

# COMMUNAL LAND AND AGRICULTURAL PRODUCTIVITY

CHARLES GOTTLIEB AND JAN GROBOVŠEK

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ABSTRACT. This paper quantifies the aggregate impact of communal land tenure arrangements such as those that predominate in Sub-Saharan Africa. For this we use a general equilibrium selection model featuring agents that are heterogeneous in agricultural and non-agricultural skills. A fraction of aggregate land is communal and there are policy rules governing its expropriation and redistribution. These create operational frictions by subjecting rented-out communal land to the risk of expropriation. They also create occupational frictions as agricultural employment lowers the risk of expropriation as well as raises the prospect of communal land accumulation. The quantification of the model is based on policies deduced from Ethiopia. It reveals that communal land decreases productivity in agriculture relative to non-agriculture roughly by 20% in nominal and 10% in real terms. Employment and GDP, however, are not substantially affected. That serves as a reminder that ostensibly highly distortionary policies need not have substantial bite when individuals strategically adjust to them.

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UNIVERSITY OF CAMBRIDGE  
UNIVERSITY OF EDINBURGH

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## 1. INTRODUCTION

One of the most salient and puzzling features distinguishing poor from rich economies is their low labor productivity in agriculture relative to non-agriculture. The cross-country gap in the relative agricultural productivity difference (APD) is large both in *real* as well as in *nominal* terms.<sup>1</sup> The real APD between the richest and poorest deciles of countries is estimated to be roughly a factor of ten. These findings, as in Caselli (2005) and Restuccia, Yang and Zhu (2008), rely on an older dataset that may admittedly be out of date.<sup>2</sup> However, more recent calculations of real labor productivity in the most relevant staple crop sectors by Gollin, Lagakos and Waugh (2014a) confirm the possibility of a startlingly large real APD gap. As for the more easily computable nominal APD gap, Gollin, Lagakos and Waugh (2014b) show that even after a series of adjustments (hours worked and human capital) there remains roughly a factor of two between the richest and the poorest quartiles of countries.

Two questions come to mind. First, is the APD gap a phenomenon induced by policies in poor countries? Standard models hint at the likely properties of such policies: misallocation within the agricultural sector to lower real productivity, incentives towards over-employment in farming to lower nominal productivity. Second, do such policies have real welfare consequences or is the APD gap just a statistical red herring? Given that poor countries are populated mainly by farmers, mechanical cross-sectoral reallocation of labor evokes low-hanging fruits.<sup>3</sup> But that may well be a mirage brought about by distorted prices and selection.

This paper evaluates one policy institution that at face value has serious potential to contribute to the APD gap, the institution of communal land tenure. Communal land is a regular occurrence in the developing world, and in particular in Sub-Saharan Africa. There, land ownership is usually either prescribed by customary law or the law does not recognize private ownership at all. Such systems cover roughly three-quarters of land in Sub-Saharan Africa.<sup>4</sup> We focus on the following characteristics of communal land that are regularly observed in Sub-Saharan Africa. Ownership bestows user rights to a particular individual while its ultimate control is vested in the community or the state. Individuals “owning” such land have pretty much exclusive user rights, an important distinction from pure common land.<sup>5</sup> Those rights, however, are periodically and contingently reviewed. Crucially, expropriation and redistribution may hinge on the individual’s actions, and severe obstacles to market transfers may limit acquisition to grants or inheritance. As we will see shortly, that cocktail entails distortions of agricultural land allocation across operators and encourages individuals to become farmers.

The contribution of this paper is to quantify the distortions created by communal land policies via an equilibrium model. Our framework is an off-the-shelf selection model where agents of heterogeneous skills make an occupational choice between agriculture and non-agriculture. Workers in non-agriculture are employees while in agriculture each of them runs her own farm. The only endogenous farm input is land, which comes in two types. Private land is secure and can be traded without frictions. Communal land, meanwhile, is acquired in the form of a transfer of exclusive user rights over one period. The right

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<sup>1</sup>Physical output per labor is referred to as real while value-added per labor is referred to as nominal

<sup>2</sup>One stringent requirement for real sectoral comparisons is the availability of data on agricultural producer prices as well as intermediate input prices across countries. This limits the comparison to data collected by the FAO around 1985.

<sup>3</sup>See for instance Vollrath (2009) and McMillan and Rodrik (2011).

<sup>4</sup>See for instance Holden, Otsuka and Place (2009b).

<sup>5</sup>In Africa, pastureland frequently falls under the latter category. Our framework is ill-suited to analyze the additional classical incentive issues raised by common land.

is automatically renewed unless expropriation occurs. We focus on the following regimes governing expropriation and eligibility for communal land transfers. (1) Communal land sales are prohibited and the risk of expropriation rises in the fraction of such land that is rented *out*. (2) Only current farmers are eligible to a transfer of communal land, and the probability of receiving a transfer is decreasing in the amount of existing holdings. These central assumptions are, amongst others, grounded in evidence from our data collection in Ethiopia and Uganda. Finally, note that the model is dynamic and stochastic, for three reasons. First, we capture the fact that the process of communal land accumulation is uncertain. Second, any comparison across equilibria requires a stationary distribution that is independent of the initial allocation of communal land. Third, allowing individual skills to vary over time is at the heart of measuring the potential misalignment between individual productivities and the distribution of communal land.

The model reveals two types of misallocation. First, occupational distortions occur as individuals choose agricultural activities in order to shield current holdings from expropriation and to raise the probability of obtaining additional transfers. Second, operational distortions are driven by individuals who own more communal holdings than they optimally wish to operate - thus, they limit the amount of land that they rent out. Because communal land acts as a magnet into agriculture labor income ceases to be the only concern in the occupational choice. That lowers nominal productivity in agriculture. Moreover, operational distortions as well as the influx of unskilled farmers act to depress real labor productivity.

We go on to quantify the model. A frictionless environment with no communal land serves to match cross-sectional sectoral income distributions for the U.S., as in Lagakos and Waugh (2013). In a second step we lower TFP and land endowment to match a representative Sub-Saharan economy before targeting a specific communal land regime. Our target choice is Ethiopia, a country where customary tenure regimes are institutionally formalized. The land distribution is highly egalitarian and tenants hold *de facto* permanent and inheritable user rights. All land, however, belongs formally to the state. Sales of land are illegal and rental arrangements are highly circumscribed and typically bounded by 50% of holding size. Many tenants have acquired official certificates of their user rights, but perceived land tenure remains insecure.<sup>6</sup> Major land redistributions have recurred as recently as the 1990s. In general, there is a sense that continued enjoyment of land rights is contingent on physical residence in the village.<sup>7</sup>

With policy parameters in hand we then compare the frictionless economy with one featuring communal land. Two economies are studied separately, a rich economy with few farmers as the U.S. and a poor one with an agricultural employment level of Sub-Saharan Africa. We find that when communal land is raised to three-quarters, the real APD opens by some 25% in the rich economy, but only by roughly 4% in the poor economy. As for the nominal APD, it opens by about 35% in the rich economy, and by around 15% in the poor one. These results indicate quite substantial action on the nominal gap, but surprisingly little movement on the real one. That is not surprising given the small increase in agricultural employment, up by 1 and 1.5 percentage points, respectively, in the rich and poor environment. As for GDP, it is practically not affected at all in the rich economy, and drops only by a modest 2% in the poor one.

It turns out that the forward-looking strategic behaviour and selection largely undo what *prima facie* appears to be a highly distortionary policy. Here, individual communal land holdings end up being sufficiently aligned with agricultural skills because talent changes slowly. It is the good farmers that, on average, end up detaining the land. True,

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<sup>6</sup>See e.g. Deininger, Ali, Holden and Zevenbergen (2008) and Holden, Deininger and Ghebru (2009a).

<sup>7</sup>See e.g. Rahmato (2003).

many of the least-skilled agents are potentially eager to switch into farming where assets may be obtained for free, but the equilibrium decline of the price of agricultural goods shuts down the attractiveness of that sector. Our sensitivity analysis reveals that the results are very robust to individual parameter variations. One policy parameter that does matter, however, is the elasticity of expropriation to the fraction of rented-out communal land. The benchmark parameter is such that the expropriation risk is almost nil as long as the landlord remains in farming. When that risk is increased for farmers as well, the rental market for land shuts down, causing more serious operational missallocation, more agricultural employment and a higher real APD gap. Even that, however, requires an extreme fraction of aggregate communal land. The conclusion is that communal land regimes - via occupational and operational misallocation - produce a perceptible drop in the nominal APD (on average about 20%) and a more modest fall in the real one (about 10%). Welfare and employment effects, however, remain largely muted.

This paper follows in the footsteps of a growing macroeconomic literature explaining the agricultural productivity gap via allocation of heterogeneous skills. An important contribution is Adamopoulos and Restuccia (2014b) who model heterogeneity in farmer skills to predict output losses associated with generic tax wedges. The results imply potentially large losses through misallocation. More recently, Restuccia and Santaella-Llopis (2015) uncover significant dispersion in farmer skills based on household data from Malawi. These data confirm the existence of potentially large operational wedges that may well be related to a lack of a functioning land market.<sup>8</sup> The model in the present paper is borrowed from Lagakos and Waugh (2013) in that individuals have distinct but correlated skills across the agricultural and non-agricultural sector.<sup>9</sup> Their message is that the real - though not nominal - relative APD gap may arise naturally via differences in aggregate TFP that causes variations in average sorting across sectors.<sup>10</sup> Ours is a complementary story that superimposes policy distortions on top of potential TFP differences.

One highly related paper is Chen (2014). He also investigates how non-transferable land holdings affect agricultural productivity in a world of heterogeneous skills across two sectors. The paper is complementary to ours in many respects, especially as it investigates an agricultural production function with different properties that allows to target the farms size distribution. Our paper, meanwhile, is more general in the flexibility of the institutional environment that includes amongst others the possibility of renting out insecure land, albeit at a risk. We are also the first to investigate agricultural productivity through the lens of a truly dynamic environment featuring an endogenous distribution. Having agents take forward-looking decisions is not merely a token to realism, but rather spells out how distortionary policies lose bite due to strategic equilibrium adjustments. This sets us apart from another paper that is similar in spirit, Adamopoulos and Restuccia (2014a). They provide a precise case study of misallocation due to a sudden land reform and farm size caps in the Philippines. Their model allows for a quantification of a one-off event that is highly detailed. Their underlying institutional arrangement, however, is very distinct. We study a process of slow but continuous land redistribution where agents take actions to fend off the threat of expropriation, and where the ultimate distribution of communal land ownership evolves endogenously.

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<sup>8</sup>At the aggregate level, Gollin, Parente and Rogerson (2004) explain the nominal APD gap by distortions that encourage home work in the rural sector, while Gollin and Rogerson (2014) attribute a fraction of it to high transportation costs. Restuccia et al. (2008) study the real APD gap through barriers to intermediate input use in agriculture.

<sup>9</sup>Additional evidence on selection across sectors in developing countries is provided by Young (2013).

<sup>10</sup>Donovan (2014) also explains real agricultural productivity via differences in TFP in conjunction with incomplete financial markets. He exploits the notion that risky productive investment departs strongly from the first-best when farmers are close to subsistence consumption.

We also touch base with a sizeable microeconomic literature on tenure insecurity and agricultural productivity. A limited number of these papers focus on misallocation across users. The contributions in Holden et al. (2009b) for example provide indirect evidence that land sale and rental markets (which presumably depend positively on land security) produce allocative gains, in several Sub-Saharan African countries. A study on the Dominican Republic by Macours, de Janvry and Sadoulet (2010) finds that insecure land rights prompt owners to limit land rentals to close kin, thus preventing allocation to more efficient users. In the case of Mexico, Macours, de Janvry and Sadoulet (2012) document that formal land titling enabled a market-based reallocation (through sales and rentals) to more productive land-poor from less productive land-rich farmers, and a stronger out-migration of the latter. These papers misallocation in a *partial* setting while our paper stresses equilibrium adjustments.

One crucial aspect that the present paper ignores are productive investment incentives in the face of tenure insecurity. This is beyond the present paper, but we do note that our framework is well-suited for such an extension. Suffice it to say that the empirical literature on the effect of tenure insecurity on investment in the African context has been very active, identifying several pathways. First, investment can increase as the likelihood of recouping its returns is higher, as shown by Besley (1995) and Goldstein and Udry (2008) in studies on Ghana, by Ali, Dercon and Gautam (2011) in Ethiopia, and by Fenske (2011) in several countries in West Africa. Second, land investment may also decrease as individuals with weak titles feel more compelled to secure their user rights via intensive outlays - see for instance Sjaastad and Bromley (1997), Place and Otsuka (2002), and Deininger and Jin (2006). Third, securing land rights may raise collateral to be used for credit and investment.<sup>11</sup> In Africa, however, such an effect has hardly been identified so far.<sup>12</sup>

The organization of the paper is as follows. The next section presents the model environment. Section 3 describes the model's equilibrium characteristics. In Section 4 we discuss the calibration strategy. Section 5 lays out the empirical results, while Section 6 tests the model's predictions under distinct parameter values. Section 7 concludes.

## 2. A MODEL OF COMMUNAL LAND

### 2.1. *The Economy*

The economy is populated by a unit measure of infinitely lived individuals. These maximize present expected discounted utility with a period utility that is linear in expenditure  $b$ . Time is discrete and discounted at the factor  $\beta \in (0, 1)$ . The individual's state space, denoted by  $x$ , includes the following elements: (i) his productive skill in the agricultural sector,  $z_a > 0$ ; (ii) his productive skill in the non-agricultural sector,  $z_n > 0$ ; (iii) his endowment of communal land,  $l_c \geq 0$ ; and (iv) his savings  $s$ .<sup>13</sup> Individual skills are exogenous and drawn from a joint cumulative distribution,  $\{z_a, z_n\} \sim \Psi(z_a, z_n)$ . With probability  $\zeta \in [0, 1]$  the individual's entire skills set is re-drawn in the following period, and otherwise persists unchanged. The elements  $l_c$  and  $s$ , on the other hand, evolve endogenously.<sup>14</sup>

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<sup>11</sup>See Feder (1985) for a formal treatment. This idea has been popularized by De Soto (2000).

<sup>12</sup>Besley (2002), for instance, reject it in a study on Burkina Faso.

<sup>13</sup>Note that  $s$  is not bounded, i.e. individuals can go short.

<sup>14</sup>In fact, in the stationary equilibrium only  $l_c$  evolves, while  $s$  remains constant. We include it in the present exposition for reasons of consistency.



### 2.1.1. Occupational choice and production

In each time period the individual disposes of one unit of labor and opts for his current occupation, agriculture ( $\mathbb{1}_a = 1$ ) or non-agriculture ( $\mathbb{1}_a = 0$ ). In non-agriculture, there is a representative competitive firm that produces non-agricultural output  $Y_n$  according to  $Y_n = AE_n$  where  $E = \int [1 - \mathbb{1}_a(x)] z_n(x) dH(x)$  denotes efficiency units in non-agriculture, and  $A > 0$  is TFP. The non-agricultural wage in efficiency units is denoted by  $w_n$  while the price of the non-agricultural product is normalized to unity. With profit maximization an individual's non-agricultural labor income is hence  $w_n z_n$ .

In agriculture, by contrast, each of our agents runs his own farm. Its output  $y_a = y_a(z_a, l)$  depends on farming skills as well as the choice of land operations  $l \geq 0$ . Let

$$y_a = Az_a^{1-\gamma} l^\gamma.$$

The focus here is on land, which is why we abstract from variable labor inputs. Neglecting hired labor, at any rate, is not a first-order simplification as most farms as well as most of the farmland across the world (including developed countries) is operated by family farmers. We also abstract from capital and other inputs to single out the interplay between skills and land operations.<sup>15</sup> Land is rented-in at the rate  $r$ , and agricultural output is valued at  $p$  so that agricultural labor income is simply  $w_a = p_a y_a - ql$ . The choice of the agricultural production function yields that in absence of frictions the aggregate land shares is constant, and labor income is linear in skills.

Before the occupational choice the individual's budget constraint is

$$b + s' = \mathbb{1}_a [p_a A z_a^{1-\gamma} l^\gamma - ql] + (1 - \mathbb{1}_a) w_n z_n + (1 + i)s + ql_c.$$

Savings earn a return  $i$ . Moreover, the individual may potential earn income from renting out communal land holdings,  $l_c$ , to which we turn next.

### 2.1.2. Communal land

The economy's aggregate endowment of land is  $L$ . A fraction  $\lambda \in [0, 1]$  of it is communal,  $L_c = \lambda L$ , while the rest is strictly private,  $L_p = (1 - \lambda)L$ . Private land is detained by an aggregate savings fund and can be freely traded. Communal land, by way of contrast, is held individually ( $l_c$ ), requiring  $L_c = \int l_c(x) dH(x)$ . One central hypothesis is that within a given time period the individual has exclusive user rights over  $l_c$ , whether that be for the purpose of operating it or renting it out. However, the sale of an individual's  $l_c$  is not permitted. For example, in Ethiopia, the attempt to buy or sell land without the consent of the local authority is a crime punishable by imprisonment. In many customary land tenure regimes in Africa, land sales require the joint consent of close family members as well as notables such as village chiefs or clan leaders. Such consent is often difficult to obtain.<sup>16</sup>

We now turn to the description of the dynamics of individual communal land holdings. Individual communal land holdings evolve through public interventions via expropriation and redistribution. The basic properties of these policies are informed by evidence from the micro development literature on tenure systems in Sub-Saharan Africa. We also build on evidence from our own data collection in Ethiopia and Uganda - please refer to the Appendix for more details. The first component is expropriation. Expropriation is stochastic and occurs in the beginning of the following model period. When it occurs, it affects the entire current holding  $l_c$ . Individuals face no expropriation risk as long

<sup>15</sup>In the agricultural sector, the use of capital and intermediate inputs as well as their composition vary significantly between rich and poor countries.

<sup>16</sup>An alternative assumption is to permit land sales but make the expropriation of the *new* tenant a contingent function of the seller's future state. The market value of land may then coincide with its shadow price to the tenant in the current setting.

as they operate at least the equivalent of their entire communal holding,  $l \geq l_c$ .<sup>17</sup> When operations fall short of that level,  $l < l_c$ , the risk of expropriation is positive and increasing in the fraction of rented out communal land,  $(l - l_c)/l_c$ . The principle of “use it or lose it” applies - by renting out land that is not formally under her control, the individual increases the risk of losing it. For instance, land may become squatted. Or, the act of renting out land can well be taken as a signal that the individual does not need communal land, prompting the local authority to re-assign its ownership. Furthermore, we assume that the expropriation rate is highest in the case of zero operations,  $l = 0$ , which in our model coincides with the choice of non-agricultural employment. This is often synonymous with rural-urban migration. Anecdotal evidence from Uganda, for example, suggests that migrating individuals do not automatically lose their ownership of land under customary tenure. Rather

Formally, the expropriation hazard function is

$$m(l, l_c) = \begin{cases} \tau [(l_c - l)/l_c]^\mu & \text{if } l_c - l > 0; \\ 0 & \text{otherwise.} \end{cases}$$

The parameter  $\tau \in [0, 1]$  represents the highest possible rate of expropriation while  $\mu \geq 1$  governs the convexity of the function. Consider the properties of expropriation for two distinct individuals with holdings  $l_c$  and  $\tilde{l}_c = \xi l_c$  such that  $\xi > 1$ . For any given amount of rented-out communal land  $\Delta = l_c - l = \tilde{l}_c - \tilde{l} > 0$  the probability of expropriation is larger for individuals detaining smaller endowments as  $m(l, l_c)/m(\tilde{l}, \tilde{l}_c) = \xi^\mu > 1$ . Expropriation impacts the entire holding and so the individual with the larger land endowment has more to lose. It is then only natural to suppose that she at least faces a lower probability of expropriation. In general, the expropriation hazard is convex in both the absolute amount of rented out land ( $\Delta > 0$ ) as well as its fraction ( $\Delta/l_c$ ). The parameter  $\mu$  spans extreme cases. For  $\mu \rightarrow \infty$  expropriation can only ever occur following non-agricultural employment,  $l = 0$ . For  $\mu = 1$ , meanwhile, each unit of rented-out land is subject to the same risk. Technically,  $\mu > 1$  ensures that strictly positive land operations will be bounded away from the corner  $l_c$ .

If there is expropriation, there must be redistribution for the communal land market to “clear” - the second component of our story. We assume that it occurs stochastically in the following period via lump-sum transfers  $v$ . This is a suitable assumption because land reallocation in practice has a random component. One reason why this may be so is that some individuals receive a better ex post treatment by the local authorities than others. We also postulate that only current farmers ( $\mathbb{1}_a = 1$ ) are eligible for it. Moreover, we entertain the assumption that it is progressive in the sense that the probability of further transfers depends negatively on the amount of current communal holdings. These choices are guided by empirical evidence from our dataset. As Table (??) suggests, most households (40.9%) emphasize that communal land allocation occurs primarily to households with little land. Secondly, around a third of the respondents suggests that communal land allocation is completely random. Only some 20% of respondents believe that communal land allocation follows a productive criterion (farmer output or farmer skill).

Formally, the redistribution function is defined as

$$g(l_c, v) = \begin{cases} \phi \left[ 1 - \left( \frac{l_c/v}{1+l_c/v} \right)^\epsilon \right] & \text{if } \mathbb{1}_a = 1; \\ 0 & \text{otherwise.} \end{cases}$$

The parameter  $\phi \in (0, 1]$  represents the highest possible probability of transfer receipt at zero current holdings ( $l_c = 0$ ). The degree of progressivity of the transfer function,

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<sup>17</sup>We assume that agents use their holding  $l_c$  before renting-in any additional land.

meanwhile, is governed by  $\epsilon \geq 0$ ; the lower it is, the lower is the likelihood of an additional transfer for any given strictly positive level of  $l_c > 0$ . Conversely, as  $\epsilon \rightarrow \infty$  the transfer policy becomes independent of current holdings. In the stationary equilibrium, lump-sum transfers are identical across periods. Equilibrium holdings of communal land can then be expressed on a discrete grid,  $l_c = nv$  where  $n \in \mathbb{N}$  is the individual's history of the number of accumulated transfers uninterrupted by expropriation.

### 2.1.3. Consumption

Consumption occurs at the level of the aggregate economy by means of a stand-in household. Individuals contribute their expenditure levels  $b$  to the household's budget who then decides consumption levels by solving  $\max_{C_a, C_n} U(C_a, C_n)$  subject to  $p_a C_a + C_n = \int b(x) dH(x)$ . Utility is given by

$$U(C_a, C_n) = \eta \log(C_a - \bar{C}_a) + (1 - \eta) \log C_n.$$

where  $\bar{C}_a > 0$  represent's the economy's subsistence requirement in agricultural consumption. It is the element that drives structural transformation in the present economy. The rationale for decoupling production from consumption decisions is that we do not want the curvature of the utility function to impact savings decisions through financial markets. In an alternative scenario we could presume that agents cannot perfectly insure against income shocks as in a standard Aiyagari-type economy. In that case the land rights regime would acquire a secondary purpose as an additional insurance vehicle to complete markets. While interesting in its own right, such an analysis is beyond the present paper.

### 2.1.4. Financial markets and capital

Finally, there exists an aggregate savings fund that holds private land  $L_p$ , valued at  $q$ . It rents out capital that yielding the rental rate  $r$ .

## 3. STATIONARY EQUILIBRIUM

### 3.1. Definition of the stationary equilibrium

Starting from an initial allocation of  $H_0(x)$  such that  $\int l_c(x) dH_0(x) = L_c$ , a stationary equilibrium is the set of individual decisions  $b(x)$ ,  $\mathbb{1}_a(x)$ ,  $l(x)$ ,  $y_a(x)$ ,  $w_a(x)$ ,  $s(x)$ ,  $\forall x$ ; implicit choices of  $m(x)$ ,  $g(x)$ , and  $l'_c(x)$ ,  $\forall x$ ; aggregate prices  $p$ ,  $r$ ,  $w_n$ ,  $q$ , and  $i$ ; aggregate allocations  $C_a$ ,  $C_n$ ,  $E$ ,  $Y_n$ , and  $Y_a$ ; a transfer value  $v$ ; allocations  $l_c(x)$ ,  $\forall x$ ; and a stationary distribution  $H(x)$ , such that:

- (i) all agents of type  $x$  solve their maximization problem;
- (ii) the representative non-agricultural firm maximizes profits;
- (iii) the aggregate household solves its maximization problem;
- (iv) the agricultural market clears:  $C_a = Y_a = \int y_a(x) dH(x)$ ;
- (v) the non-agricultural market clears:  $C_n = Y_n$ ;
- (vi) the aggregate land market clears:  $\int l(x) dH(x) = L$ ;
- (vii) the financial market clears:  $\int s(x) dH(x) = qL_p$ ;
- (viii) expropriated land is redistributed consistently so that  $\int l'_c(x) dH(x) = \lambda L$ ;
- (ix) the stationary distribution  $H(x)$  is consistent:

### 3.2. Aggregate outcomes

Let us assume that the stationary equilibrium is well-defined, i.e. the economy is sufficiently efficient to ensure  $Y_a > \bar{C}_a$ . The household's first order condition then pins down the agricultural price through  $p = [\eta/(1 - \eta)]Y_n/(Y_a - \bar{C}_a)$ . The Euler equation with respect to savings and the non-arbitrage condition on financial markets yield the standard equilibrium prices  $q = \beta/(1 - \beta)r$ , and  $i = (1 - \beta)/\beta$ . Financial markets lead



to  $s'(x) = s(x)$ ,  $\forall x$ . The remaining equilibrium objects are  $p$ ,  $r$ , and  $v$ , the endogenous bit of the distribution  $H(z_a, z_n, l_c)$ , as well as choices  $\mathbb{1}_a(x)$  and  $l(x)$ ,  $\forall x$ .

### 3.3. Characterization of individual choices

Let  $\tilde{V}(x)$  be the individual's value-function. With linear utility the state space is reduced to three elements, so an alternative formulation is  $V(z_a, z_n, l_c) = \tilde{V}(x) - s(x)/\beta$ . It takes the following recursive form:

$$\begin{aligned} V(z_a, z_n, l_c) = \max_{\mathbb{1}_a, l} & \left\{ \mathbb{1}_a w_a(z_a, l) + (1 - \mathbb{1}_a) A z_n + q l_c \right. \\ & + \beta \left( \mathbb{1}_a [1 - m(l_c, l)] g(l_c, v) \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c + v)] \right. \\ & + \mathbb{1}_a [1 - m(l_c, l)] [1 - g(l_c, v)] \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c)] \\ & + \mathbb{1}_a m(l_c, l) g(l_c, v) \mathbb{E}_{z'|z} [V(z'_a, z'_n, v)] \\ & + \mathbb{1}_a m(l_c, l) [1 - g(l_c, v)] \mathbb{E}_{z'|z} [V(z'_a, z'_n, 0)] \\ & + (1 - \mathbb{1}_a) (1 - \tau) \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c)] \\ & \left. \left. + (1 - \mathbb{1}_a) \tau \mathbb{E}_{z'|z} [V(z'_a, z'_n, 0)] \right) \right\} \end{aligned}$$

where  $\mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c)] = (1 - \zeta) V(z_a, z_n, l_c) + \zeta \int V(z'_a, z'_n, l_c) d\Psi(z'_a, z'_n)$  and  $w_a(z_a, l) = p_a y_a(z_a, l) - q l$ .

We are now ready to identify the sources of misallocation, both occupational and operational. Notice that the mere existence of communal land ( $\lambda > 0$ ) is not sufficient to create distortions. These can only arise through strategic actions when there is risk of expropriation or the possibility of transfer acquisition ( $v > 0$ ) which is itself conditional on expropriation in equilibrium. Both of them require that  $\tau > 0$ . In the absence of expropriation, farmers would optimally choose land operations  $\hat{l} = (\gamma p A / r)^{1/(1-\gamma)} z_a$  with the corresponding labor income  $\hat{w}_a = (1 - \gamma) / \gamma [\gamma p A / r]^{1/(1-\gamma)} r z_a$ . That is the optimal choice in the presence of expropriation as well, conditional on not detaining too much communal land,  $\hat{l} \geq l_c$ . After all, mind that farmers choosing  $l < l_c$  would both lower their labor income *and* raise the expropriation probability. Two thresholds are then of interest. The first is the point at which agricultural labor income with undistorted land operations equals non-agricultural labor income,  $\hat{w}_a = A z_n$ , or  $z_a = [r / (\gamma p A)]^{1/(1-\gamma)} \gamma / [(1-\gamma)r] A z_n \equiv B^*(z_n; p, r)$ . The second threshold is the one where optimal land operations exactly equal communal land holdings,  $\hat{l} = l_c$ , or  $z_a = [r / (\gamma p A)]^{1/(1-\gamma)} l_c \equiv B^\dagger(l_c; p, r)$ .

#### 3.3.1. Occupational choice with undistorted land operations

Let us first consider individuals such that  $z_a \geq B^\dagger$ , i.e. those who choose undistorted land operations conditional on agricultural employment. These are guys who rent-in as farmers - they detain little communal land relative to their farming skills. Such agents opt for agriculture if and only if

$$\begin{aligned} \hat{w}_a + \beta \left\{ \tau \left( \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c) - V(z'_a, z'_n, 0)] \right) \right. \\ \left. + g(l_c, v) \left( \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c + v) - V(z'_a, z'_n, l_c)] \right) \right\} \geq A z_n. \end{aligned} \quad (1)$$

As long as  $\hat{w}_a \geq A z_n$ , i.e.  $z_a \geq B^*$ , individuals choose agriculture independently of any strategic consideration. Thus, types  $z_a \geq \max\{B^*, B^\dagger\}$  *efficiently* opt for the agricultural occupation. Suppose now that  $z_a < B^*$ . From (1) we see that there are two forces that could convince such an agent to prefer the recreation in the field to the glitz of the city. The first is the risk of expropriation. The higher is his communal holding  $l_c$ , the more

he risks losing by choosing non-agriculture. The second is the promise of additional land transfers in the future. The higher is the transfer probability  $g(\cdot)$ , the more appealing is the agricultural activity. It is worth mentioning that as long as  $\mathbb{E}[V(\cdot)]$  is concave in  $l_c$  that second rationale declines in communal holdings, both because a future transfer become increasingly unlikely and because its added value diminishes. What we can retain is that there exists a threshold  $\bar{B}(z_n, l_c; p, r, v)$  such that individuals  $\max\{\bar{B}, B^\dagger\} \leq z_a < B^*$  suboptimally choose agricultural employment. Compared to the undistorted equilibrium, they put downward pressure on the agricultural price  $p$ . They also exert upward pressure on the rental rate  $r$  by limiting the supply of rented land ( $l_c$ ) as well as by generating additional demand for it ( $l - l_c$ ). They do not, however, feature distorted land operations.

### 3.3.2. Occupational choice with distorted land operations

On the other end of the spectrum, consider types  $z_a < B^\dagger$ , individuals characterized by detaining a lot of communal land relative to their farming skills. As farmers, these individuals prefer to rent out land. Agriculture is chosen if and only if

$$\begin{aligned} \tilde{w}_a + \beta \left\{ [\tau - m(l_c, \tilde{l})] \left( \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c) - V(z'_a, z'_n, 0)] \right) \right. \\ \left. + g(l_c, v) [1 - m(l_c, \tilde{l})] \left( \mathbb{E}_{z'|z} [V(z'_a, z'_n, l_c + v) - V(z'_a, z'_n, l_c)] \right) \right. \\ \left. + g(l_c, v) m(l_c, \tilde{l}) \left( \mathbb{E}_{z'|z} [V(z'_a, z'_n, v) - V(z'_a, z'_n, 0)] \right) \right\} \geq Az_n \end{aligned} \quad (2)$$

where  $\tilde{w}_a(\tilde{l}) < \hat{w}_a$  and  $\hat{l} < \tilde{l} < l_c$ .

These individuals can again be broken down into two types. There are the ones that could choose  $\hat{w}_a$  and for whom  $\hat{w}_a \geq Az_n$ , or alternatively  $z_a \geq B^*$ . Observe from (2) that for any choice  $l > 0$  such that these individuals prefer the agricultural activity. Yet they prefer to limit their amount of rented-out land so as to shield their communal land from expropriation. Agents of type  $B^* \leq z_a < B^\dagger$  therefore optimally position themselves into agriculture, but distort land operations. Compared to the undistorted equilibrium they apply downward pressure on the agricultural price  $p$  through overproduction and upward pressure on the rental rate  $r$  by limiting the supply of land on the rental market ( $\tilde{l} - \hat{l}$ ). Finally, we also have individuals of type  $z_a < B^*$ . Absent the policy they would opt out of farming. Here, they may choose otherwise. Thus there exists a threshold  $\bar{B}(z_n, l_c; p, r, v)$  such that types  $\bar{B} \leq z_a < \min\{B^*, B^\dagger\}$  inefficiently sort into agriculture *and* feature distorted land operations. They too exert downward pressure on  $p$  and raise  $r$  by limiting the supply of land on the rental market ( $\tilde{l}$ ).

The difference between the thresholds (1) and (2) stems from the fact that renting out land while residing in the countryside opens the room for expropriation. When  $\mu \rightarrow \infty$  we have that  $m(l_c, \tilde{l} | \tilde{l} > 0) \rightarrow 0$ ,  $\tilde{l} \rightarrow \hat{l}$ , and (2) collapses to (1). In that case there exist no operational distortions, only occupational ones.

### 3.4. General equilibrium forces

Compared to the first-best, the distorted equilibrium pushes towards higher land rentals which may well discourage some potential farmers from entering agriculture. These are the ones with little communal land and a relatively high outside option in non-agriculture. To the extent that agricultural and non-agricultural may be strongly correlated, such agents may well be good potential farmers. It is therefore not obvious whether in the aggregate we end up with relatively high or low agricultural output, i.e. whether the price of the agricultural good is likely to be lower or higher than in the first-best. We can loosely juxtapose two potential scenarios to describe the effect of introducing the policy of communal land redistribution into the first-best.

In the first scenario the additional individuals entering agriculture are relatively good farmers. Operational distortions are low, either because communal land is held predominantly by relatively good farmers or because the rental market of communal land remains sufficiently active. The economy features overproduction of agricultural output so that its price  $p$  drops steeply. This prevents a large number of additional entrants into agriculture and the aggregate effect on occupation is limited. The other scenario is one where the influx of farmers creates large distortions in land operations. Agricultural production therefore does not rise much in relative terms, and may even fall. As a result, the agricultural price  $p$  does not drop strongly or may even increase. Lacking a strong countervailing general equilibrium force, the economy exhibits a large influx of farmers.

#### 4. PARAMETRIZATION

We propose the following calibration strategy. As a first step, we determine the parameters governing the skill distributions, technology and intratemporal preferences by matching empirical outcomes from the U.S., an environment that features no communal land ( $\lambda = 0$ ). Targeting an environment that is relatively frictionless as opposed to, say, economies in Sub-Saharan Africa, allows to net-out other prevalent sources of distortions and market failures, such as financial, product or labor market frictions. In the second step of our calibration, we investigate the effect of introducing communal land policies. Since the space of potential policies is large, we calibrate our policy parameters to match features from the land holdings distribution in Ethiopia. Subsequently, we conduct a sensitivity analysis. This calibration strategy allows us to isolate the effects of communal land tenure arrangements on allocations in a fairly general environment.

##### 4.1. Skill distribution, technology, and preferences over goods

The level of TFP ( $A$ ) and the total endowment of land ( $L$ ) are normalized to unity. For the distribution of sectoral skills we follow Lagakos and Waugh (2013) by assuming that  $\Psi(z_a, z_n) = C[\Psi_a(z_a), \Psi_n(z_n)]$  is a Frank copula of the individual Fréchet distributions  $\Psi_a(z_a) = \exp(-z_a^{-\psi_a})$  and  $\Psi_n(z_n) = \exp(-z_n^{-\psi_n})$ . The parameter  $\rho \in (-\infty, \infty) \setminus \{0\}$  governs the interdependence of the draws, with possibilities ranging from complete negative interdependence ( $-\infty$ ) via independence (0) to complete positive interdependence ( $\infty$ ). Because our benchmark model almost exactly matches that of Lagakos and Waugh (2013) we can run with their calibrated parameters ( $\psi_a = 5.3$ ,  $\psi_n = 2.7$ , and  $\rho = 3.5$ ) to hit the proposed equilibrium outcomes. These are the cross-sectional variance in the persistent component of agricultural and non-agricultural labor income in logs (0.144 and 0.224, respectively) as well as the aggregate ratio of average agricultural to non-agricultural labor income (0.701).<sup>18</sup>

The parameter  $\gamma$  is set to  $1/3$ , translating into an aggregate land income share of one-third in the agricultural sector. This is somewhat higher than the value found in Valentinyi and Herrendorf (2008) where income accruing to land is a fraction  $0.18/(0.18 + 0.64) = 0.28$  of the combined labor and land shares. In that paper the relatively low value of the land share results from the imputation of the indirect contribution of land via intermediate inputs that mostly derive from the non-agricultural sector where land is negligible. Because labor income here is defined at the industry level and because we abstract from intermediate inputs we prefer to use a direct decomposition of value-added in agriculture between land and labor. Historically, sharecropping arrangements have

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<sup>18</sup>Abstracting from capital, our model is identical to that of the extended version of Lagakos and Waugh (2013) in Section 5.

assigned by rule-of-thumb a value of between  $1/3$  and  $1/2$  to landowners as reported e.g. in Mundlak (2005) so we settle for the more conservative lower bound.

The preference parameter  $\eta$  is fixed at 0.01. We then set the subsistence requirement  $\bar{C}_a$  to 0.03 to match an agricultural employment rate of 2 percent. The resulting outcome suggests that subsistence represents 27 percent of U.S. agricultural consumption. This is reasonable to the extent that the lowest average energy intake in countries such as Eritrea or Congo is about 42 percent of the U.S. value.<sup>19</sup>

#### 4.2. Policy and intertemporal parameters

To compute the benchmark policy parameters we first modify the endowments so as to generate an environment reminiscent of Sub-Saharan Africa. We lower the land endowment to  $L' = 1/3$  as this corresponds exactly to the endowment of arable land per capita of Ethiopia relative to the U.S. It also matches pretty well the endowment of arable land per capita of the World Bank's Least Developed economies relative to the U.S., which stands at 0.37.<sup>20</sup> Second, we lower aggregate TFP to  $A' = 1/19$ . In the absence of communal land this generates an agricultural employment share of 0.642 and GDP per capita of 0.037 relative to the benchmark economy.<sup>21</sup> Empirically, the agricultural employment share in Sub-Saharan Africa corresponds to 0.568 while GDP per capita is 0.045 relative to the U.S.<sup>22</sup> The choice of TFP cannot hit both targets simultaneously so we content ourselves with a convex combination of the two.

In the absence of communal land the calibration is independent of any intertemporal choices. To match policies, let the time unit be a year. We first fix  $\beta = 0.96$ , a standard time discount factor used in frictionless environments to generate an interest rate of 4 percent. Second, we set the hazard rate  $\zeta$  to 0.025, which implies that the entire set of individual-specific skills changes on average once in 40 years or roughly once in a generation. Such a choice is halfway between recognizing the respective likelihood that within-generational autocorrelation is not perfectly positive while cross-generational one is, albeit weakly. Because  $\zeta$  is a non-trivial parameter we will also perform sensitivity checks on it.

The policy parameter with the clearest interpretation is  $\tau$ , i.e. the (maximal) expropriation rate of farmland conditional on choosing non-agricultural employment. We parametrize  $\tau$  to 0.5 based on the *Land Declarations of Ethiopia's Regions*. Not only do these declarations assert the criminal nature of land sales, they also set an upper limit of 50% of land holdings that households are permitted to rent out. When landholders move to the urban sector they either rent/sharecrop out land, lend it to a family members or informally delegate family members to manage their holding. If follow the rules, only 50% of their land will be rented out while the other half remains with family members who do not pay rent. Alternatively, they risk certain expropriation. In a nutshell, households that decide to urban areas in theory remain in control of their land. Yet the nature of the arrangements, whether formal or informal, introduce substantial uncertainty on the prospects of individuals regaining their land fully after a period of migration. Table (1) summarizes the calibration.

<sup>19</sup>Statistics available from FAO at [www.fao.org](http://www.fao.org).

<sup>20</sup>See <http://data.worldbank.org/indicator/AG.LND.ARBL.ZS>.

<sup>21</sup>We compare GDP across economies using the agricultural price  $p^B$  generated for the baseline U.S. economy, i.e.  $(p^B Y_a + Y_n)/(p^B Y_a^B + Y_n^B)$ . As is well known, international GDP comparisons are based on international prices that give disproportionate weight to rich economies, in particular the U.S.

<sup>22</sup>Due to missing data we compute the average agricultural employment share as an average over the period 2003-2012, which captures most of Sub-Saharan African countries. GDP per capita is taken from <http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD>.

We now turn to the calibration of our policy parameters to Ethiopia by using the LSMS-ISA dataset of 2011 as well as our own dataset of 2014. In Ethiopia private property of land is not recognized so we set  $\lambda = 1$  with a light conscience.<sup>23</sup> We jointly calibrate the policy parameters  $\epsilon$ ,  $\mu$ , and  $\phi$  by matching features of the distribution of land operations. Two moments of interest are the fraction of land that is rented out and the fraction of landless households. From the LSMS-ISA database the fraction of land that is rented-in is the ratio of the total rented land area in the sample relative to the total area of surveyed land, 17.7%.<sup>24</sup> The fraction of landless households corresponds to the share of households whose scale of operation equals the total amount of land rented-in. It amounts to 3.4%. This number is consistent with the evidence that in Sub-Saharan Africa very few rural households are landless, in contrast to developing countries in Asia or South America (CITATION). This fact is often quoted as a consequence of a communal tenure regime aiming for equity. The third moment, the equilibrium rate of expropriation, is computed based on our own dataset. We determine a lower and an upper bound for the expropriation rate based on interview questions that we then adjust to the periodicity of the model. The space that we obtain for the expropriation rate ranges from 0.25% to 0.845%. Based on this evidence, we fix the expropriation to 0.6% and later conduct sensitivity analyses.

The resulting parameters merit a comment. The probability of obtaining a land transfer,  $\phi = 0.211$ , implies that households need to remain on average farmers for 5 years before expecting to obtain land. That appears reasonable and can justify the low fraction of the landless population. The curvature parameter of the redistribution function,  $\epsilon = 0.024$ , is very low. It implies that the transfer probability drops steeply after the first transfer, which is consistent with the highly egalitarian land distribution in Ethiopia. Finally, the curvature parameter of the expropriation probability,  $\mu = 5.341$ , is very high. It implies that short of renting out all communal land, there is very little risk of expropriation. Again, this is reasonable as the rental market in Ethiopia is quite vibrant.

Parameter	Value	Target	Data
No communal land ( $\lambda = 0$ )			
Land endowment ( $L$ )	1	Normalization	-
TFP ( $A$ )	1	Normalization	-
Fréchet agriculture ( $\psi_a$ )	5.3	Variance log agr. income	0.144
Fréchet non-agriculture ( $\psi_n$ )	2.7	Variance log non-agr. income	0.224
Interdependence ( $\rho$ )	3.5	Labor income agr. vs. non-agr.	0.701
Subsistence ( $\bar{C}_a$ )	0.03	U.S. agr. empl. share	0.020
Preference agr. ( $\eta$ )	0.01	Avg. energy intake poorest vs. U.S.	0.420
No private land ( $\lambda = 1$ )			
Land endowment ( $L'$ )	1/3	Farmland/person poorest vs. U.S.	-
TFP ( $A'$ )	1/19	Africa agr. empl share & GDP	-
Discount factor ( $\beta$ )	0.95	Frictionless interest rate	0.04
Hazard skill change ( $\zeta$ )	0.025	Exp. duration of skill set (years)	40
Max. expropriation probability ( $\tau$ )	0.5	Max. rented fraction of land	-
Max. transfer probability ( $\phi$ )	0.211	Fraction of landless households	0.034
Progressivity of redistribution ( $\epsilon$ )	0.024	Expropriation rate	0.5
Curvature of expropriation ( $\mu$ )	5.341	Share of rented land	0.177

TABLE 1. Benchmark calibration

<sup>23</sup>“Land is a common property of the Nations, Nationalities and Peoples of Ethiopia and shall not be subject to sale or to other means of exchange.” according to Article 40 of the Constitution of Ethiopia.

<sup>24</sup>This is the ratio of the sum of the variables describes in Tables (2) in Appendix A.



## 5. EMPIRICAL RESULTS

In the following we employ the quantitative version of the model to gauge the effect of introducing communal land into a frictionless economy. We investigate several fractions of aggregate communal land while keeping constant all the other policy parameters backed out in the section above. The experiment is run separately in two distinct environments, the benchmark U.S. economy as well as the baseline poor economy reminiscent of Sub-Saharan Africa.

### 5.1. Benchmark economy

What is the rich world to become if it were to revert back to communal land tenure arrangements? While being admittedly far from any policy agenda such a thought experiment extends to any country with relatively few farmers. It certainly includes a number of Latin American and Asian economies where communal land arrangements exist in various forms and guises.

#### 5.1.1. Individual choices

Let us first focus on the impact that communal land generates on individual choices. Figure (1) depicts individual land operations as a function of agricultural skills. For any  $z_a$  these operations are conditional expectations over types  $z_n$  and  $l_c$ , but they are not conditioned on occupational choice. From the left panel we note that the presence of distortions ( $\lambda = 0.5$ ,  $\lambda = 1$ ) induces low-skilled farmers to operate more land. Some of the least skilled farmers detain communal land, which prompts them both to enter agriculture as well as to employ excessive land operations. Agents with higher agricultural skills, meanwhile, are likely to operate less land. They react to price changes, namely the drop of the agricultural price, as will be shown shortly. The right panel provides a sense of the magnitude of these distortions. Here we compare cumulative expected land operations as a function of the cumulative distribution of agricultural talent. While land operations are clearly concentrated amongst higher-skilled farmers in the baseline equilibrium, the correlation between land operations and agricultural talent is substantially weakens as  $\lambda$  increases.

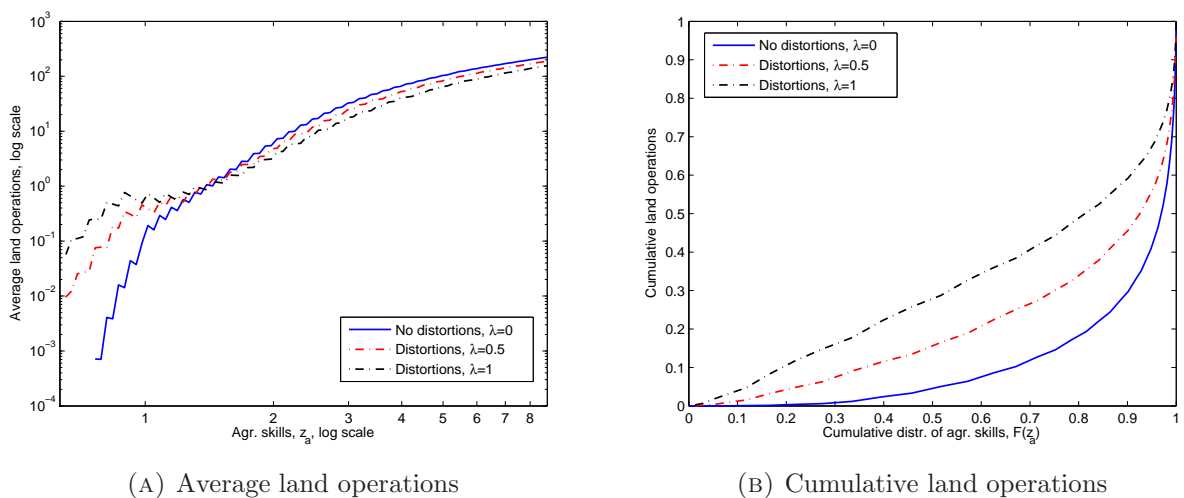


FIGURE 1

These distortions of land use across  $z_a$  types may stem from misallocation across occupations or proper operations. We turn to Figure (2) and individual-specific agricultural

employment. It closely follows the distribution of land operations; communal land encourages more entry into agriculture by low-skilled farmers while discouraging better farmers. What is more, the distortionary effect on the occupational choice is somewhat stronger. In effect, because renting out communal land bears little expropriation risk conditional on farming, a fair number of agents become rural-based renting-out landlords. As a result, the distortion arising from the pure operational choice plays second fiddle to that of the occupational one.

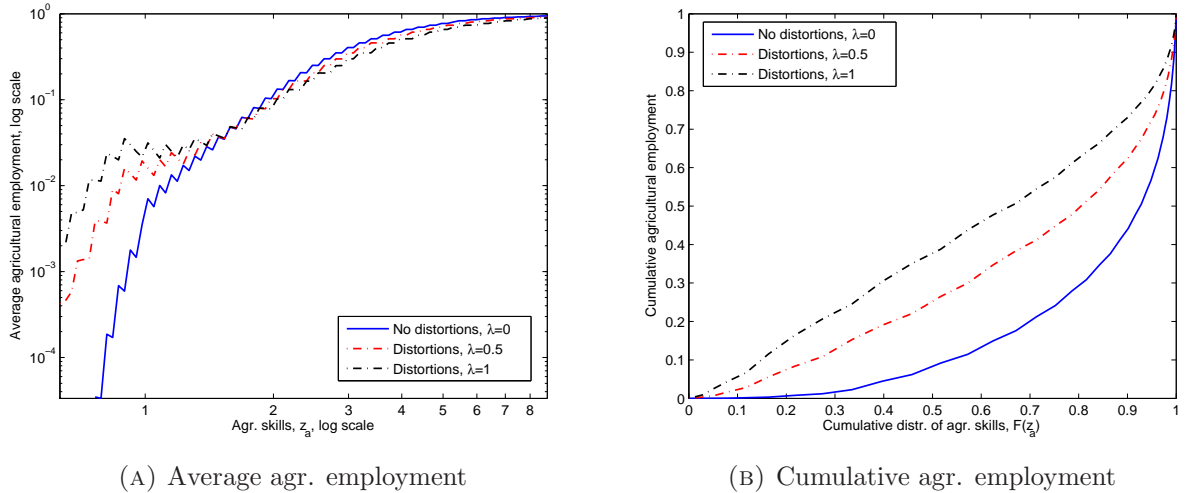


FIGURE 2

Finally, consider the actions of individuals as a function of their communal land holdings, as in Figure (3). In the baseline equilibrium actions are evidently independent of holdings.<sup>25</sup> In each of the distorted equilibria, on the other hand, landless individuals are significantly less likely to operate land (left panel), related to the fact that they shun agricultural employment (right panel). There are two equilibrium forces at play. The first is the fact that relative to the baseline world individuals owning little communal land see few incentives to become farmers. True, agriculture does raise the spectrum of obtaining future transfers, but the relatively high rental rate of land coupled with a depressed price for agricultural produce dominate the choice. The other equilibrium force is that those individuals who do own communal land are more likely to be better farmers in the first place. Because the skill set changes slowly, the stock of communal land holders is disproportionately drawn from previously and hence persistently talented farmers. The lucky agents detaining any positive amount of communal land will hence almost surely opt for the agricultural occupation (right panel). They will not, however, operate all of their holdings due to the aforementioned low expropriation rate conditional on farming. This can be viewed from the departure of operations from the 45 degree line. In addition, we note that the distribution of communal land (depicted in the following section) is highly skewed to the left for both  $\lambda = 0.5$  and  $\lambda = 1$ , so there is a trivial mass of agents that are truly rich in communal land.

### 5.1.2. Aggregate statistics

The next plots illustrate a number of key aggregate observations. We pay particular attention to the comparison between the frictionless environment and that of  $\lambda \in [0.5; 1]$ , i.e. economies where communal land predominates. Figure (4) depicts the evolution of

<sup>25</sup>Here, these holdings are naught, but remember this would also be true with no expropriation ( $\tau = 0$ ).

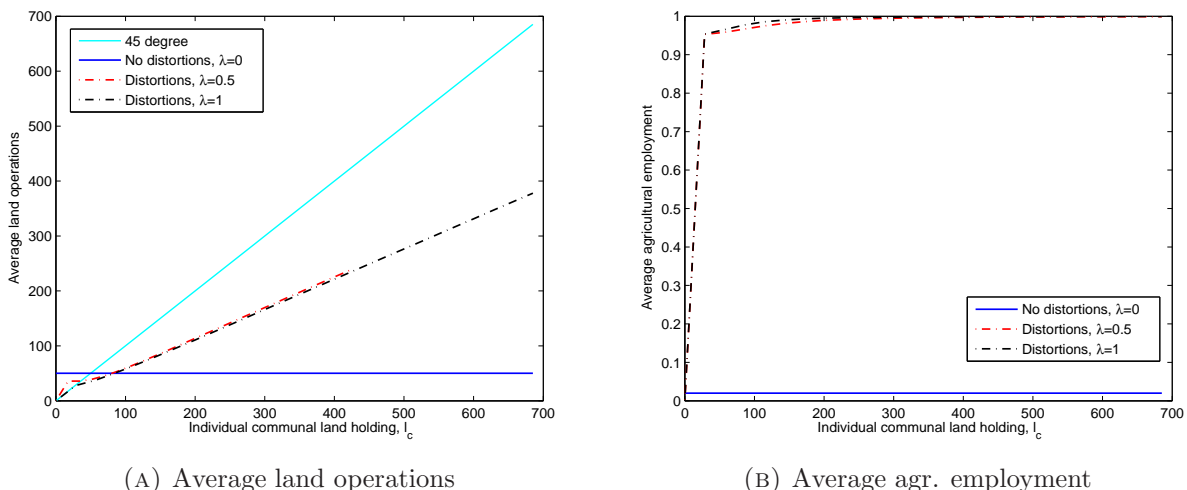


FIGURE 3

real statistics over the institutional space. Aggregate agricultural output ( $Y_a$ ) rises substantially with  $\lambda$ , by up to 19%, while non-agricultural output ( $Y_n$ ) falls minimally, by up to 0.005%. Overall, GDP measured in benchmark economy prices drops trivially.<sup>26</sup> The key variable underlying these changes is agricultural employment (last panel). For  $\lambda = 0.75$  it reaches about 3% compared to the benchmark of 2%. Is that a lot? It is certainly not a big change in absolute terms, which is why we can hardly expect large changes in GDP or in non-agricultural production. In relative terms, however, an employment increase of 50% is not insubstantial for the agricultural sector. Because that factor is palpably higher than the factor increase in agricultural production, real agricultural productivity,  $Y_a/N_a$ , falls non-trivially. Real non-agricultural productivity,  $Y_n/N_n$ , rises trivially as the aggregate effects are too modest to have substantial bite into either the numerator or the denominator.

We turn to relative productivity and prices, Figure (5). Following the previous discussion real productivity in agriculture relative to non-agriculture,  $(Y_a/N_a)/(Y_n/N_n)$ , must fall (first panel). At  $\lambda = 0.75$ , our central focus, we measure a drop by about 15%. It is a respectable drop, though not huge. The statistic that experiences more action is nominal relative agricultural productivity,  $(pY_a/N_a)/(Y_n/N_n)$ . At  $\lambda = 0.75$  we end up with a plummet of more than 35%. While real relative agricultural productivity declines, the price of agricultural goods  $p$  does not rise but follows south. We interpret this to be a consequence of the relatively few distortions that occur on the land market. Compared to the baseline prices, the presence of communal land makes agriculture attractive for many would-be farmers. The new entrants as well as the resulting land allocations do not wreak havoc on farming, but rather contribute to agricultural output gains. As a result the agricultural price must decline, which limits the number of entrants. The loss in real relative agricultural productivity is therefore subdued while the nominal one is pronounced. As for the rental rate of land (last panel), it is lower under communal land arrangements. That also results from the drop in the agricultural price. Despite the aforementioned upward pressure induced by limited supply on the rental land market,

<sup>26</sup>GDP drops because the base level of  $Y_n = 1.45$  is much higher than  $Y_a = 0.11$ , while the original relative price is  $p = 0.27$ . The quantitative evolution of welfare, measured via the stand-in household's utility function, is almost identical to that of GDP. We not report welfare here, but note that it is highly aligned with the GDP measure in all of the subsequent experiments as well.

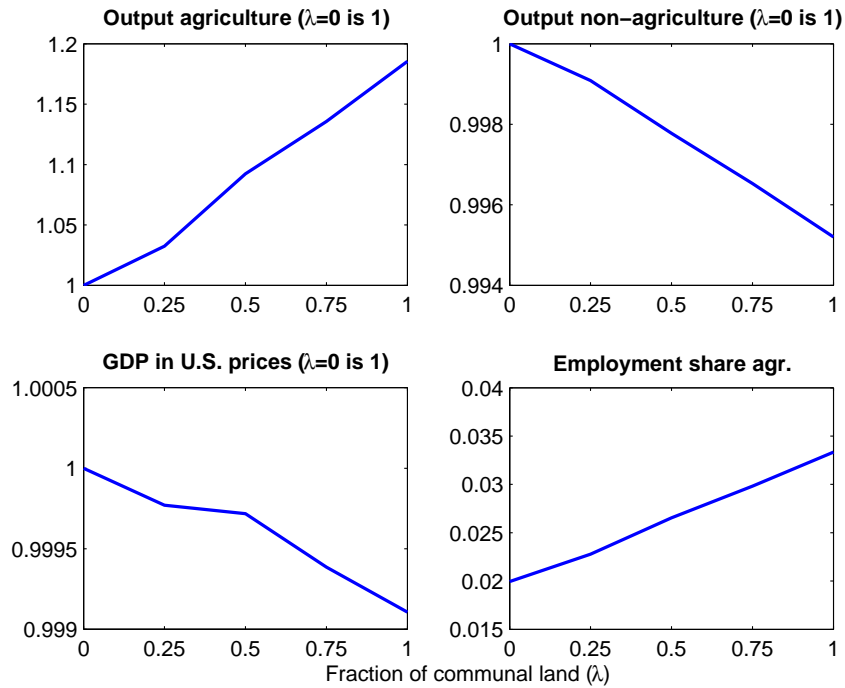


FIGURE 4. Real variables

the decline of the agricultural price puts a lid on land demand. In addition, the fact that the rental market remains sufficiently active (even with no private land) implies that the supply of rented land is not extremely curtailed.

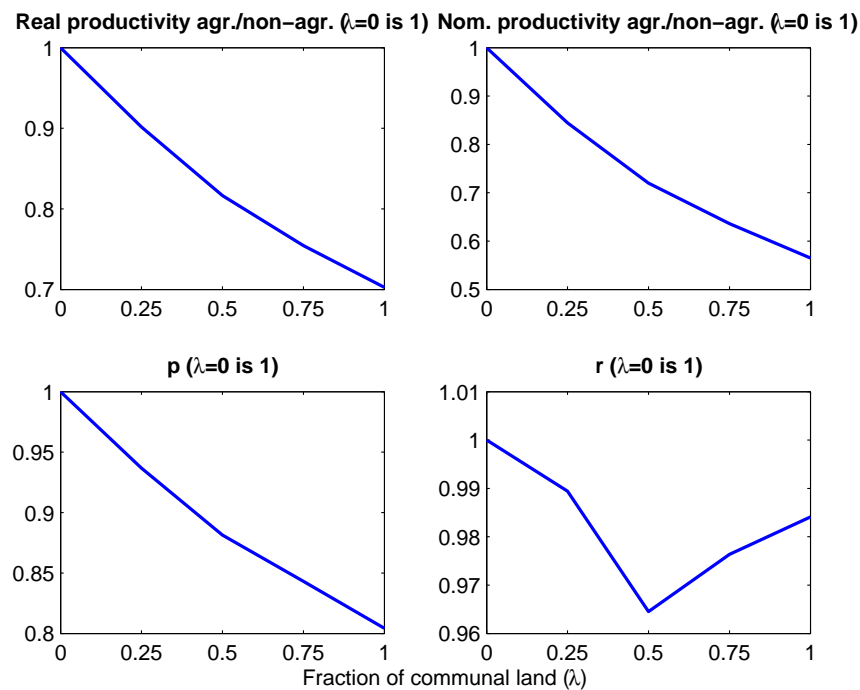


FIGURE 5. Relative productivity and prices

Additional policy-induced variables of interest are summarized in Figure (6). The first panel plots the transfer size with respect to the mean farm size,  $v/(L/N_a)$ . It is almost

exactly linear in  $\lambda$ , for two reasons. First, the vast majority of communal land holders detain one single transfer,  $l_c = v$ . Second, almost all of the communal land is owned by farmers. It follows that in the extreme case of no private land, land ownership - though not the operation of land - is extremely equally distributed. Mind that the expropriation rate (second panel) is quite high at more than 2% and it does not vary much across different (strictly positive) fractions of aggregate communal land. We also measure the share of farmers who prefer to rent out communal land. As  $\lambda$  rises that share shoots up substantially. Finally, we note that the fraction of communal land that is rented out (panel 4) increases with  $\lambda$  because of the lower availability of private land.

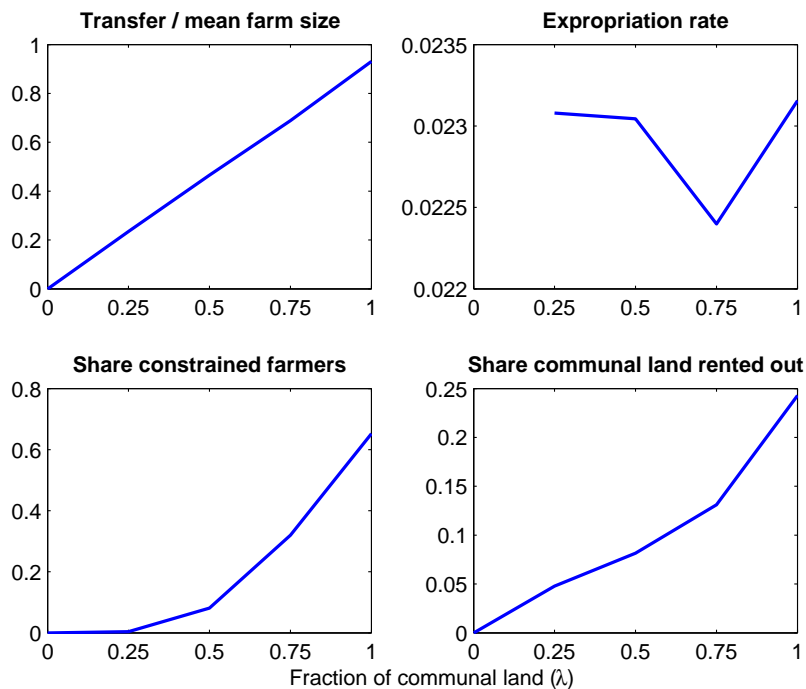


FIGURE 6. Variables on communal land

## 5.2. Poor economy

We repeat the above exercise on an environment that is representative of Sub-Saharan Africa in output, agricultural employment, and land endowment. It is obviously the more interesting counterfactual experiment - communal land is after all mostly found in rural economies. We recognize, however, that we are on somewhat shakier ground here as the cross-sectional variations in income in the baseline are not directly targeted to such economies.

### 5.2.1. Individual choices

The left panel of Figure (7) again illustrates how the presence of communal land induces more pronounced land operations by unskilled farmers at the expense of better skilled farmers. High values of  $\lambda$  generate an outcome by which unconditional land operations are almost independent of farming skill (right panel). We do note, however, that even in the baseline scenario that relation is pretty weak. As in Lagakos and Waugh (2013), the large fraction of individuals drawn into farming by high food prices water down the strong positive assortative matching of operations and farming skills typical of the benchmark rich economy.



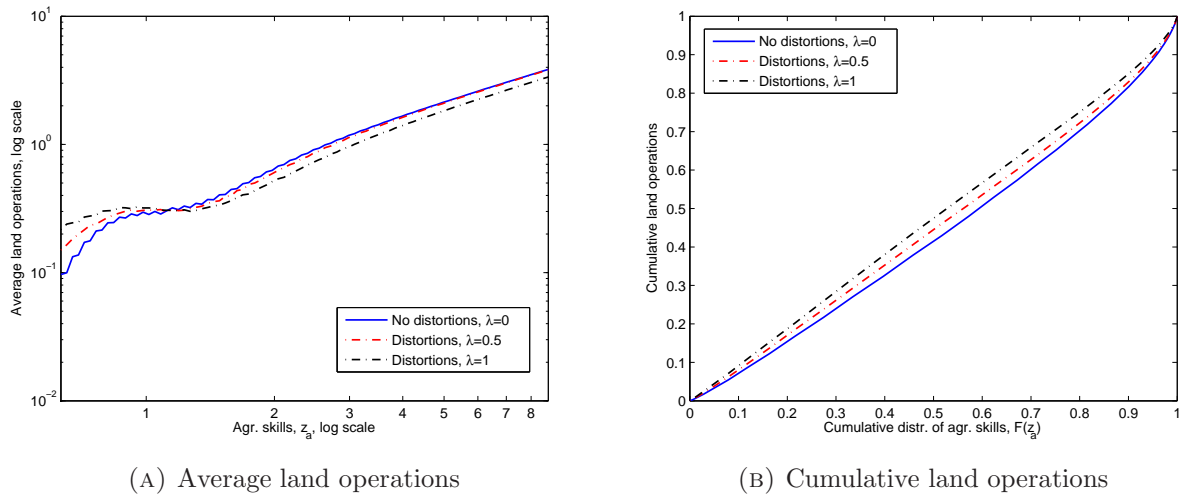


FIGURE 7

That tendency becomes even more evident by observing agricultural employment in Figure (8). From the left panel we have that even in the frictionless economy positive assortative matching between agricultural employment and agricultural skills breaks down over a portion of the skill state space, a by-product of positive correlation across sectoral skills. The communal land regime accentuates that pattern. Because negative assortative matching occurs on a segment with substantial mass, in the distorted equilibrium agricultural employment ends up being negatively correlated with agricultural skills. One can appreciate that from the right panel where the plot for the distorted economy lies above the 45 degree line.

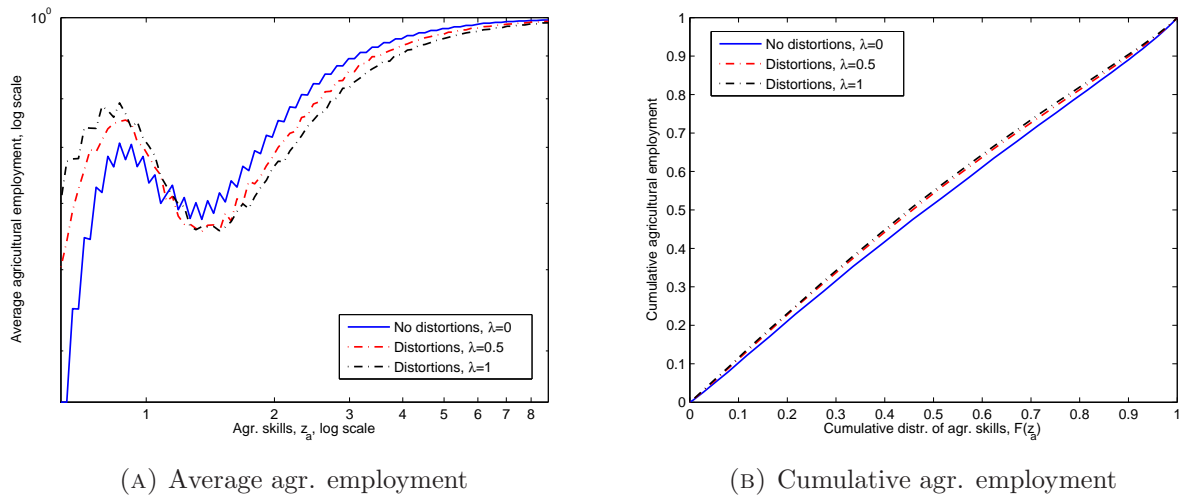


FIGURE 8

For completeness, Figure (9) relates occupations and operations to communal land holdings. The pattern is almost identical to that of the benchmark rich economy, so it does not warrant further clarification.

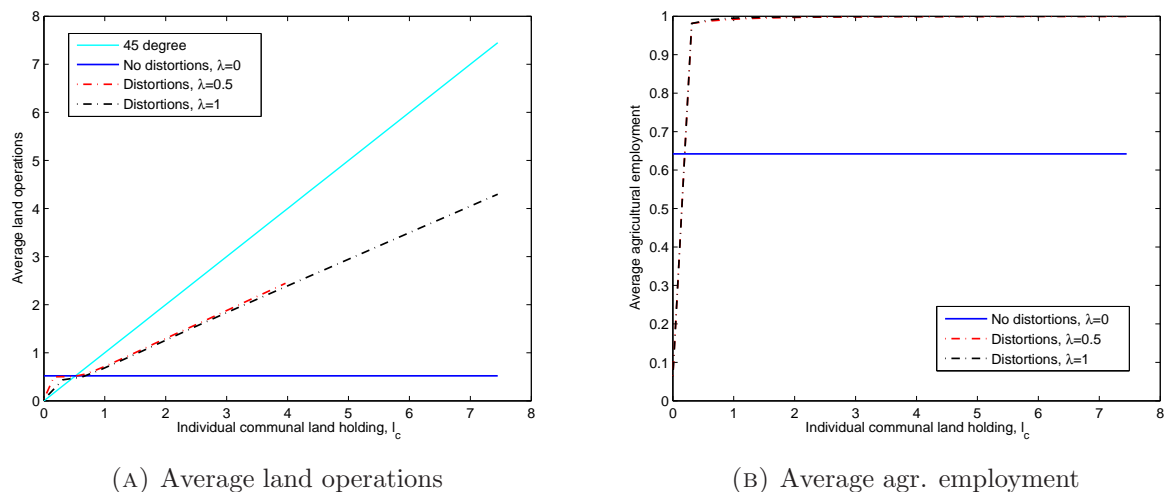


FIGURE 9

### 5.2.2. Aggregate statistics

The central result of this paper is the impact of communal land on aggregate variables in a poor economy. From Figure (10) we note that contrary to the previous economy, more communal land does not lead to a substantial rise of agricultural production. Non-agricultural production, on the other hand, declines more steeply. The combination of the two induce a decline in GDP. For three-quarters of communal land the loss is worth about 2% - small, but not entirely negligible. The mass of additional agricultural employment at that point amounts to some 1.5 percentage points (last panel). As this is not large in relative terms, real agricultural productivity is not affected enormously.

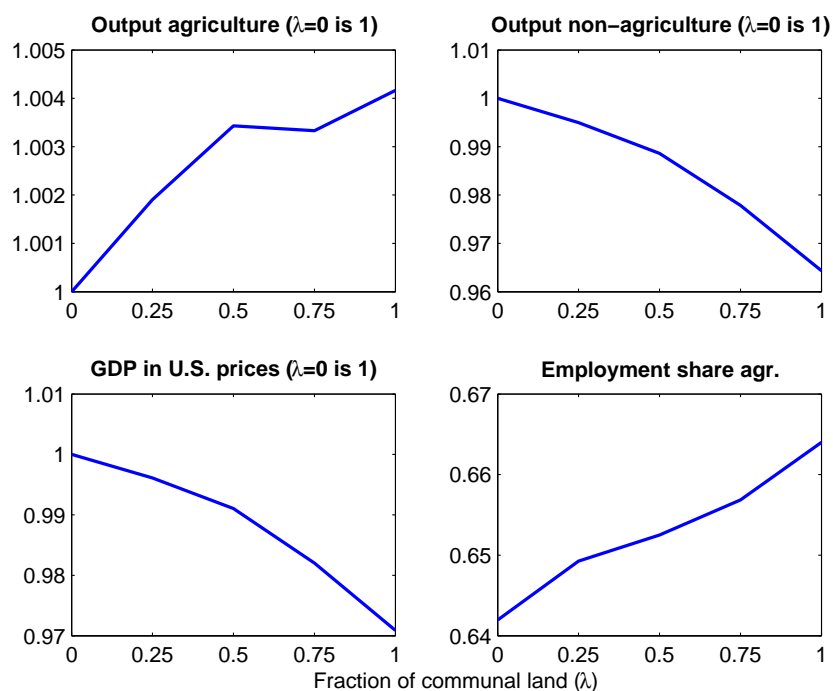


FIGURE 10. Real variables

Figure (11) reports relative productivities and prices. For  $\lambda = 0.75$  real agricultural productivity relative to non-agriculture drops by roughly 4%. The reason for such a modest decline relates to the fact that the mass of switchers is not large compared to the stock of workers in either sector. It is once more nominal relative agricultural productivity that measures larger drops, by more than 15% for the case of three-quarters of communal land. Its decomposition reveals that the lion's share of this is due to the fall in the agricultural price, amounting to almost 25%. Finally, it is worth noting that the interest rate experiences a steady and substantial decline over the whole range of  $\lambda$ , in large part due to the decline of the price of food. In summary, and just as in the rich economy, communal land here appears to create few distortions on the land market. What it does is to attract individuals into farming. The general equilibrium then produces a sufficiently strong drop in  $p$  to stem the wave of additional arrivals.

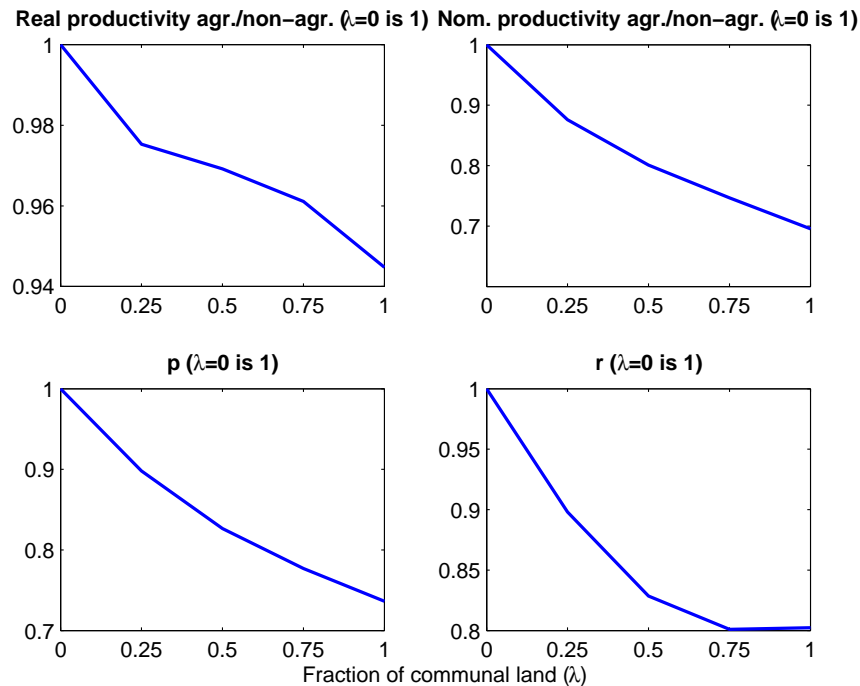


FIGURE 11. Relative productivity and prices

For completeness, Figure (12) illustrates the outcomes for additional variables of interest. What merits attention is that the expropriation rate declines steadily over the range of  $\lambda$  up to the calibrated value of 0.6%. The multitude of forces at play mask a clear interpretation of that phenomenon. One reason is surely the fact that fewer individuals are willing to switch sectors in equilibria to the right, as expropriation occurs mainly by agents leaving farming. We also note that the mass of farmers desiring to rent out land again grows larger with more communal land, yet does not reach extreme values. The land market, meanwhile, remains quite active as observed from the last panel.

## 6. SENSITIVITY

TO BE ADDED

## 7. CONCLUSION

TO BE ADDED

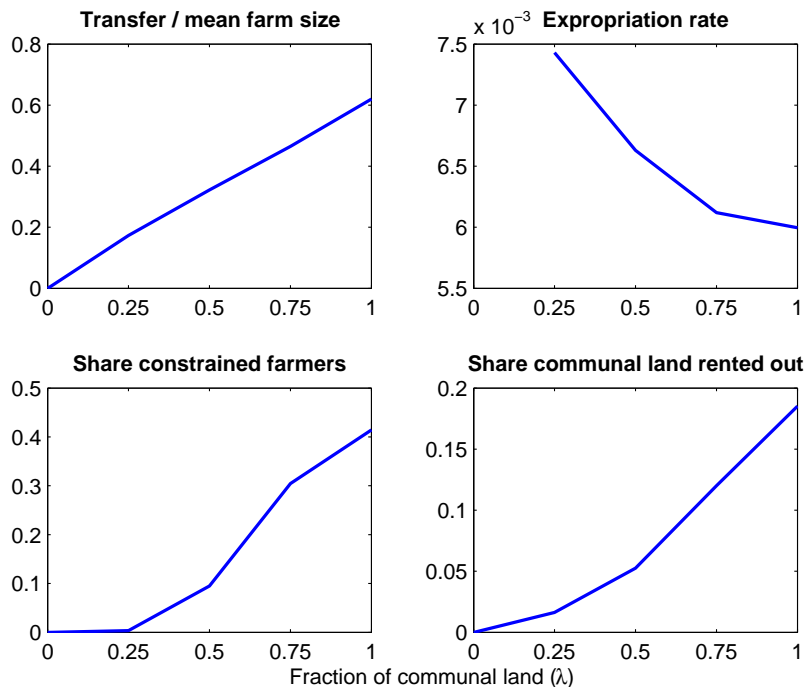


FIGURE 12. Variables on communal land

## 8. APPENDIX

8.1. *Data sources*8.1.1. *LSMS-ISA dataset*

The moments from the land holding distribution are computed using the LSMS-ISA dataset. This dataset reports the agricultural activity on 32,086 parcels that are operated by the sampled households ( $N=3,118$ ). For most parcels (27,168) GPS coordinates are available. For 4,585 parcels no GPS coordinates are available so we use self-reported measures. For another 333 parcels, neither GPS nor self-reported measures are available. For those parcels, we impute the size of those parcels by using the median parcel size of the distribution of the other 31,753 parcels. Based on the obtained distribution of parcel size, we compute the total size of land operated by household. The moments of that distribution are reported in Table (??).

Our next object of interest is the distribution of land rental operations. In particular, we are interested in the total size of land that is rented-in for each household. Using information from the Parcel Roster of the LSMS-ISA dataset on the acquisition of the operated parcels. Parcels can either be acquired from local leaders, inherited, rented, borrowed for free, moved in without permission or other.<sup>27</sup> Using the above distribution of parcel sizes, we compute the size of land that households either rented or borrowed for free. The distribution is found in Table (2).

The ratio of the sum of land rented over the sum of operated land is obtained by dividing the two sums from the above Tables so that 17.7% of the land operated is rented or borrowed for free.

The second moment that our calibration targets is the fraction of land-less households. Households that pursue an agricultural activity but who are landless, operate only land that they rent-in. Thus we define our measure of landless households as the fraction of

<sup>27</sup>LSMS-ISA Dataset 2011, Ethiopia, Section 2 Household Roster, Question 3.

TABLE 2. Distribution of Land by household in hectare

Statistics	Land Operated	Land Rented
N	3,118	836
mean	1.78	1.09
p50	1.02	0.55
min	0.00	0.00
max	87.37	57.84
sum	1.89e+07	3.36e+06
p25	0.42	0.15
p50	1.02	0.55
p75	1.97	1.40

Source: LSMS-ISA Dataset Ethiopia (2011)

households whose agricultural operations finds only place on rented-in land. Based on the two above distributions we find that to be a fraction of 3.4% of the population.

### 8.1.2. Own dataset

In December 2014, we interviewed randomly selected households in 7 villages (*kebele*) across 4 sub-regions (*woreda*) in the Ethiopia's two main regions (Amhara and Oromia) which cover 60% of the country's population. In each village, we interviewed 6 to 7 households to obtain a sample 44 households. A section of this questionnaire was devoted to land expropriation and redistribution for the purpose of informing the set-up and calibration of the present model, in particular the law of motion for communal land holdings. The following Tables deliver descriptive statistics of our dataset that we use to discuss the calibration of policy parameters.

As part of our section on land expropriation and redistribution, household heads were asked whether since they became household head, one of their household member has been subject to land expropriation - see Table (??). Responses suggest an expropriation rate of 6.8%. We consider this number to be quite conservative given the numerous episodes of land expropriation and redistribution that have taken place in Ethiopia over the last decades. This is confirmed by further evidence from our dataset, which documents that the parents of the household head (or spouse) experienced a rate of land expropriation that is substantially higher, 36% - see Table (??).

Given our model's annual frequency we adjust those expropriation rates to annual rates. To do so, we divide the computed expropriation rate by the average number of years they have been household head.<sup>28</sup> This gives us a lower bound of 0.25%. Doing the same adjustment with the expropriation rate on the parents of the household head, and adjusting it with an average generation length of 43 years (to give a life expectancy of 63 years in Ethiopia seems reasonable) gives us an upper bound of 0.845% for the expropriation rate. Based on these rough computations, we decide to fix the expropriation rate to 0.6%.

We also asked household heads to evaluate the tenure security of their land holdings. We document the frequency of response in Tables (3), (...), and (...).

<sup>28</sup>Here, the household head's average age is 48.5 years and the average age of their oldest children is 21.8 years. If we consider a household to be created at birth of the first child, the household heads in our sample have been in that position for 26.7 years on average.



TABLE 3. Distribution of responses to the question: "Which of the following statement is true?"

Country	Ethiopia		Frequency
	Frequency	Percent	
All of my land is completely secure from expropriation	30	68.18	22
Some fields are completely secure from expropriation, and some are not	6	13.64	3
There is always some risk of expropriation	5	11.36	4
My land is not secure from expropriation at all	3	6.82	2
Sample Size	44	100	31

Source: own dataset Ethiopia 12/2014 & Uganda 01/2015

TABLE 4. Distribution of responses to the question: "Do farmers in this kebele (village) take any of the following actions to protect their land from expropriation ? "

Country	Ethiopia		Uganda	
	Frequency	Percent	Frequency	Percent
They prefer not to rent out land	2	4.55	1	3.23
They prefer not to reveal their intention to sell	-	-	1	3.23
They prefer not to move away	2	4.55	17	54.83
They use modern agricultural techniques	15	34.09	0	0
They plant trees	10	22.73	11	35.48
They build irrigation canals	5	11.36	0	0
They prefer not to leave land fallow	10	22.73	0	0
Other	0	0	1	3.23
Sample Size	44	100	31	100

Source: own datasets Ethiopia 12/2014 & Uganda 01/2015

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TABLE 5. Distribution of responses to the question: "Which of the following is the most important reason that local authorities grant land to a farmer?"

Country	Ethiopia		Uganda	
	Frequency	Percent	Frequency	Percent
Output - if farmer produces little	1	2.27	1	4.17
Output - if farmer produces much	4	9.09	7	29.16
Skills if farmer is skilful	5	11.36	4	16.66
Skills if farmer is not skilful	0	0	0	0
Land ownership - if farmer has little land	18	40.91	1	4.17
Land ownership - if farmer has much land	0	0	0	0
Land quality - if farmer has bad quality land	0	0	1	4.17
Land quality - if farmer has good quality land	0	0	0	0
Household size if farmer has large household	0	0	1	4.17
Household size if farmer has small household	0	0	0	0
Age if farmer is old	0	0	0	0
Age if farmer is young	3	6.82	3	12.5
The household is respected in the community	1	2.27	1	4.17
It is completely random, nothing changes the odds	12	27.27	5	20.83
Sample Size	44	100	24	100

Source: own dataset Ethiopia 12/2014 & Uganda 01/2015

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