kung and Bai, 2011). While peasants are granted the right to farm/use their allotted plots, the right to transfer the ownership of their plots through market exchanges is significantly constrained.

The economic implications of this lack of land markets in rural China, where nearly half of the labor force is employed (Adamopoulos et al., 2017), has become a focal issue in the recent academic literature.[2] Given its enormous implications for the efficiency of the economy, as well as the welfare of hundreds of millions of households, China's rural land reform also remains a central policy issue (Tao and Xu, 2007; Henderson, 2009; World Bank, 2014). However, despite its paramount significance, the political economy of China's land reform has received remarkably little attention in the economics literature. We are not aware of political economy models that analyze the political incentives toward land reform in China. In this paper, we develop such a model and provide a theoretical analysis of the equilibrium determination of rural land policy.

The model features some key characteristics of economics and politics in China. Since our primary focus is analyzing the government's incentives in the context of China's rural and urban sectors, we consider a simple static model for a two-sector economy (Lewis, 1954; Jorgenson, 1961; Todaro, 1969; Harris and Todaro, 1970). In the model, rural-urban migration incentives are driven by the consideration of income differences between working in the rural sector and working in the urban

[2] For example, Adamopoulos et al. (2017) estimate that over 80% of China's rural labor force (which constitutes 46% of the total labor force) is inefficiently tied to the rural sector due to the missing land market; Benjamin and Brandt (2002) find that the constraints on rural land property rights lower agricultural efficiency.

sector.

On the political side, our assumptions capture the tendency of Chinese politics to be biased in favor urban residents. Compared to their rural counterparts, the disproportionate political power of urban residents has long been acknowledged as a salient feature of politics in autocratic states (Lipton, 1977). The geographic concentration and proximity of urban residents to power centers often affords them greater political influence than their rural counterparts (Bates, 1984; Huang, 2012). Located in remote rural areas far from power centers, peasants often lack such influence. Observers studying China agree that the urban bias observed in many non-democratic countries is also a fundamental aspect of Chinese politics (Perkins and Yusuf, 1984; Yang and Cai, 2000; Wallace, 2014).

Another feature of Chinese politics is the policy of controlling rural-urban migration. These policies are intimately related to China's urban-biased politics. Naturally, the policy-driven disparity in living standards between urban and rural residents provides incentives for large-scale rural–urban migration. While the government may value urban employment to modernize the economy, large-scale rural-urban migration could pose a threat in the form of an explosive growth in the urban population, undermining the fiscal sustainability of urban privileges, and, hence, endangering the stability of the regime (Ades and Glaeser, 1995). China's government has responded to this threat by institutionalizing barriers to rural–urban migration through the infamous household registration system named *hukou*. A pillar of this policy, and the focus of our study, is the land tenure system that ties access to rural land with a residency requirement in a rural village and restricts peasants rights to engage in land transactions. This "insecurity of individual land use rights act as a back–pulling force" on rural-urban migration (De La Rupelle et al., 2008, 35), since those who migrate may have to "give up a stream of future land earnings" (Yang, 1997, 101). Our model shows how these motives of industrializing the economy and controlling rural-urban migration could affect the leader's choice in a way that is consistent with actual policies in China.

We focus on how the potential consequences of land reform on rural-urban migration could affect the government's incentives toward land reform. While decreasing the growth of the urban population (by lowering rural–urban migration) helps to lower the cost of financing the economic privileges of the urban population, it also undermines the industrialization of the economy by tying labor to the rural sector. Thus, for a government that desires to modernize the economy, as many scholars agree to be the case for China (Xu, 2011), migration policy poses conflicting political incentives with regard to industrializing the economy and sustaining the economic privileges of the urban population.

We consider land reform in which the government removes ownership restrictions on rural land. To this end, we assume that the government chooses between two types of land ownership rights, which we refer to as *unrestricted ownership rights* and *restricted ownership rights*. Under unrestricted ownership rights (UOR), we assume that land is owned by private owners with unrestricted rights to transfer their land through land markets. Restricted ownership rights (ROR), on the other hand, closely resemble the currently existing rural land tenure in China, where peasants have the right to use their plot (i.e., farm their plot), but they do not have the right to transfer their plots through land markets. The important implication of the differences between ROR and UOR relates to how they affect migration incentives. Under ROR, peasants who move to the urban sector give up compensation from both labor and land in agricultural production. Under UOR, however, peasants who move to the urban sector give up compensation only from their labor (but not from land). Thus, the opportunity cost of rural–urban migration is higher under ROR than under UOR.[3]

[3]The assumption of outright confiscation is shorthand for land income that rural–urban migrants must forgo due to imperfections in the land market. Alternatively, one can also describe land property rights as the probability of the confiscation of land (or a portion of forgone land income due to migration). Land reform can then be described as a decrease in the probability but not necessarily a reduction from 1 to 0. Considering different probability values (other than the change from 1 to 0) would not change our conclusion.

We formalize, in as a simple fashion as possible, the government's trade-off between industrializing the economy (by increasing the share of labor in the urban sector) and lowering the cost of financing the economic privileges of the urban population (by decreasing the size of the urban population). We assume that (1) the urban output constitutes the leader's rent base and (2) the leader and urban residents split the urban output in which urban residents are guaranteed a certain level of consumption. The size of the guaranteed consumption is interpreted as the level of political power wielded by urban residents (Acemoglu, 2005; Shifa, 2013). Then, the leader adopts *UOR* when the benefits from expanding the urban rent base (due to the increase in rural–urban migration) exceed the cost of financing the increases in urban consumption.

The model sheds some key insights as to how the modernization of the economy, as indicated by the level of urbanization and productivity of the urban sector, could affect China's prospects for rural land reform, and how those effects interact with features of the urban production function, urban political power and rural labor market. Our analysis of the model shows that increases in urbanization and productivity pull the leader's incentives in opposite directions. Whereas a higher level of urbanization encourages a switch to UOR (from the current ROR), an increase in urban productivity has the opposite effect. The race between the effects of urban productivity and that of urbanization is, in turn, found to depend on the income share of labor (vis-à-vis land) in the rural sector, the level of political power by urban residents, and the elasticity of labor demand in the urban sector. While increases in the income share of rural labor and the elasticity of demand for urban labor make adoption of UOR more likely, an increase in urban political power has the opposite effect.

The level of urbanization matters because the effect of migration on the marginal product of labor (in the urban sector) depends on the number of migrants *relative to* the existing number of urban residents. The stock of complementary inputs available in the urban sector, including public infrastructure and private capital stock, is likely to increase with increases in the current stock of urban population. Thus, we assume that the stock of capital in the urban sector increases with the level of urbanization (i.e., the size of the pre-migration urban population). This assumption implies that the marginal product of migrant labor increases with the level of urbanization. As a result, an increase in the level of urbanization increases the leader's incentive to adopt land reform.

Urban productivity is shown to have counteracting effects on the leader's incentive with respect to the choice of land policy. On the one hand, an increase in urban productivity increases the productivity of labor in the urban sector and, hence, contributes positively to the leader's rent base. All else being equal, this effect provides a stronger incentive for the leader to prefer *UOR*. On the other hand, an increase in urban productivity increases urban-rural inequality and leads to a larger increase to the urban labor supply, raising the leader's cost of financing the guaranteed consumption of urban residents. This effect implies that the leader's incentive to prefer *UOR* decreases as urban productivity increases. For a lower level of urban productivity, the former effect is found to dominate, so that the government adopts *UOR*. The opposite is true for a higher level of urban productivity.

The model provides predictions that are consistent with observed policy changes in China. It also sheds light on the prospects for land reform as the economy transforms toward more urbanization and higher productivity. Over the past years, China has implemented significant measures to improve living conditions for migrant workers in cities. Rather than restricting rural-urban migration, these policies appear to have aimed at attracting such migrations. China has also shown more willingness to strengthen rural land property rights (CPC, 2013). Though land sales are still illegal and ownership remains communal, recent policy reforms have offered peasants greater tenure security to rent out their use rights.[4] By and large, these policies

[4]Over the past 10 years, the Chinese government has initiated a land titling policy. On the premise of collective ownership, the titles are meant to ease the transfer of land usage rights among

show a trend toward willingness to encourage rural-urban migration but fall short of outward adoption of *UOR*.

The model shows that policy changes that we observe in China (i.e., encouraging migration but falling short of adopting *UOR*) could result from an increase in urbanization in which the urbanization level is sufficiently high to induce marginal changes in polices but is not high enough to result in a large-scale land reform of adopting *UOR*. The model also shows with the rapid increase in China's urbanization, the prospect of adopting *UOR* also increases. And the current policy reforms are equilibrium outcomes that arise in the intermediate range of urbanization that will eventually culminate into the adoption of *UOR*. However, the model also shows the possibility that, due to the counteracting effects of urbanization and productivity on political incentives, restrictions on rural land ownership could persist despite the further modernization of the economy.

This study contributes to the growing literature on the political economy of policy reforms in China. Zhang (2011) develops a model in which competition among Chinese local leaders to attract investments results in the inefficient reallocation of agricultural land for industrial development. Xie and Xie (2017) develop a model that shows how belief differences among competing party factions within the ruling elite could result in a gradual rolling out of economic reforms. Lau, Qian, and Roland (2000) develop a model of "dual-track" liberalization in China, in which adopted reforms target not only increasing the overall efficiency of the economy but also protecting the economic rents enjoyed by incumbent beneficiaries. Wei (1997) shows how the gradual adoption of reforms splits political resistance that could have blocked the reform if it had been implemented by a single large push. In the context of land reform, our model also shares this premise of protecting economic rents by incumbent beneficiaries as a precondition for policy reform.[5]

rural households. For more introductions to recent rural land policies in China, see the No. 1 Document of the Central Committee of CPC for 2013 (CPC, 2013) and the guide from the central government (PRC, 2015).

[5]For a detailed review of the political economy of economic reforms (including in China), see

We also contribute to the broader literature on the political economy of rural land ownership, in which the choice of land property rights is viewed as a purposeful political decision by the powerful elite.[6] In a closely related work, Fergusson (2013) shows how the colonial rural elite with large landholdings undermined the land property rights of local peasants, which discouraged peasants from migrating to the urban sector instead of staying in rural areas to protect their land. The resulting increase in the rural labor supply lowered rural wages and increased the profit of large farms, which are the principal employers of rural labor. Diaz (2000) also attributes the lack of secure property rights for peasants in many Latin American countries to the disproportionate influence of the elite who own large farms. The weak property rights of peasants lower the supply of rental land and, hence, increase rental income for the elite who, unlike the peasants, enjoy tenure security and can rent their land without fear of expropriation. Fergusson, Larreguy, and Riaño (2015) note that in Mexico, the allocation of communal land has been used to foster the dependence of peasants on the state and facilitate clientelistic transfers by the incumbent party. Assuming that peasants can engage in appropriative activities, Grossman (1994) shows that if the technology of the extralegal appropriation of peasants is effective, landlords prefer to distribute land to peasants and discourage them from appropriative activities.[7] Our model extends the notion of land policy as the elite's purposeful choice to a setting featuring urban bias.

The remainder of the paper is structured as follows. Section 2 introduces the historical and institutional background of the rural land ownership regime in China. Section 3 introduces the model. An analysis of the model follows in Sections 4, 5 and 6. We conclude with Section 8. Detailed proofs and derivations are provided in

Roland (2002).

[6]Some early theoretical studies examine the welfare and efficiency implications of changes in land ownership regimes. For example, Moene (1992) shows that land redistribution reduces poverty only when land is scarce. Rosenzweig (1978) builds a three-sector competitive general equilibrium model of a dualistic agricultural labor market and heterogeneous labor and finds a negative association between rural income and landholding inequality.

[7]See also Horowitz (1993), who shows that land reform can be a dynamic process, because the current reform contains the seeds of future reform.

the appendix.

2 Historical and Institutional Background

The Communist Party of China (CPC) took control of mainland China in 1949. Over the past seven decades, the CPC's rural land policy has gone through three main stages: "land to the tiller," collectivization, and the Household Contract Responsibility System (HCRS). These stages in the rural land policy also correspond to major shifts in political power and in the ideology of the CPC. The shift from the era of "land to the tiller" during the CPC's early years to that of collectivization corresponds to the party's shift from a rural guerrilla insurgency desperate for peasant support to that of the sole political party in control of China. On the other hand, the policy change from collectivization in favor of the HCRS concurred with the ideological shift towards a more open economy in the late 1970s.

The CPC came to power by mobilizing peasants in a rural-based insurgency against the state (Zhu et al., 2006), which was then controlled by the Nationalist Party of China (KMT). During the civil war years leading up to CPC gaining control of China in 1949, the CPC was heavily dependent on the support of peasants, who constituted an overwhelming majority of the population in rural China (Meisner, 1986). Given the crucial importance of land in the rural economy, under the motto "land to the tiller," land redistribution played a central role in the CPC's attempt to win peasant support. This took the form of redistributing land from prominent landlords to poor peasants in the territories that came under CPC control (Kung, 2008).

This policy of land redistribution was formalized in 1947 in the CPC's programmatic document, which was adopted as the Outline Land Law of China (**?**). The document stipulated "the abolishment of the land system of feudal and semi-feudal exploitation and "implementation of the system of land to the tillers" (Article 1).

The land reform continued in the years after the CPC seized power in 1949 and was more or less completed in 1952, when nearly 300 million peasants received land from the government.[8] This egalitarian approach to land ownership was finally enshrined in Article 8 of the Constitution of the PRC (1954): "The state protects the right of peasants to own land and other means of production according to law" (Han, 2008).

Once the CPC overthrew the KMT and consolidated its power, it moved to assert firm control over peasants through an extensive rural party structure and through the security forces. The support of ordinary peasants was no longer deemed crucial for the CPC's survival. Whatever threat, if any, that the party perceived to its control came mainly from urban unrest in the form of street revolution. The party that was once desperate for peasant support now finds urban China to be its core constituency (Knight, 2017). Describing this twist in the political power of rural versus urban residents in China, Fukuyama, in his book titled *The Origins of Political Power*, noted the following:

> Dispersed, indigent, and poorly educated, peasants could seldom achieve significant collective action . . . peasant uprisings could help overturn a Chinese dynasty. But the peasantry could seldom act as a corporate group or force long-term institutional change that would take its interests into account (Fukuyama, 2011, p. 423).

The consolidation of the CPC's control and the diminished need for peasant support was thus followed by policies that massively disadvantaged rural residents and that still persist under the current system of rural-urban migration control called *hukou*. Until the 1940s and early 1950s, peasants operated their farms with greater autonomy. However, toward the end of the 1950s, as the CPC consolidated its power, the government required all peasants to organize under local agricultural collectives that were controlled by the state (Lin, Cai, and Li, 2003). Peasants were required to surrender their plots and work on plots owned and managed by the col-

[8] See http://www.gov.cn/test/2009-08/20/content_1397342.htm

lectives. Proceeds from the collective farms would be distributed among villagers. The collectives, under the leadership of local cadres, took control of both (1) land ownership and (2) the management of farms (i.e., production management and the remuneration of farmers). Their livelihood now tied to membership of local collectives, rural residents were locked in their villages with little freedom of migration. Through the collectives, the state exerted direct control over the management of peasant agriculture.[9]

This control over the peasantry was instrumental in enabling the state to implement policies that highly discriminated against rural residents. Having instituted firm control in the peasant economy, the state engaged in a massive extraction of agricultural resources, which were then utilized to finance the expansion of industries in urban areas, helping to create better job opportunities for urban residents (Lin, Cai, and Li, 2003; Chang and Brada, 2006; Zhou, Feng, and Dong, 2016). The state also provided urban residents with greater access to public welfare, such as public housing, education, and medical care (Chan and Zhang, 1999). Through the regulation of agricultural markets in order to lower food prices, urban residents also benefited from a cheaper supply of food, which came at the expense of the rural residents who produced the agricultural goods. This policy took the form of imposing mandatory grain quotas on agricultural households and direct price controls on agricultural products (Kung, 2002). A tragic effect of this discrepancy in the treatment of urban versus rural residents was manifested in the Great Leap Famine (1958–61), the toll of which was particularly devastating for the rural population (Chang and Wen, 1997).

In the late 1970s and early 1980s, China undertook a number of incremental reforms in what has come to be known as the Household Contract Responsibility

[9]The party established three levels of administration in rural areas, including the People's Commune, the production brigade, and the production team, which is the basic farm production unit. In the beginning, the collective owner of the land was the People's Commune. Later, the government adjusted the land ownership among the three administrative levels, and the production team became the main landowner. See Lin, Cai, and Li (2003) for a detailed description of China's organizational structure of agricultural production and rural administration.

System (HCRS).[10] However, the reforms were mostly limited to granting greater autonomy to peasants in the management of their farms while retaining the core aspects of the restrictions on rural–urban migration. Whereas the collectives controlled management and owned land during the collectivization period, the HCRS delegated the management of farms to peasants while still retaining the collective ownership of land. Under the HCRS, the collectives distribute land among villagers on an egalitarian basis, and individual households are in charge of the production decisions on their allotted plots. As a statutory owner of the land, the collectives can redistribute plots in response to, for example, changes in household sizes among villagers. Even though some recent revisions of the laws and directives on land policy have aimed to improve the security of usage rights and minimize the risk of land confiscation (CPC, 2013), the basic model of collective land ownership remains a crucial feature of the land policy in present-day China.[11] Thus, markets for agricultural land sales are virtually nonexistent, plot sizes are extremely small (averaging approximately 0.7 hectares), and land rentals remain quite limited (Benjamin and Brandt, 2002; Adamopoulos et al., 2017).

3 The Model Environment

We begin discussion of our model by presenting, in this section, the main assumptions about the economy and politics. Then, we present the analysis of the model in three stages. First, in Section 4, we illustrate the role of urban political constraints in the

[10] The implementation of the HCRS system across the country was announced in the Circular of the Central Committee of the Communist Party of China on the Work of Rural Areas in 1984. See http://cpc.people.com.cn/GB/64162/135439/8134254.html

[11] For example, the Land Management Law (1986) and the more recent Law of the PRC on Land Contract in Rural Areas (2002) stipulate that land should be owned by the collective. The Land Administration Law of the PRC was adopted in 1986 and revised twice, in 1998 and 2004. The collective land ownership is emphasized in all three versions. Another recent regulation issued by the Central Committee of the CPC and the State Council of the P.R.C. on January 19, 2014, is the document titled Some Opinions on Comprehensively Deepening the Rural Reform and Speeding up the Modernization of Agriculture (see http://www.gov.cn/jrzg/2014-01/19/content_2570454.htm), which supports farmers' contract rights on the basis of implementing collective rural land ownership (Article 17).

choice of land policy. Next, in Section 5, we discuss how the choice of land policy is affected by the income share of labor in the rural sector, the political power of urban residents, and the labor elasticity of urban output. Finally, in Section 6, we analyze how the modernization of the Chinese economy, as reflected by increases in the level of urbanization and urban productivity, affects the choice of land policy.

3.1 Production

We consider a simple static model for the dual economy with rural and urban sectors. The initial (i.e., pre-migration) size of the urban and rural working-age populations equal $N_r \in (0, \infty)$ and $N_u \in (0, \infty)$, respectively. Some of the rural population could migrate out of the rural sector in order to work in the urban sector. Thus, the total (i.e., post-migration) number of workers in the rural and urban sectors are $L_r = N_r - m$ and $L_u = N_u + m$, respectively, where m represents the number of rural–urban migrants.

As is commonly done in dual-economy models, we assume that production in the rural sector utilizes labor and land, while the urban sector utilizes capital and labor. The economy is endowed with $A \in (0, \infty)$ units of agricultural land. Output in the agricultural sector, Y_r, is a Cobb-Douglass function of land and labor:

$$Y_r = A^{\lambda} L_r^{1-\lambda}, \quad \lambda \in (0, 1) \qquad [1]$$

The per capita output in the rural sector, y_r, then equals $(A/L_r)^{\lambda}$.

Output in the urban sector is given by

$$Y_u = K^{\alpha} (z L_u)^{1-\alpha}, \quad \alpha \in (0, 1) \qquad [2]$$

where z, henceforth referred to as "urban TFP," represents the level of productivity in the urban sector.

We assume that the stock of complementary inputs in the urban sector (e.g., public infrastructure and private capital stock) may not change immediately in response to changes in the supply of rural-urban migrants due to, for example, the presence of adjustment costs. It is also likely that the stocks of such complementary inputs available in the urban sector increase with an increase in the existing urban population. We formalize this by assuming that the level of K is proportional to the pre-migration level of effective labor force in the urban sector, zN_u,

$$K = \psi^{\frac{1}{\alpha}} zN_u \qquad [3]$$

where $\psi > 0$ is some constant that, without a loss of generality, is normalized to 1.[12] Combining [2] and [3], urban output becomes

$$Y_u = \tilde{z} K^{\alpha} L_u^{1-\alpha} \qquad [4]$$

where $\tilde{z} = z^{1-\alpha}$ and K is given by [3]. The marginal product of migrant labor in the urban sector is given by

$$\frac{dY_u}{dm} = (1-\alpha)\tilde{z} K^{\alpha} L_u^{-\alpha} \qquad [5]$$

Since this expression equals $(1-\alpha)zN_u^{\alpha}L_u^{-\alpha}$ (from Equation [3]), the effect of the labor supply by immigrants (m) on urban output depends on the *relative* quantity of migrants in the urban population, in which the marginal product of migrant labor increases in the pre-migration level of urbanization (N_u).[13]

Over the past several decades, much of China's urbanization has resulted from

[12] This proportionality between capital stock and effective labor also mimics the assumption that the marginal product of capital equals an exogenously given interest rate r when urban employment equals the pre-migration number of the urban population,

$$r = \alpha K^{\alpha-1}(zN_u)^{1-\alpha} \Longrightarrow K = \left(\frac{\alpha}{r}\right)^{\frac{1}{1-\alpha}} zN_u.$$

[13] Taking the derivative of the log (i.e., monotonic transformation) of Equation [5] with respect

increases in the urban population that do not have urban *hukou*. Nevertheless, many of those without urban *hukou* are woven into the urban economy for long enough that the stocks of complementary inputs in the urban sector have likely adjusted to their presence. Thus, to the extent that such adjustments of complementary inputs have taken place to accommodate those rural *hukou* holders who have long been working in the urban sector, N_u can also be considered to reflect their number (in addition to the urban *hukou* holders). Thus, it is more reasonable to interpret rural–urban migrants in our model, m, as representing recent migrants to whom the urban capital stock has not yet adjusted instead of as the stock of all rural *hukou* holders in the urban sector. By assuming that all workers are identical, we also abstract from potential differences in the composition of the labor force. However, this is not consequential to our conclusion since, as we show below, the important factor for the leader's decision is the effect of migration on the total urban output (i.e., the rent base).

3.2 Politics

In our assumptions about politics, we intend, in as simple fashion as possible, to capture the conflicting motives that the government may face between the benefits of industrializing the economy (by allowing more migration to urban areas) and the cost of financing the economic benefits for a larger urban population. We do this by first tying the leader's economic privilege to the size of the modern sector in the economy, in which we assume that the leader's consumption, T, is given by:

$$T = \tau Y_u \qquad [6]$$

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to N_u, one gets

$$\frac{d\log\left(\frac{dY_u}{dm}\right)}{dN_u} = \frac{\alpha}{N_u} - \frac{\alpha}{L_u}.$$

This expression is greater than zero for positive migration (i.e., $L_u > N_u$).

where τ is the share of the urban output, henceforth "tax rate", consumed by the leader. Thus, an increase in urban output increases the leader's rent base.[14] The remaining $(1-\tau)Y_u$ of the urban output will be consumed by the urban residents. Urban consumption per worker is given by

$$C_u = \frac{(1-\tau)Y_u}{L_u} \qquad [7]$$

We model the political power of the urban population by imposing a constraint in which the leader must guarantee a minimum level of per capita consumption for the urban residents (by controlling migration and/or setting tax rates):

$$C_u \geq C_{min} = \gamma \overline{C}, \qquad \gamma \in (0,1) \qquad [8]$$

The parameter γ captures the level of political power wielded by the urban population. A larger value of γ means that the leader has to ensure that urban residents receive a higher level of consumption. $\overline{C}$ represents per capita urban consumption when both m and τ are set equal to 0, so that the inequality in [8] imposes a constraint on the combined effect of taxes and migration on the consumption of urban residents. Plugging the value of K from [3] into the urban consumption function [7], it can be shown that $\overline{C}$ equals z.

With regard to land policy, we consider two types of land property rights: *restricted ownership rights* and *unrestricted ownership rights*. Under unrestricted ownership rights (*UOR*), we assume that land is owned by private "absentee landowners" who have unrestricted rights to sell and rent and that there are fully functional labor and land markets in the rural sector. We assume that rural wages in such a market equal $\eta_w y_r$, where y_r is output per worker in the rural sector and $\eta_w \in (0,1)$ represents an exogenously given income share of workers in the rural labor market. The

[14]The assumption of the urban sector as the government's main rent base is also consistent with the minimal role that agricultural taxes, which were abolished in 2006, play in government revenue.

income share of land, η_r, is assumed to equal $1 - \eta_w$.

Under restricted ownership rights (ROR), land is equally distributed among peasants, and peasants have the right only to use their plot. Peasants who migrate to urban sector give up their rural land, which is redistributed to the peasants who remain in the rural sector. This assumption of the outright redistribution of migrants' land is shorthand to capture the missing land market and is not particularly essential for our conclusions. The conclusions remain the same if we instead assume, more realistically, that land reallocation occurs with some positive probability that is less than 1 (Adamopoulos et al., 2017). Similarly, even though we focus on full ownership right as land reform, the mechanisms would remain the same if one consider partial reforms, such as strengthening of peasants' rights to lease their plots (but not necessarily to sell their land). The essential feature is that the level of land market imperfection under UOR is lower than that under ROR, so that migrants expect to receive a large share of the land rent under the former.

For a peasant, the opportunity cost of migrating to the urban sector is the income that she could have earned had she remained in the rural sector. This opportunity cost, denoted by C_r, depends on the land property right regime, p:

$$C_r = \begin{cases} y_r & \text{if } p = 0 \\ w_r = \eta_w y_r & \text{if } p = 1 \end{cases} \qquad [9]$$

where p equals 1 for UOR and 0 otherwise. Thus, the key difference between ROR and UOR relates to their effect on migration decisions. The opportunity cost of migration under ROR equals agricultural output per worker, y_r, which equals $(A/L_r)^\lambda$ (see Equation [1]). On the other hand, the opportunity cost of migrating under UOR is only w_r, as the income that a landowner may receive is not dependent on her location of work.[15]

[15] Note that we assume that agricultural productivity (as captured by effective land size A) is the same under ROR and UOR. We also abstract from changes in relative prices between agricultural and non-agricultural goods. However, we conjecture that allowing for a higher level of productivity

We assume that migration continues until the consumption from working in the urban sector equals the opportunity cost of leaving the rural sector:

$$C_u = C_r. \qquad [10]$$

We abstract from migration costs. This is certainly not the case in China, where the government divides its urban population into those who are officially recognized as urban residents (urban *hukou* holders) and those who are not (rural *hukou* holders), and imposes enormous costs on the latter. Almost all rural–urban migrants fall in the category of rural *hukou* holders. The immigrants in urban areas often face discrimination in public services and labor markets, suppressing their level of consumption. Thus, it would be more realistic to include two separate values of γ for the urban and rural *hukou* holders in which the latter's political power is less than the former. In Appendix B, we allow for two values of γ and show that our conclusions do not change even if we let the leader choose a lower level of urban consumption for the immigrant group.

Given the political constraints imposed by the urban population (Equation [8]) and the migration parity condition (Equation [10]), the tax rate τ^* and land property right regime $p^* \in \{0,1\}$ that maximize the leader's total rent T are given by:

$$(\tau^*, p^*) = \underset{\tau,p}{\operatorname{argmax}}\ T \qquad [11]$$
$$s.t. \quad [4], [6] - [10]$$

Throughout our analysis, since our objective is to analyze the prospect of land reform in the context of rural–urban migration, we restrict our attention to the case where migration occurs only from rural to urban areas so that $0 \leq m \leq N_r$. The reverse case, in which initial rural incomes are higher than urban incomes, is also

under *UOR* and/or relative price changes do not change our propositions under realistic scenarios (i.e., as long as *ROR* results in a smaller level of rural–urban migration than *UOR* does). See the discussion in Section 5 on the effect of η_w.

not empirically relevant, since productivity levels and incomes in urban areas are much larger than those in rural areas. This restriction is achieved by assuming that initial incomes are higher in urban areas. In summary, our parameter space, denoted by $\bar{\mathbf{\Omega}} \subset \mathbb{R}^8$, is restricted to the following set:

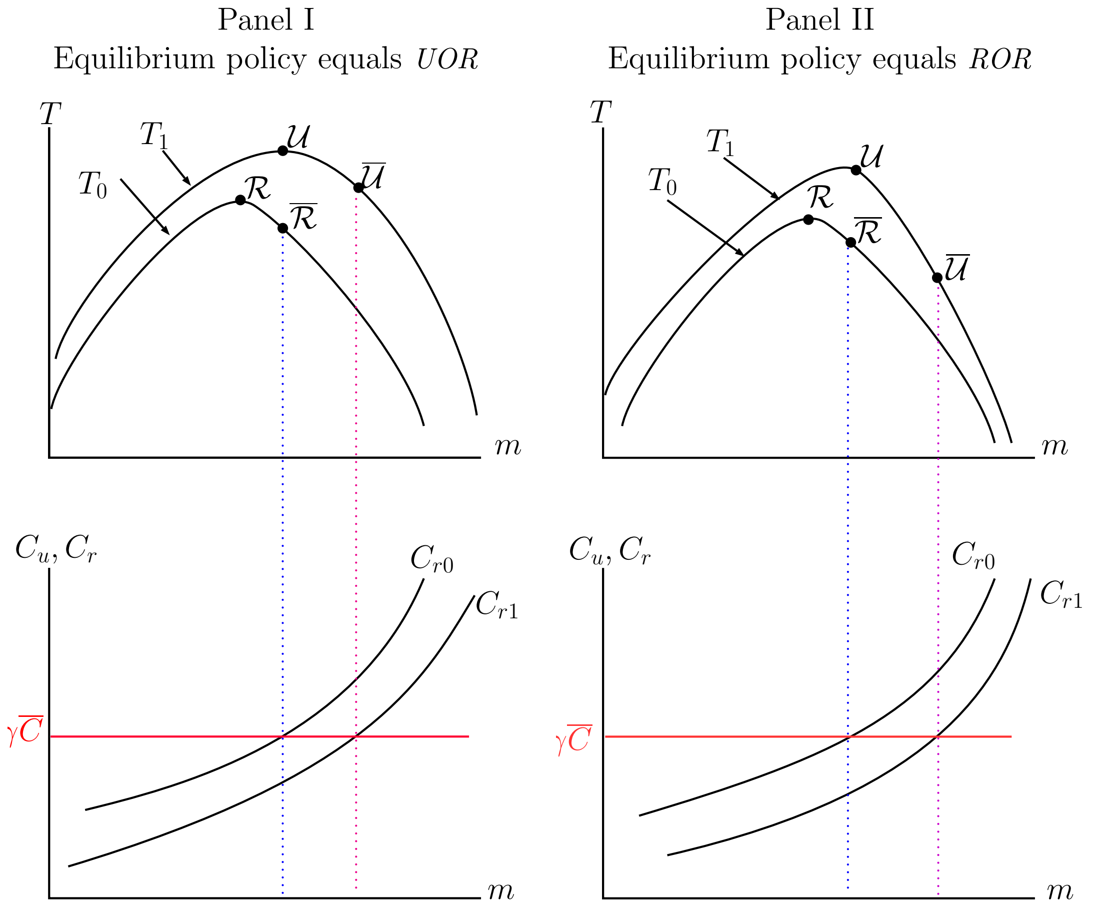
$$\begin{aligned} \bar{\mathbf{\Omega}} = \Big\{ & (\gamma, \alpha, \eta_w, \lambda, z, A, N_r, N_u) : \\ & \gamma, \alpha, \eta_w, \lambda \in (0, 1); \\ & z, N_r, N_u \in (0, \infty+); \\ & \left(\frac{A}{N_r}\right)^{\lambda} < \gamma z \Big\} \end{aligned} \quad [12]$$

The last inequality rules out the possibility that rural residents receive a higher consumption than urban residents.

4 The Role of Political Constraint

We now illustrate the role of urban political constraint in the choice of land policy. It is shown that for parameter values where the political constraint is not binding, the leader chooses *UOR*. Moreover, even if the political constraint is binding, this does not necessarily preclude the leader from adopting *UOR*. We present the conditions for the leader to adopt *UOR* under the scenario of a binding political constraint. These conditions will then be used as the basis to examine the effect of various parameters on the leader's choice of property rights in subsequent sections.

To see how the political constraint [8] affects the choice of rural land policy, it is instructive to first focus on a case where such a constraint is not relevant (i.e., not binding). Combining [6] and [7], the leader's maximization problem in [11] can be



Notes: The top two graphs in both panels show the leader's revenue as a function of migration level under *UOR* (T_1) and *ROR* (T_0). The bottom graphs show the number of migrants as a function of urban consumption. The horizontal line $\gamma\overline{C}$ is the political constraint. Panel I (Panel II) represents a scenario in which the leader's preferred land policy is *UOR* (*ROR*).

Figure 1: Land policy under a binding political constraint

rewritten as:

$$\max_{m,p\in\{0,1\}} T = Y_u - C_u L_u \qquad [13]$$

$$s.t. \quad [4], [8], [9] \text{ and } [10]$$

This maximization lends itself to an intuitive interpretation. The first term of T represents the total output produced by the urban sector. The second term equals the total consumption by urban workers. The difference between these terms—the portion of urban output that is not consumed by urban workers—equals the leader's rent. On the one hand, increasing m, which can be attained by increasing urban consumption C_u, expands the rent base and, hence, can make a positive contribution to the leader's revenue. On the other hand, this raises the leader's cost of financing urban consumption, which is represented by the second term.

It is thus instructive to approach the leader's maximization problem in two stages: first, choose the optimal level of migration under each of the two property right regimes, and then, select the regime with the highest T. Let m_0^* and m_1^* denote the levels of migration that maximize the leader's revenue under *ROR* and *UOR*, respectively:

$$m_p^* = \underset{m}{\text{argmax}}\ T(m; p) \qquad [14]$$

The change in the leader's revenue due to switching from *ROR* to *UOR* equals:

$$\Delta = T(1, m_1^*) - T(0, m_0^*) \qquad [15]$$

The leader chooses *UOR* over *ROR* if this gain is positive:

$$p^* = \underset{p\in\{0,1\}}{\text{argmax}}\ T(p, m_p^*) = \begin{cases} 1 & \text{if } \Delta \geq 0 \\ 0 & \text{otherwise} \end{cases} \qquad [16]$$

Figure 1 plots the relationships among urban consumption, the level of migration and the leader's rent under the two ownership regimes. Panels I and II demonstrate scenarios under which *UOR* and *ROR*, respectively, are the optimal land policy. The top graphs in both panels plot the leader's rent as a function of m. The curve T_1 represents the leader's revenue under *UOR*, while T_0 represents the revenue under *ROR*.

An important difference between T_1 and T_0 is that for each level of m, the former is larger than the latter. To verify this, plug the values of C_r and C_u from [9] and [10] into the expression for the leader's rent in [13]. Then, the vertical gap between the two curves is given by:

$$T(p = 1, m) - T(p = 0, m) = \Big(C_r\,(0, m) - C_r\,(1, m)\Big) L_u \qquad [17]$$

This expression shows that, for any given level of migration m, the adoption of *UOR* increases the leader's rent if the opportunity cost of migration under *ROR*, $C_r\,(0, m)$, is greater than that of the cost under *UOR*, $C_r\,(1, m)$. To see that this is indeed the case, use $y_r = (A/L_r)^\lambda$ and plug [9] into [17]:

$$T(p = 1, m) - T(p = 0, m) = (1 - \eta_w) \left(\frac{A}{L_r}\right)^\lambda L_u \qquad [18]$$

Since the labor share parameter η_w is less than 1, this expression is always positive. Intuitively, the adoption of *UOR* decreases the opportunity cost of rural–urban migration. Assuming no political constraints, the decrease in the opportunity cost enables the leader to attract migrant labor and expand the rent base at a lower cost of financing urban consumption, as shown in [17].

In Figure 1, the maximum value of T_1 is indicated by point $\mathcal{U}$ (for "unrestricted"), which is greater than the maximum value of T_0 (point $\mathcal{R}$, for "restricted"'). If unbounded by the political constraint, the leader will thus prefer *UOR* to *ROR*, as the former option delivers the highest revenue. Whether the political constraint binds depends, in turn, on the net contribution of an extra migrant worker to the leader's revenue. Figure 2 illustrates this point. Taking the derivative of T with respect to m:

$$\frac{\mathrm{d}T(p, m)}{\mathrm{d}m} = \frac{\mathrm{d}Y_u}{\mathrm{d}m} - \left(C_u(p, m) + L_u \frac{\mathrm{d}C_u(p, m)}{\mathrm{d}m}\right) \qquad [19]$$

The downward sloping *MR* curve and the upward sloping *MC* curve are given by the first and second terms in [19], respectively:

$$MR(m) = \frac{\mathrm{d}Y_u}{\mathrm{d}m} \tag{20}$$

$$MC(p,m) = C_u(p,m) + L_u \frac{\mathrm{d}C_u(p,m)}{\mathrm{d}m} \tag{21}$$

The MR curve represents the marginal contribution of an additional migrant to the total rent base, while MC captures the marginal effect of an additional worker on the total urban consumption. Holding the value of urban consumption per worker constant, an increase in the number of urban workers increases the total consumption in the urban sector $(N_u + m)C_u$. In addition, an increase in m, by increasing the land–labor ratio in the rural sector, also increases C_r. Since C_u and C_r have to reach an equilibrium, the increase in C_r implies an increase in urban consumption. This latter effect is captured by the term $L_u(\mathrm{d}C_r/\mathrm{d}m)$. The curve C_r describes the positive relationship between rural–urban migration and the opportunity cost of migration. Since $C_r = C_u$, this curve also represents the supply of migrants, as a function of C_u. If the political constraint is not binding, the leader's optimal level of migration is given by the intersection of the MC and MR curves. The corresponding urban consumption and migration levels equal $\hat{C}_u$ and $\hat{m}$, respectively.

Suppose that $\bar{\gamma}$ and $\underline{\gamma}$—corresponding, respectively, to the top and bottom horizontal lines in Figure 2—represent two scenarios regarding the political power of urban residents. The optimal migration level $\hat{m}$ is attainable if $\gamma = \underline{\gamma}$. In contrast, if we consider the scenario in which the constraint is given by the top horizontal line (i.e., $\gamma = \bar{\gamma} > \underline{\gamma}$), setting urban consumption at the level of $\hat{C}_u$ is politically unfeasible. At a minimum, the leader must provide $\gamma\overline{C}$ to urban residents, i.e., the lowest amount of urban consumption that is politically feasible. This will result in $\bar{m}$ level of migration.[16] From [9] and [10], this migration level under ROR and UOR is given by:

[16]Higher urban consumption due to the political pressure by urban residents is cited as an explanation for the emergence of megacities in developing countries (Ades and Glaeser, 1995).

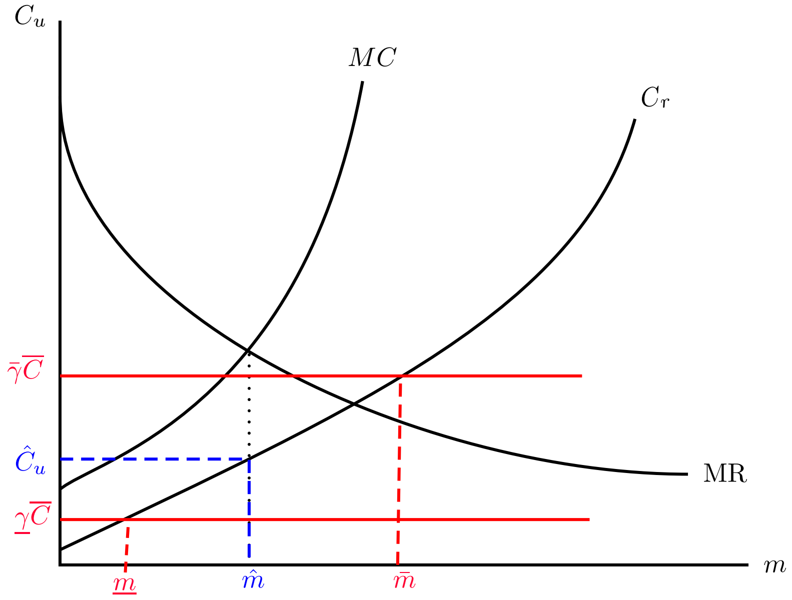


Figure 2: Political constraints and urban political power

$$\bar{m}_0 = N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \quad [22]$$

$$\bar{m}_1 = N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \quad [23]$$

Since the opportunity cost of migrating (for peasants) is lower under ROR, $\bar{m}_1$ is greater than $\bar{m}_0$.

Whether the political constraint is binding depends on whether MC is greater than MR at the point of intersection between the horizontal constraint curve and the C_r curve. Inserting the value of $\bar{m}_0$ from [22] into the expressions for MR and MC ([20] and [21]), the political constraint under ROR binds if:

$$MC\left(0, \bar{m}_0\right) \geq MR\left(\bar{m}_0\right) \quad [24]$$

Similarly, the constraint binds under UOR if:

$$MC\left(1, \bar{m}_1\right) \geq MR\left(\bar{m}_1\right) \quad [25]$$

Since $\bar{m}_1 > \bar{m}_0$ and $\eta_w < 1$, condition [24] is more stringent than condition [25] in the sense that if the political constraint binds under *ROR*, it also binds under *UOR* (see Lemma 1). Intuitively, the political constraint binds when the leader is forced to set urban consumption at a level that is higher than what he ideally wants and is, as a result, faced with excessive migration. If this problem of excessive migration exists under *ROR*, it should also exist under *UOR*, since the latter ownership regime results in a higher level of rural–urban migration.

Lemma 1 describes the parameter space for the two scenarios: (1) the political constraint is binding under both *UOR* and *ROR* or (2) it is binding under neither *ROR* nor *UOR*.[17]

Lemma 1. *The political constraint binds both under ROR and under UOR if:*

$$(1-\alpha)\left(\frac{N_u}{N_u+N_r-A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}}\right)^{\alpha} \leq \gamma+\frac{\lambda}{A}z^{\frac{1}{\lambda}}\gamma^{\frac{\lambda+1}{\lambda}}\left(N_u+N_r-A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right). \quad [26]$$

The political constraint binds under neither ROR nor UOR if:

$$(1-\alpha)\left(\frac{N_u}{N_u+N_r-A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}}\right)^{\alpha} \geq \gamma+\frac{\lambda}{A}\left(\frac{z}{\eta_w}\right)^{\frac{1}{\lambda}}\gamma^{\frac{\lambda+1}{\lambda}}\left(N_u+N_r-A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right) \quad [27]$$

Proof. See Appendix A.1. □

Conditions [26] and [27] show how some of the key parameters determine whether the political constraint binds. For instance, a higher γ forces the leader to increase urban consumption, which, in turn, attracts more migrants to the urban sector.

[17] A third scenario is that the constraint binds under *UOR* but does not bind under *ROR*. The results from this case are shown in Appendix C.

This will then decrease MR, increase MC, and make condition [27] more likely to be satisfied. Therefore, as γ increases, the political constraint is more likely to be binding. The effect of α is similar to that of γ. Another interesting parameter is η_w. An increase in η_w through an increase in the opportunity cost of rural–urban migration under *UOR*, decreases the number of migrants to the urban sector. Thus, MR increases and MC decreases. Hence, condition [26] is more likely to be satisfied. The political constraint under *UOR* is, thus, more likely to bind for smaller values of η_w.

In Figure 1, if the condition is binding under neither *UOR* nor *ROR*, the leader can choose freely between the two maximum points on T_0 and T_1, which results in the adoption of *UOR*. The following proposition summarizes this result.

Proposition 1. *Let* $p^* : \bar{\boldsymbol{\Omega}} \to \{0, 1\}$ *where* p^* *is given by* [16]. *For all* $\boldsymbol{\omega} \in \bar{\boldsymbol{\Omega}}$ *such that* [27] *is satisfied, UOR is the equilibrium policy.*

Proof. See Appendix A.2. □

Even though [27] provides a sufficient condition for the adoption of *UOR*, it is not a necessary one. The leader could still choose *UOR* even if this inequality is not satisfied. Figure 1 illustrates this point. In both the right and left panels, the political constraint is assumed to bind. Panel I represents a scenario wherein the leader chooses *UOR*, while he adopts *ROR* in Panel II.

The upward sloping curves in the bottom panels present $C_r(m; p)$, i.e., the opportunity cost of migration as a function of m. By increasing the land-labor ratio in the rural sector, an increase in m increases the rural per capita output and hence increases the opportunity cost of leaving the rural sector. Since $C_r = C_u$, the vertical axes in the bottom plots also represent urban consumption. Thus, the curves in the bottom panels represent the relationship between migration supply and urban consumption. The migration supply for *UOR* lies to the right of the curve for *ROR* due to lower opportunity cost of migration under the former.

The points $\mathcal{U}$ and $\mathcal{R}$ represent the levels of migration at which the leader's rent is maximized under *UOR* and *ROR*, respectively. In the absence of the political constraint, $\mathcal{U}$ is preferable in both panels. However, choosing between these points implies setting urban consumption below $\gamma\overline{C}$, which is not feasible due to the political constraint. Hence, the leader will instead set urban consumption at $\gamma\overline{C}$, corresponding to the points $\bar{\mathcal{U}}$ and $\bar{\mathcal{R}}$. This will result in migration levels of $\bar{m}_0$ and $\bar{m}_1$, which are given by [22] and [23], respectively. In Panel I, the leader's rent at $\bar{\mathcal{U}}$ is greater than the rent at $\bar{\mathcal{R}}$ and, hence, the leader will choose *UOR*. The opposite is true in Panel II.

Lemma 2 presents the condition for adoption of *UOR* when the political constraint binds.

Lemma 2. *Let* $p^* : \bar{\mathbf{\Omega}} \rightarrow \{0, 1\}$ *where* p^* *is given by* [16]. *For all* $\boldsymbol{\omega} \in \bar{\mathbf{\Omega}}$ *such that* [26] *is satisfied,* $p^*(\boldsymbol{\omega}) = 1$ *if and only if:*

$$N_u^\alpha \left\{ \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} \right\} \geq \gamma A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \left(1 - \eta_w^{\frac{1}{\lambda}} \right) \quad [28]$$

Proof. See Appendix A.3. □

The left-hand side of [28] represents the leader's gain from adopting *UOR*, while the right-hand side captures the cost. Recall that *UOR* leads to a larger number of migrants (i.e., $\bar{m}_1 > \bar{m}_0$). So, *UOR* benefits the leader by increasing the rent base. On the other hand, extra migrants are also costly, as they increase the total urban consumption, which equals γz times the number of urban workers. The right-hand of [28] captures this cost. The adoption of *UOR* is optimal when the benefit exceeds the cost.

To summarize, the conditions under Lemma 1 and 2 show two possibilities that may result in the adoption of *UOR*. Either the political constraint does not bind (i.e., [27] is satisfied) or the political constraint binds, but the leader still chooses *UOR* (both [26] and [28] are satisfied). Condition [27] implies that the government wants more migrants in the urban sector. This is clearly not the case in present-day China, where the government still discourages migrants from moving into many urban centers with better job opportunities. Thus, in analyzing the effect of various parameters, we mostly restrict our focus to the case in which the political constraint binds and the parameter space is thus given by:

$$\boldsymbol{\Omega} = \left\{\boldsymbol{\omega} \in \bar{\boldsymbol{\Omega}} \text{ such that [26] holds}\right\} \quad [29]$$

where $\bar{\boldsymbol{\Omega}}$ is given by [12]. This restriction helps to simplify the analysis, since we can examine the effects of changes in parameter values by looking at how those changes affect whether condition [28] holds. Otherwise, as we show in Appendix C, although derivations of the solutions become more complicated, our main conclusions remain the same even if we remove the restriction in [29].

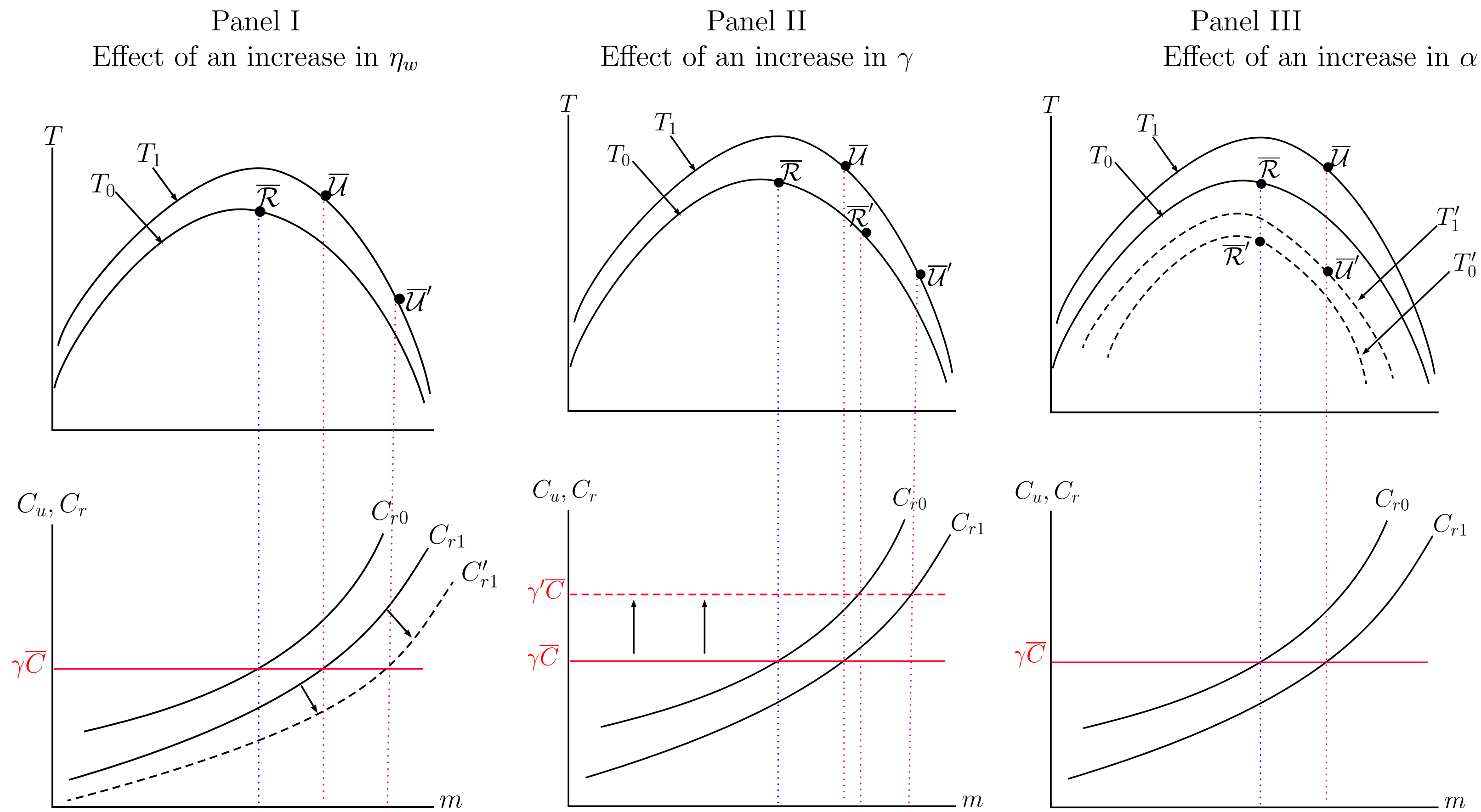
5 Rural Income Share, Political Power and Urban Labor Elasticity

We now briefly highlight how the choice of land policy is affected by parameters related to the income share of labor in the rural sector (η_w), the political power of urban residents (γ), and labor elasticity in the urban sector (α). A closer look at the effects of these three parameters is also useful in discerning the mechanisms behind the effects of urbanization and TFP, which we will discuss next. Figure 3 provides an intuitive illustration of how the choice of land policy is affected by these three parameters: Panels I, II and III show the effects of increases in η_w, γ and α, respectively. The proofs for these effects follow Proposition 2.

For the benchmark case in all panels, i.e., prior to the changes in the parameters, the leader's optimal rent under *UOR* and *ROR* are denoted by $\bar{\mathcal{U}}$ and $\bar{\mathcal{R}}$ (i.e., the maximized value of T under a binding political constraint), respectively. Since the leader's rent under *UOR* (corresponding to point $\bar{\mathcal{U}}$) is larger than that under *ROR* (point $\bar{\mathcal{R}}$), this benchmark case represents a scenario in which the leader's preferred land policy is *UOR*.

By decreasing the opportunity cost of rural-urban migration, a decrease in η_w increases the equilibrium level of migration under *UOR*. This effect is represented by a rightward shift in C_r (from C_{r1} to C'_{r1}). When the political constraint is binding, the leader is already faced with an excessive level of migration. Hence, the increase in migration decreases the leader's rent under *UOR* (from the equilibrium point $\bar{\mathcal{U}}$ to $\bar{\mathcal{U}}'$). In the example displayed by Panel I, the decrease in η_w changes the leader's optimal policy from *UOR* to *ROR*.[18]

[18]The change in η_w can also represent other changes that can affect agricultural wages. For example, if land reform leads to increases in rural wages due to, say, a greater investment in land, this leads to increases in the opportunity cost of migration, and hence, can be represented by an increase η_w in our model. On the other hand, if land reform decreases rural wages due to, for instance, a shift away from labor-intensive technologies (toward capital-intensive technologies) because of land consolidation, the effect of this change on migration is similar to that of a decrease in η_w.



Notes: The top graphs in all panels show the leader's revenue as a function of migration level under UOR (T_1) and ROR (T_0). The bottom graphs show the number of migrants as a function of urban consumption. The horizontal line $\gamma\overline{C}$ is the political constraint.

Figure 3: Effects of changes in the labor share of income in the rural sector (Panel I), urban political power (Panel II) and labor elasticity of urban output (Panel III)

A higher γ means that the leader has to ensure a higher level of consumption for the urban population, which is indicated by the upward shift in the political constraint (from $\gamma\overline{C}$ to $\gamma'\overline{C}$ where $\gamma' > \gamma$). This has two consequences. First, per capita urban consumption increases (from $\gamma\overline{C}$ to $\gamma'\overline{C}$). Second, this increase in per capita urban consumption attracts more migrants to the urban sector, increasing the level of migration.

The marginal effect of a unit increase in urban consumption on migration is larger under *ROR* than under *UOR*. This holds because the land-labor ratio is already high under *UOR* (i.e., $\bar{m}_1 > \bar{m}_0$), and since the opportunity cost of migration is convex in m, a unit increase in urban consumption results in a lower number of migrants under *UOR*. The convexity of C_r also means that the rent curve for *UOR* (at point $\bar{\mathcal{U}}$) is steeper than the curve for *ROR* (at point $\bar{\mathcal{R}}$). As we show in Proposition 2, this difference in the slope of the two curves implies that a unit increase in γ under *ROR* results in a larger loss in the leader's rent than it does under *UOR*. Thus, as the political constraint tightens further, the leader's gain from switching to *UOR* (from *ROR*) decreases.

Turning to effect of α, note that the labor elasticity of urban output is given by (from the production function [2])

$$\frac{\partial \log Y_u}{\partial \log L_u} = 1 - \alpha. \qquad [30]$$

A decrease in this elasticity (i.e., an increase in α) implies a decrease in the marginal contribution of a migrant worker to urban output. In Panel III of Figure 3, this effect is manifested as a downward shift in the rent curves. By lowering the contribution of migrant labor to the leader's rent base, an increase in α decreases the leader's incentive to adopt *UOR*. For the scenario displayed in Panel III, the increase in α changes the leader's optimal policy from *UOR* to *ROR* (i.e., from point $\bar{\mathcal{U}}$ to point $\bar{\mathcal{R}}'$).

Proposition 2 provides a formal summary of the effects of these three parameters on the choice of land policy.

Proposition 2. *Let $p^* : \theta \to p$, where $p^*(\theta; \boldsymbol{\omega}_\theta)$ is given by* [16], $\theta \in \{\eta_r, \gamma, \alpha\}$, $p \in \{0, 1\}$ *and* $\boldsymbol{\omega}_\theta$ *is a vector containing all parameters except* θ.

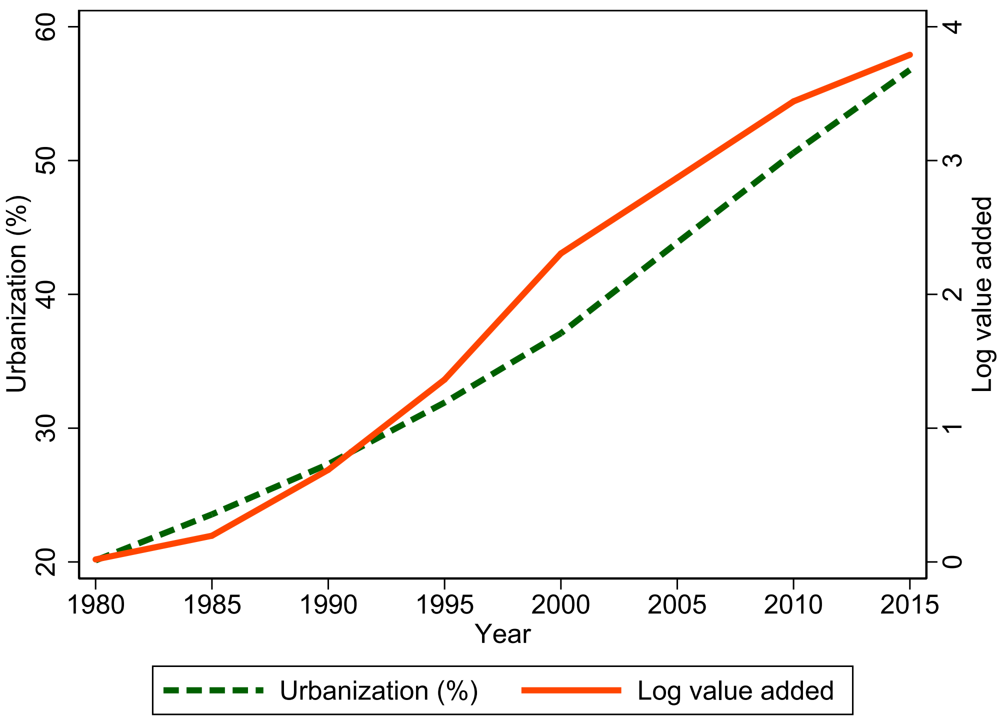
- *If* $p^*(\theta; \boldsymbol{\omega}_\theta) = 1$ *for some* $\theta = \bar{\theta}$, *then for all* $\theta < \bar{\theta}$, $p^*(\theta; \boldsymbol{\omega}_\theta) = 1$.
- *If* $p^*(\theta; \boldsymbol{\omega}_\theta) = 0$ *for some* $\theta = \underline{\theta}$, *then for all* $\theta > \underline{\theta}$, $p^*(\theta; \boldsymbol{\omega}_\theta) = 0$.

Proof. See Appendix A.4. □

6 Urbanization and Urban Productivity

As displayed in Figure 4, China's urban sector has been going through a rapid expansion, in terms of both improved productivity and a rising share of employment. What are the possible consequences of this economic transformation on China's prospect for land reform? We turn to this question by analyzing how increases in the level of the urbanization and productivity of the urban sector influence the government's incentives regarding land policy. Since the stock of complementary inputs in the urban sector (i.e., capital stock) and, hence, the impact of migrant labor supply (m) are conditional on the pre-migration number of urban workers, we consider $\mu \equiv N_u/(N_u + N_r)$ as the parameter to represent the level of urbanization. Regarding urban productivity, we examine how changes in z affect the choice of land policy.

We show that the equilibrium land property rights feature what could be characterized as a race between urbanization and TFP—while an increase in urbanization encourages the shift toward *UOR*, an increase in TFP has the opposite effect. Whereas the former effect suggests a possible reason for why China may not adopt land reform at the early stage of development, the latter effect points to why China may refrain from land reform in the face of an ever-modernizing economy. We then



Source: National Bureau of Statistics of China (2018).

Figure 4: Urbanization and log manufacturing value added per worker in China

turn to examining the conditions that determine which one of these two opposing effects dominates in the choice of land property rights.

6.1 Urbanization and land policy

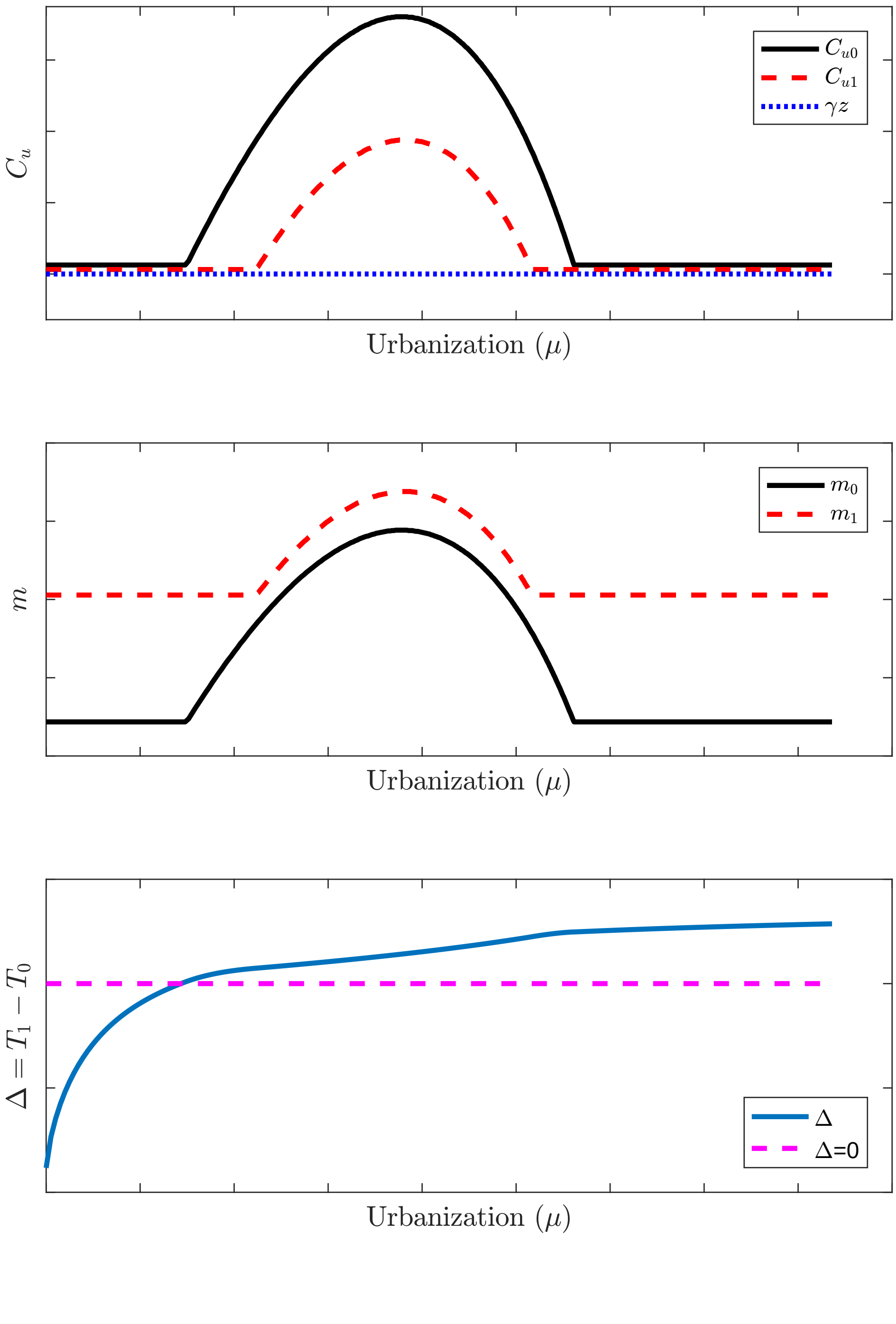
Urbanization has two opposing effects on the leader's incentive to adopt land reform. On the one hand, by increasing the marginal product of migrant labor, an increase in urbanization expands the urban sector's capacity to absorb more migrants. On the other hand, an increase in urbanization increases the cost of financing urban consumption. Figure 5 presents a visual illustration of how these counteracting effects of urbanization unfold in equilibrium. The top and middle panels show how urbanization levels affect the levels of urban consumption and migration that optimize the leader's rent, respectively. The bottom panel displays the effect of urbanization on the leader's rent.[19]

The bell-shaped curves in the consumption plot (top panel) indicate the per capita urban consumption: C_{u0} (solid line) and C_{u1} (broken line) represent consumption under *ROR* and *UOR*, respectively. The dotted horizontal line in this panel represents $\gamma\overline{C}$, the minimum consumption level dictated by the political constraint. Thus, the regions where the consumption curves overlap with the horizontal line (i.e., $C_{u0} = \gamma\overline{C}$ or $C_{u1} = \gamma\overline{C}$) show the level of urbanization in which the political constraint binds.

Two patterns are noteworthy. First, the political constraint binds when the level of urbanization is either sufficiently low or sufficiently high. In the intermediate levels of urbanization, the political constraint does not bind. This is due to how the level of urbanization affects the leader's benefit. An increase in the level of urbanization increases the marginal contribution of migrant labor to the leader's rent base (see Equation [5]). Thus, for a sufficiently low level of urbanization, the leader wants to suppress urban consumption, but he is bounded by the political constraint. As the level of urbanization increases, the marginal contribution of migrant labor increases so that the leader is willing to increase consumption beyond what is dictated by the political constraint.

However, in addition to increasing the marginal contribution of migrant labor, higher urbanization also increases the cost of financing urban consumption. If the leader increases urban consumption to attract more migrants (captured by the term dC_u/dm in Equation [19]), this increase applies to the consumption of *all* workers in the urban sector (hence, the term $dC_u/dm * L_u$ in Equation [19]). Thus, an increase in urbanization increases the cost of attracting new migrants through increasing urban consumption. This effect will eventually dominate, and the leader will decrease urban consumption until he is bound by the political constraint.

[19]Note that since we take N_u as given, we are focusing on the urban-rural inequality as the primary channel through which z affects migration and land policy. We abstract from the potential effect of z through changing the level of urbanization, which we instead analyze by directly examining the effect of N_u.



Notes: This graph displays the effect of urbanization on the level of consumption (top panel), migration (middle panel) and the leader's gain from adopting UOR.

Figure 5: Effect of urbanization (μ)

Second, urban consumption under *ROR* tends to be higher than that under *UOR*. This is due to the higher opportunity cost of migration under the former, increasing the level of urban consumption that is needed to attract rural workers to the urban sector. The differences in C_{u0} and C_{u1} also echo Lemma 1, where the range of urbanization in which the political constraint binds is wider under *UOR*.

The migration plots (middle panel) mimic the consumption plots. The level of migration increases in tandem with increases in urban consumption, as the latter attract more migrants to the urban sector. Moreover, for each level of urbanization, the level of migration is higher under *UOR* than under *ROR*.

The bottom panel shows how the level of urbanization affects the leader's gain from switching to *UOR* from *ROR*, i.e., the difference in the leader's rent under the two ownership regimes ($\Delta = T_1 - T_0$, see Equation [15]). We see that an increase in urbanization always increases the leader's gain from switching to *UOR*. We provide proof for this result in the appendix (see Proposition 3). Intuitively, a combination of three explanations underlies why the gain from adopting *UOR* could increase with urbanization. First, as discussed above, the contribution of migrant labor to urban output increases with urbanization. Second, whenever the political constraint binds, migration is set at a fixed value, given by $C_r^{-1}(\gamma z)$. Hence, when the constraint binds, an increase in urbanization does not affect the cost of financing urban consumption via dC_u/dm (Equation [19]). Third, when the political constraint does not bind (in the intermediate ranges of urbanization in Figure 5), the effect of migration on the contribution of migrant labor is sufficiently high enough that it dominates the effect on the cost of financing urban consumption.

The following proposition summarizes this effect of urbanization on the leader's choice of land policy.

Proposition 3. *Let* $p^* : \mu \to p$ *where* $p^*(\mu; \boldsymbol{\omega}_u)$ *is given by* [16], $p \in \{0, 1\}$ *and* $\boldsymbol{\omega}_u$ *is a vector containing all parameters except* N_u.

- *Suppose that UOR is the equilibrium policy for some* $\mu = \underline{\mu}$. *Then, UOR is also* *the equilibrium policy for all $\mu > \underline{\mu}$.*

- *Assume that ROR is the equilibrium policy for some $\mu = \bar{\mu}$. Then, ROR is also the equilibrium policy for all $\mu < \bar{\mu}$.*

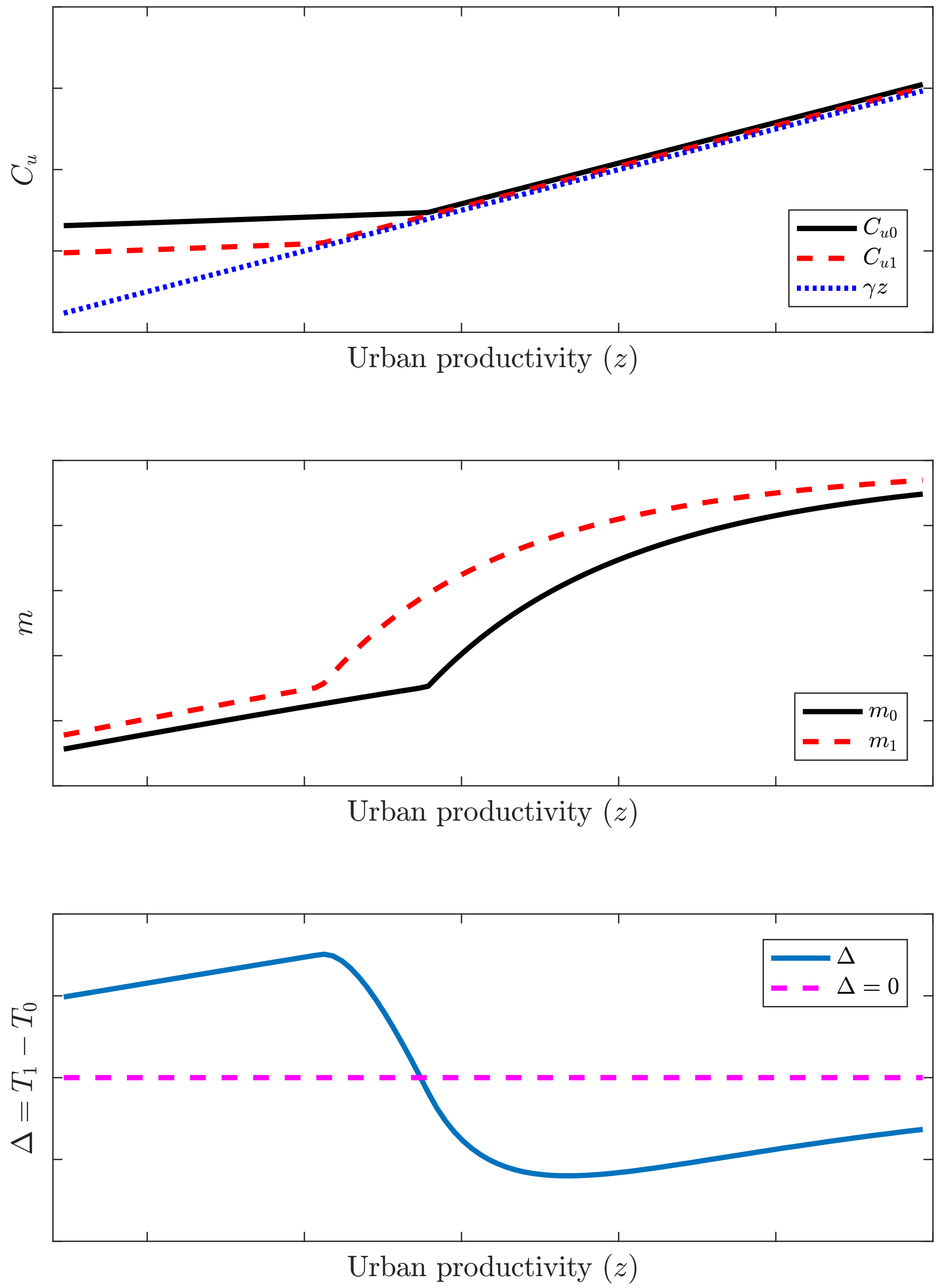
Proof. See Appendix A.5. □

6.2 Urban productivity and land policy

An increase in urban TFP has a counteracting effect on the leader's incentive to adopt *UOR*. On the one hand, it increases the productivity of labor in the urban sector, increasing the contribution of labor to the leader's rent base. All else being equal, this effect provides more incentive for the leader to adopt *UOR*. On the other hand, increases in z widen urban–rural inequality, leading to more migration and, hence, increasing the cost of financing urban consumption. Figure 6 displays how these counteracting effects of z manifest in determining the land policy.

The topmost panel plots the relationship between z and the level of urban consumption that maximizes the leader's rent. This relationship is plotted for each of the ownership regimes. The curves C_{u0} (solid line) and C_{u1} (broken line) indicate levels of urban consumption under *ROR* and *UOR*, respectively. The upward sloping straight curve (dotted line) equals $\gamma\overline{C}$, the minimum consumption level imposed by the political constraint. Since $\overline{C} = z$, this line also represents γz. The middle panel shows the relationship between z and the level of migration that maximize the leader's rent. The bottom panel displays the leader's gain from switching to *UOR* from *ROR* ($\Delta = T_1 - T_0$).

At a sufficiently low level of z, rural–urban inequality is low enough that the political constraint does not bind. So the leader sets urban consumption above the level dictated by the political constraint so as to expand urban output. As z increases further, this results in more migrants, and hence, the increase in the cost of financing urban consumption begins to outweigh the benefit from increased urban



Notes: This graph displays the effect of urban TFP (z) on the level of consumption (top panel), migration (middle panel) and the leader's gain from adopting *UOR*.

Figure 6: Effect of urban TFP (z)

output. Thus, the political constraint starts to bind: the consumption curves hit the constraint line (i.e., urban consumption is set equal to $\gamma\overline{C}$). Similar to the case in the graphs for urbanization (Figure 6), for each level of z, the number of migrants is larger under *UOR* than it is under *ROR*, as the opportunity cost of migration is lower under the former. Moreover, the range of z for which the political constraint binds is wider under *UOR* than it is under *ROR*, as noted in Lemma 1.

The relationship between z and m also shows a distinguishable break at the point where the political constraint starts to bind. At low levels of z when the political constraint does not bind, the effect of z on consumption is more modest. However, once the political constraint starts to bind, the leader is forced to increase consumption at a faster rate. This increase in consumption results in a larger increase in migration. The increase in migration eventually flattens—as more workers leave the rural sector, the marginal product of labor in the rural sector increases, making migration an attractive option to fewer and fewer rural workers.

Because of these counteracting effects, the leader's gain from switching to *UOR* (from *ROR*) first increases as z increases, then starts to decrease and, finally, turns into a loss (i.e., becomes negative). As z increases further, the pattern starts to reverse. This reversal happens because the effect of z on Δ is driven by the difference in the number of migrants under the two ownership regimes. As z becomes very large, much of the rural labor leaves agriculture, irrespective of the land ownership regime, leading to an ever smaller difference in the number of migrants between the two regimes. However, as we prove in Proposition 4, once Δ becomes negative (crosses the horizontal line), it remains negative when z increases. Thus, the leader does not choose *UOR* if z is above a certain threshold level. The following proposition formally summarizes this effect of z on the choice of land policy.

Proposition 4. *Let* $p^* : z \to p$ *where* $p^*(z;\boldsymbol{\omega}_z)$ *is given by* [16], $p \in \{0,1\}$ *and* $\boldsymbol{\omega}_z$ *is a vector containing all parameters except* z.

- *If* $p^*(z;\boldsymbol{\omega}_z) = 1$ *for some* $z = \bar{z}$, *then for all* $z < \bar{z}$, $p^*(z;\boldsymbol{\omega}_z) = 1$.

- *If* $p^*(z;\boldsymbol{\omega}_z) = 0$ *for some* $z = \underline{z}$*, then for all* $z > \underline{z}$*,* $p^*(z;\boldsymbol{\omega}_z) = 0$*.*

Proof. See Appendix A.6. □

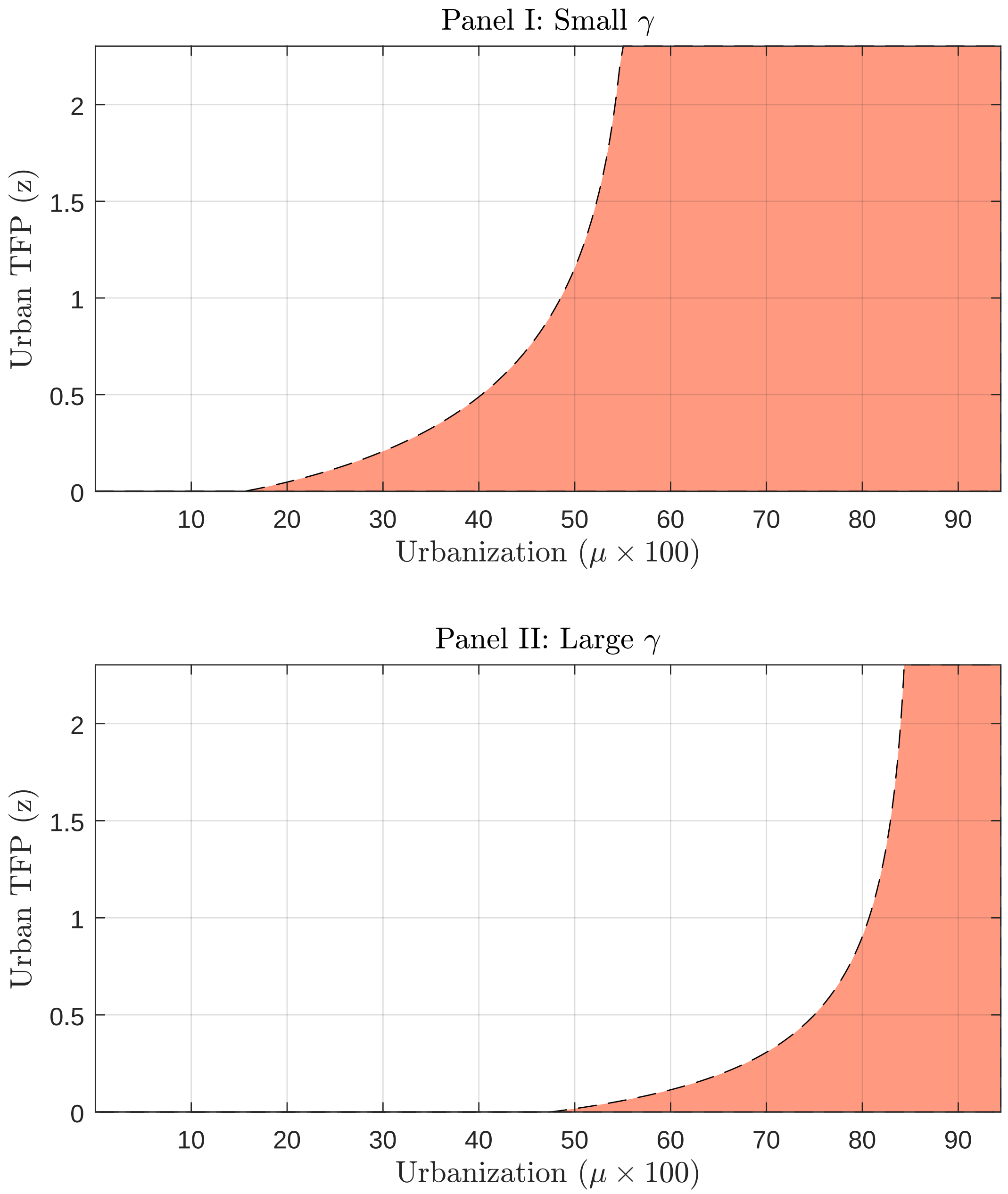
6.3 The race between urbanization and urban productivity

Propositions 3 and 4 point to how the transformation of China's economy, in terms of increases in the level of urbanization and urban productivity, may pull the government's incentive in opposite directions—while further urbanization is more likely to encourage the adoption of *UOR*, higher TFP does the opposite. Thus, for a given level of urban productivity (urbanization), the net effect of these counteracting forces determines the threshold level of urbanization (urban productivity) that the economy should achieve before the leader adopts land reform. Figure 7 displays this relationship between the levels of urbanization and urban productivity. In both panels, the horizontal and vertical axes represent the level of urbanization (μ) and urban TFP (z), respectively. The shaded areas indicate the set of (μ, z) such that the leader adopts *UOR*. As the level of urban TFP increases, the figures show that the threshold level of urbanization to adopt *UOR* also increases.

This threshold depends on, among other factors, the political power of urban residents, the labor elasticity of urban output and the income share of labor in the rural sector. The two panels in Figure 7 show how urban political power (γ) affects threshold urbanization. The change between the top and bottom panels represents the effect of an increase in the value of γ, i.e., the value of γ is larger in the bottom panel. When γ increases, for each level of z, the required level of urbanization to adopt *UOR* increases. In the bottom panel, this effect is represented by the shrinking of the shaded area further to the right.

Increases in α and decreases in η_w also have qualitatively identical effects, i.e., they shrink the shaded area to the right (not shown here).

Whether the leader prefers *UOR*, even for a very large level of urbanization, is



Notes: The shaded area represents the set of urbanization level and urban productivity pairs (μ, z) for which the leader prefers UOR to ROR.

Figure 7: The race between TFP and urbanization

also not a forgone conclusion. One cannot rule out the possibility that the effect of an increased level of urbanization is fully countered by increases in TFP, and thus, *UOR* may not be adopted. The following proposition presents the crucial condition for whether the leader will adopt *UOR* in response to a sufficiently high level of urbanization.

Proposition 5. *Let* $p^* : \mu \to p$ *where* $p^*(\mu; \boldsymbol{\omega}_u)$ *is given by* [16], $p \in \{0, 1\}$ *and* $\boldsymbol{\omega}_u$ *is a vector containing all parameters except* N_u.

Then, $\lim_{\mu \to 1} p^*(\mu; \boldsymbol{\omega}_u) = 1$ *if and only if:*

$$1 - \alpha - \gamma > 0. \qquad [31]$$

Proof. See Appendix A.7. □

This proposition has two important implications. First, the labor elasticity of urban output (i.e., $1 - \alpha$) should be large enough for migrant labor to be valued adequately by the leader. Second, the power of urban people should be sufficiently diminished to contain the political constraint. Without a combination of these two preconditions in place, so that [31] holds, higher urbanization on its own is not destined to lead to *UOR*.

Another, less trivial, implication of Proposition 5 is that as the level of urbanization becomes very large, the income share of labor in the rural sector (i.e., η_w) has no bearing on the leader's choice of land policy. This holds because the effect of migration on the capital-labor ratio depends on the level of urbanization. Note that η_w matters because of its effect on the level of migration (see Equation [23]). As the pre-migration level of the urban population becomes very large, the urban sector's capital stock will also become very large (see Equation 3). Then, according to Equation [5], changes in the level of migration will have a negligible effect on the capital–labor ratio. Thus, the effect of η_w on the marginal contribution of migrant labor becomes negligible when the urban sector is very large.

7 Discussion: China's reforms through the lens of the model

Historically, China's migration control strategy combined the twin strategies of weak rural land property rights and suppressing the welfare of migrant workers in cities. The latter took place mostly in the form of excluding migrant workers from access to social services, such as health care and education. However, in recent decades, the government has moved toward improving the welfare of migrant workers and their access to social services. Many observers of China note that these policies are at least partly aimed at encouraging rural-urban migration. This raises two important questions regarding the consistency of our model with these policy reforms. First, is this shift toward improving the welfare of migrant workers consistent with the predication of our model? Second, if the government desires to encourage rural-urban migration, how can we reconcile the fact that the government still retains the ownership restrictions on rural land while increasing urban consumption to attract migrant workers?

In the context of our model, the answer to these questions lies in how the increase in China's urbanization may affect the government's incentive. Note that the lower bound for C_u (consumption of urban workers) is equal to γz, which is set by the political constraint (equation [8]). If the leader sets C_u to be larger than γz, this means that leader is using the extra consumption $(C_u - \gamma z)$ to attract migrant workers to the urban sector.

Figure 8 illustrates how an increase urbanization could affect, in a way consistent with the observed policy changes in China, land policy and the level of C_u offered by the leader. The top panel shows shows C_u, as a function of urbanization (μ).

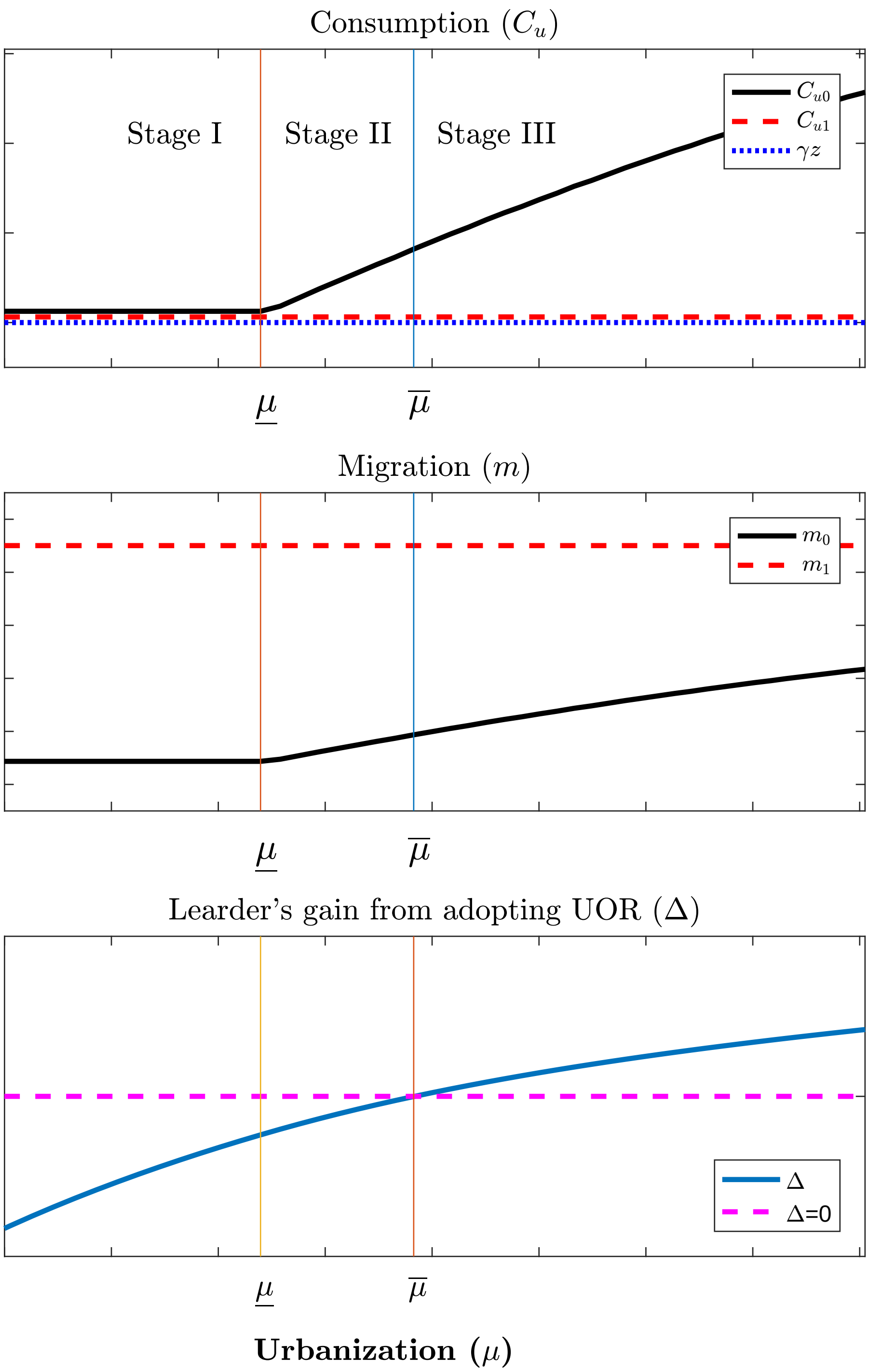
The middle and bottom panels, respectively, show migration (m) and the leader's gain from adopting *UOR* (Δ).

In Stage I, where the level of urbanization is less than $\underline{\mu}$, Δ is negative. So, the optimal land policy us *ROR*. In this stage, C_u is set at γz, which is the lowest feasible value given the political constraint. Thus, this stage represents the level of urbanization in which the government uses *both* C_u and land policy to restrict rural-urban migration, as was observed in the earlier decades of the PRC.

In Stage II, where the level of urbanization is greater than $\underline{\mu}$ but less than $\bar{\mu}$, Δ is still negative, and hence, the optimal land policy is *ROR*. However, C_u is set *above* γz. Thus, this stage represents the level of urbanization in which the government uses raising C_u to *increase* migration but refrains from adopting *UOR*.

Finally, in Stage III, where urbanization is greater than $\bar{\mu}$, Δ is positive and the optimal land policy is *ROR*. C_u is also set *above* γz. For the range of urbanization in Stage III, the leader uses both raising C_u the land policy to *increase* migration.

China's policy reforms over the past years are quite consistent with the movement from Stage I to Stage II. Except for restrictions in a few very large cities, the government has moved toward encouraging rural-urban migration by improving living conditions for workers who move to the urban sector. According to our model, this shift is captured by the increase in C_u that happens in Stage II. On other hand, even though China has started encouraging migration through policies that raise consumption for migrant workers, this happened without adopting *UOR*, as predicted in Stage II of our model. A key aspect of this shift to Stage II is that it represents the leader's desire to increase migration at the *margin*, but not to the extent that is implied by a large scale land reform. That is, even if the leader wants more migrants, this demand for extra workers is not large enough to accommodate the level of migration ushered by adopting *UOR*. Nevertheless, according to our model, these policy changes to Stage II can also be viewed as initial steps toward a gradual removal of ownership restrictions as the economy moves to Stage III.



Notes: The graph shows the level of consumption (top panel), migration (middle panel) and the leader's gain from adopting UOR, as functions of urbanization. In Stage I,C_u equals γz and ROR is the land policy. In Stage II, C_u is set to above γz and ROR is the land policy. In Stage III, C_u is set to above γz and UOR is the land policy.

Figure 8: Sages of policy reforms

8 Concluding remarks

Land policy is certainly one of the most important economic issues in China. It has substantial implications for the efficiency of the economy and the welfare of hundreds of millions of households. Even though China has moved toward market-friendly policies over the past several decades, its rural land policy has remained highly restrictive.

In this paper, we take a positive approach and develop a political economy model that takes into account some important features of China. We focus on how the potential consequences of land reform on rural–urban migration could affect the government's incentives toward land reform.

One of the central insights from our model relates to how the urbanization of the economy and the increased productivity of the urban sector affect the government's choice of land policy. While an increased level of urbanization is shown to provide a stronger incentive to remove ownership restrictions, an improvement in the productivity of the urban sector has a counteracting effect. These counteracting effects are shown to be mediated by the political power of urban residents, the labor elasticity of urban output, and the income share of labor in the rural sector. Importantly, our model provides predictions that show how the government may relax migration restrictions and reform the land policy in a way that are consistent with observed policy patterns.

Compared to the enormous welfare implications of land reform, the political economy of China's land reform has received remarkably little attention in the development literature. Although our results provide important insights on the political incentives affecting land reform, the economic and political ramifications of land tenure are too many to fully address in a single paper. Many questions still beg for more research. We focus on the migration implications of land reform for urban politics. Other potentially relevant considerations in the choice of rural land policy, such as rural governance and social control of the rural population, ideology and food self-sufficiency, fall outside our scope (Xu, 2011). Our model is a static one, and hence, issues of policy credibility and dynamic interactions are also beyond the scope of our paper. These and other remaining questions certainly warrant more research. We hope to address some of them in future studies.

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Appendix A Proofs

A.1 Proof of Lemma 1

Plugging [9] into [13], the leader's maximization problem for a given p becomes

$$\max_{m} T(p,m) = zN_u^{\alpha}(N_u+m)^{1-\alpha} - C_r(p,m)(N_u+m) \qquad [32]$$
$$s.t. \quad [8]$$

where $C_r(p,m)$ is given by [1] and [10]. The Lagrange of this maximization is given by

$$\mathcal{L}(p,m) = zN_u^{\alpha}(N_u+m)^{1-\alpha} - C_r(p,m)(N_u+m) - \mu(p)(\gamma z - C_r(p,m)), \qquad [33]$$

where μ is the multiplier for the political constraint. The first order and complementary slackness conditions are:

$$(1-\alpha)zN_u^{\alpha}(N_u+m)^{-\alpha} - (N_u+m)\frac{\partial C_r(p,m)}{\partial m} - C_r(p,m) + \mu(p)\frac{\partial C_r(p,m)}{\partial m} = 0 \qquad [34]$$

$$\mu(p)(\gamma z - C_r(p,m)) = 0 \qquad [35]$$

From [1] and [9],

$$\frac{\partial C_r(0,m)}{\partial m} = \frac{\partial y_r(m)}{\partial m} = \lambda\frac{A^{\lambda}}{(N_r-m)^{1+\lambda}} \qquad [36]$$

$$\frac{\partial C_r(1,m)}{\partial m} = \eta_w\frac{\partial y_r(m)}{\partial m} = \lambda\eta_w\frac{A^{\lambda}}{(N_r-m)^{1+\lambda}} \qquad [37]$$

If the constraint does not bind, $\mu = 0$ and the value of m satisfying [34] is unique. If the constraint binds, $\mu > 0$ and the value of m satisfying [35] (i.e., $\gamma z = C_r(p,m)$)

is unique. Combining $\gamma z = C_r(p,m)$ with [1] gives us the values of $\bar{m}_0$ and $\bar{m}_1$ (in [22] and [23]):

$$\bar{m}_0 = N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \tag{38}$$

$$\bar{m}_1 = N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \tag{39}$$

Since $\partial C_r(p,m)/\partial m > 0$, when the political constraint binds (i.e., $\mu > 0$), the last term in [34] is positive. It then follows from [34] that the political constraint binds if $MC\left(p, \bar{m}_p\right) \geq MR\left(\bar{m}_p\right)$:

$$(N_u + \bar{m}_p)\left.\frac{\partial C_r(p,m)}{\partial m}\right|_{m=\bar{m}_p} + C_r(p,\bar{m}_p) \geq (1-\alpha) z N_u^{\alpha}(N_u + \bar{m}_p)^{-\alpha}. \tag{40}$$

Plugging the value of $\bar{m}_1$ from [39], inequality [40] under UOR implies

$$\begin{aligned}\gamma z + \left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\lambda\eta_w \frac{A^{\lambda}}{\left(N_r - \left(N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\right)^{1+\lambda}} \\ \geq (1-\alpha) z \left(\frac{N_u}{N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}}\right)^{\alpha}\end{aligned} \tag{41}$$

Rearranging [41]

$$\begin{aligned}\gamma + \frac{\lambda}{A}\left(\frac{z}{\eta_w}\right)^{\frac{1}{\lambda}}\gamma^{\frac{\lambda+1}{\lambda}}\left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right) \\ \geq (1-\alpha)\left(\frac{N_u}{N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}}\right)^{\alpha}\end{aligned} \tag{42}$$

Plugging the value of $\bar{m}_0$ from [38], inequality [40] under ROR implies,

$$\begin{aligned}
&\gamma + \frac{\lambda}{A} z^{\frac{1}{\lambda}} \gamma^{\frac{\lambda+1}{\lambda}} \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right) \\
&\geq (1-\alpha) \left(\frac{N_u}{N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}}} \right)^{\alpha}
\end{aligned} \qquad [43]$$

Since $\eta_w \in (0,1)$, the right-hand side of [43] is greater than the right-hand side of [42] and the left-hand side of [43] is less than the left-hand side of [42]. Hence, [43] implies [42].

A.2 Proof of Proposition 1

This proposition follows straightforwardly from [17] where, for any number of rural–urban migrants $m \in [0, N_r]$, the leader's revenue is higher under UOR than it is under ROR.

A.3 Proof of Lemma 2

Let $T(p, m_p)$ represent the leader's revenue as a function of the property right regime $p\{0,1\}$ and the level of migration m_p. The gain from switching to UOR (from ROR) equals

$$\Delta = T(1, m_1^*) - T(0, m_0^*) \qquad [44]$$

where m_p^* $p \in \{0,1\}$ is the solution to the maximization problem [32]. The leader adopts UOR if this gain is positive: $\Delta \geq 0$.

When the constraint binds, we have that $m_p^* = \bar{m}_p$ where $\bar{m}_p$ is given by [38] and [39]. Plugging this values of m_p^* into [32],

$$T(1, \bar{m}_1) = zN_u^{\alpha} \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \gamma z \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right) \qquad [45]$$

$$T(0, \bar{m}_0) = zN_u^{\alpha} \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \gamma z \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right) \qquad [46]$$

Plugging these values into [44],

$$\Delta = zN_u^{\alpha} \left\{ \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} \right\} - \gamma z A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \left(1 - \eta_w^{\frac{1}{\lambda}} \right) \qquad [47]$$

The leader chooses *UOR* over *ROR* if the former one gives a higher revenue (i.e., $\Delta \geq 0$), which implies [28].

A.4 Proof of Proposition 2

Let $f : \theta \rightarrow \Delta$ such that

$$\begin{aligned}\Delta =& f(\theta; \Theta_\theta) \\ =& zN_u^\alpha \left\{ \left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \right. \\ & \left. \left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{1-\alpha} \right\} - \gamma z A \left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \left(1 - \eta_w^{\frac{1}{\lambda}}\right) \end{aligned} \quad [48]$$

where Δ represents the gain from switching to *UOR* from *ROR*. The proposition implies that $f(\theta; \Theta_\theta)$ crosses the zero line at most only once for $\theta \in (0, 1)$.

A.4.1 Proof for $f(\alpha; \Theta_\alpha)$

$f(\alpha; \Theta_\alpha)$ crosses the zero line at most only once if $f(\alpha; \Theta_\alpha)$ is strictly monotonic in α. In order to show that $f(\alpha; \Theta_\alpha)$ is strictly monotonic, divide [48] by zN_u:

$$\kappa_1^{1-\alpha} - \kappa_0^{1-\alpha} - \frac{\gamma A}{N_u}\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) - \frac{\gamma A}{N_u}\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) \quad [49]$$

where

$$\kappa_1 = \frac{N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}}{N_u} = \frac{N_u + \bar{m}_1}{N_u}$$
$$\kappa_0 = \frac{N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}}{N_u} = \frac{N_u + \bar{m}_0}{N_u}$$

Factoring out κ_0, [49] becomes

$$\kappa_0^{1-\alpha}\left(\left(\frac{\kappa_1}{\kappa_0}\right)^{1-\alpha} - 1\right) - \frac{\gamma A}{N_u}\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) \quad [50]$$

Notice that we restrict the parameter space to cases where $\bar{m}_0 \geq 0$ (see [29]). Since $\eta_w < 1$ and $\bar{m}_1 > \bar{m}_0$, it follows that $\kappa_1 > \kappa_0 > 1$ (i.e., the ratio $\kappa_1/\kappa_0 > 1$) and the expression in [50] is therefore strictly decreasing in α. Since (1) the value of [50] is positive for $\alpha = 0$ and negative for $\alpha = 1$; and (2) f is strictly monotonic, f crosses the zero line only once.

A.4.2 Proof for $f(\gamma; \Theta_\gamma)$

We now prove that (1) $f(\gamma; \Theta_\gamma)$ crosses the zero line at most only once and (2) $f(\gamma; \Theta_\gamma)$ is positive (negative) to the left (right) hand side of the crossing point.

Define $\hat{\mathcal{L}}$

$$\hat{\mathcal{L}}(m_1, m_0) = \mathcal{L}(1, m_1) - \mathcal{L}(0, m_0), \tag{51}$$

where $\mathcal{L}(p, m)$ is given by the Lagrange expression [33]. For $m_0 = \bar{m}_0$ and $m_1 = \bar{m}_1$, it follows that

$$f(\gamma) = \hat{\mathcal{L}}(m_1, m_0) \tag{52}$$

Taking the derivative,

$$\begin{aligned} \frac{d\hat{\mathcal{L}}(m_1, m_0)}{d\gamma} =& \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \gamma} + \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial m_1} \frac{dm_1}{d\gamma} + \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial m_0} \frac{dm_0}{d\gamma} + \\ & \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \mu(1)} \frac{d\mu(1)}{d\gamma} + \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \mu(0)} \frac{d\mu(0)}{d\gamma} \end{aligned} \tag{53}$$

For $m_0 = \bar{m}_0$ and $m_1 = \bar{m}_1$, the optimization condition [34] implies that

$$\left. \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial m_1} \right|_{m_1 = \bar{m}_1} = \left. \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial m_0} \right|_{m_0 = \bar{m}_0} = 0 \tag{54}$$

Similarly, [35] implies that

$$\left.\frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \mu(1)}\right|_{m_1=\bar{m}_1} = \left.\frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \mu(0)}\right|_{m_0=\bar{m}_0} = 0 \qquad [55]$$

It then follows (from [53], [54] and [55]) that

$$\begin{aligned}\left.\frac{d\hat{\mathcal{L}}(m_1, m_0)}{d\gamma}\right|_{m_0=\bar{m}_0, m_1=\bar{m}_1} &= \frac{\partial \hat{\mathcal{L}}(m_1, m_0)}{\partial \gamma} \\ &= -\mu(1)z + \mu(0)z \qquad [56]\end{aligned}$$

where $\mu(p)$ is the Lagrange term in [33]. Combining [34], [35] and [38],

$$\begin{gathered}(1-\alpha)N_u^{\alpha}\left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha} - \\ \left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\frac{\lambda\gamma}{A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}} - \gamma + \mu(0)\frac{\lambda\gamma}{A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}} = 0\end{gathered} \qquad [57]$$

Combining [34], [35] and [39],

$$\begin{gathered}(1-\alpha)N_u^{\alpha}\left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha} - \\ \left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\frac{\lambda\gamma}{A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}} - \gamma + \mu(1)\frac{\lambda\gamma}{A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}} = 0\end{gathered} \qquad [58]$$

Combining [57] and [58],

$$\begin{gathered}\frac{\mu(1)}{\mu(0)} = \\ \frac{\left(N - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\frac{\lambda\gamma}{A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}} - \eta^{\frac{1}{\lambda}}\left((1-\alpha)N_u^{\alpha}\left(N - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha} - \gamma\right)}{\left(N - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right)\frac{\lambda\gamma}{A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}} - \left((1-\alpha)N_u^{\alpha}\left(N - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha} - \gamma\right)}\end{gathered} \qquad [59]$$

Define $\bar{\gamma}$ such that

$$(1-\alpha)N_u^{\alpha}\left(N_u+N_r-A\left(\frac{1}{\bar{\gamma}z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha}-\bar{\gamma}=0 \qquad [60]$$

Since $\mu(1), \mu(0) > 0$ when the constraint binds, both the numerator and denominator in the right-hand side of [59] are positive. It follows from [59] that for $\gamma < \bar{\gamma}$, $\mu(1) > \mu(0)$, which, according to [56], implies that

$$\left.\frac{d\hat{\mathcal{L}}(m_1, m_0)}{d\gamma}\right|_{m_0=\bar{m}_0, m_1=\bar{m}_1} < 0$$

That is, f is strictly decreasing for all $\gamma < \bar{\gamma}$. Hence, if $f(\gamma) > 0$ for $\gamma = \hat{\gamma} < \bar{\gamma}$, then $f(\gamma) > 0$ for $\gamma < \hat{\gamma}$. Similarly, if $f(\gamma) < 0$ for $\gamma = \hat{\gamma} > \bar{\gamma}$, then $f(\gamma) < 0$ for $\gamma \in [\hat{\gamma}, \bar{\gamma}]$.

It remains to show that $f(\gamma) < 0$ for $\gamma \in [\bar{\gamma}, 1]$. The gain from switching to *UOR* from *ROR* is given by

$$\begin{aligned}\Delta =& \bar{T}_1 - \bar{T}_0 && [61]\\ =& zN_u^{\alpha}\left((N_u+\bar{m}_1)^{1-\alpha}-(N_u+\bar{m}_0)^{1-\alpha}\right)-\gamma z\left(\bar{m}_1-\bar{m}_0\right) && [62]\\ =& z\int_{\bar{m}_0}^{\bar{m}_1}\left[(1-\alpha)N_u^{\alpha}\left(N_u+m\right)^{-\alpha}-\gamma\right]dm && [63]\end{aligned}$$

where $\bar{m}_0, \bar{m}_1, \bar{T}_1$ and $\bar{T}_0$ are given by, respectively, [38], [39], [45] and [46].

Since $(1-\alpha)N_u^{\alpha}\left(N_u+m\right)^{-\alpha}-\gamma < 0$ for $\gamma > \bar{\gamma}$, Δ is negative when $\gamma > \bar{\gamma}$.

A.4.3 Proof for $f(\eta_w; \Theta_{\eta_w})$

We prove now that (1) if $f(\eta_w; \Theta_{\eta_w}) \geq 0$ for some $\eta_w = \bar{\eta}$, $f(\eta_w; \Theta_{\eta_w}) \geq 0$ for all $\eta_w \in [\bar{\eta}, 1]$; and (2) if $f(\eta_w; \Theta_{\eta_w}) \leq 0$ for some $\eta_w = \bar{\eta}$, $f(\eta_w; \Theta_{\eta_w}) \leq 0$ for all

$\eta_w \in [0, \bar{\eta}]$. Let

$$u \equiv A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}, \text{ and} \qquad [64]$$

$$x \equiv u\eta_w^{\frac{1}{\lambda}} \qquad [65]$$

Substituting these values into [48],

$$\begin{aligned}\Delta =& zN_u^{\alpha}\left\{\left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{1-\alpha} - \left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{1-\alpha}\right\} - \\ & z\gamma A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) \\ =& zN_u^{\alpha}\left((N_u + N_r - x)^{1-\alpha} - (N_u + N_r - u)^{1-\alpha}\right) - (\gamma z u - \gamma z x) \\ =& zN_u^{\alpha}(N_u + N_r - x)^{1-\alpha} + \gamma z x - z\left(\gamma u + N_u^{\alpha}(N_u + N_r - u)^{1-\alpha}\right) \qquad [66]\end{aligned}$$

Let $h(x; \Theta_x)$ be given by [66] where Θ_x is a vector of all arguments in [66] except x. Note that x is strictly increasing in η_w (see [64] and [65]). Hence, it suffices to show that (1) if $h(x; \Theta_x) \geq 0$ for some $x = \hat{x}$, $h(x; \Theta_x) \geq 0$ for all $x \in [\hat{x}, \mu]$; and (2) if $h(x; \Theta_x) \leq 0$ for some $x = \hat{x}$, $h(x; \Theta_x) \leq 0$ for all $x \in [0, \hat{x}]$.

Taking the derivative of h,

$$\frac{dh(x; \Theta_x)}{dx} = -z(1-\alpha)N_u^{\alpha}(N_u + N_r - x)^{-\alpha} + \gamma z \qquad [67]$$

This expression is strictly decreasing in x. That is, h is strictly concave. Note that $h(x) = 0$ for $x = \mu$.

Suppose that $h(x; \Theta_x) = 0$ for some $x = \hat{x} \in (0, \mu)$. Since h is strictly concave, it then follows that $h(x; \Theta_x) > 0$ for all $x \in (\hat{x}, \mu)$.

Since (1) $h(x; \Theta_x) = 0$ for $x = \hat{x}$, and (2) $h(x; \Theta_x) > 0$ for all $x \in (\hat{x}, \mu)$, $h'(x) > 0$ for some $\bar{x} \in [\hat{x}, \mu]$. Since h' is strictly decreasing in x (see [67]), $h' > 0$ for all $x \in [0, \hat{x}]$. It then follows that $h(x; \Theta_x) < 0$ for all $x \in [0, \hat{x}]$.

A.5 Proof of Proposition 3

Let $f : N_u \to \Delta$ where $f(N_u; \boldsymbol{\omega}_u) = \Delta$ is given by [47], and $\boldsymbol{\omega}_u$ is a vector containing all parameters except N_u. We prove Proposition 3 by showing that (1) f crosses the zero line only once and (2) f is negative (positive) to the left (right) of the crossing point. This will be the case if

$$\frac{df(N_u; \Theta_{N_u})}{dN_u} > 0$$

Taking the derivative,

$$\begin{aligned}
\frac{df(N_u; \Theta_{N_u})}{dN_u} =& \alpha N_u^{\alpha-1} z \left\{ \left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{1-\alpha} \right\} - \\
& (1-\alpha) z N_u^{\alpha} \left\{ \left(N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{-\alpha} - \left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \right)^{-\alpha} \right\} \\
=& \alpha z \left\{ \left(\frac{N_u + \bar{m}_1}{N_u}\right)^{1-\alpha} - \left(\frac{N_u + \bar{m}_0}{N_u}\right)^{1-\alpha} \right\} - \\
& (1-\alpha) z \left\{ \left(\frac{N_u + \bar{m}_0}{N_u}\right)^{-\alpha} - \left(\frac{N_u + \bar{m}_1}{N_u}\right)^{-\alpha} \right\} \\
=& \alpha z \left(a^{1-\alpha} - b^{1-\alpha}\right) - (1-\alpha) z \left(b^{-\alpha} - a^{-\alpha}\right),
\end{aligned} \qquad [68]$$

where

$$\begin{aligned}
\bar{m}_1 &= N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \\
\bar{m}_0 &= N_u + N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \\
a &= \frac{N_u + \bar{m}_1}{N_u} \\
b &= \frac{N_u + \bar{m}_0}{N_u}
\end{aligned}$$

If the right-hand side of [68] positive, then

$$=\frac{\alpha(a-1)+1}{\alpha(b-1)+1} \geq \left(\frac{a}{b}\right)^{\alpha} \quad [69]$$

Let g and h functions represent the left- and right-hand sides of [69]:

$$g(\alpha) =\frac{\alpha(a-1)+1}{\alpha(b-1)+1}$$
$$h(\alpha) = \left(\frac{a}{b}\right)^{\alpha}$$

Taking the derivative of the left-hand side of [69] with respect to α:

$$\frac{g(\alpha)}{d\alpha} =\frac{(a-1)\left[\alpha\left(b-1\right)+1\right]-(b-1)\left[\alpha(a-1)+1\right]}{\left(\alpha\left(b-1\right)+1\right)^2}$$
$$=\frac{a-b}{\left(\alpha\left(b-1\right)+1\right)^2}$$

This is positive and decreasing in α. That is, the left-hand side of [69] is increasing and concave in α:

$$\alpha g(0)+(1-\alpha)g(1) < g(\alpha) \quad [70]$$

Taking the derivative of the right-hand side of [69] with respect to α:

$$\frac{h(\alpha)}{d\alpha} = \left(\frac{a}{b}\right)^{\alpha} \ln\left(\frac{a}{b}\right)$$

This is positive and increasing in α (since $a > b > 1$). That is, the right-hand side of [69] is increasing and convex in α:

$$\alpha h(0)+(1-\alpha)h(1) > h(\alpha) \quad [71]$$

g and h are equal when $\alpha = 0$ and $\alpha = 1$:

$$g(0) = h(0) = 1 \tag{72}$$

$$g(1) = h(1) = a/b \tag{73}$$

From [70], [71], [72] and [73],

$$g(\alpha) > h(\alpha) \tag{74}$$

A.6 Proof for Proposition 4

Let $f : z \rightarrow \Delta$ where $f(z; \boldsymbol{\omega}_z) = \Delta$ is given by [47] and $\boldsymbol{\omega}_z$ is a vector containing all parameters except z. We prove Proposition 4 by showing that (1) f crosses the zero line only once and (2) f is positive (negative) to the left (right) of the crossing point.

Define $h(z)$ by dividing [48] by z,

$$\begin{aligned} h(z) \equiv \frac{G}{z} = N_u^\alpha \left(N_u + N_r - az^{-\frac{1}{\lambda}}\right)^{1-\alpha} - \\ N_u^\alpha \left(N_u + N_r - bz^{-\frac{1}{\lambda}}\right)^{1-\alpha} - cz^{-\frac{1}{\lambda}}, \end{aligned} \tag{75}$$

where

$$\begin{aligned} N =& N_u + N_r \\ a =& A\left(\frac{\eta_w}{\gamma}\right)^{\frac{1}{\lambda}} \\ b =& A\left(\frac{1}{\gamma}\right)^{\frac{1}{\lambda}} \\ c =& \gamma A\left(\frac{1}{\gamma}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) \end{aligned}$$

Since z is positive, h and f are of the same sign. Taking the derivative,

$$\begin{aligned}\frac{dh}{dz} =&(1-\alpha)\frac{1}{\lambda}z^{-\frac{1+\lambda}{\lambda}}N_u^{\alpha}\left(a\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-b\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}\right)\\&+\frac{1}{\lambda}cz^{-\frac{1+\lambda}{\lambda}}\end{aligned}$$

$$\Longleftrightarrow$$

$$\begin{aligned}\lambda z^{\frac{1+\lambda}{\lambda}}\frac{dh}{dz} =&N_u^{\alpha}(1-\alpha)\left(a\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-b\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}\right)+c\\=&(1-\alpha)N_u^{\alpha}\left(a\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-b\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}\right)+b\gamma-a\gamma\\=&a\left((1-\alpha)N_u^{\alpha}\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)-\\&b\left((1-\alpha)N_u^{\alpha}\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)\end{aligned}$$

$$\Longleftrightarrow$$

$$\begin{aligned}b^{-1}\lambda z^{\frac{1+\lambda}{\lambda}}\frac{dh}{dz} = \eta^{\frac{1}{\lambda}}&\left((1-\alpha)N_u^{\alpha}\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)-\\&\left((1-\alpha)N_u^{\alpha}\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)\end{aligned} \quad [76]$$

Define $\bar{z}$ such that

$$(1-\alpha)N_u^{\alpha}\left(N-b\bar{z}^{-\frac{1}{\lambda}}\right)^{-\alpha}=\gamma$$

Since $b > a > 0$ and $\eta \in (0,1)$, for $z \leq \bar{z}$,

$$\eta^{\frac{1}{\lambda}}\left((1-\alpha)N_u^{\alpha}\left(N-az^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)<\left((1-\alpha)N_u^{\alpha}\left(N-bz^{-\frac{1}{\lambda}}\right)^{-\alpha}-\gamma\right)>0$$

Hence, when $z < \bar{z}$, [76] is negative (h is strictly decreasing). That is, if $h > 0$ for $z = \hat{z}$, $h > 0$ for $z < \hat{z}$. Likewise, if $h < 0$ for $z = \hat{z}$, $h < 0$ for $z \in [\hat{z}, \bar{z}]$. It remains to show that $h < 0$ for $z > \bar{z}$.

The gain from switching to UOR from ROR is given by

$$\Delta = \bar{T}_1 - \bar{T}_0 \tag{77}$$

$$= zN_u^\alpha \left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \bar{m}_0)^{1-\alpha} \right) - \gamma z \left(\bar{m}_1 - \bar{m}_0 \right) \tag{78}$$

$$= z \int_{\bar{m}_0}^{\bar{m}_1} \left[(1-\alpha) N_u^\alpha (N_u + m)^{-\alpha} - \gamma \right] dm \tag{79}$$

where $\bar{m}_0, \bar{m}_1, \bar{T}_1$ and $\bar{T}_0$ are given by, respectively, [38], [39], [45] and [46].

Since $(1-\alpha) N_u^\alpha (N_u + m)^{-\alpha} - \gamma < 0$ for $z > \bar{z}$, Δ (hence h) is negative when $z > \bar{z}$.

A.7 Proof of Proposition 5

Let $f : N_u \to \Delta$ where $f(N_u; \boldsymbol{\omega}_u) = \Delta$ is given by [47], and $\boldsymbol{\omega}_u$ is a vector containing all parameters except N_u. We prove this proposition by showing that $\lim_{N_u \to +\infty} f(N_u; \boldsymbol{\omega}_u) > 0$ if and only if $1 - \alpha - \gamma > 0$.

Define $g(N_u)$ as

$$\begin{aligned} g(N_u) =& \frac{f(N_u; \Theta_{N_u})}{z} \\ =& z \left\{ N_u^\alpha \left[\left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} - \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{1-\alpha} \right] - \right. \\ & \left. \gamma A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \left(1 - \eta_w^{\frac{1}{\lambda}} \right) \right\} \\ =& N_u^\alpha \left[(N_u + \bar{m}_1)^{1-\alpha} - (N_u + \bar{m}_0)^{1-\alpha} \right] - c. \end{aligned} \tag{80}$$

where

$$\bar{m}_1 = N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}},$$
$$\bar{m}_0 = N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}},$$
$$c = \gamma A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right),$$

Since $z > 0$, f and g are of the same sign. Taking the limit of [80],

$$\begin{aligned}
\lim_{N_u \to +\infty} g\left(N_u\right) &= \lim_{N_u \to +\infty}\left\{N_u^{\alpha}\left[\left(N_u+\bar{m}_1\right)^{1-\alpha}-\left(N_u+\bar{m}_0\right)^{1-\alpha}\right]-c\right\} \\
&= \lim_{N_u \to +\infty}\left\{\left[\left(N_u+\bar{m}_1\right)\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha}-\left(N_u+\bar{m}_0\right)\left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha}\right]-c\right\} \\
&= a\lim_{N_u \to +\infty}\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha}-\bar{m}_0\lim_{N_u \to +\infty}\left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha}+ \\
&\quad \lim_{N_u \to +\infty}\left\{N_u\left[\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha}-\left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha}\right]\right\}-c \\
&= \bar{m}_1-\bar{m}_0-c+\lim_{N_u \to +\infty}\left\{N_u\left[\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha}-\left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha}\right]\right\} \\
&= \bar{m}_1-\bar{m}_0-c+\lim_{N_u \to +\infty}\frac{\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha}-\left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha}}{\frac{1}{N_u}}
\end{aligned}$$

Applying L'Hôpital's rule,

$$\begin{aligned}
\lim_{N_u\to+\infty} g\left(N_u\right) =& \bar{m}_1 - \bar{m}_0 - c + \lim_{N_u\to+\infty} \frac{\alpha\left[\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha-1}\frac{\bar{m}_1}{\left(N_u+\bar{m}_1\right)^2} - \left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha-1}\frac{\bar{m}_0}{\left(N_u+b\right)^2}\right]}{-\frac{1}{N_u^2}} \\
=& \bar{m}_1 - \bar{m}_0 - c \\
& - \alpha \lim_{N_u\to+\infty}\left[\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha-1}\frac{\bar{m}_1 N_u^2}{\left(N_u+\bar{m}_1\right)^2} - \left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha-1}\frac{\bar{m}_0 N_u^2}{\left(N_u+\bar{m}_0\right)^2}\right] \\
=& \bar{m}_1 - \bar{m}_0 - c \\
& - \alpha \lim_{N_u\to+\infty}\left[\left(\frac{N_u}{N_u+\bar{m}_1}\right)^{\alpha-1}\frac{\bar{m}_1}{1+\frac{2\bar{m}_1}{N_u}+\frac{\bar{m}_1^2}{N_u^2}} - \left(\frac{N_u}{N_u+\bar{m}_0}\right)^{\alpha-1}\frac{\bar{m}_0}{1+\frac{2\bar{m}_0}{N_u}+\frac{\bar{m}_0^2}{N_u^2}}\right] \\
=& \bar{m}_1 - \bar{m}_0 - c - \alpha\left(\bar{m}_1 - \bar{m}_0\right) \\
=& \left(1-\alpha\right)\left(\bar{m}_1 - \bar{m}_0\right) - c. \qquad [81]
\end{aligned}$$

Inserting the values of $\bar{m}_1, \bar{m}_0$ and c into [81],

$$\begin{aligned}
\lim_{N_u\to+\infty} g\left(N_u\right) =& (1-\alpha)\left[N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} - N_r + A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\right] - \gamma A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right) \\
=& (1-\alpha)A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right) - \gamma A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right) \\
=& (1-\alpha-\gamma)A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right). \qquad [82]
\end{aligned}$$

Since $A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}\left(1-\eta_w^{\frac{1}{\lambda}}\right) > 0$, [82] is positive if and only if $1-\alpha-\gamma > 0$.

Appendix B Allowing for *hukou*

Assume that the political power of urban workers with rural *hukou* (γ_r) is less than that of urban workers with urban *hukou* (γ_u). Then, the levels of urban per capita consumption for holders of rural and urban *hukou* equal, respectively, $\gamma_r z$ and $\gamma_u z$ (with $\gamma_u > \gamma_r$). Then, the leader's rent under (Equations [45] and [46]) is now given by

$$T = zN_u^{\alpha}L_u^{1-\alpha} - L_{uu}\gamma_u z - L_{ur}\gamma_r z \quad [83]$$

where L_{uu} and L_{ur} denote the number of urban workers that are urban *hukou* holders and rural *hukou* holders, respectively. All migrants are included in the latter group.

The levels of migration under ROR and UOR now become (Equations [22] and [23])

$$\bar{m}_0 = N_r - A\left(\frac{1}{\gamma_r z}\right)^{\frac{1}{\lambda}} \quad [84]$$

$$\bar{m}_1 = N_r - A\left(\frac{\eta_w}{\gamma_r z}\right)^{\frac{1}{\lambda}} \quad [85]$$

After plugging these values of migration into the the leader's rent under ROR and UOR (Equations [45] and [46]), the leader's gain from adopting UOR becomes (Equation [47]):

$$\Delta = zN_u^{\alpha}\left\{\left(N_u + N_r - A\left(\frac{\eta_w}{\gamma_r z}\right)^{\frac{1}{\lambda}}\right)^{1-\alpha} - \left(N_u + N_r - A\left(\frac{1}{\gamma_r z}\right)^{\frac{1}{\lambda}}\right)^{1-\alpha}\right\} - \gamma_r z A\left(\frac{1}{\gamma_r z}\right)^{\frac{1}{\lambda}}\left(1 - \eta_w^{\frac{1}{\lambda}}\right) \quad [86]$$

This expression for the leader's gain is similar to Equation [47] except that γ is substituted by γ_r. Thus, by simply substituting γ in the main text with γ_r, one can repeat all of the analyses and get the same propositions.

Appendix C Results from expanded parameter space

This section presents further results allowing for an expanded parameter space. We show that for the key results on the effect of urbanization and TFP to hold, one need not restrict the parameter spaces to the case where the political constraint binds (see [29]).

C.1 The effect of z (Proposition 4)

We prove that Proposition 4 holds even if we remove the parameter restriction in [29] so that the parameter space is defined by [12].

For m_0 and m_1 levels of migration (under *UOR* and *ROR*, respectively), the difference in the leader's revenue under *UOR* and *ROR* is

$$\begin{aligned}\Delta(m_1, m_0) =& T(1, m_1) - T(0, m_0)\\ =& zN_u^\alpha \left((N_u + m_1)^{1-\alpha} - (N_u + m_0)^{1-\alpha}\right) - \\ & \left(\eta_w \left(\frac{A}{N_r - m_1}\right)^\lambda (N_u + m_1) - \left(\frac{A}{N_r - m_0}\right)^\lambda (N_u + m_0)\right) \qquad [87]\end{aligned}$$

The leader adopts *ROR* if $\Delta(m_1^*, m_0^*) \geq 0$ where m_p^* for $p \in \{0, 1\}$ satisfy the following optimization conditions (see [34] and [35]):

$$(1-\alpha)z\left(\frac{N_u}{N_u + m}\right)^\alpha - (N_u + m)\frac{\partial C_r(p,m)}{\partial m} - C_r(p,m) + \mu(p)\frac{\partial C_r(p,m)}{\partial m} = 0 \quad [88]$$

$$\mu(\gamma z - C_r(p,m)) = 0 \quad [89]$$

Let $\hat{m}_p$ be the values of m that solves [88] when $\mu(p) = 0$. Let $\bar{m}_p$ be the values of m that solve [89] when $\mu(p) > 0$. That is, $\hat{m}_p$ and $\bar{m}_p$ represent, respectively, the equilibrium values of m when the political constraint binds and does not bind. They are given by [91], [92], [93] and [94].

From [91], $\hat{m}_0$ satisfies

$$\left.\frac{\partial T(m;p=0)}{\partial m}\right|_{m=\hat{m}_0} = 0 \tag{90}$$

$$\begin{aligned} &=(1-\alpha)z\left(\frac{N_u}{N_u+\hat{m}_0}\right)^{\alpha} - \\ &\left(\left(\frac{A}{N_r-\hat{m}_0}\right)^{\lambda} + (N_u+\hat{m}_0)\left(\frac{A}{N_r-\hat{m}_0}\right)^{\lambda}\frac{\lambda}{N_r-\hat{m}_0}\right) \\ &=(1-\alpha)z\left(\frac{N_u}{N_u+\hat{m}_0}\right)^{\alpha} - \left(\frac{A}{N_r-\hat{m}_0}\right)^{\lambda}\left(1+\frac{\lambda\left(N_u+\hat{m}_0\right)}{N_r-\hat{m}_0}\right) \end{aligned} \tag{91}$$

From [92], $\hat{m}_1$ satisfies

$$\left.\frac{\partial T(m;p=1)}{\partial m}\right|_{m=\hat{m}_1} = 0$$

$$\begin{aligned} &=(1-\alpha)z\left(\frac{N_u}{N_u+\hat{m}_1}\right)^{\alpha} - \\ &\left(\eta_w\left(\frac{A}{N_r-\hat{m}_1}\right)^{\lambda} + (N_u+\hat{m}_1)\left(\frac{A}{N_r-\hat{m}_1}\right)^{\lambda}\frac{\lambda\eta_w}{N_r-\hat{m}_1}\right) \\ &=(1-\alpha)z\left(\frac{N_u}{N_u+\hat{m}_1}\right)^{\alpha} - \eta_w\left(\frac{A}{N_r-\hat{m}_1}\right)^{\lambda}\left(1+\frac{\lambda\left(N_u+\hat{m}_1\right)}{N_r-\hat{m}_1}\right) \end{aligned} \tag{92}$$

$\bar{m}_0$ and $\bar{m}_1$ are given by

$$\bar{m}_0 = N_r - A\left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \tag{93}$$

$$\bar{m}_1 = N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \tag{94}$$

Let F^0 and F^1 be given by [95] and [96], respectively.

$$F^0 = z\gamma + z\frac{\lambda}{A} z^{\frac{1}{\lambda}} \gamma^{\frac{\lambda+1}{\lambda}} \left(N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}} \right) - z(1-\alpha) \left(\frac{N_u}{N_u + N_r - A \left(\frac{1}{\gamma z} \right)^{\frac{1}{\lambda}}} \right)^{\alpha} \qquad [95]$$

$$F^1 = z\gamma + z\frac{\lambda}{A} \left(\frac{z}{\eta_w} \right)^{\frac{1}{\lambda}} \gamma^{\frac{\lambda+1}{\lambda}} \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right) - z(1-\alpha) \left(\frac{N_u}{N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}}} \right)^{\alpha} \qquad [96]$$

Consider three cases as to whether the political constraint binds or not:

Case a: $F^0 < 0$ and $F^1 < 0$. The constraint binds neither under *UOR* nor under *ROR*. In this case, $m_0^* = \hat{m}_0$ and $m_1^* = \hat{m}_1$.

Case b: $F^0 < 0$ and $F^1 > 0$. The constraint binds under *UOR* but not under *ROR*. In this case, $m^* = \hat{m}_0$ and $m_1^* = \bar{m}_1$.

Case c: $F^0 > 0$ and $F^1 > 0$. The constraint binds under both *UOR* and *ROR*. In this case, $m_0^* = \bar{m}_0$ and $m_1^* = \bar{m}_1$.

Since $F^1 > F^0$, a fourth case where $F^0 > 0$ and $F^1 < 0$ is not possible.

For $i \in \{a, b, c\}$, define Δ^i as follows.

$$\begin{aligned}\Delta^a \equiv & \Delta(\hat{m}_1, \hat{m}_0) \\ = & z N_u^\alpha \left((N_u + \hat{m}_1)^{1-\alpha} - (N_u + \hat{m}_0)^{1-\alpha}\right) - \\ & \left(\eta_w \left(\frac{A}{N_r - \hat{m}_1}\right)^\lambda (N_u + \hat{m}_1) - \left(\frac{A}{N_r - \hat{m}_0}\right)^\lambda (N_u + \hat{m}_0)\right) \qquad [97]\end{aligned}$$

$$\begin{aligned}\Delta^b \equiv & \Delta(\bar{m}_1, \hat{m}_0) \\ = & z N_u^\alpha \left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \hat{m}_0)^{1-\alpha}\right) - \\ & \left(\gamma z (N_u + \bar{m}_1) - \left(\frac{A}{N_r - \hat{m}_0}\right)^\lambda (N_u + \hat{m}_0)\right) \qquad [98]\end{aligned}$$

$$\begin{aligned}\Delta^c \equiv & \Delta(\bar{m}_1, \bar{m}_0) \\ = & z N_u^\alpha \left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \bar{m}_0)^{1-\alpha}\right) - (\gamma z (N_u + \bar{m}_1) - \gamma z (N_u + \bar{m}_0)) \\ = & z N_u^\alpha \left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \bar{m}_0)^{1-\alpha}\right) - \gamma z (\bar{m}_1 - \bar{m}_0) \qquad [99]\end{aligned}$$

Both F^0 and F^1 are increasing in z. Moreover, $F^1(z) > F^0(z)$. Let z_l and z_u represent the values of z such that $F^l(z_l) = 0$ and $F^0(z_u) = 0$. Thus, the z space can be split into three intervals corresponding to the three cases:

$$\begin{aligned}&\text{Case a: } z < z_l \Longrightarrow F^1 < 0 \text{ and } F^0 < 0 \\ &\text{Case b: } z_l < z < z_u \Longrightarrow F^1 > 0 \text{ and } F^0 < 0 \\ &\text{Case c: } z_u < z \Longrightarrow F^1 > 0 \text{ and } F^0 > 0\end{aligned}$$

For $i \in \{a, b, c\}$, let $f^i(z) : z \to \Delta^i$ where $f^i(z; \boldsymbol{\omega}_z) = \Delta^i$ such that Δ^a, Δ^b and Δ^c are given by, respectively [97], [97] and [99], and $\boldsymbol{\omega}_z$ is a vector containing all parameters except z.

Let $f : z \to \Delta$ where $\boldsymbol{\omega}_z$ is a vector containing all parameters except z and

$$f(z) = \begin{cases} f^a(z) = \Delta(\hat{m}_1, \hat{m}_0) \text{ if } z < z_l \\ f^b(z) = \Delta(\bar{m}_1, \hat{m}_0) \text{ if } z_l \leq z < z_u \\ f^c(z) = \Delta(\bar{m}_1, \bar{m}_0) \text{ if } z \geq z_u \end{cases} \quad [100]$$

Under Proposition 4 where the parameter space is restricted such that $z > z_u$, we proved that if $\Delta^c > 0$ for some $z = \hat{z} > z_u$, $\Delta^c > 0$ for all $z \in [z_u, \hat{z}]$. That is, we proved that $f(z) > 0$ for $z \in [z_u, \hat{z}]$. We now prove that $f(z) > 0$ for $z < z_u$.

Define $h(z)$ as

$$h(z) \equiv \frac{f(z; \boldsymbol{\omega}_z)}{z} \quad [101]$$

Since z is positive, h and f are of the same sign. Define $\bar{z}$ as follows:

$$(1-\alpha)N_u^\alpha \left(N_u + N_r - A \left(\frac{\eta w}{\gamma \bar{z}} \right)^{\frac{1}{\lambda}} \right)^{-\alpha} - \gamma = 0 \quad [102]$$

From [34] and [35], it follows that $\bar{z} > z_l$. In order to show that $f(z) > 0$ for $z < \hat{z}$, we now proceed in two steps. First, we show that

$$h(z_u) > 0 \quad [103]$$

$$h_z(z) \equiv \frac{dh(z)}{dz} < 0 \text{ if } z \in [\bar{z}, z_u] \quad [104]$$

$$f_{zz}(z) \equiv \frac{d^2h(z)}{dz^2} < 0 \text{ if } z \in [z_l, \bar{z}] \quad [105]$$

$$f(z) > 0 \text{ if } z \leq z_l \quad [106]$$

Second, given these four inequalities are true (which we will prove next), we show that $f(z) > 0$ for $z < \hat{z}$.

Inequalities [103] and [104] imply that

$$h(z) > 0 \text{ for } z \in [\bar{z}, z_u]. \qquad [107]$$

According to [105], f is strictly concave for $z \in [z_l, \bar{z}]$. That is, for all $z_i, z_j \in [z_l, \bar{z}]$ and $z_i \neq z_j$,

$$f(\epsilon z_i) + f\left((1-\epsilon)\, z_j\right) > \epsilon f(z_i) + (1-\epsilon) f(z_j) \quad \forall \epsilon \in (0,1) \qquad [108]$$

According to [107] and [106], respectively $h(\bar{z}) > 0$ and $f(z_l) > 0$. Due to the strict concavity of f in the interval $[z_l, \bar{z}]$, it follows that $f(z) > 0$ for $z \in [z_l, \bar{z}]$:

$$f(\epsilon z_l) + f\left((1-\epsilon)\, \bar{z}\right) > \epsilon f(z_l) + (1-\epsilon) f(\bar{z}) > 0 \quad \forall \epsilon \in (0,1)$$

We now prove that the four inequalities [103] through [106] hold.

Inequality [103] follows directly Proposition 4: $h(z_u) > 0$ since $z_u < \hat{z}$ and $f(z_u) = \Delta^c(z_u)$.

Define $h^i(z)$ as

$$h^i(z) \equiv \frac{f^i(z; \boldsymbol{\omega}_z)}{z} \qquad [109]$$

Taking the derivative,

$$\begin{aligned} \frac{dh^i(z)}{dz} &= \frac{z f^i_z(z) - f^i(z)}{z^2} \\ \Longrightarrow \left(\frac{dh^i(z)}{dz} < 0\right) &\Longleftrightarrow \left(z^2 \frac{dh^i(z)}{dz} > 0\right) \end{aligned} \qquad [110]$$

where $f^i_z(z) = df(z)/dz$. For $z \in (z_l, z_u)$, $dh^i(z)/dz < 0$ if $z f^b_z(z) - f^b(z) < 0$. Taking the derivative of $f^b(z)$:

$$f_z^b(z) = \left.\frac{d\Delta^b(m_1, m_0)}{dz}\right|_{m_0=\hat{m}_0, m_1=\bar{m}_1} \quad [111]$$

$$= \left(\frac{\partial\Delta^b(m_0, m_1)}{\partial z} + \frac{\partial\Delta^b(m_0, m_1)}{\partial m_0}\frac{\partial m_0}{\partial z} + \frac{\partial\Delta^b(m_0, m_1)}{\partial m_1}\frac{\partial m_1}{\partial z}\right)_{m_0=\hat{m}_0, m_1=\bar{m}_1} \quad [112]$$

$$= \left(\frac{\partial\Delta^b(m_0, m_1)}{\partial z} + \frac{\partial\Delta^b(m_0, m_1)}{\partial m_1}\frac{\partial m_1}{\partial z}\right)_{m_0=\hat{m}_0, m_1=\bar{m}_1} \quad [113]$$

Equation [113] follows from [112] because, under Case (b),

$$\left.\frac{\partial\Delta(m_0, m_1)}{\partial m_0}\right|_{m_0=\hat{m}_0} = \left.\frac{\partial T(m; p=0)}{\partial m}\right|_{m=\hat{m}_0} = 0 \quad [114]$$

Equation [114] follows from [90]. Combing [98] and [114],

$$\begin{aligned} f_z^b =& N_u^\alpha\left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \hat{m}_0)^{1-\alpha}\right) - \\ & \gamma(N_u + \bar{m}_1) + \left((1-\alpha)\, z N_u^\alpha \left(N_u + \bar{m}_1\right)^{-\alpha} - \gamma z\right)\frac{\partial \bar{m}_1}{\partial z} \end{aligned} \quad [115]$$

From [94],

$$\frac{d\bar{m}_1}{dz} = \frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} z^{-1} \quad [116]$$

Plugging [116] into [115],

$$\begin{aligned} f_z^b =& N_u^\alpha\left((N_u + \bar{m}_1)^{1-\alpha} - (N_u + \hat{m}_0)^{1-\alpha}\right) - \\ & \gamma(N_u + \bar{m}_1) + \left((1-\alpha)\, N_u^\alpha \left(N_u + \bar{m}_1\right)^{-\alpha} - \gamma\right)\frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} \end{aligned} \quad [117]$$

From [100], [110] and [117],

$$\begin{aligned}
z^2 \frac{dh^i(z)}{dz} &= z f_z^b(z) - f^b(z) \\
&= z\left((1-\alpha)\, z N_u^{\alpha}\left(N_u + \bar{m}_1\right)^{-\alpha} - \gamma z\right) \frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} - \\
&\quad \left(\frac{A}{N_r - \hat{m}_0}\right)^{\lambda}\left(N_u + \hat{m}_0\right) \\
&= z^2\left((1-\alpha)\left(\frac{N_u}{N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}}\right)^{\alpha} - \gamma\right)\frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} - \\
&\quad \left(\frac{A}{N_r - \hat{m}_0}\right)^{\lambda}\left(N_u + \hat{m}_0\right)
\end{aligned} \qquad [118]$$

For $z \in [\bar{z}, z_u]$, this expression is negative because

$$\left((1-\alpha)N_u^{\alpha}\left(N_u + N_r - A\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\right)^{-\alpha} - \gamma\right)\frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} < 0$$

$$\left(\frac{A}{N_r - \hat{m}_0}\right)^{\lambda}\left(N_u + \hat{m}_0\right) > 0$$

We now prove [105], i.e., f is strictly concave for $z \in [z_l, z_u]$. From [117],

$$\begin{aligned}
f_{zz}(z) \equiv & \frac{d^2 f^b(z)}{dz^2} = \frac{df_z^b(z)}{dz} \\
=& (1-\alpha)N_u^{\alpha}\left(N_u + \bar{m}_1\right)^{-\alpha}\frac{\partial \bar{m}_1}{\partial z} \\
& - (1-\alpha)N_u^{\alpha}\left(N_u + \hat{m}_0\right)^{-\alpha}\frac{d\hat{m}_0}{dz} \\
& - \gamma\frac{\partial \bar{m}_1}{\partial z} \\
& - \alpha\left((1-\alpha)\, N_u^{\alpha}\left(N_u + \bar{m}_1\right)^{-\alpha-1}\right)\frac{A}{\lambda}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}}\frac{\partial \bar{m}_1}{\partial z} \\
& - \left((1-\alpha)\, N_u^{\alpha}\left(N_u + \bar{m}_1\right)^{-\alpha} - \gamma\right)\frac{A}{\lambda^2}\left(\frac{\eta_w}{\gamma z}\right)^{\frac{1}{\lambda}} z^{-1}
\end{aligned}$$

Plugging [116] and rearranging,

$$
\begin{aligned}
f_{zz}(z) = -(1-\lambda)\times \\
\left((1-\alpha)\, N_u^{\alpha} \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{-\alpha} - \gamma \right) \frac{A}{\lambda^2} \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} z^{-1} \\
-\alpha \left((1-\alpha)\, N_u^{\alpha} \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{-\alpha-1} \right) \left(\frac{A}{\lambda} \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{2} z^{-1} \\
-(1-\alpha) N_u^{\alpha} \left(N_u + \hat{m}_0 \right)^{-\alpha} \frac{d\hat{m}_0}{dz}
\end{aligned}
\qquad [119]
$$

From the first order condition [34], $\frac{d\hat{m}_0}{dz} > 0$. For $z \in [z_l, z_u]$,

$$
(1-\alpha)\, N_u^{\alpha} \left(N_u + N_r - A \left(\frac{\eta_w}{\gamma z} \right)^{\frac{1}{\lambda}} \right)^{-\alpha} > \gamma
$$

Hence, for $z \in [z_l, z_u]$, $f_{zz} < 0$, i.e., [108] holds.

Under Case (a), $h(z) = h^a(z)$. From Proposition 1, $h^a(z)$ is positive. Hence, [106] holds.

C.2 The effect of N_u (Proposition 3)

Define Δ_{N_u}

$$
\Delta_{N_u} \equiv \left. \frac{d\Delta(m_1, m_0)}{dN_u} \right|_{m_0 = m_0^*, m_1 = m_1^*}
$$

Taking the derivative of this expression,

$$
\frac{d\Delta(m_1, m_0)}{dN_u} = \frac{\partial \Delta(m_0, m_1)}{\partial N_u} + \frac{\partial \Delta(m_0, m_1)}{\partial m_0} \frac{\partial m_0}{\partial N_u} + \frac{\partial \Delta(m_0, m_1)}{\partial m_1} \frac{\partial m_1}{\partial N_u} \qquad [120]
$$

Notice that following four conditions hold.

1. If the constraint does not bind under ROR, from [91],

$$\left.\frac{\partial \Delta(m_0, m_1)}{\partial m_0}\right|_{m_0=\hat{m}_0} = \left.\frac{\partial T(m, p=0)}{\partial m}\right|_{m=\hat{m}_0} = 0. \qquad [121]$$

2. If the constraint does not bind under UOR, from [92],

$$\left.\frac{\partial \Delta(m_0, m_1)}{\partial m_1}\right|_{m_1=\hat{m}_1} = \left.\frac{\partial T(m, p=1)}{\partial m}\right|_{m=\hat{m}_1} = 0. \qquad [122]$$

3. If the constraint binds under ROR, from [93]

$$\left.\frac{\partial m_0}{\partial N_u}\right|_{m_0=\bar{m}_0} = 0. \qquad [123]$$

4. If the constraint binds under UOR, from [94]

$$\left.\frac{\partial m_1}{\partial N_u}\right|_{m_1=\bar{m}_1} = 0. \qquad [124]$$

Combining [120] with [121], [122], [123] and [124], for each of the above four cases, we have that

$$\begin{aligned}\Delta_{N_u} &= \left(\frac{\partial \Delta(m_0, m_1)}{\partial N_u} + \frac{\partial \Delta(m_0, m_1)}{\partial m_0}\frac{\partial m_0}{\partial N_u} + \frac{\partial \Delta(m_0, m_1)}{\partial m_1}\frac{\partial m_1}{\partial N_u}\right)_{m_0=m_0^*, m_1=m_1^*} \\ &= \left.\frac{\partial \Delta(m_0, m_1)}{\partial N_u}\right|_{m_0=m_0^*, m_1=m_1^*} \end{aligned} \qquad [125]$$

We now show that [125] is positive. From [87]

$$
\begin{aligned}
&\left.\frac{\partial \Delta(m_0, m_1)}{\partial N_u}\right|_{m_0=m_0^*, m_1=m_1^*} = \\
&\alpha z N_u^{\alpha-1}\left((N_u+m_1^*)^{1-\alpha}-(N_u+m_0^*)^{1-\alpha}\right) \\
&+(1-\alpha) z N_u^{\alpha}\left((N_u+m_1^*)^{-\alpha}-(N_u+m_0^*)^{-\alpha}\right) \\
&+\left(\frac{A}{N_r-m_0^*}\right)^{\lambda}-\eta_w\left(\frac{A}{N_r-m_1^*}\right)^{\lambda}
\end{aligned} \qquad [126]
$$

We now show that

$$
\begin{aligned}
\Gamma_1 =& \alpha z N_u^{\alpha-1}\left((N_u+m_1^*)^{1-\alpha}-(N_u+m_0^*)^{1-\alpha}\right) \\
&+(1-\alpha) z N_u^{\alpha}\left((N_u+m_1^*)^{-\alpha}-(N_u+m_0^*)^{-\alpha}\right) > 0
\end{aligned} \qquad [127]
$$

$$
\Gamma_2 = \left(\frac{A}{N_r-m_0^*}\right)^{\lambda}-\eta_w\left(\frac{A}{N_r-m_1^*}\right)^{\lambda} \geq 0 \qquad [128]
$$

Inequalities [127] and [128] imply that [126] is positive. We now show that both [127] and [128] hold.

Let

$$
\begin{aligned}
a &= \frac{N_u+m_1^*}{N_u} \\
b &= \frac{N_u+m_0^*}{N_u}.
\end{aligned}
$$

Plugging these into [127],

$$
\Gamma_1 = \alpha z\left(a^{1-\alpha}-b^{1-\alpha}\right)-(1-\alpha) z\left(b^{-\alpha}-a^{-\alpha}\right), \qquad [129]
$$

where

If [129] positive, then

$$=\frac{\alpha(a-1)+1}{\alpha(b-1)+1} \geq \left(\frac{a}{b}\right)^{\alpha} \qquad [130]$$

Let g and h functions represent the left- and right-hand sides of [130]:

$$g(\alpha) =\frac{\alpha(a-1)+1}{\alpha(b-1)+1}$$
$$h(\alpha) = \left(\frac{a}{b}\right)^{\alpha}$$

We show that $g(\alpha) > h(\alpha)$ for all $\alpha \in (0,1)$.

Taking the derivative of the left-hand side of [130] with respect to α:

$$\frac{g(\alpha)}{d\alpha} =\frac{(a-1)\left[\alpha\left(b-1\right)+1\right]-(b-1)\left[\alpha(a-1)+1\right]}{\left(\alpha\left(b-1\right)+1\right)^{2}}$$
$$=\frac{a-b}{\left(\alpha\left(b-1\right)+1\right)^{2}}$$

This is positive and decreasing in α. That is, the left-hand side of [130] is increasing and concave in α:

$$g(\alpha) > \alpha g(0) + (1-\alpha)g(1) \qquad [131]$$

Taking the derivative of the right-hand side of [130] with respect to α:

$$\frac{h(\alpha)}{d\alpha} = \left(\frac{a}{b}\right)^{\alpha} \ln\left(\frac{a}{b}\right)$$

This is positive and increasing in α (since $a > b > 1$). That is, the right-hand side of [130] increasing and convex in α:

$$h(\alpha) < \alpha h(0) + (1-\alpha)h(1) \qquad [132]$$

g and h are equal when $\alpha = 0$ and $\alpha = 1$:

$$g(0) = h(0) = 1 \qquad [133]$$

$$g(1) = h(1) = a/b > 1 \qquad [134]$$

From [131], [132], [133] and [134], it follows that for all $\alpha \in (0, 1)$,

$$g(\alpha) > \alpha g(0) + (1-\alpha)g(1)) = \alpha + (1-\alpha)\frac{a}{b} = \alpha h(0) + (1-\alpha)h(1)) > h(\alpha)$$

$$\implies g(\alpha) > h(\alpha)$$

We now show that [128] holds for three cases as to whether the political constraint binds or not. Given the values of F^0 and F^1 from [95] and [96], respectively,

Case a: $F^0 < 0$ and $F^1 < 0$. The constraint binds nether under *UOR* nor under *ROR*. In this case, $m_0^* = \hat{m}_0$ and $m_1^* = \hat{m}_1$.

Case b: $F^0 < 0$ and $F^1 > 0$. The constraint binds under *UOR* but not under *ROR*. In this case, $m^* = \hat{m}_0$ and $m_1^* = \bar{m}_1$.

Case c: $F^0 > 0$ and $F^1 > 0$. The constraint binds under both *UOR* and *ROR*. In this case, $m_0^* = \bar{m}_0$ and $m_1^* = \bar{m}_1$.

Since $F^1 > F^0$, a fourth case where $F^0 > 0$ and $F^1 < 0$ is not possible.

C.2.1 Case (a)

Under Case (a), μ in [34] equals zero. So [34], [36] and [37] imply

$$\underbrace{(1-\alpha)zN_u^\alpha(N_u+\hat{m}_0)^{-\alpha}}_{MR_0} = \underbrace{\frac{A^\lambda}{(N_r-\hat{m}_0)^\lambda}}_{C_0}\underbrace{\left(1+\frac{\lambda(N_u+\hat{m}_0)}{N_r-\hat{m}_0}\right)}_{\overline{MC}_0} \qquad [135]$$

$$\underbrace{(1-\alpha)zN_u^\alpha(N_u+\hat{m}_1)^{-\alpha}}_{MR_1} = \eta_w\underbrace{\frac{A^\lambda}{(N_r-\hat{m}_1)^\lambda}}_{C_1}\underbrace{\left(1+\frac{\lambda(N_u+\hat{m}_1)}{N_r-\hat{m}_1}\right)}_{\overline{MC}_1} \qquad [136]$$

Since $\eta_w < 1$, $\hat{m}_1 > \hat{m}_0$, this implies

$$(1-\alpha)zN_u^\alpha(N_u+\hat{m}_1)^{-\alpha} = MR_1 < MR_0 = (1-\alpha)zN_u^\alpha(N_u+\hat{m}_0)^{-\alpha} \qquad [137]$$

$$1+\frac{\lambda(N_u+\hat{m}_1)}{N_r-\hat{m}_1} = \overline{MC}_1 > \overline{MC}_0 = 1+\frac{\lambda(N_u+\hat{m}_0)}{N_r-\hat{m}_0} \qquad [138]$$

Equations [135], [136], [137] and [138] imply that

$$\frac{A^\lambda}{(N_r-\hat{m}_0)^\lambda} = C_0 > C_1 = \eta_w\frac{A^\lambda}{(N_r-\hat{m}_1)^\lambda}$$

$$\implies \Gamma_2 > 0$$

C.2.2 Case (b)

In Case (b), the political constraint does not bind under *ROR*, but it binds under *UOR*. Hence,

$$C_r(p,m_0^*) = \frac{A^\lambda}{(N_r-\hat{m}_0)^\lambda} > \gamma z \qquad [139]$$

$$C_r(p,m_1^*) = \eta_w\frac{A^\lambda}{(N_r-\bar{m}_1)^\lambda} = \gamma z \qquad [140]$$

Hence,

$$\frac{A^\lambda}{(N_r-m_0^*)^\lambda} > \eta_w\frac{A^\lambda}{(N_r-m_1^*)^\lambda}$$

$$\implies \Gamma_2 > 0$$

C.2.3 Case (c)

Under Case (c), [128] holds since:

$$\left(\frac{A}{N_r - \bar{m}_0}\right)^\lambda = \eta_w \left(\frac{A}{N_r - \bar{m}_1}\right)^\lambda = \gamma z$$

$$\Longrightarrow \Gamma_2 = 0$$

C.3 Effect of N_u (Proposition 5)

We now show that Proposition 5 does not need to restrict the parameter space to [29]. This is the case because the constraint indeed binds for a large enough N_u:

$$\lim_{N_u \to \infty} F^0 = \lim_{N_u \to \infty} \left\{ z\gamma + z\frac{\lambda}{A} z^{\frac{1}{\lambda}} \gamma^{\frac{\lambda+1}{\lambda}} \left(N_u + N_r - A \left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}} \right) - z(1-\alpha) \left(\frac{N_u}{N_u + N_r - A \left(\frac{1}{\gamma z}\right)^{\frac{1}{\lambda}}} \right)^\alpha \right\} > 0$$