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Abstract

China's hukou system imposes two main barriers to population movements. Agricultural workers get land to cultivate but run the risk of losing it if they migrate. Social transfers (education, health, etc.) are conditional on holding a local hukou. We show that the land policy is a more important barrier on industrialization. This distortion can be corrected by giving property rights to farmers. Social transfers dampen mainly urbanization. We calculate that the two policies together lead to overemployment in agriculture of 6.7 points, under-employment in the urban sector of 6.3 points and have practically no impact on the rural non-agricultural sector.
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1 Introduction

Barriers to labor mobility delay the transition of labor from traditional to new sectors of economic activity and are an important reason for the failure of developing countries to catch up with richer ones. Simon Kuznets noted the importance of such barriers in his influential 1966 book on economic growth when he wrote, "a high rate of modern economic growth is attainable only if the required marked shifts in industrial structure are not too impeded by resistance - of labor and of capital, of people and their resources in the old and accustomed grooves." (Kuznets, 1966, 157). This paper is about the role of a particular policy barrier in China, the *hukou* system of household registration. It will argue that despite the large transitions that took place in China over the last three decades, the *hukou* registration system is causing a slowing down of both industrialization and urbanization, and consequently a bigger income gap between China and the group of high-income countries than can be justified by its fundamentals.

Fast industrialization began in China following Deng Xiaoping's market reforms in the 1980s and has been accompanied by a structural transformation that saw labor move from agricultural employment in rural areas to industry and services in predominantly urban areas. Many Chinese scholars attribute a large part of the rise in industrial productivity in China over this period to the shift from low productivity agricultural employment to higher productivity manufacturing jobs (Brandt and Zhu, 2010, Dekle and Vandenbroucke, 2012). And yet, it could have gone further. Alwyn Young (2003), who does not include agriculture in his analysis of productivity growth in China, makes a strong point for the study of policies that "kept the peasantry tied up in agriculture," instead of releasing labor to work in higher productivity activities. Similar conclusions were reached by others; in a 2005 survey of 17 provinces that account for the vast majority of Chinese farmers, Zhu et al. (2006) find that China's land policies are largely responsible for a massive widening of the income gap between rural and urban households.[1] The policies responsible for these disparities are the subject of this paper.

The large movements of labor from agricultural to non-agricultural activities (industrialization) and the related movement from rural to urban locations (urbanization) are documented in Figure 1. Between 1978 and 2013, the employment share of agriculture fell from 68 percent to 21 percent, with a corresponding increase in industrial and service employment.[2] Most of the

[1] A more accessible summary of results with policy recommendations is available in Zhu and Prosterman (2007).

[2] The data in Figure 1 were constructed by Brandt and Zhu (2010) and subsequently extended by them to 2013. They made two adjustments to the employment data of the

new jobs were in urban employment but the rural non-agricultural sector also expanded, a point that we address in this paper. Despite this transformation, however, large productivity differences across sectors remain. Productivity in agriculture is still much lower than it is in non-agricultural jobs, something that indicates barriers to labor mobility. According to the calculations of Brandt and Zhu (2010), in 2013 agricultural labor productivity (at current prices) was only about 38 percent of industrial productivity and close to half of service productivity (see also, Brandt, Hsieh, and Zhu, 2008). Considering that prices of industrial goods did not rise by as much as food prices in recent years, in real terms the disparity is likely to be even larger.

Gollin, Lagakos and Waugh (2014) show that such "unexplained" disparities in cross-sector productivities are a common feature of developing countries. Both their causes and consequences have attracted attention from economists. For example, Vollrath (2009) finds that on average employment misallocations account for about 40 percent of income differences across countries and up to 80 percent of differences in total factor productivity (TFP). Ngai (2004) and Gollin, Parente and Rogerson (2002, 2007) show how the delay in the transition out of the traditional agriculture sector contributes to cross-country income differences by delaying the start of modern economic growth. Restuccia, Yang and Zhu (2008) highlight the role of barriers in intermediate goods markets and agriculture for productivity differences and cross-country income differentials. These papers argue for the advantages of Lewisian (Lewis, 1955) two-sector models of economic development, one for agriculture and one for other economic activities (non-agriculture for short), which can highlight the role of the structural transformation from agriculture to non-agriculture in the country's development path.

In this paper we describe the mobility barriers that are embedded in the *hukou* household registration system and then formally derive their implications for employment allocations in a three-sector model related to the *hukou* registration, with agriculture, rural non-agriculture and urban non-agriculture. The *hukou* registration, introduced in 1958, initially tied people to their area and job and did not allow any labor migration at all. Restrictions have been relaxed piecemeal and not uniformly across the country, but the registration system is still largely in place and it is still an impediment to labor mobility. In our view, barriers to mobility from the *hukou* registration system arise mainly along two dimensions. First and foremost in the use of

National Bureau of statistics (NBS). First, following Holz (2006), they fixed a major discontinuity in the NBS employment data beginning in 1990. Second, they made use of detailed labor supply data for rural households collected by the Research Centre for the Rural Economy to reestimate primary sector employment, in order to address concerns that the NBS data underestimated the rate of employment decline in this sector.

land, which is provided free by the state to rural families but is in principle withdrawn when the farmer gives up agricultural employment to move to a different job; and second in the provision of social services such as education and health, which are conditional on each person's *hukou* registration and in particular the area that she lives.

We begin with a frictionless model and derive optimal labor allocations across the three sectors of the model. We then compute the misallocations due to the distortionary policies associated with land and social transfers. An important contribution of our paper is the computation of the value of the social subsidies associated with the *hukou* registration system, by making use of several diverse official sources. We then show that the misallocations due to policy can be calculated with knowledge of very few parameters commonly used in economic models, most importantly the share of labor in the agricultural production function and the elasticity of substitution between agricultural and non-agricultural goods. We do not require knowledge of technological parameters (except for the share of labor in agriculture), which are notoriously difficult to measure.[3]

We find that despite the exceptionally high growth and structural transformation rates experienced by China over the last three decades, the mobility barriers are still having a large impact on the migration of labor from agriculture to non-agricultural jobs, and consequently on industrialization and social welfare. Table 1 shows the results of our calculations for 2013 for our benchmark parameters. We show that the land policy embedded in the *hukou* system slows down migration from the land and calculate that this has led to overemployment in agriculture of 6.3 percentage points. The 6.3 points of overemployment in agriculture have come at the cost of 4.1 points underemployment in urban sectors and 2.2 points underemployment in rural non-agricultural sectors. The policy followed with respect to social transfers has further held back migration out of agriculture by another 0.4 percentage points. The biggest impact of the social transfer policy, however, is on urbanization (rather than industrialization). Because of it, rural businesses overexpanded at the expense of urban businesses, as agricultural workers prefer to stay in rural areas to benefit from their local *hukou* registration than move to the city and lose their local *hukou*. We calculate that when social transfers are added to the land policy the underemployment in urban areas increases from 4.1 to 6.3 percentage points, whereas the social transfer policy virtually offsets the land policy distortion on rural non-agricultural

[3]There is a large literature covering different aspects of the *hukou* system. We refer to several in our discussion of the system in section 2. For more general discussion see the survey by Brandt, Hsieh and Zhu (2008).

employment.[4]

Correcting for these distortions is easy in principle. As advocated by the World Bank and others, a land policy reform that gives land property rights to the farmers when they migrate restores optimality; extending social transfer entitlements to migrants does the same for social policies.[5] Giving property rights to farmers induces them to fully take into account the cost of the land when they decide to cultivate it themselves, and as they can lease their land for an income, it frees them to pursue employment elsewhere if they consider this a better option than farming. Extending social transfers to migrants gets rid of the distortion that we study in this paper, whereby migrants pay taxes in their new location but are not entitled to benefits, but of course a properly-designed social transfer system involves many other pre-requisites that are beyond the scope of this paper.

Several papers analyse sources of mobility barriers in institutional features of different countries, as we do here for China. Caselli and Coleman (2001) attribute barriers to mobility out of agriculture in the early years of industrialization in the United States to different educational levels in urban and rural locations. Hayashi and Prescott (2008) show that the prewar Japanese social custom of requiring a son to inherit the land from his father and remain in agriculture can account for the delay in Japan's catch-up with the United States. Beegle, De Weerdt and Dercon (2011) propose home community networks as exit barriers preventing migration in Tanzania and Munshi and Rosenzweig (2016) investigate the role of rural caste insurance and social networks as barriers in rural India. For China, Brandt, Hsieh and Zhu (2008) and Cao and Birchenall (2013) discuss the implications of the *hukou* system as a mobility barrier without quantitative measurements, whereas Tombe and Zhu (2015) model formally trade liberalization and its impact on the economy, modelling also labor market restrictions. They attribute important barriers to unspecified impediments that reduce the effective productivity of rural labor in the cities (see also our discussion of their results in section 5). Land policy as a mobility barrier also plays a role in Adamopoulos et al. (2016), who focus on workers' selection effects in a heterogeneous labor model as the explanation for China's sectoral productivity differences. None of these papers models explicitly both land policy effects and social subsidies in a three-sector economic model for China, which is our main contribution in this paper.[6]

[4]Distortions in sectoral allocations caused by social transfers are common in Europe's welfare states and China is no different, except that the level of transfers is below European levels. See Ngai and Pissarides (2011).

[5]See World Bank (2014) and, e.g., Zhu and Prosterman (2007).

[6]Au and Henderson (2006) also use a three-sector model (agriculture, township and

Section 2 outlines the household registration system and describes its history and impacts, paying particular attention to land policy and the role of social subsidies. Section 3 sets up the allocation problem and derives some conditions that hold in all our policy equilibria. In Section 4 we derive the frictionless allocation when there are competitive markets for land and all goods, which we use to compare with the equilibrium distorted by the *hukou* policy. Our analysis of the implications of the land policy and the analysis of the implications of a policy reform that has been advocated, which gives land property rights to farmers, are in Section 5. Social subsidies are studied in Section 6. Quantitative evaluation of the impact of the *hukou* system via both the land policy and government subsidies is in Section 7.

2 China's mobility barriers

2.1 The *hukou* system of registration and its impact

The *hukou*, or household registration system, assigns a *hukou* to each citizen of the People's Republic and on that basis the person becomes eligible for some state benefits, in the form of either use of land or social subsidies. The system was institutionalized in 1958, when a four-way classification was introduced for each citizen, urban agricultural or non-agricultural worker, and rural agricultural or non-agricultural worker. The objective of the policy was to promote a Communist ideology connected to the use of land (which belonged entirely to the state) and the provision of social services. Agricultural workers were given the land to cultivate and were given access to some social services provided by rural collectives, whereas urban workers were expected to work in factory or office jobs and had a job-related access to social benefits, which included housing, medical care and education for their children. The biggest beneficiaries from the social subsidies were urban workers in state enterprises.

Initially the *hukou* registration system was strictly enforced and practically eliminated all possibilities for industrial or geographical labor mobility. Up to 1998, offspring inherited their mothers' *hukou* status and changes were

village nonagriculture and city nonagriculture) which broadly corresponds to our three-sector model of agriculture, rural nonagriculture and urban nonagriculture. They employ the techniques of new economic geography to show that both city size and the township and village enterprise sectors are too small, which is indication of the existence of mobility barriers out of agriculture. Our results show that the big distortion is in the too small urban sector, whereas the nonagricultural rural sector, although below optimal, is about the right size.

not allowed.[7] As a result, before 1980, practically all people living in an area had a local *hukou* and all workers working in industry or services had a non-agricultural *hukou* (Li, Gu and Zhang, 2015).

Naturally, this situation was not compatible with a market economy with industrializing ambitions, as China became after Deng's reforms. Agriculture was too big to be productive and industrialization needed labor. In response to this need, the *hukou* system was gradually softened and reformed, eventually (by the late 1990s) allowing free migration across jobs and areas, albeit with registration never abolished and rarely allowed to change during one's lifetime. There have been too many reforms of varying degrees to enable a manageable narrative or the description of a system that currently applies to everyone. To make things worse, the strictness with which the system is now applied and the ease with which one could change her registration is left to local authorities, and different local authorities apply different rules. The more prosperous large cities (especially the big three, Beijing, Shanghai and Guangzhou) generally follow stricter policies than towns or smaller cities (see Fan, 2008; Meng, 2014; Chan, 2009; Chan and Buckingham, 2008).

For modelling purposes, however, we can cut through this complex situation by identifying three types of *hukou*: urban, which is entirely non-agricultural; and rural agricultural or non-agricultural. The majority of the analytical literature restricts itself to two, rural and urban. In the earlier period of industrialization the agricultural/non-agricultural classification in urban areas was also important but more recently agriculture has become too small in urban areas to matter and the distinction no longer applies. The distinction is losing importance in some rural areas too (Fan, 2008, p.69) but we retain it because it has important implications for the allocation of land. We do assume, however, that social services are available according to location and not according to the type of *hukou* that one holds.

Some authors have argued that migrants are either discriminated against or have skills that are not suited to the ones required in urban locations, so income loss is a major barrier to migration from rural to urban areas (see for example Meng and Zhang, 2001; Frijters, Kong and Meng, 2011; Démurger, Gurgand, Li and Yue, 2009). We do not model this type of barrier, focusing instead on the distortions that stem from policy, the official land allocations and the provision of social services by the state.[8]

With regard to social services, the condition that only local *hukou* holders qualify for them was embedded in the original design of the *hukou* system

[7] In 1998 the law was changed and children were permitted to inherit either parent's *hukou* status.

[8] See Tombe and Zhu (2015) and Adamopoulos et al. (2016) for a discussion of the implications of heterogeneity and income loss from migration.

and it still pervades today. Rural *hukou* holders get access to social services in their locality but not to social services in the city after they move, except in some cases to a limited degree. Because of this, many rural migrants leave their families behind when they migrate to the city; women may go back to their village when they have a child to take advantage of available social services; and many men return to their rural locations after a few years in the city, especially if they have children of school age and they want to take advantage of free education in their origin state.

These movements undoubtedly cause social problems for families but the economic cost is much less important. Formally modelling return migration due to changing family circumstances would be extremely difficult to model and we do not pursue it.[9] The feature of the system that we emphasize is the loss of a right to land once the farmer leaves agricultural employment, an issue that we describe in more detail in the next subsection, and the loss of social subsidies when the rural worker (agricultural or non-agricultural) migrates to the city. These policies impose costs on migration both across industrial sectors and across locations.

2.2 Chinese land economics

Agricultural (and forest) land is distributed among the rural population on the basis of family size and other needs, in an attempt to achieve more equality in the village. The property rights do not pass on to the villager but he and his family can cultivate the land and the income is all theirs. Two issues are particularly important to farmers (see Kung, 1995; Mullan, Grosjean and Kontoleon, 2011): security of tenure and the possibility of selling or renting the land to other farmers for an income.

Rural land is managed under the Household Responsibility System. When the system was first set up no renting of land was allowed and periodically the village leader would reallocate land on the basis of household changes. It was also possible that agricultural land could be taken over by the government for infrastructure projects (e.g., road building) or construction. So there was no security of tenure and it was not possible to take advantage of the land to earn an income, other than self-production. In 2002, the Rural Land Contracting Law passed to strengthen property rights. It offered more secure tenure by limiting reallocations and permitting transfer of lands between households (see Li, 2003). But reallocations continued after 2002 at the discretion of village leaders, who did not follow the new law to its letter.

[9] We also do not pursue the modelling of changing *hukou* type, which some localities offer after a certain period of work in their area and subject to the qualifications of the worker. Such changes remain rare (Chan, 2009).

The reallocation threat introduced tenure risks but the threat that rural land could be acquired for urban or infrastructure development was considered to be an even more serious one by farmers. Such acquisitions carried a compensation but farmers never considered the compensation sufficiently high to give them security. Consequently, farmers did not have the incentive to undertake long-term investments or other long-term initiatives, like mergers, and this may partially account for the very low relative productivity of agriculture. But despite the acquisitions, it is reasonable to assume that as long as a farmer remained in agriculture and had an agricultural *hukou* she was guaranteed a piece of land to cultivate for own use.

Land transfers for rent payments were allowed in the 2002 Act when the farmer migrated but farmers taking advantage of this scheme lived under the threat that they may not be able to get their land back if they returned to the village to cultivate it themselves; or that the village leader would consider that they no longer needed the land and take it away from them. As a result, land transfers are limited and where they do happen they are usually to relatives or within the family for a compensation that is well below what could be considered as a market rate. The World Bank (2014, chapter 4) finds that the transfers that take place are at reduced rates, they are unrecorded and so they are subject to a lot of uncertainties which reduce the real value of the land to farmers.

In the formal modelling that follows we deal with the complex issue of transfers by focusing on two extremes, one with no transfers and one with full property rights with transfers. We consider the former to be a much closer description of the present situation in China, whereas the latter corresponds to a policy reform that involves the privatization of land, something not yet contemplated by the People's Republic.

3 Consumer allocations and production functions

In order to focus the analysis on labor distortions we assume that goods markets are frictionless and all consumers face the same prices, so the optimal consumer allocation decisions can be stated up front and will hold in all migration equilibria. For this to hold all goods must be transferable without cost across space, an assumption that we make. We further assume that there are only two regions, a rural one that produces both agricultural and non-agricultural goods, and an urban one that produces only non-agricultural goods. We do not distinguish between manufacturing and services. We

denote all agricultural production by subscript a and all non-agricultural production by subscript n. Non-agricultural goods produced in the urban and rural regions are differentiated products. When the non-agricultural good is produced in the rural sector it is distinguished by subscript r and when produced in the urban sector by subscript u.

The utility function of representative agent i is defined by

$$\begin{aligned} U^i &= \log c^i, \\ c^i &= \left(c_a^i - \bar{c}_a\right)^{\omega} \left(c_n^i\right)^{1-\omega} \end{aligned} \tag{1}$$

where $\omega \in [0,1]$ and $\bar{c}_a$ is a subsistence level for agricultural goods (which delivers a lower and more realistic income elasticity for agricultural goods than non-agricultural ones), c^i is the consumption aggregate for each person, c_a^i and c_n^i respectively denote consumption of the agricultural and the aggregate of the non-agricultural goods, defined by:

$$c_n^i = \left[\psi {c_r^i}^{\frac{\eta-1}{\eta}} + (1-\psi) {c_u^i}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}. \tag{2}$$

Throughout the paper we use superscript i for individual and subscripts $j = a, r, u$ for types of goods. Individuals can be of different types due to the *hukou* they hold or the sector in which they are employed.

We assume the absence of real or financial assets, so we can work with a one-period model. Land is rented from the landowner (the state, or if it is privatized from the farmer) on a per-period basis for cultivation and cannot be used to make intertemporal transfers (e.g., through mortgages). All output is consumed in the period that it is produced and consumers are price-takers.

The budget constraint facing each person is

$$p_a c_a^i + p_r c_r^i + p_u c_u^i \leq I^i. \tag{3}$$

where p_a is the price of the agricultural good, p_j (with $j = r, u$) the price of non-agricultural goods, and I^i is the income of individual i.

Maximization of the utility function subject to the budget constraint gives the usual marginal rate of substitution (MRS) equations, first between the two non-agricultural goods,

$$\frac{c_r^i}{c_u^i} = \left(\frac{1-\psi}{\psi}\frac{p_r}{p_u}\right)^{-\eta}, \tag{4}$$

and second between the agricultural good and the aggregate of the non-agricultural goods,

$$\frac{c_a^i - \bar{c}_a}{c_n^i} = \frac{\omega}{1-\omega}\frac{p_n}{p_a}. \tag{5}$$

where p_n is a price aggregator for the consumption of non-agricultural goods, defined by $p_n c_n^i \equiv p_r c_r^i + p_u c_u^i$. Making use of the definition of the price index p_n, the non-agricultural aggregator c_n^i in (2) can be expressed as:

$$c_n^i = c_u^i \left(\frac{p_u}{(1-\psi)\, p_n} \right)^{\eta}, \tag{6}$$

an expression that will prove useful in the later analysis. In light of (4) and (6), p_n can be expressed as,

$$p_n = \left[\psi^{\eta} p_r^{1-\eta} + (1-\psi)^{\eta} p_u^{1-\eta} \right]^{\frac{1}{1-\eta}}. \tag{7}$$

Let υ be the fraction of the population that holds an urban *hukou* while $1-\upsilon$ holds a rural *hukou*. Throughout the paper, υ is an exogenous policy parameter. The distortions introduced by the *hukou* registration system alter net incomes received by different groups of workers but not the prices that they face (see below for more details). So the allocation conditions (4), (5) and (6), as well as the implicit price of non-agricultural goods (7), hold in all equilibria described in this paper. Aggregate consumption for each type of good is obtained by summing the consumption levels of individual agents, all of which satisfy the conditions above but may be at different levels because of differences in their budget constraints.

The production possibilities in this economy are also unaffected by the *hukou* system and we derive them here. Let a fraction of $0 \leqslant \rho_j \leqslant 1$ of the labor force be employed in sector $j = a, r, u$. We assume that all workers are employed and work a fixed number of hours each, normalized to unity. The value-added production functions for non-agricultural goods are

$$y_j = \rho_j A_j; \quad j = r, u \tag{8}$$

where y_j denotes output, which in the one period model is equal to the total consumption of each good, and the A_j are technology parameters.

Given the important role of land in our analysis, the agricultural production function has to take it into account explicitly, noting that all agricultural land is officially owned by the state. We let l denote the total amount of land made available for agricultural use and assume it to be a policy constant, and let l_a^i be the land cultivated by a single farmer i. The farmer's production function is given by,

$$y_a^i = A_a \left(l_a^i \right)^{1-\beta} \qquad 0 \leq \beta < 1, \tag{9}$$

where A_a is agricultural technology. Throughout the paper we assume that all farmers use the same amount of land so the land constraint satisfies[10]:

$$l_a^i = l_a = l/\rho_a, \tag{10}$$

where l is the exogenous supply of agriculture land. Aggregate food production is given by the summation of y_a^i over i, which in view of (10) it is $\rho_a y_a^i$:

$$y_a = A_a \rho_a^\beta l^{1-\beta}. \tag{11}$$

The case $\beta = 0$ is an interesting special case. It says that food production is a linear function of the acres of land in cultivation but for land to be productive a farmer needs to be attached to it. Aggregate food production is then constant and independent of the number of farms in the region but the labor input varies. If there are more farms there are more people employed to produce the given quantity of food, so there are diminishing returns to labor at the aggregate level but constant returns to land.[11]

The rest of this paper derives equilibrium conditions for different policy regimes that alter personal incomes and the resource allocations in the economy.

4 First-best equilibrium

We begin by deriving the first-best equilibrium allocation of labor, which is achieved when there are no policy distortions. Farmers rent their land from the state on a per-period basis, for a rental r. The state, as the owner of the land, returns the revenue from the rents received from farmers to all citizens as a non-distortionary lump-sum transfer T_a. Total income for an individual i working in sector j satisfies:

$$I^i = T_a + w_j; \quad j = a, r, u. \tag{12}$$

Farmers rent their plot of land to maximize their profit and the rental rate is set so as to clear the market for land, by equating the total demand

[10] Given recent Chinese history we also assume that migration is always from agriculture to non-agriculture, so all farmers hold the rural *hukou*. This makes all farmers identical in all the policy regimes we consider.

[11] A corollary from this is that if $\beta = 0$ it is optimal to employ only one person in agriculture and release all others to work in industry and services. This may not be totally against the data from rich countries, where agricultural employment has been monotonically declining, but it depends on other factors too, such as who gets the returns from land cultivation and the productivity of the non-agricultural sector. Our formulas below are for $0 < \beta < 1$ as the case $\beta = 0$ requires different wage determination mechanisms.

for land by farmers to the exogenous supply l. In view of the production function (9) the optimal l_a^i satisfies

$$r = (1-\beta)p_a A_a \left(l_a^i\right)^{-\beta} = (1-\beta)p_a A_a \left(l/\rho_a\right)^{-\beta}. \tag{13}$$

All farmers face the same prices so they all rent the same quantity of land, l_a, that maximizes their profit, giving the second part of equation (13). The farmer's return from cultivation is the value of total production $p_a y_a^i$ less the cost of land rl_a. Because of the assumptions of competitive equilibrium and constant returns to farming, the farmer's return is equivalent to the wage that labor would have been paid in competitive equilibrium. We denote it by w_a and it is a fraction β of the value of a single farmer's output:

$$w_a = \beta p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{14}$$

The remainder of the farmer's production yield is equal to rl_a and it is paid to the landowner. We state it here for completeness

$$rl_a = (1-\beta)p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{15}$$

The lump-sum transfer T_a from the state to all citizens satisfies

$$T_a = \rho_a r l_a = (1-\beta)p_a A_a \rho_a^{\beta} l^{1-\beta}. \tag{16}$$

In the non-agricultural sector with linear production functions and competitive equilibrium all revenue is passed on to labor, so wages are:

$$w_u = p_u A_u; \quad w_r = p_r A_r. \tag{17}$$

In frictionless equilibrium workers allocate themselves between the three production sectors until income levels are equalized. With the lump-sum transfer from the state the same for all workers, migration equilibrium implies equality of wages across all sectors:

$$w = p_r A_r = p_u A_u = \beta p_a A_a \left(l/\rho_a\right)^{1-\beta}, \tag{18}$$

Consumption levels are also equal across individuals, by the equality of incomes, so the market clearing conditions imply,

$$c_j^i = c_j = y_j; \quad j = a, r, u. \tag{19}$$

4.1 Allocations across non-agricultural sectors

We begin by studying the allocation between the two non-agricultural sectors and then derive the allocation between agriculture and the aggregate of non-agricultural production. For the two non-agricultural sectors equality of wages implies the familiar negative relation between relative prices and relative productivities:

$$p_r A_r = p_u A_u. \tag{20}$$

We substitute this relation, market clearing conditions (19) and the production function (8) into the MRS condition (4), to derive the labor allocation,

$$\frac{\rho_r}{\rho_u} = \left(\frac{\psi}{1-\psi}\right)^{\eta} \left(\frac{A_u}{A_r}\right)^{1-\eta}. \tag{21}$$

The aggregate labor allocated to non-agricultural production is $1-\rho_a$, and we use (21) to derive the distribution of this labor across the rural and urban sectors as:

$$\rho_u = \frac{1-\rho_a}{1+\left(\frac{\psi}{1-\psi}\right)^{\eta}\left(\frac{A_u}{A_r}\right)^{1-\eta}}, \tag{22}$$

with $\rho_r = 1-\rho_a-\rho_u$.

We next derive an aggregate production function for non-agricultural goods. We substitute the market clearing condition (19) and production function (8) into (6) to derive:

$$c_n^i = (1-\rho_a)\, A_u \left(\frac{p_u}{(1-\psi)\, p_n}\right)^{\eta}, \tag{23}$$

which, in combination with the definition of p_n in (7), relative prices in (20) and labor allocation in (22), yields the aggregate production function and aggregate productivity level for non-agricultural production:

$$c_n^i = c_n = y_n = (1-\rho_a)\, A_n; \quad A_n = \left[\psi^{\eta} A_r^{\eta-1} + (1-\psi)^{\eta} A_u^{\eta-1}\right]^{\frac{1}{\eta-1}}. \tag{24}$$

The MRS equation (5), the definition of aggregate price p_n in (7) and the production function for aggregate non-agricultural production (24) enable us to work with only the aggregate non-agricultural good when policy does not distort the allocation between the two non-agricultural sectors. Given the equality of wages in (20), it is clear from the definition of aggregate spending and the three production functions for non-agricultural goods that,

$$p_n A_n = p_r A_r = p_u A_u. \tag{25}$$

4.2 Allocations in agriculture

Returning now to the free mobility condition that equates wages in all sectors of the economy in (18) and making use of (25), we write the equality of wages in agriculture and non-agriculture, which gives a condition linking relative prices with relative productivities in the two sectors:

$$p_n A_n = \beta p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{26}$$

As in the allocation within the non-agricultural sectors, for a given labor allocation relative prices are inversely related to productivities, but here two further properties hold. For a given labor allocation, a lower share of labor in agriculture raises the relative price of agricultural goods, and a smaller farm size also raises the price of agricultural goods. Intuitively, the reason for the former is that fewer workers join agriculture if the share of labor is lower and for the latter that there are diminishing returns to labor in agriculture, and given the policy constraint on the overall size of agricultural land, a smaller farm size implies that more workers are renting land from the state.

The first-best equilibrium is defined by the three consumption levels (c_a, c_r, c_u), which satisfy the marginal rate of substitution equations (4) and (5) and the budget constraints (3) with income specified in (12) (where all agents have the same income and choose the same consumption levels); the wage levels in (18) and a land rental that satisfies (13); the lump-sum transfer from the state that satisfies (16); the relative prices that satisfy (26); and a labor allocation in the three production sectors (ρ_a, ρ_r, ρ_u), which, given the consumption levels, can be obtained from the production functions (8) and (11) by the property that all outputs are consumed.

The key unknown in this equilibrium is ρ_a, which together with (21) and (22) define the allocation of labor across the economy's sectors. In order to derive the equilibrium ρ_a, we substitute the market clearing condition (19) into the MRS condition (5) to obtain,

$$y_a - \bar{c}_a = \left(\frac{\omega}{1-\omega}\frac{p_n}{p_a}\right)\left(1-\rho_a\right)A_n. \tag{27}$$

Using the relative prices from (26) and the production functions for agriculture and the aggregate of the non-agricultural sector, (11) and (24), we obtain the key equation satisfied by the optimal ρ_a :

$$\beta(1-\rho_a) = \left(\frac{1-\omega}{\omega}\right)\rho_a\left(1 - \frac{\bar{c}_a}{A_a l^{1-\beta}}\rho_a^{-\beta}\right); \tag{28}$$

This clearly has a unique positive solution for ρ_a between 0 and 1 given that $0 < \beta < 1$.

5 Equilibrium with policy: land

We consider now the implications of the labor market policies followed by the Chinese government, beginning with land policy. As we previously noted, the state makes available land plots to farmers who can cultivate them for a yield but they do not have property rights over them: they get them free of rent but cannot lease them or sell them. Although it is apparent that some unrecorded transfers of land are taking place, we ignore them in this derivation. They are small in number, the rental is unrecorded but believed to be below market rate and they do not make much difference to farmer's attitudes (see World Bank, 2014, chapter 4). But given that some migrant workers do find ways to retain some income from their land, the impact that we calculate should be treated as an upper bound for the costs of the policy. We derive the implications of the state's land policy and our purpose is to compare outcomes between the first-best of the preceding section and this policy.

In the first-best equilibrium the state leases the land at market prices; in the policy state of this section it does not collect rents. In the first-best the share of the farmer from the farm production is β, as in equation (14) and the lump-sum transfer to all citizens is (16). In the policy state the farmer's share is 1 and the lump-sum transfer is 0. It follows that the farmer's return from cultivation is the value of the entire output of her farm,

$$p_a y_a^i = p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{29}$$

As before, we write l/ρ_a for the size of the farm, on the assumption that all agricultural plots are of equal size and there is no excess capacity in agriculture.

Allocations within the non-agricultural sector are not affected by this policy so the aggregate production function for non-agriculture is the same as in (24). The key implications of the land policy is the employment allocation across agriculture and non-agriculture. Intuitively farmers now receive a land windfall and under free labor mobility and the assumption that they lose their right to the land when they migrate, the migration condition that equates wage rates in agricultural and non-agricultural employment, (26), is replaced by one that equates non-agricultural wages to the value of farm output $p_a y_a^i$:

$$p_n A_n = p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{30}$$

By the migration condition (30) all agents in this economy receive the same income and consume the same quantities but because the policy takes away the lump sum transfers from non-agricultural workers and lets farmers

claim the entire farm output, the overall equilibrium is at a lower welfare level. In the land-policy equilibrium there are too many farmers relative to the first-best equilibrium. Formally, substitute the relative prices from (30) into the MRS condition (5) to obtain the equilibrium condition for ρ_a as:

$$1-\rho_a = \left(\frac{1-\omega}{\omega}\right)\rho_a\left(1-\frac{\bar{c}_a}{A_a l^{1-\beta}}\rho_a^{-\beta}\right), \tag{31}$$

Comparing the two equilibrium conditions (28) and (31) we immediately find that the solution for ρ_a in (31) is at a higher level than it is in (28): the right-hand sides are the same increasing function of ρ_a while the left-hand side of (31) is higher than the left-hand side of (28) and decreasing in ρ_a. Thus they imply ρ_a is higher in the land-policy equilibrium. Production function (8) implies that non-agricultural labor productivities are equal in both equilibria, as they are equal to A_r and A_u; while production function (11) implies that agricultural labor productivity is equal to $A_a\left(l/\rho_a\right)^{1-\beta}$ so it is lower in the land-policy equilibrium due to the higher ρ_a. Thus the following proposition holds:

Proposition 1 *If land is an essential input into production, $\beta < 1$, and comparing with the first best, the land policy is a non-trivial barrier to labor mobility, inducing a bigger labor allocation in agriculture and less in non-agricultural production in both rural and urban regions. These allocations coexist with a lower relative productivity in agriculture.*

Proposition 1 delivers an important message: the land policy followed in China is consistent with the observation that there is a large fraction of employment in agriculture despite its lower relative productivity. By extension, this misallocation of labor contributes to a lower aggregate productivity in the economy as a whole.

Taking the ratio of the two equilibrium conditions (28) and (31), the comparison between agricultural employment in the first-best and the policy model, respectively denoted by ρ_a^* and ρ_a, satisfies:

$$\beta\frac{1-\rho_a^*}{1-\rho_a} = \left(\frac{\rho_a^*}{\rho_a}\right)\left(\frac{1-\bar{c}_a/y_a^*}{1-\bar{c}_a/y_a}\right), \tag{32}$$

where y_a and y_a^* follow from the aggregate agricultural production function given in (11). It follows from (32) that the two key parameters in the comparison of agricultural employment levels are β and $\bar{c}_a$, the income share of labor in the agricultural production function and the subsistence agricultural consumption. This is intuitive. The impact of β is obvious from our solution: in the first-best labor gets a share β of agricultural output whereas

in the policy equilibrium it gets share 1, so the higher is β the closer the two equilibrium outcomes will be. The intuition behind $\bar{c}_a$ is that a higher value for $\bar{c}_a$ implies that substitution possibilities between agricultural and non-agricultural consumption are more limited so giving more incentives to farmers to stay on the land does not have as much impact on their decisions as in cases where consumers are more likely to switch between agricultural and non-agricultural goods.

As a Corollary to Proposition 1, compared with the first best, the land policy equilibrium has a lower level of output and consumption of non-agricultural goods and a higher level of agricultural output and consumption and a higher relative price for non-agricultural goods. Intuitively, these things happen because with higher farm incomes fewer farmers migrate, producing and supplying to the market more food than in the optimal state.

We have interpreted the mobility barrier in the model with land policy as resulting from a gift of land from the state if the rural family does not migrate but another way of interpreting it is as a loss of income in the new (non-agricultural) state. This can be seen by rewriting the migration condition (26) as,

$$\beta p_n A_n = \beta p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{33}$$

Migration equates the value of marginal product of labor in agriculture to a fraction of that in non-agriculture, a typical feature of the misallocation of resources.[12] It follows that comparing (33) to the first-best (26), β (on the left-hand side of (33)) can also be interpreted as a measure of income "loss" by rural migrants in the non-agricultural destination state, compared with local residents who receive the full wage $p_n A_n$. Tombe and Zhu (2015) follow an approach along these lines and interpret the lower returns that migrants get in the new state as resulting from a reduction in the migrant's productivity due to the move or a loss in time available for work. They treat this cost as exogenous and calculate it to be more than half of the wage. In the present interpretation of our model this cost is an endogenous outcome and is equal to the share of land $(1-\beta)$ in the production function in competitive equilibrium. We show later that a reasonable number for this value is about 0.5, giving an implicit income loss in the new state of about 50%.

[12] Hsieh and Klenow (2009) apply similar ideas in their study of capital misallocation in China's manufacturing sector.

5.1 Policy reform: land property rights

A policy reform advocated by many (see for example The World Bank, 2014, chapter 4) is to pass the property rights on the land to the farmers. By the nature of recent Chinese economic development and policy towards residence, all farmers can be assumed to have rural agricultural *hukou*, so the policy can easily be implemented, either by giving property rights to land to all holders of agricultural *hukou* or only to those who happen to be farmers in some initial year. Given that agricultural *hukou* holders who have migrated are scattered throughout the country, a reasonable assumption that makes the policy more easily implementable is that the land property rights are given to the current users of land; namely that agricultural *hukou* holders who migrated do not receive land.

Once property rights are granted and the land becomes marketable the rental cost of the land is reinstated but the beneficiary is now the farmer and not the state. If a farmer leaves her land she gives up the non-rental return from the land, w_a in (14), but keeps the rental return, (15), for herself. So the migration conditions return to those of the first-best, (26), but now there are differences in incomes and consumption levels across agents. All persons who were farmers in the pre-reform equilibrium now receive either $w_a + rl_a = p_a y_a$ if they continue cultivating their land or $w_j + rl_a$ if they migrate to one of the non-agricultural sectors $j = r, n$. By the migration condition (26) the wage income levels are the same in all three sectors but crucially workers who were farmers in the pre-reform equilibrium are now better off than the non-agricultural workers because they receive in addition land rents.

To derive the new budget constraints, let again ρ_a be the number of agricultural workers in the new equilibrium. A number of non-agricultural workers, denoted by m, were agricultural workers in the pre-reform equilibrium but elected to leave their land and become migrants in a non-agricultural sector. It is irrelevant for the model of this section where these migrants go because they carry their land property rights with them in both their region and in the urban region. In light of this property, we arbitrarily assume that all migrants go to urban locations (this will make the notation easier to follow in the next section). In this case, ρ_a rural *hukou* holders remain in the rural region and work in agriculture and m rural *hukou* holders with land property rights work in non-agriculture in the urban sector. The ρ_u urban workers in the new equilibrium are therefore now split between $\rho_u - m$ workers without land and m rural *hukou* holders with land. The budget constraints for all persons are still (3) but they are crucially different by their income,

$$I^a = p_a A_a \left(l/\rho_a\right)^{1-\beta}; \quad I^n = p_r A_r = p_u A_r \tag{34}$$

where superscript a refers to those who were farmers in the pre-reform year (who are also the new land-owners); and superscript n refers to those who were non-agricultural workers in the pre-reform year. We note that all agricultural workers in the post-reform equilibrium, denoted by ρ_a, receive income I^a whereas of the $1-\rho_a$ non-agricultural workers m receive income I^a and $1-\rho_a-m$ receive income I^n. The market clearing condition (19) is replaced by

$$(\rho_a + m)\, c_j^a + (1 - \rho_a - m)\, c_j^n = y_j; \quad j = a, r, u \tag{35}$$

The rest of the equations of the policy reform model are the same as in the first-best, so, importantly, the allocation ρ_a is determined by (26) and not by (30), as in the policy model without property rights. So the only substantive difference between the policy reform model and the first-best is in the budget constraints - the farmers who get the property rights to their farm are better off; in the first best the rents from the land were distributed to all persons in the economy equally.

To derive the properties of the land reform equilibrium, we aggregate the MRS condition (4) across individuals $i = a, n$ and use the market clearing condition (35) to obtain:

$$y_r = \left(\frac{1-\psi}{\psi}\frac{p_r}{p_u}\right)^{-\eta} y_u, \tag{36}$$

which, together with the production functions (8) and the migration condition (20), implies that the allocation of non-agricultural workers into sectors r and u is the same as in the first-best equilibrium; i.e., equations (21)-(22) hold. Next we aggregate equation (6) across individuals $i = a, n$ and use the market clearing condition (35) to obtain,

$$y_n = y_u \left[\frac{p_u}{(1-\psi)\, p_n}\right]^{\eta}, \tag{37}$$

where $y_n \equiv (\rho_a + m)\, c_n^a + (1 - \rho_a - m)\, c_n^n$ is defined as the aggregate non-agricultural output. We can obtain the same aggregate production function for non-agricultural goods as in (24) by substituting the production function (8), labor allocation (22) and relative price (20) into (37).

Using the aggregate production function for non-agriculture in (24), we can aggregate the MRS condition (5) across individuals $i = a, n$ to obtain

$$y_a - \bar{c}_a = \left(\frac{\omega}{1-\omega}\right)\left(\frac{p_n}{p_a}\right)(1-\rho_a)\, A_n, \tag{38}$$

which is the same as condition (27) in the first-best equilibrium. Given that the functional form for relative prices p_a/p_n is the same as in the first-best,

it follows that ρ_a in the reform equilibrium is the same as in the first-best equilibrium, satisfying (28). It also follows from (21) and (26) that (ρ_r, ρ_u) and relative prices p_a/p_n are the same as in the first-best. These results is summarized in the following proposition:

Proposition 2 *In a policy reform that passes land property rights to farmers the employment allocation, sectoral outputs, sectoral labor productivities and relative prices are all restored to the values that they attain in the first-best equilibrium.*

The only difference that remains between the reform equilibrium and the first best is that in the reform equilibrium there is consumption inequality across individuals, as the farmers in the year of reform have higher income than the rest of the population. Using (26) and (34), $\beta I^a = I^n$. For $\beta \simeq 0.5$, the income of those who were farmers in the pre-reform state is about twice that of other workers.

6 Government subsidies

We now introduce the second main policy tool that discriminates between rural and urban workers, government subsidies. We introduce the subsidies in the model with the land policy described in section 5, whereby land is leased to the farmers free of rents. As we argued in that section, this policy regime corresponds most closely to the current policy environment in China. In this policy model, and without government subsidies, farmers keep the entire farm output as their yield but all citizens are equally well off by the free migration condition. Government subsidies, however, alter this equilibrium and for the first time in our modelling there is now a non-trivial difference between working in the non-agricultural sector in a rural or in an urban location (which is the reason that we assumed the existence of the two non-agricultural differentiated products, something not normally done in the literature).

Following on from our discussion of government policy in section 2, we assume that the government supplies to each individual goods and services, as follows. Each rural *hukou* holder, irrespective of whether her *hukou* is agricultural or non-agricultural, receives from the state goods supplied locally, such as education and other social services, in addition to the land received by agricultural *hukou* holders. These goods are denoted by $\bar{c}_r$. Urban *hukou* holders also receive from the state goods and services produced locally, again mostly social services, denoted by $\bar{c}_u$. Thus, the policy parameters with state

subsidies are $(\upsilon, \bar{c}_r, \bar{c}_u)$, which are taken as given, and where υ is the fraction of the population with urban *hukou* and $(1-\upsilon)$ the fraction with rural *hukou*.

The cost of these subsidies to the state in rural and urban locations is $p_r\bar{c}_r$ and $p_u\bar{c}_u$ respectively and we assume that they are financed by lump-sum taxes. The question of who pays the lump-sum tax is not trivial, given free migration. We assume that subsidies are entirely financed by taxes levied in the region where they are paid, i.e., there are no regional fiscal transfers. Our objective is to concentrate on the implications of social transfers and not mix up the effects with fiscal non-neutrality. Nevertheless, the alternative assumption that there are transfers makes only marginal differences to the points that we want to emphasize. Let T_r be the lump-sum tax paid by rural workers and T_u the tax paid by the urban workers, both of which balance the regional government budgets.

6.1 Worker/consumer's decisions

Since rural workers do not lose their right to social subsidies if they remain in the rural areas, mobility between the agricultural and non-agricultural sectors in rural locations is unaffected by the introduction of subsidies. Therefore, the free mobility condition in rural areas implies wage incomes are equalized across agricultural and non-agricultural jobs:

$$p_a A_a \left(l/\rho_a\right)^{1-\beta} = p_r A_r, \tag{39}$$

which is the condition that also holds in the policy equilibrium without subsidies, (30). With no urban migrants in rural areas, it follows that both agricultural and non-agricultural workers in rural areas receive the same income, same subsidies and pay the same taxes. Thus, we do not need to differentiate between individuals in rural locations and we refer to both types as rural workers, distinguished by superscript r. The consumer budget constraints for rural workers can be written as:[13]

$$p_a c_a^r + p_r(c_r^r - \bar{c}_r) + p_u c_u^r = p_r A_r - T_r = p_a A_a (l/\rho_a)^{1-\beta} - T_r. \tag{40}$$

In urban areas there are migrant workers who are not entitled to government subsidies but pay local taxes.[14] The budget constraint for these workers

[13]Note that to rule out the case that consumers may want to "sell" social services received from government, we assume that the transfers are smaller than the equilibrium consumption levels: $c_i^i > \bar{c}_u$ for $i = r, n$. We verify this condition later in the paper.

[14]See Pan and Wei (2013), who write, "Unfortunately, children of migrant workers in China are deprived of the right to compulsory education despite the fact that these workers pay taxes in their host cities and their employers pay the so-called "city construction fees" and "educational surcharge"..."

is different than the one in rural areas, where taxes balance the cost of the subsidies. As before, let the number of rural *hukou* holders who migrate to urban areas be m. These workers' income is the non-agricultural urban wage, they pay urban taxes and receive no subsidies. The budget constraint satisfies,

$$p_a c_a^m + p_r c_r^m + p_u c_u^m = p_u A_u - T_u, \tag{41}$$

where superscript m identifies the individual as a migrant. In contrast, urban *hukou* holders benefit from government subsidies:

$$p_a c_a^u + p_r c_r^u + p_u (c_u^u - \bar{c}_u) = p_u A_u - T_u. \tag{42}$$

Using (40) and (41), the migration condition across rural and urban locations is:

$$p_r A_r + p_r \bar{c}_r - T_r = p_u A_u - T_u \tag{43}$$

6.2 Government's budget constraint

Budget balance in rural locations requires,

$$p_r \bar{c}_r = T_r, \tag{44}$$

because all rural residents are also rural *hukou* holders. In urban locations the recipients of subsidies are the υ urban *hukou* holders whereas the tax payers are the same υ workers plus the m migrants with rural *hukou:*

$$\upsilon p_u \bar{c}_u = (\upsilon + m) T_u. \tag{45}$$

Using the lump sum taxes T_r obtained from the government's financing constraint (44), the consumer budget constraints (40) for rural residents become:

$$p_a c_a^r + p_r c_r^r + p_u c_u^r = p_r A_r = p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{46}$$

We note that the introduction of taxes and subsidies in the budget constraints of rural residents have done nothing to alter the budget constraints of the model without subsidies. But conditions in urban locations are different. Using the lump-sum taxes T_u obtained from (45), the budget constraint (41) for migrants becomes:

$$p_a c_a^m + p_r c_r^m + p_u c_u^m = p_u A_u - \frac{\upsilon}{\upsilon + m} p_u \bar{c}_u, \tag{47}$$

and the one for urban *hukou* holders, (42), becomes:

$$p_a c_a^u + p_r c_r^u + p_u c_u^u = p_u A_u + \frac{m}{\upsilon + m} p_u \bar{c}_u. \tag{48}$$

It follows from the two budget constraints (46) and (47) and the migration condition (43) that rural *hukou* holders enjoy the same consumption and utility levels wherever they are. But urban *hukou* holders (who by assumption work in the urban sector) are better off because of the subsidies that they receive, as direct comparison of the migrant budget constraint (47) and the urban budget constraint (48) immediately shows. The key impact of subsidies on allocations is through the fact that urban dwellers receive a tax subsidy from migrants.

To proceed, we further assume that government sets subsidies as a fraction of regional non-agricultural output. In other words, they buy a fraction of non-agricultural output (e.g., educational and health services) and distribute it to local residents, and their policy parameter is the fraction that they buy:

$$\bar{c}_j = s_j y_j; \quad j = r, u. \tag{49}$$

The policy parameters are (υ, s_r, s_j). Employment in urban and rural non-agricultural jobs satisfy, respectively,

$$\begin{aligned} \rho_u &= \upsilon + m, \\ \rho_r &= 1 - \rho_a - \upsilon - m. \end{aligned} \tag{50}$$

With subsidies (49) and the government's financing constraints in (44) and (45), together with the production functions (8), the equilibrium migration condition (43) across rural and urban non-agriculture becomes:

$$p_r A_r = p_u A_u \left(1 - \upsilon s_u\right), \tag{51}$$

It is clear from (51) that the implications of social subsidies is to restrain rural-urban migration further, because of the loss of social subsidies by the migrants (the "floating workers"). To compare to the migration condition for the first-best (18), we write (39) and (51) together as:

$$\beta \left(1 - \upsilon s_u\right) p_u A_u = \beta p_r A_r = \beta p_a A_a \left(l/\rho_a\right)^{1-\beta}. \tag{52}$$

We have already shown in section 5 that the land policy acts as a type of labor mobility barrier against the movement from agriculture to non-agriculture; equation (52) further shows that the presence of social subsidies ($s_u > 0$) acts as an additional type of barrier against the movement from rural locations to urban. The presence of $\upsilon s_u > 0$ on the left-hand side of (52) is an additional source of income loss relative to the land-policy equilibrium in equation (33).

The interaction of the two policies generates a rather complex picture of migration barriers. Agricultural workers' main barrier is the land, because

they could go to a non-agricultural job in their locality without affecting the taxes and social subsidies they face; rural non-agricultural workers' main barrier is the tax that finances the urban social subsidy, because they have to pay taxes in urban locations but receive no subsidies; in urban locations both barriers bite for new job openings that require migrant labor, as by assumption during economic growth more jobs are created in urban locations than in rural ones.

Given the difference between migrants and local *hukou* holders in urban areas, the key unknowns are now two, instead of the one that we had up to this point. As before, one is the fraction of workers who work in agriculture, ρ_a, and the other is the fraction of rural workers who migrate to urban locations, m. The first one is the one that is mainly distorted by land policy and the second the one distorted by the subsidies policy. We derive these distortions in the remainder of this section.

6.3 Market Equilibrium

Making use of the production functions (8) and (11), the market clearing conditions for agricultural goods satisfy,

$$(1-\upsilon-m)\,c_a^r + mc_a^m + \upsilon c_a^u = A_a l^{1-\beta}\rho_a^{\beta}. \tag{53}$$

For non-agricultural goods the market-clearing equation is modified to,

$$(1-\upsilon-m)\,c_j^r + mc_j^m + \upsilon c_j^u = \rho_j A_j; \quad j=r,u. \tag{54}$$

Given policy parameters (υ, s_r, s_u), the equilibrium labor allocation (ρ_a, m) or equivalently (ρ_r, ρ_u), and the consumption allocations $\{c_a^i, c_r^i, c_u^i\}_{i=r,m,u}$, satisfy MRS conditions (4) and (5); the migration conditions (39) and (51); the consumer budget constraints (41), (46), and (48), and the market clearing conditions (53) and (54). The equilibrium lump-sum taxes (T_r, T_u) satisfy the government budget constraints (44) and (45).

We first derive the allocation across rural and urban non-agricultural jobs by aggregating the MRS condition (4) over individuals i and using the market clearing conditions (54) to derive,

$$\rho_r A_r = \left(\frac{\psi}{1-\psi}\right)^{\eta}\left(\frac{p_u}{p_r}\right)^{\eta}\rho_u A_u. \tag{55}$$

Deriving the relative price of the two goods from (51), we obtain the relative size of the rural to the urban non-agricultural employment share:

$$\frac{\rho_r}{\rho_u} = \left(\frac{\psi}{1-\psi}\right)^{\eta}\left(\frac{A_u}{A_r}\right)^{1-\eta}(1-\upsilon s_u)^{-\eta} \equiv X. \tag{56}$$

Not surprisingly, when $s_u = 0$ this is the same as in the first-best and the land-policy equilibrium (21). Comparing (56) to (21), it follows that relative to urban employment, the size of the rural non-agricultural sector is larger when there are positive urban subsidies (for $\eta > 0$, X rises in s_u). The reason for this is that once rural migrants arrive in urban locations they have to pay a tax to finance the subsidies but receive nothing in return.

By definition, $\rho_r + \rho_u = 1 - \rho_a$, so (56) implies that the urban employment share is:

$$\rho_u = \frac{1 - \rho_a}{1 + X}. \tag{57}$$

To derive the allocations across agriculture and non-agriculture we substitute (6) into the MRS condition (5), aggregate across individuals and make use of the market clearing conditions (53) and (54) we obtain,

$$A_a l^{1-\beta} \rho_a^{\beta} - \bar{c}_a = \left(\frac{\omega}{1-\omega}\right)\left(\frac{p_r}{p_a}\right)\left(\frac{p_n}{p_r}\right)^{1-\eta}\left(\frac{p_u}{(1-\psi)\,p_r}\right)^{\eta} \rho_u A_u. \tag{58}$$

Bringing in p_n from (7), relative prices from (39) and (51), and making use of the definition of X in (56) and (57), the equilibrium condition (58) becomes

$$\left(\frac{\upsilon s_u}{(1-\upsilon s_u)\,(1+X)} + 1\right)(1-\rho_a) = \left(\frac{1-\omega}{\omega}\right)\rho_a\left(1 - \frac{\bar{c}_a}{A_a l^{1-\beta}}\rho_a^{-\beta}\right). \tag{59}$$

Equilibrium conditions (57) and (59) imply that social transfers in rural areas, s_r, do not play a role in the employment allocation. The intuition is twofold: first, movements between agricultural and non-agricultural jobs in rural areas do not affect the social subsidies and taxes paid by rural workers, so they do not distort the rural allocation decisions, and second, once rural *hukou* holders decide to move to urban locations, they lose the rural benefits but also do not have to pay rural taxes, and these balance each other out by the assumption of regional budget balance. In contrast, the presence of social subsidies in urban areas distorts the allocations in all three sectors, by distorting the migration from rural to urban areas. Comparing (57) with (22) and (59) with (31) we find that the urban subsidies lead to smaller urban sector but larger rural agricultural and non-agricultural sectors. The results with government subsidies are summarized in the following Proposition:

Proposition 3 *Social subsidies given to urban hukou holders act as mobility barriers by reducing migration from rural to urban locations. The implications of subsidies is to slow down both industrialization and urbanization (by reducing the size of the urban non-agricultural sector and increasing the size of the rural agricultural and non-agricultural sectors.)*

7 Quantitative evaluation of policy distortions

Given the non-trivial consequences of the *hukou* system, via the land policy and government subsidies (summarized in Propositions 1 and 3) we now discuss their quantitative importance. More specifically, we compare the policy outcomes with the first-best derived in section 4 by making use of statistical information from China.

Taking the ratio of the two equilibrium conditions (28) and (59), the comparison between agricultural employment in the first-best and the policy model, respectively denoted by ρ_a^* and ρ_a, satisfies the key equation:

$$\beta\left(\frac{1-\rho_a^*}{1-\rho_a}\right)\left(\frac{\upsilon s_u}{(1-\upsilon s_u)(1+X)}+1\right)^{-1}=\left(\frac{\rho_a^*}{\rho_a}\right)\left(\frac{1-\bar{c}_a/y_a^*}{1-\bar{c}_a/y_a}\right), \qquad (60)$$

where y_a and y_a^* follow from the aggregate agricultural production function given in (11). This equation can be quantified because given values for β, $\bar{c}_a/y_a$ and X, we can use it to derive a numerical relation between ρ_a^* and ρ_a. By making the assertion that the observed employment allocation (ρ_a, ρ_r, ρ_u) is the one obtained in the model with both a land and a subsidy policy, equation (60) can be used to compute the gap between the optimal allocation of labor to agriculture and the observed one.

The "unknowns" β and $\bar{c}_a/y_a$ are technology and preference parameters, the former being the share of labor in agricultural production and the latter the "subsistence" level of food consumption.[15] Given the employment allocation, the value of the final unknown, X, can be calculated from the model's equilibrium, since by (56), it is equal to the ratio ρ_r/ρ_u, which is observed in the data.

We take the employment shares (ρ_a, ρ_r, ρ_u) from Brandt and Zhu (2010), as in Figure 1. We explain in the Appendix how we construct s_u using the data on the sectoral employment shares, the nominal value-added of non-agriculture $p_n y_n$, the share of urban *hukou* υ and social spending in urban areas, $p_u\bar{c}_u$. The share of urban *hukou* υ is from Chan (2012), who compiled the numbers from *Chinese Statistical Yearbooks* and *China Population Statistical Yearbooks*. The data are available from 1970 to 2013. The social spending data $p_u\bar{c}_u$ are constructed using a large number of official sources

[15] The subsistence level of consumption is directly related to the elasticity of substitution between food and other consumption goods; the higher it is, the harder it is for the individual to substitute out of food consumption. In quantitative work $\bar{c}_a$ is usually calculated in terms of total food consumption, i.e., $\bar{c}_a/c_a$, and not the absolute value $\bar{c}_a$, is the meaningful parameter in the calibration (the fraction of food consumption that is necessary for subsistence). In our one-period model this is equivalent to the ratio $\bar{c}_a/y_a$ that we use in our computations.

including the webpage of the Ministry of Finance and the publications *Educational Statistics Yearbook of China*, *China Health Statistical Yearbook*, *Finance Yearbook of China, China Civil Affairs' Statistical Yearbook* and *China Statistical Yearbook*. We include all social service costs related to *hukou* (World Bank 2014, chapter 3) including education, health care services, pensions, and other social assistance programs (e.g., basic living subsidies). We collected detailed data of government spending for urban and rural areas separately. These data are available only for 1998-2013. Due to this, we restrict our analysis to this period. The time series for (υ, s_u), and for comparison s_r (although it plays no role in our quantitative comparisons), are reported in Table 2. The fraction of urban *hukou* υ increased from about 25% to 36% over this period while s_u increased from 5.6% to 14.4% of urban value-added. Subsidies in rural areas are a lot less at 6.6% of rural value-added.

The remaining two values needed for deriving the quantitative results are for β and $\bar{c}_a/y_a$. With a constant-return-to-scale Cobb-Douglas production function in agriculture, we can compute β from the three-factor share estimates of Cao and Birchenall (2013). Building on the work of Chow (1993) they estimate for Chinese agriculture a share of capital of 0.25, land 0.37 and labor 0.38. Allocating the share of capital to the other two we find $\beta = 0.38/0.75 = 0.51$, which is the number that we use throughout our analysis.[16]

There are no direct computations of subsistence food consumption. In order to derive plausible values we go through the following steps. We first choose a plausible value for $\bar{c}_a/y_a$ in a given base year and subsequently use it in (59), along with the aggregate agricultural production function (11) and the observed ρ_a, υ, s_u and X, to compute the implied preference parameter ω for that year, from the rearranged equation:

$$\frac{\omega}{1-\omega} = \left(1 - \frac{\bar{c}_a}{y_a}\right) \frac{\rho_a}{1-\rho_a} \left(\frac{\upsilon s_u}{(1-\upsilon s_u)(1+X)} + 1\right)^{-1}. \tag{61}$$

This parameter is then assumed to hold in all years in the sample, being a fixed preference parameter. Rearranging (61) once again and using subscript t for a year in our sample, we obtain a time series for $\bar{c}_a/y_a$, conditional on

[16] Formally, consider a production function with three factors: $Y = BK^{\alpha}L^{1-\alpha-\gamma}N^{\gamma}$, where K, L, N denotes capital, labour and land. If the rental rate of capital is equal to the marginal product of capital, then this production function is reduced to our production function with $\beta = (1-\alpha-\gamma)/(1-\alpha)$. More recently, Adamopolous et al. (2016) find similar shares of capital 0.18, land 0.36 and labor 0.46, which imply $\beta = 0.56$. Our results are not sensitive to such small differences in β.

the chosen base-year value of this ratio, which was used to compute ω :

$$\left(\frac{\bar{c}_a}{y_a}\right)_t = 1 - \left(\frac{\omega}{1-\omega}\right)\left(\frac{\upsilon_t s_{ut}}{(1-\upsilon_t s_{ut})(1+X_t)} + 1\right)\frac{1-\rho_{at}}{\rho_{at}}. \tag{62}$$

Thus the variation in $\bar{c}_a/y_a$ comes entirely from the variation in $(\rho_a, \upsilon s_u)$, and more specifically it is an increasing function of ρ_a, with range from a very large negative number for very small ρ_a, to 1 for $\rho_a = 1$. Since only positive values for $\bar{c}_a/y_a$ are feasible and ρ_a is decreasing over time in our sample, we ensure that we do not violate nonnegativity constraints by choosing as base year the most recent year in the sample and work backwards to obtain $\bar{c}_a/y_a$ in all other years in the sample. We report results for three values for $\bar{c}_a/y_a$ in our base year 2013, which cover a wide range of possibilities. The three values are 0.2, 0.5 and 0.8.[17] As reported below, results are not too sensitive to small variations in subsistence consumption levels.

The key equation (60) now has only observable time series of all variables except for ρ_a^* and $\bar{c}_a/y_a^*$. But the production function (11) implies:

$$\frac{\bar{c}_a}{y_a^*} = \frac{\bar{c}_a}{y_a}\left(\frac{\rho_a}{\rho_a^*}\right)^{\beta}. \tag{63}$$

Substituting this into (60) enables the computation of a series for ρ_a^* conditional on the series for ρ_a. By comparing the two series we study the impact of policies on the agricultural employment rate.

Turning now to the impact of policies on urbanization, putting more emphasis on subsidies which distort the allocation across rural and urban non-agricultural allocations, we derive the implied urban employment share using (22) and the definition of X in (56):

$$\rho_u^* = \frac{1-\rho_a^*}{1+X(1-\upsilon s_u)^{\eta}}. \tag{64}$$

We have measures of ρ_a^* but a new parameter is now introduced, the elasticity of substitution across rural and urban non-agricultural goods, η. For any observed employment allocation (ρ_a, ρ_r, ρ_u), which gives a value for X, a higher η implies a higher ρ_u^* relative to the observed one (given $1 > \upsilon s_u > 0$). This is intuitive. The subsidies act as barriers to urbanization and when the rural sector produces closer substitutes to urban goods the gap between the

[17] We note that the corresponding subsistence values of agricultural consumption in 1998 obtained from these base year values are 0.75, 0.84 and 0.94. In 1998 the agricultural employment share was still 45 percent and only about 25 percent of the population were holding urban *hukou*, so the high computed values of subsistence consumption are plausible.

optimal urban allocation ρ_u^* and the observed ρ_u (which is always less than ρ_u^* when $s_u > 0$) grows as more workers remain in rural non-agricultural employment. We report results for $\eta = 1, 2$ and 5.

We derived results both for $s_u = 0$ and for the full policy model with the computed value of s_u to shed light on the relative importance of each distortionary policy. Figure 2 plots the difference between the actual agricultural employment share ρ_a and the first-best ρ_a^*, with $s_u = 0$, when the land policy is the only distortion, and $s_u > 0$, when both the land policy and the social transfers distort the allocation. Our results show that the distortions in the allocation of employment to agriculture and non-agriculture (industrialization) are substantial, and they get worse as consumption moves away from subsistence levels and substitution possibilities between agricultural and non-agricultural goods increase. For the full model, at the mid-point $\bar{c}_a/y_a = 0.5$, overemployment in agriculture in 2013 was calculated to be 6.7 percentage points (so instead of the observed share of 20.9%, optimality required 14.2%). For the much lower subsistence value of 0.2 the distortion is 8.6% points and for the much higher 0.8 it is 3.3%. It is important to note that almost all distortion on industrialization is due to the land policy (see also Table 1 for summary results for 2013).

Turning now to the impact of *hukou* on urbanization, Figure 3 shows the difference between the actual urban employment share ρ_u and the first-best ρ_u^*, as in Figure 2 both when only the land policy distorts allocations and when social transfers operate as well. Our results show that the distortions in labor allocations across the rural and urban areas are important, and again they get worse as consumption moves away from subsistence levels. For the full model and at the mid-points $\bar{c}_a/y_a = 0.5$ and elasticity of substitution $\eta = 2$, underemployment in urban areas in 2013 was calculated to be 6.3 percentage points (so instead of the observed share of 49.7% optimality required 56%). These results are sensitive both to the subsistence consumption level and the elasticity of substitution between urban and rural goods. For example, at the same $\eta = 2$ and $\bar{c}_a/y_a = 0.2$, underemployment in urban areas is 7.6 percentage points whereas at $\bar{c}_a/y_a = 0.8$ it falls to 4.2 points. Figure 3 shows the dependence of urbanization on the elasticity of substitution between urban and rural non-agricultural goods at the midpoint $\bar{c}_a/y_a = 0.5$, which rises from 5.3 to 9.4 percentage points as η rises from 1 to 5. The distortion due to land policy is still dominating in these calculations but social subsidies play an important role here as well. The main contribution of social subsidies is to generate more employment in the rural non-agricultural sector, which slows down the process of urbanization. But as we show in Table 1, the additional employment generated in rural non-agricultural sectors by the social subsidies are approximately of the same magnitude as the negative

impact of the land policy.

8 Conclusion

We have shown that the two main components of the *hukou* household registration system, the allocation of land cultivation rights and entitlement to social subsidies, lead to overemployment in agriculture and underemployment in the urban non-agricultural sector, whereas the rural non-agricultural sector is subject to a negative influence from the land policy and positive from the subsidization policy, which offset each other. A reform that allocates property rights to farmers, such that they can lease their land and collect rents, gets rid of the distortions in agriculture. Extending full entitlement to social subsidies to migrants (the "floating workers") corrects the distortions due to the discrimination in the social transfer policies.

We find that land policy and the absence of property rights for farmers are the main channels through which the *hukou* system distorts both urbanization and industrialization. The social subsidies are too small by comparison, and although they have an impact on urbanization and the growth of rural enterprises, their impact on industrialization is much less. This is an important finding in light of the literature that highlights the role of *hukou* in restricting the access of migrants to the social services received by urban *hukou* holders. Such restrictions may have important social consequences but their distortionary effects on migration flows are not large. Our results are derived from a model that has strong qualitative implications and quantitative calculations that depend on a small number of parameters. We derived them independently of productivity parameters, which would be notoriously difficult to measure.

Generalizing from our findings, we could argue that the excess labor in agriculture (combined with the absence of tenure security, which we did not model) reduces the incentives to mechanise agriculture, which is a current problem in China (World Bank, 2014). This is an additional reason for the failure of China to close more of the income gap with richer countries that was highlighted in the paper on the dual economy cited in our Introduction. Extensions of our work should introduce endogenous technology adoption and derive the quantitative impact of our results on mechanization and productivity growth.

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9 Appendix

9.1 Data

The employment shares (ρ_a, ρ_r, ρ_u) are from Brandt and Zhu (2010), which have been further extended to 2013. The nominal value-added of non-agriculture $(p_n y_n)$ is the sum of secondary and tertiary nominal value-added reported by the NBS. These data are available from 1978 to 2013.

The share of urban *hukou* υ is from Chan (2012), who compiled the number from *Chinese Statistical Yearbooks* and *China Population Statistical yearbooks*. It is available from 1970 to 2000 at five-year intervals, then annually from 2001 to 2010. The urban *hukou* population refers to the non-agricultural population (NAP) as defined by the *hukou*, administered by the Ministry of Public Security. Only those with local *hukou* in a particular administrative unit are included in this statistic. In other words, the number excludes those who live in the unit but lack local *hukou* registration, whether it is agricultural or non-agricultural *hukou*. We extend the series

to 2013 using the same data source of Chan (2012) – *the China Population and Employment Statistical Yearbook*.[18] We assume that the growth rate of urban *hukou* is uniform between 1995 and 2000 to obtain the urban *hukou* for the years 1998 and 1999.

The social spending data $(p_r\bar{c}_r, p_u\bar{c}_u)$ are constructed using a large number of official sources including *Educational Statistical Yearbook of China*, *China Health Statistical Yearbook*, Ministry of Finance (MOF) webpage, *Finance Yearbook of China*, *China Civil Affairs' Statistical Yearbook* and *China Statistical Yearbook*. We include all social service costs related to *hukou* (World Bank 2014, chapter 3) including education, health care services, pensions, and other social assistance programs (e.g., basic living subsidies). We collected detailed data of government spending for urban and rural areas respectively. These data are for 1998–2013. The main components are:

Education – This corresponds to the category "Government Appropriation for Education" from the *Educational Statistical Yearbook of China*. For the rural education we included only the spending for 9 years of compulsory education and we derived the urban education spending by subtracting the rural spending from the total government spending on education. We regard this as a proper method of measuring the education service in urban and rural areas given the large disparity between them.[19] Complete data for rural and urban areas are available for all years except for 2012, which we take as the average number of 2011 and 2013.

Health – The data are from the *China Health Statistical Yearbook*. The total government spending on health is available, which is the fiscal budget appropriation for health from governments at all levels.[20] However, we only have separate data for rural and urban areas on total health spending, which includes altogether the spending from the government, social entities and individuals. We therefore assume that the distribution of rural and urban spending is the same in total health spending and in government health

[18]The name of *China Population Statistical Yearbook* has been changed to *China Population and Employment Statistical Yearbook* since 2007.

[19]Using the 2005 1% Population Sampling Survey data, Zhang, Li and Xue (2015) show average years of schooling of various birth cohorts of the rural and urban labor force. They find that "for those aged 15–65 years old, the average years of schooling increased from 4 to nearly 8 for the rural labor force and from 7 to 12 for the urban labor force."

[20]See Zhao (2005): based on the economic purpose, government health expenditure can be classified into two categories: subsidy for provider and subsidy for consumer. Government subsidy for provider includes recurrent expenses on health, recurrent expenses on traditional medicine, recurrent expenses on family planning, expenses for food and drug administration, intra-budget capital investment, expenses for medical research and expenses for health administration; the subsidy for consumer mainly includes government appropriation for various insurance schemes and medical assistance scheme.

spending. We impute the government spending for rural and urban areas using the ratios of total health expenditures between these areas. The data are available for 1998–2013.

Pensions – For rural areas, this variable denotes the government subsidies on the New Rural Pension System (for rural residents) from the MOF webpage. The data start from 2010. We set the previous years' number to be zero because this system was officially implemented in October 2009.[21] For urban areas, it denotes the government subsidies on the Urban Enterprise Basic Pension Insurance (for workers with urban *hukou*) and Urban Residents Social Pension Insurance (for non-employed residents with urban *hukou*), from the *Finance yearbook of China* and *MOF Webpage*. For the Urban Enterprise Basic Pension Insurance, the data of government subsidies are available for 1998-2013. For the Urban Residents Social Pension Insurance, the data start from 2012. We set the previous years' number to be zero because the scheme was officially announced in June 2011.[22]

Other Urban Welfare – This is government spending on Unemployment Insurance, Work Injury Insurance and Maternity Insurance, which local urban *hukou* employees are eligible for. The data are extracted from the *Finance yearbook of China* and MOF webpage, and are available for 2007–2013. These numbers are very small compared to education and health so we set the levels to zero prior to 2007.

Basic Living Subsidies – This variable includes basic living standard subsidies for urban and rural areas, from the *China Civil Affairs' Statistical Yearbook*. The data are available for 1999–2013 and are in general very small, so we set the data of 1998 to zero.

Other Social Relief – This is other social relief spending for urban and rural areas from *China Statistical Yearbook*. The data are available for 2009–2013. We set the previous years' statistics to zero, given the fact that these numbers are very small compared to other social spending categories.

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9.2 Deriving social subsidies

We explain how we construct (s_r, s_u) using data on sectoral employment shares (ρ_a, ρ_r, ρ_u), nominal value-added for non-agriculture $p_n y_n$, share of urban *hukou* υ, and social spending $(p_r \bar{c}_r, p_u \bar{c}_u)$.

To derive (s_r, s_u) we need to divide the nominal value-added of non-agriculture into rural and urban non-agriculture. We explain below how we can do this by using the equilibrium condition **(51).** By definition, $p_n y_n = p_r y_r + p_u y_u$. Let $\theta_u \equiv p_u y_u / p_n y_n$ be the share of urban non-agriculture out of total non-agriculture. Using the equilibrium condition **(51)**:

$$(1 - \upsilon s_u) \frac{\theta_u}{\rho_u} = \frac{1 - \theta_u}{\rho_r}, \tag{65}$$

we derive,

$$\theta_u = \frac{\rho_u}{\rho_u + (1 - \upsilon s_u) \rho_r}. \tag{66}$$

Using the definition of the transfers share:

$$s_u = \frac{p_u \bar{c}_u}{\theta_u p_n y_n} = \left(\frac{p_u \bar{c}_u}{p_n y_n} \right) \frac{\rho_u + (1 - \upsilon s_u) \rho_r}{\rho_r}, \tag{67}$$

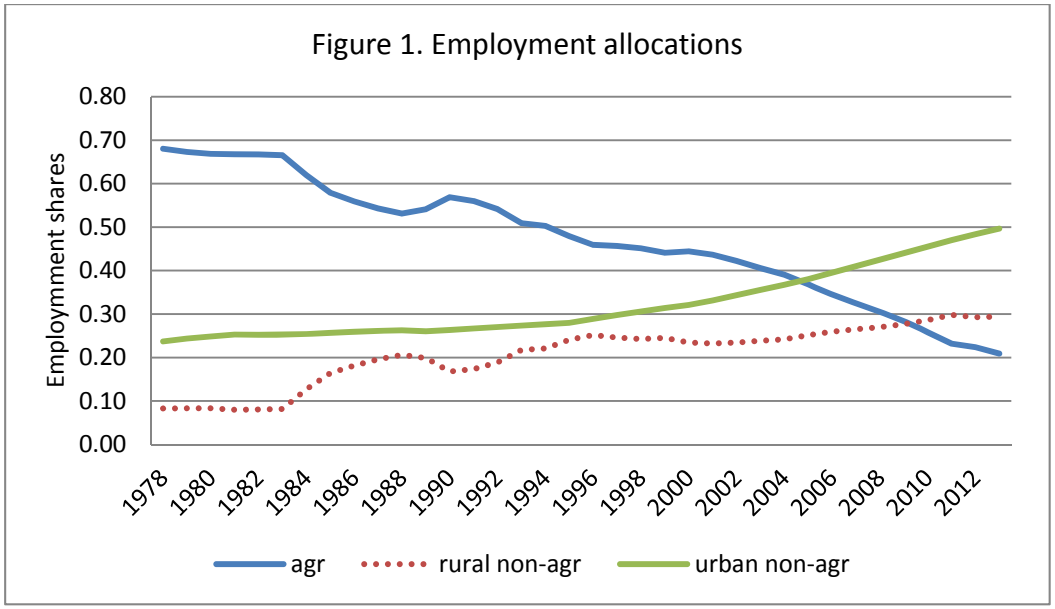
where the last equality follows from substituting (66). It follows that

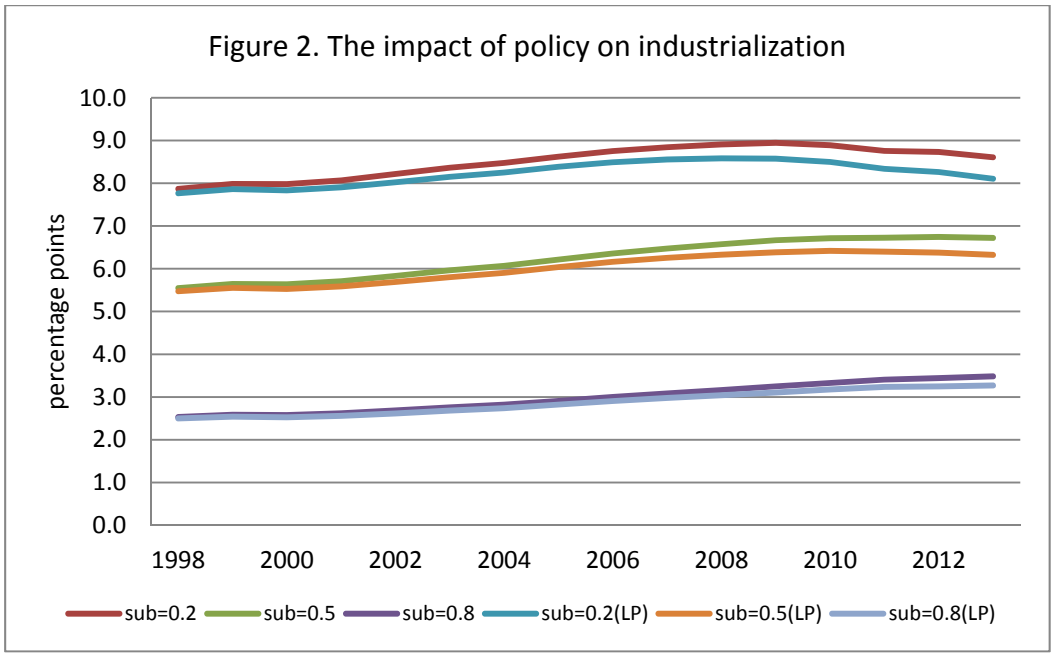
$$s_u = \frac{\varepsilon_u (\rho_u / \rho_r + 1)}{1 + \varepsilon_u \upsilon}, \tag{68}$$

where $\varepsilon_u \equiv \frac{p_u \bar{c}_u}{p_n y_n}$ can be directly measured in the data. Given the value of s_u, the value of s_r is obtained from its definition

$$s_r = \frac{p_r \bar{c}_r}{(1 - \theta_u) p_n y_n} = \frac{p_r \bar{c}_r}{p_n y_n} \left(\frac{\rho_u / \rho_r + 1 - \upsilon s_u}{1 - \upsilon s_u} \right). \tag{69}$$

The computed time series for (s_r, s_u) for 1998-2013 and the data on urban *hukou* υ are reported in Table 2.





Note: "sub" denotes the ratio of $\bar{c}_a/y_a$ in 2013. The bracket (LP) refers to the model's prediction when only land policy is in place, i.e. when subsidies are zero.

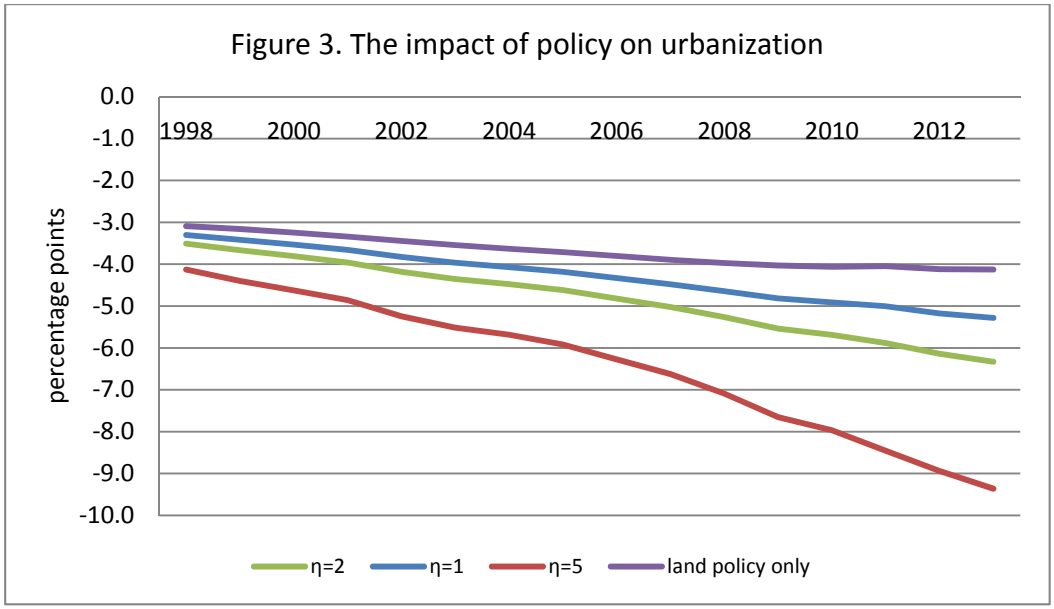


Table 1. Policy impacts on employment allocation in 2013

	agriculture	Rural nonagriculture	Urban nonagriculture
Optimal allocations (% of total)	14.2	29.8	56.0
Land policy distortion (percentage points)	+6.3	-2.2	-4.1
Full policy distortion (percentage points)	+6.7	-0.4	-6.3

Table 2. Policy parameters

year	urban hukou (as % of total)	urban subsidy (as % of urban value-added)	rural subsidy (as % of rural value-added)
1998	24.6	5.6	3.0
1999	25.0	6.5	3.0
2000	25.5	7.2	3.0
2001	26.0	7.7	3.3
2002	27.2	8.5	3.4
2003	29.0	8.6	3.3
2004	30.1	8.4	3.4
2005	31.3	8.4	3.3
2006	32.0	8.9	3.3
2007	32.6	9.4	3.9
2008	33.1	10.3	4.3
2009	33.7	11.4	5.1
2010	34.3	11.8	5.1
2011	34.9	12.6	5.7
2012	35.4	13.6	6.2
2013	36.1	14.4	6.6