Incomplete Markets and Land Institutions in an Agrarian Economy

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Introduction

A key feature of many developing countries is that a large share of their labor force is engaged in agriculture, where returns are particularly low (Gollin et al., 2014). Consequently, understanding the policies and institutions that draw so many in developing countries to agriculture is central to understanding cross country income differences. Land management practices in developing countries have recently come under increased scrutiny for their role in misallocating land and the potentially large consequences of this misallocation (Adamopoulos et al., 2017; Restuccia and Santaeulalia-Llopis, 2017; Chen et al., 2017). In many countries in Africa for example, agricultural land operates on the basis of *use it or lose it*, with village chiefs playing a central role in allocating agricultural land, often to poor landless cultivators who lack other means to earn a living. Through the lens of a standard model with heterogeneous productivity in agriculture, removing the distortive role of chiefs would allow more productive farmers to accumulate land and lead to significant allocative efficiency gains. In Restuccia and Santaeulalia-Llopis (2017) for example, the authors estimate the aggregate agricultural output gain from removing idiosyncratic distortions to be 3.6-fold, much larger than those reported for the manufacturing sector in China and India documented in Hsieh and Klenow (2009). A growing consensus sees these institutions as placing limits on the scope of land markets as the key source of misallocation that plagues agricultural productivity in developing countries. These institutions however fulfill a secondary objective, akin to social insurance that the literature on land misallocation largely abstracts from.

In this paper, I evaluate a secondary objective fulfilled by land institutions in developing countries - providing informal insurance when activities outside of agriculture fail. I do this by building a model that features incomplete markets to insure consumption, and the ability to gain use rights on land where the only risk the household faces is that of losing land. I then match the model to micro data for Malawi where these features on land management practices are both salient and affect large sects of society. My insight is that in countries where these institutions are prevalent, when households leave land behind, village chiefs reallocate idle land to agricultural cultivators who have no land for farming. Households with low productivity in non-agriculture know this and are willing sustain even lower incomes in agriculture in hopes of gaining access to farmland that they then get to keep. As a result, agricultural work operates as both a queue that village chiefs draw from when reallocating land and an investment opportunity into potential land access for households facing transitory shocks.

The model I build incorporates both incomplete consumption insurance in the tradition of Huggett (1993) and Aiyagari (1994) and also adds new features that allow me to assess the role of land institutions in offering greater scope for consumption insurance. I build on a growing field seeking to understand the effects of consumption insurance frictions on agricultural productivity and development (Donovan, 2020; Brooks and Donovan, 2020; Lagakos et al., 2018). I also build on the land misallocation literature (Adamopoulos et al., 2017; Restuccia and Santaeulalia-Llopis, 2017; Chen et al., 2017) by modeling the dynamic tradeoffs inherent in land institutions that are salient in countries where measured land misallocation is particularly severe. My focus on consumption insurance and risk outside of agriculture however presents a new channel by which land institutions in developing countries create tradeoffs for households that are independent of farm level distortions.

The features I incorporate in the model are present across various land management systems in developing countries but are by no means exhaustive. In many countries for instance, there is an important gender component where land passes down to sons in patrilineal societies and daughters in matrilineal societies. I abstract from many of these aspects in the model, instead I focus on three features. First, in the model, households face stochastic income when they leave agriculture. This captures the idea that when leaving agriculture, opportunities are risky and social insurance often insufficient in developing countries like Malawi. Secondly, households have to produce in agriculture in order to keep the land and pass it on to their children. This captures the *use it or lose it* aspect of land that shows up both in practice and as perceptions in surveys related to land markets and tenure. And thirdly, only households supplying agricultural labor become available for land allocation in agriculture. This captures the idea that it is by moving to rural areas where most employment opportunities lie in agriculture that households get to access land when it becomes available.

These features are particularly stark in Malawi, however it is by no means an exception in Africa. In the first wave of the panel survey, only 16% percent of households operate any land acquired through a market transaction while 84% of households only operate land that is either inherited or allocated through local traditional authorities.

My paper is also timely as Malawi is undergoing a large scale titling program that is geared towards allowing households to engage in more market transactions with the land they hold. Malawi has tried this before in a largely failed effort in the early 2000's. The government did not obtain buy in from local traditional authorities who maintained their grip on village land. As a result, few households sought out titles as they were of little use without local support and the benefits envisaged never materialized. The new effort involved years of negotiations between the government and local traditional authorities, and culminated in a multi-year implementation that is ongoing and has promising prospects.

The data I draw on comes from the Living Standards and Measurement Survey (LSMS) administered by the World Bank along with the local statistical agencies. I use the short term panel waves of the LSMS from 2009/2010 and 2012/1013 seasons that have detailed information on income generating activities, inputs and outputs in production, household assets, and mode of land acquisition for agricultural land. In an initial exercise, I use aggregate and micro moments from the data to estimate the parameters of the model. I then use the model to study the effects of land reform on both aggregate welfare and distributional outcomes. In a final exercise, I incorporate heterogeneity in permanent productivity in agriculture and match these to the micro data in the tradition of the land misallocation literature. I then compare the gains from reallocation in the farm sector with and without the details of the land institutions that I incorporate in my model. Finally, with the model, I can assess how much misallocation is left after I take into account the salient features from land institutions that I model and match to micro data for Malawi.

In the sections that follows, I first present some motivating evidence for the channels I explore in the paper. I then delineate the model that I build to study land institutions. I then explain how I quantify and estimate the model with Malawi's micro data. And finally, I perform the policy experiments and close with a brief conclusion.

Historical Context

Since I match the model to micro and macro moments from Malawi, a brief discussion of their land management practices is in order. Legally, there are three types of land tenure in Malawi - and in fact most of Sub-Saharan Africa. Land can be under leasehold, public or customary tenure. Land under leasehold is analogous to private ownership. The holder of the lease has a long term contract with the government to manage the land. It is the closest concept to that of private property in developed countries. Public lands are similar to public land in developed countries as parks and other government held lands. Land under customary tenure differs by country but largely it means that land is held by familial lineages and usufruct rights are managed by village leaders who grant these rights to poor households without land.

For a great deal of smallholder farmers in Malawi, land is acquired through customary tenure. Under this system, farmers gain access to land by virtue of being a member of the village's local lineage under the supervision and discretion of local traditional authorities. These systems act as a safety net when other economic activities residents might pursue fail (Ellis, 2005). Although customary rights over land allows the farmer only usufruct rights, the rights user retain the ability to pass the land down to their descendants as long as users continue to engage in farming (Chirwa, 2008). When farmers leave their farmland behind to pursue other activities, traditional authorities reallocate land to local residents lacking in land and other income sources.

Model

Demographics. There are two types of agents in this economy. There is a unit measure of dynastic households who discount utility at rate β and a village elder who has control over agricultural land, appropriates land under his/her control and grants use rights to households in the economy.

Preferences. Dynastic households maximize expected discounted utility where per period utility is a function of both goods produced in the economy and can be written as follows.

$$U = \sum_{t=s}^{\infty} \beta^{t-s} u(c_a, c_n) \tag{1}$$

Endowments. Households are endowed with one unit of labor they can supply in agriculture and earn a wage. If a household has rights on non-marketed land, they have control over ℓ_c units of land they can use for agricultural production. All households are endowed with efficiency $z_t \in \mathcal{Z}$ in non-agriculture that they can use to run a business. Finally, households can save on an asset $b_t \in \mathcal{B}$ with gross return R_t but face a borrowing constraint.

Occupations. As in Roy (1951), households choose the sector where they want to produce after observing their productivity in non-agriculture and use rights on land. Use rights on land cannot be traded and the household may loose this right randomly - this captures non-market means in which people loose access to land. If a household has no such right, working in agriculture means becoming *farm cultivator* and enter a queue for land when it becomes available. If land becomes available, this household can be allocated a plot - matching in random - and walks into the next period with rights on land it can use for production in agriculture. When producing on their own land, the household becomes a *farmer*. At any point, the household can walk away from agriculture to run a *household business* in non-agriculture.

Technology. Households with access to land produce according to a technology that uses land and labor $\varepsilon_a f_a(\ell_c, n_a)$ whenever they choose to produce in agriculture. Households without access to land, can supply their labor in agriculture and earn the wage w_a. At any point, the household can choose to work in non-agriculture and access a technology to produce according to $f_n(z) = \varepsilon_n z$

Decisions. Housholds make dynamic decisions according to their current situation - access to land, productivity and assets - and their future possibilities. These individual states can be represented by $x \in \mathcal{Z} \times \mathcal{B} \times \mathcal{L}$ such that $\mathcal{L}$ is binary and represents access to land and the other states are continuous. Let $V^n : \mathcal{Z} \times \mathcal{B} \to \mathbb{R}$ represent the value of running a household business and define $V^a : \mathcal{Z} \times \mathcal{B} \to \mathbb{R}$ and $W^a : \mathcal{Z} \times \mathcal{B} \to \mathbb{R}$ as the value for working in agriculture when having use rights on land and not respectively. Their dynamic occupation decisions can then be written as follows:

$$V(z, b) = \max \{V^a(z, b), V^n(z, b)\} \tag{2}$$

$$W(z, b) = \max \{W^a(z, b), V^n(z, b)\} \tag{3}$$

For now, suppose agricultural and non-agricultural goods are perfect substitutes so that we can abstract from the distinction between the two goods in the utility. Hence we can write the value of working in non-agriculture as

$$W^n(b, z) = \max_{c, b'} \quad u(c) + \beta \mathbb{E}_{z'|z}[W(b', z')]$$
$$c + b' = f_n(z) + Rb, \quad b' \geq -\phi$$

The value of working in agriculture depends on whether or not a household has access to land. If one has access to land and chooses agriculture, they solve the following problem

$$V^a(b, z) = \max_{c, b', n_a} \quad u(c) + \beta \mathbb{E}_{z'|z} \left[\pi_e W(b', z') + (1 - \pi_e) V(b', z')\right]$$
$$c + b' = \varepsilon_a f_a(\ell_c, n_a) - w_a n_a + Rb, \quad b' \geq -\phi$$

where π_e is the probability that a household loses their use rights on land. Let L_a be the mass of agents with use rights on agricultural land. Then, the household without rights solve the following problem.

$$
\begin{aligned}
W^a(b,z) = &\max_{c,b'} \;\; u(c) + \beta \mathbb{E}_{z'|z}\left[\pi_a(L_a)V(b',z') + (1-\pi_a(L_a))W(b',z')\right] \\
& c + b' = w_a + Rb, \quad b' \geq -\phi
\end{aligned}
$$

where π_a is the probability of gaining access to land and is determined in equilibrium based on how much land is available, how many households are getting expropriated and choosing to leave behind their land.

A noteworthy aspect of the model I present is the way savings is occupation dependent since the occupation choice determines the risk exposure of a household. This problem is inherently different from models of occupation choice/entrepreneurship in development like Buera and Shin (2013). In their model, the occupation choice is independent of assets and is made each period based on the returns to occupation. Hence, while in their model, households choose whichever occupation pays more, in my economy they take agricultural wages that are lower than their returns in non-agriculture because it comes with the opportunity to gain use rights on land. At this low wage, households will hold out for land as long as their asset holdings are sufficient to allow for consumption smoothing. As households run out of assets, landless agriculture is too costly and they switch to non-agriculture where the returns to their skill is larger.

Equilibrium. I focus on a stationary equilibrium where the distribution of states in the economy are constant. A stationary equilibrium in this economy is an agricultural wage (w_a), a land allocation probability (π_a), and value functions $V(b,z), W(b,z)$ such that:

- Households solve their individual problems
- Agricultural labor markets clear:

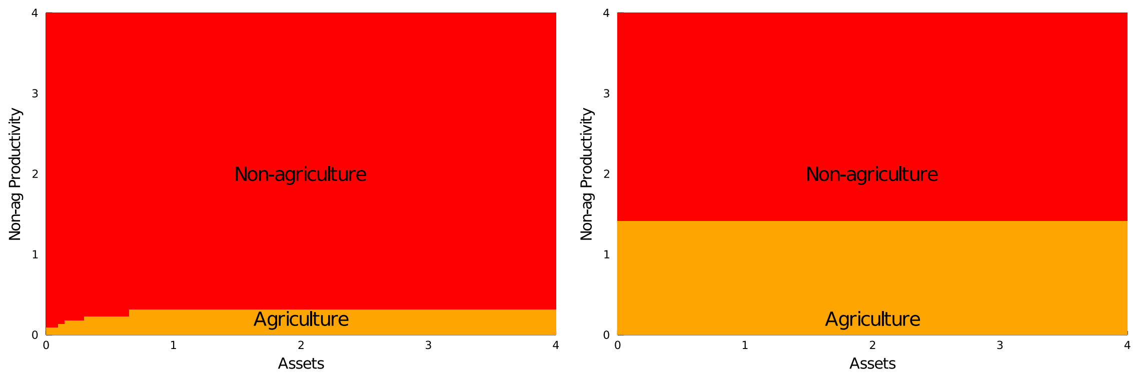
$$
n_a \int_V \mathbb{I}_{(occ=a)} dF(x) = \int_W \mathbb{I}_{(occ=a)} dF(x)
$$

- Communal land used in agriculture production cannot exceed supply

$$
\ell_c \int_V dF(x) = \ell_c N_c \leq L
$$

Note here that I can calibrate L or π_a since the probability of land allocation works as a price and its supply is constant. I calibrate π_a to match aggregate moments in the stationary distribution but in my policy experiment I ensure the equilibrium rate is consistent with the initial land supply.

(a) Without Land Use Rights - $W(b, z)$ (b) With Land Use Rights - $V(b, z)$



Occupation Choice. The occupation choices in my model depart from those in the macro-development literature insignificant ways. Although landless households are paid their marginal product in agriculture, they are willing to go into agriculture even though this wage is lower than their potential earnings in non-agriculture. On the other hand, households with land access will stay in agriculture even though their farming profits are lower than their potential earnings in non-agriculture. Further, assets matter for landless households who would like to work in agriculture and enter the queue for farmland but have to draw on their assets to smooth consumption. As their assets draw down and they are not allocated land, households are forced to leave agriculture because the low wage in agriculture for a sufficient amount of time becomes too costly for them.

Data

In order to use the data to inform the parameters of my model I need to compute measures from the data with clear analogues in the model. In this section I describe these measures and how I calculate them. First, I need measures of income for the three occupations in the model, i.e. agricultural income of landed farmers, income of landless agricultural cultivators, and non-agricultural income.

Agricultural Income of Landed Farmers For agricultural income, I only compute earnings from non-permanent crops. Fisheries and livestock income will be capital income from fishing equipment and livestock capital. I consider only income from the rain season as in Restuccia and

Santaeulalia-Llopis (2017) where Value added in agriculture can be written as:

$$VA_{a,i} = Rev_{c,i} + P_{c,i}(Output^z_{c,i} - Sold_{c,i}) - Cost_{c,i} \tag{4}$$

and represents value added from product c for household i. $Rev_{c,i}$ represents household i's revenues from selling crop c, $Output^z_{c,i} - Sold_{c,i}$ represents the fraction of production of crop c that household i keeps for its own consumption and $P_{c,i,r}$ is the price received by household i for crop c (sale value of own consumption), which is replaced by the regional price when such price cannot be inferred for household i (households that report production but no sales). In order to compute this price, I proceed as follows:

1. If household i sold crop c, I use reported sales $Rev_{c,i}$ and quantity sold $Q_{c,i}$ and compute $P_{c,i,r} = Rev_{c,i}/Q_{c,i}$
2. Otherwise I attribute the median price of the crop sold by other households in the same region if available, meaning $P_{c,i} = \bar{P}_{c,j}$ where j lives in the same region as i

Finally, for the production of each crop, the household reports costs associated with various inputs and factors. I aggregate costs across inputs

$$Cost_{c,i} = \sum_v Cost^v_{c,i} \tag{5}$$

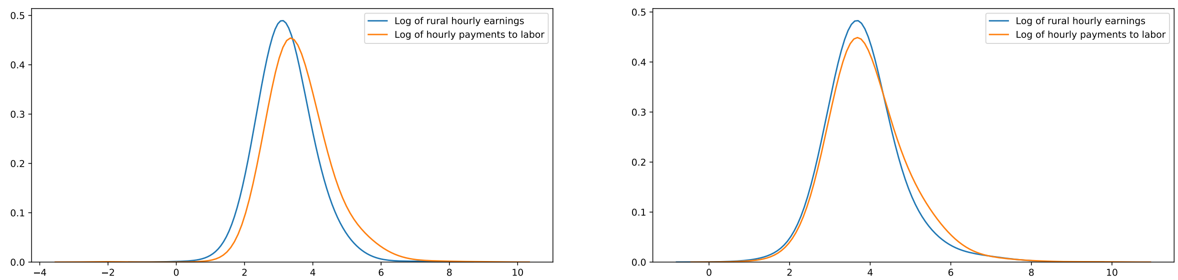
where $v \in \{intermediates, labor, capital, land, transportation\}$ represents the costs associated with production. After computing $VA_{c,i}$ for each crop and household, define household farm earnings as the sum of value added across crops

$$VA_i = \sum_c VA_{c,i} \tag{6}$$

which represents the income of farmers that get their land in Malawi through the customary tenure system.

Agricultural Labor Income. There are two ways to compute wages paid to agricultural labor. In the time use side, the only labor income that is tied to agriculture are wages paid in the formal sector. The farms paying these salaries are large and export oriented and highly regulated by the government. These workers are not the ones supplying labor to smallholder farmers who get land through customary tenure. There is another category in the time use portion of the survey that asks for the wage received for informal labor in rural areas. This is the first candidate for w_a. Another

Figure 2: Earnings in Rural Areas Versus Labor Payments in Agriculture



(a) LSMS 2010

(b) LSMS 2013

way of computing this is by looking at the production side and measuring labor payments made by landed farmers. These can be seen in figure 2 for each one of the years in our panel data. In short this tells us that in 2010, rural wages were reportedly higher than producers reported paying to agricultural labor. This is not surprising as perhaps that year, there were more non-agricultural activities in rural areas that households earned income from - and those paid more than agriculture. In 2013 however, they followed closely one another.

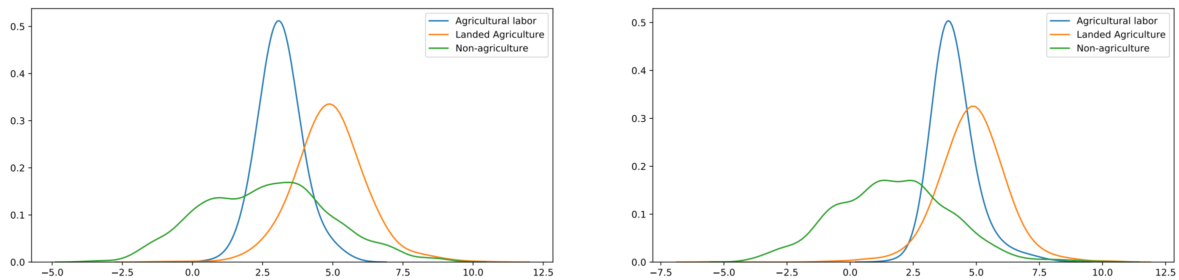
Non-agricultural Income. There are two types of non-agricultural income. Some households run non-agricultural businesses and report in the survey the revenues and costs over the year. Therefore I can write household non-agricultural business income as:

$$VA_{b,i} = Rev_{b,i} - Cost_{b,i} \tag{7}$$

In order to have a comparable measure against other income sources, I compute the non-agricultural business income per hour of household member spent on working at the business. Further, there is also a set of formal workers who earn non-agricultural wages. These are professional workers with education who work in the formal and government sectors of the economy. I also measure their hourly wage.

Summary. In order to assign an occupation to households in our data, I assign them to the occupation (landed agriculture, agricultural labor, non-agriculture) where the household spends most of their time in. After doing this, I can characterize the distribution of income across the three occupations in our economy as seen in figure 3.

Figure 3: Earnings by Occupation



(a) LSMS 2010

(b) LSMS 2013

Quantitative Analysis

Functional forms. I order to assess how well the model describes the data, I first need to assign functional forms to various activities and variables. I consider agricultural technology that is constant elasticity of substitution and can be written as:

$$\varepsilon_a f_a(\ell_c, n_a) = \varepsilon_a \left(\alpha \ell_c^{\gamma} + (1-\alpha) n_a^{\gamma}\right)^{\frac{1}{\gamma}} \tag{8}$$

The non-agricultural productivity follows an auto regressive process of order 1 with a constant term that can be written as:

$$log(z_{t+1}) = (1-\rho_z)\bar{z} + \rho_z log(z_t) + \sigma_z \epsilon \tag{9}$$

where ϵ is drawn from $N(0,1)$. Finally, the utility can be written as

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma} \tag{10}$$

Altogether, there are 10 parameters to calibrate, 3 agricultural technology parameters ε_a, γ, and α, 2 preference parameters β and σ, 2 land institution parameters π_a and π_e, 3 non-agricultural process parameters $\bar{z}, \sigma_z$, and ρ_z and the interest on assets R.

Calibration. In order to find the parameters of the model that best describe the data, I pick parameters to match some aggregate moments while others to match simulated moments. Here I describe each one in turn. I have some parameters that are either normalized or are taken from the literature, some that I calibrate to match aggregate moments in the data, and the last set are picked to match simulated moments in the micro data. For the first set of moments, I normalize

ℓ_c so that each ℓ_c represents one unit of household in the aggregation of those with usufruct rights on land. I also normalize ε_a to 1.0 for now as it doesn't affect allocations, but can use later to set levels. I also use β, R, σ and ϕ from Lagakos et al. (2018) to set the model to an yearly frequency.

For the aggregate moments, I use the average productivity in non-agriculture to match the share of farmers in the economy (N_f^a) - in the data, these are the households that get their land through customary tenure managed by village chiefs. I then use the degree of land scarcity π_a to match the mass of workers in agriculture (N_w^a). This parameter determines non-pecuniary benefits of agricultural labor that allows workers to gain access to land when it becomes available. Because of the equilibrium condition and the farming technology, there is an analytical expression for the wage and profits that follow from these two aggregate targets. I can write the wage, the profits and their ratio as follows:

$$\text{farm profits} = \alpha\varepsilon_a \left(\frac{N_w^a}{N_f^a}\right)^{1-\alpha} \tag{11}$$

$$w_a = (1-\alpha)\varepsilon_a \ell_z^\alpha \left(\frac{N_w^a}{N_f^a}\right)^{-\alpha} \Rightarrow \tag{12}$$

$$\frac{\text{farm profits}}{w_a} = \frac{\alpha}{1-\alpha}\frac{N_w^a}{N_f^a} \tag{13}$$

Note that because of the equilibrium condition on agricultural labor and the cobb-douglas assumption on farming technology, this ratio is only a function of α and occupation targets, so it can be analytically characterized once we have the targets.

In order to get the last three parameters we need to simulate moments from the model to match moments in the data. In order to do this, I compute the model, simulate a panel of households from the stationary distribution, and compute moments that I then use in the estimation. This pins down the last three parameters in the model, i.e. π_e, ρ_z, and σ_z. I use π_e to match the share of households in landed agriculture who transition to non-agriculture. I use ρ_z to match the share of agricultural workers who transition to non-agriculture. And finally, I use σ_z to match the degree of risk faced by households who switch to non-agriculture - where earnings are stochastic. In the model, I follow households who began in agriculture but ended up in non-agriculture in the last period and compute the variance of their earnings in the last period. In the data, I strip out observable differences in households transitioning from agricultural work to non-agriculture from 2010 to 2013, and use the variance in residual earnings as a moment condition. Note that α can be set once we know the occupation targets. Otherwise, the 5 parameters - $\pi_a, \bar{z}, \pi_e, \rho_z$ and σ_z are jointly estimated. The estimation of the model is still in process.

Parameter	Value	Moment	Target
Predetermined Parameters			
Land endowment of landed farmers (ℓ_c)	1.00	Normalized	
Productivity of landed farmers (ε_a)	1.00	Normalized to levels of log earnings in farming	
Elasticity of substitution in farming technology (γ)	1.00	Technology cobb-douglas for now	
Discount factor (β)	0.96	Annual frequency (Waugh, Lagakos, and Mobarak)	
Risk Aversion (σ)	2.00	Literature (Waugh, Lagakos, and Mobarak)	
Interest rate (R)	0.95	Literature (Waugh, Lagakos, and Mobarak)	
Borrowing constraint (ϕ)	0.00	Literature (Waugh, Lagakos, and Mobarak)	
Calibrated from Aggregate Moments			
Land scarcity parameter (π_a)		Share of ag workers - N^a_w	0.65
Constant of non-ag productivity process ($\bar{z}$)		Share of landed ag - N^a_f	0.17
Land share (α)		Ratio of income from landed ag to ag labor	6.0
Estimated from Simulated Moments			
Probability of losing land (π_e)		Share of landed ag in 2010 in non-ag in 2013	0.25
Persistence of non-ag productivity process (ρ_z)		Share of ag workers in 2010 in non-ag in 2013	0.25
Variance of non-ag productivity process (σ_z)		Variance of non-ag productivity (log) in 2013 for ag workers in 2010	X

Policy experiment

The policy experiment is still under construction.

Conclusions

In this paper I study the implications of land reform when agricultural land in developing countries also fulfills a social insurance objective. So far, the literature on land misallocation has abstracted from this channel. The model I write can be augmented to evaluate the relative contribution of the channel I emphasize and the role of misallocation. I explore this in a different paper. In this paper, I write a model that features incomplete markets for consumption and the details on land institutions that offer wider scope for consumption insurance. I match this model to micro data for Malawi and use it to study the implications of letting markets play a larger role in allocating land in agriculture. The model I write departs from the literature on land misallocation by focusing on the role of land institutions in consumption insurance provision when activities outside of agriculture are riskier and limited. The model I build allows me to evaluate both the aggregate and distributional effects of the policy. The estimation of the model is still ongoing.

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