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Land Rental Market Reforms: Can They Increase Outmigration From Agriculture? Evidence From a Quantitative Model

Arnaud Daymard

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Abstract

Recent econometric work has found that policies improving the functioning of the land rental market have increased outmigration from agriculture in the developing world. I investigate this claim using a two-sector model of structural transformation that takes into account the well-known inverse relationship between farm size and farm productivity. Theoretically, outmigration from agriculture depends on how flexible agricultural prices are, while rigid agricultural prices lead to the reverse phenomenon of immigration in agriculture. Practically, the model predicts that for most countries, land rental market reforms cause little labor movement between sectors. In spite of this, these reforms are found to increase substantially the production efficiency and welfare of farmers.

JEL classification: O11, O13, O14, O41, F41

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1 Introduction

The structural transformation of developing economies is regularly cited as a major challenge of economic policy for the decades to come. Whether as a purely positive question, for the purpose

*THEMA, CY Cergy Paris Université & CES, Université Paris 1 Panthéon-Sorbonne

of predicting the needs of the growing urban economy, or whether on normative grounds, on the basis that a large and traditional agricultural sector is usually a drag on productivity, the question of why and how to transfer jobs to the manufacturing and service sectors has become a central piece of reflection in the developing world.

A recurrent question of agricultural policy is the effect of a dysfunctioning land market on the state of agricultural production and the mobility of labor in and out of agriculture. It has been claimed that a better functioning of the land market, in particular with respect to the diverse transaction costs that currently exists, would free labor from the agricultural sector and allow more individuals to work in off farm occupations, or to migrate to urban centers. For example Deininger et al. (2014) find that the distribution of land certificates increases the supply of off-farm labor from Chinese households, without affecting their chances to exit agriculture. A higher risk of expropriation however significantly decreases the odds that the household will quit agriculture. Kung (2002) notes that land rental transactions and off-farm employment have been rising hand-in-hand in Chinese provinces. Kung argues however that the sense of causality is from the labor market to the land market. A dramatic increase of off-farm activities caused by a large earning gap encourages farmers to rent out their land on the market. In Sub-Saharan Africa, Deininger et al. (2017) argue that ”land sales may allow households who want to move into the non-agricultural economy to mobilize the equity that will help them to exploit profitable opportunities (..)”. In Mexico, de Janvry et al. (2015) show that the land reform of 1993-2006, that ended the obligation of land use to secure land assignment and replaced it with land certificates, had the effect of increasing outmigration from agrarian communities. A related claim is that land reforms that redistribute land in a more equal manner release the constraints of a dysfunctional land market and improve the efficiency of agricultural production (e.g. Eswaran and Kotwal (1986), Lipton (1993), Deininger and Feder (2001)).

This topic however has received little attention on the theoretical side. Deininger and Jin (2005) presents a simple model of land rental market with off farm opportunities and shows that a reduction in transaction costs improves welfare and rental market activity. Deininger and Jin also conjectures that a reduction in transaction costs in the land rental market will help the non-agricultural sector to grow, even though this idea is not formalized in the model. Chernina et al. (2014) build a model of migration were migrants have to finance the setup costs of migration by selling their lands and other immobile assets. They show that a greater liquidity on the land market prompts more people to sell their assets and to migrate. They also show that greater land tenure security increases temporary migration without affecting permanent migration. However, the model does not explicitly include a land rental or sales market, nor an explicit choice of sectoral occupation. Adamopoulos and Restuccia (2014) study the effect of progressive land taxes and other size-related distortions on agricultural productivity and agricultural labor in developing countries. They show that approximately 50 per cent of the gap in labor productivity between rich and poor countries can be explained by policy distortions favoring small farms, along with differences in aggregate factors such as land, capital and economy-wide productivity. In their model, agricultural employment increases with farm-size distortions. However, they assume that farm size is related to farmer's managerial skills and that there are no imperfections in the labor and land markets (to the exception of the land tax). Although there is evidence that land and labor markets are efficient in developed countries, in the developing world a large body of evidence has shown that these markets are largely dysfunctional (Deininger and Feder (2001), Otsuka (2007), Eastwood et al. (2010)). As a result, there is a presumption that large farms might be inefficient compared to small farms (*ibid.*). Part of the explanation lies in the low mechanization of agriculture in developing countries (see e.g. Sheahan and Barrett (2017)), and therefore economies of scale that come along the use of increasingly sophisticated and lumpy equipments are likely to be limited. Rather, the *family farm theory* of agriculture holds the view that high supervision costs of hired labor limit the extent of the efficient production unit to the family farm (e.g. Binswanger and Rosenzweig (1986), Eastwood et al. (2010)).

This paper asks: what labor movement can be expected from a reduction in the transaction costs in the rental market? Specifically, the central question is: following a reduction in transaction costs in the land rental market, will the increased land rental activity induce farmers to move out of agriculture? A closely related question is: can administrative reallocation of land, in particular toward a more egalitarian distribution, motivate farmers to move out of agriculture? These questions will be answered in relation to efficient agricultural production, namely, is there a positive relation between efficiency in agricultural production and a reduction in the number of farmers?

The model is designed to take into account the most salient features of traditional agriculture. First, the production technology is assumed to have constant returns to scale given the limited availability of mechanized equipment. Second, and central to the family farm theory, hired labor is more costly than family labor due to supervision and search costs. Third, the land rental market is subject to transaction costs, implying that some farmers will optimally choose to remain in autarky. Fourth, land ownership is skewed, as I assume in this paper that the distribution of land is given by a Pareto law.

The model generates endogenously several classes of farmers and farm sizes depending on the initial land-labor ratio endowed to the farming household. It therefore builds on previous work by Feder (1985), Eswaran and Kotwal (1986) and Kevane (1996) in assuming that optimal farm size is the result of market imperfections. In the model, market imperfections in the labor and land markets generate the well documented inverse relationship between farm size and land productivity (for a review of the literature see Eastwood et al. (2010) and Gollin (2019)). Although many other market failures have been documented in traditional agriculture, a minimum of two market imperfections are required to explain inefficient behavior in a setting of constant returns to scale in production (Kevane (1996)). Feder and Eswaran and Kotwal assume failures to occur in the labor and credit markets. I assume failures to occur only in the labor and land markets, ignoring possible failures in the credit market. This is both for the sake of simplicity and because recent evidence suggests that only a small share of agricultural inputs is financed through credit (Adjognon et al. (2017)).

For the sake of intuition, the effect of a reduction in transaction costs in the land rental market is first studied in partial equilibrium, with constant agricultural price. Then agricultural prices are endogenized in a general equilibrium two-sector model. When agricultural prices are held constant, a clear picture emerges: a reduction in transaction costs increases land rental activity, but contrary to current expectations, this increased land rental activity creates a movement of labor out of non-agriculture and into agriculture. The reason for this is simple: increased land rental activity enables previously autarkic farmers to rent out their land to poorly endowed farmers, inducing them to increase their supply of work on the farm. When agricultural prices are allowed to move, a reduction in transaction costs in the land market creates additional agricultural production leading the way for a decrease in agricultural prices. This decrease in agricultural prices mitigates the partial equilibrium effect in inducing workers to move out of agriculture.

If instead of a reduction in transaction costs, administrative reallocation of land is chosen, then the expected direction of labor movement is more complex. In partial equilibrium, it can be summarized as follows: when staged from an initially very unequal land distribution, land reallocations induce workers to move out of agriculture, but when staged from an initially more equal land distribution, land reallocations induce workers to move in agriculture. In any case, land reallocations do not always favor efficient agricultural production.

Finally, the model is calibrated to assess the relative importance of partial and general equilibrium effects. Land rental market reforms and land reallocations contribute significantly to the efficiency of agricultural production and increase welfare substantially. However, the effect of these reforms on labor migration is of limited importance for most countries, to the exception of countries with a highly dysfunctional land rental market. Importantly, no clear pattern emerges for the direction of labor migration, as some countries experience a decrease in agricultural employment while others experience an increase.

To sum up, when the land rental market improves, the partial equilibrium effect prompts workers to join agriculture, but in general equilibrium, a drop in agricultural prices can partially or totally offset this mechanism. Thus the expectation that an improvement in the land rental market causes farmers to quit agriculture is predicated on the assumption of sufficiently flexible and elastic agricultural prices, an idea that is likely to be fragile in practice.

The remainder of this paper is as follows. Section 2 describes the model and solves the market equilibrium in a partial equilibrium setting, that is, agriculture is studied in isolation to the rest of the economy. Section 3 extends the model to a general equilibrium setting in which agricultural prices are endogenized. Section 4 calibrates the model to assess the relative importance of partial and general equilibrium effects. Section 5 concludes.

2 Partial equilibrium

In this section the agricultural sector is studied in isolation to the rest of the economy, with output and input prices being treated as exogenous. One exception is the price of land rental, which in the present model is endogenous to the agricultural sector.

2.1 The economic problem faced by farmers

Consider a continuum of farmer families of mass one, each having an endowment of one unit of labor, and indexed by the letter i. There is no leisure time and labor is supplied inelastically. Each family seeks to maximize its profits by choosing the appropriate quantity of labor (L_i^A), land (S_i^A) and capital (K_i) to use on the farm. The family can use its own labor either on the farm or seek for employment outside the farm. However, I assume that supervision and/or search costs for hired labor are such as to prevent each family from hiring any labor at all. This assumption is meant to reduce the complexity of the farmer's problem, since the possibility to hire with supervision costs expand the classes of farmers to up to nine different behaviors, compared to only three in the current setting. As long as supervision costs are high enough that the actual proportion of hired labor is small, the loss in predictive value should be reasonable. Table 1 below shows that this is indeed the case for most developing countries, though there are important exceptions.

Table 1: *Percentage of hired labor in total labor supply (family + hired) in agriculture*

Country	Year	Hired labor in labor supply
Albania	2005	0,4%
Bangladesh	2005	34,4%
Bolivia	2005	0,8%
Cambodia	2004	2,1%
Ethiopia	2012	10,1%
Ghana	2013	1,3%
Guatemala	2006	2,8%
Indonesia	2000	8,9%
Kenya	2005	14,3%
Malawi	2011	2,4%
Nepal	2003	1,9%
Nicaragua	2005	6,3%
Niger	2011	3,6%
Nigeria	2013	3,5%
Panama	2003	9,9%
Tajikistan	2007	32,9%
Uganda	2012	8,8%
Tanzania	2013	6,2%
Viet Nam	2008	3,5%

Source: author's computations on the FAO Smallholders dataportrait, nationally representative estimates. Labor is measured in days of work supplied to the farming household over one year. Total labor includes family and hired labor, and family labor includes both on-farm and off-farm work.

With this assumption, on-farm labor can only come from within the family. Another consequence is that off-farm employment is identified with manufacturing and services employment, since no hiring in agriculture can occur.

Each family is endowed with some land S_i, can use this land on the farm, and can additionally either rent in or rent out this land without limitation. However, legal restrictions of tenancy and other policies favoring tenants translate into transaction costs for farmers that are willing to rent out their land. These transaction costs are to be understood in a broad sense. If property rights are insecure because no formal titling process has been carried out, the transaction costs are meant to represent the fear that the tenant might claim possession of the land after a long tenancy period, or might force the landlord to rent on favorable conditions. If governments are active in the land markets, the transaction costs might stand for tenancy regulations such as prohibition of land rent or sales, restrictions on the rental price, restrictions on the duration of rental contracts, and so on. They might also represent search costs. By assumption, theses regulations involve a loss for landlords that rent land out, but do not affect tenants that rent land in. This assumption is without loss of generality because the demand for land in this model is perfectly elastic, and so the burden of transaction costs must weight on people that supply land to the market.

I assume that land tenancy consists of fixed-rent contracts. In practice sharecropping, whereby the landlord is given a share of the output in payment, is a common agreement in many parts of the developing world. These agreements are Pareto-optimal if tenants are risk-averse and landlords cannot perfectly monitor the tenant's work effort (Stiglitz (1974), Otsuka et al. (1992)). In this model there is no uncertainty and the labor supply is inelastic; as a result, fixed-rent and sharecropping contracts are equivalent. Likewise, the model assumes a financial equivalence between renting and buying and all the transactions are supposed to take place through the land rental market.

Finally, each family chooses freely the amount of capital it wants to use on its farm, and the distribution of capital ownership among families is irrelevant here. The two market failures of this model can be summarized as follows:

H1: Hiring labor on-farm is not profitable in any circumstance.

H2: Land owners that are willing to rent out their land face transaction costs. Specifying further the model, the next assumptions are simply a trade-off between realism and tractability:

H3: Agricultural technology is identical across families and is Cobb-Douglas with constant returns to scale.

H4: Land is distributed across families according to a Pareto distribution of type 1.

Using **H1-H3**, the maximization problem facing each family of farmers i can be described as follows:

$$\begin{aligned} \max_{L_i^A, L_i^O, S_i^A, S_i^O, S_i^I, K_i} \quad & p_A Y_i^A + w\, L_i^O + q\,(\theta\, S_i^O - S_i^I) - p_K\, K_i \\ \text{s.t.} \quad & Y_i^A = A\,(L_i^A)^{\alpha}\,(S_i^A)^{\beta}\, K_i^{1-\alpha-\beta}, \\ & 1 \geq L_i^O + L_i^A, \\ & S_i^I + S_i \geq S_i^O + S_i^A, \\ & 0 \leq \theta \leq 1, \end{aligned} \tag{1}$$

where p_A denotes agricultural price, Y_i^A denotes agricultural production and A is total factor productivity; L_i^O refers to off-farm employment, S_i^O and S_i^I refer to respectively land rented out and rented in; w is the wage rate, q is the land rental rate and p_K is the price of one unit of capital goods. In this paper, I assume that capital goods fully depreciate after use and thus are not distinct from intermediate inputs. K_i therefore includes tractors, harvesters and buildings as well as fertilizers and seeds. θ represents the extent of the transaction costs faced by farmers that rent land out. If θ reaches one, the land rental market operates perfectly, if θ reaches zero, the transaction costs are so high as to offset any revenue derived from renting out land.

Each farmer family is endowed with one unit of labor so that family i is endowed with the land-labor ratio $s_i = S_i$; the distribution of the endowed land-labor ratio is the same as the distribution of the land endowment. **H4** then implies that the proportion of families endowed with a land-labor ratio less than s_i is the following:

$$F(s_i) = 1 - \left(\frac{\delta - 1}{\delta}\, \frac{S_T}{s_i}\right)^{\delta}, \quad \delta > 1. \tag{2}$$

Where S_T is the total supply of land (and equals the aggregate land-labor ratio), and δ is the shape parameter. This parametrization of the Pareto law is meant to ensure that redistributing land does not increase the total supply of land. Increasing δ keeps the total supply of land unchanged while making the distribution of land more egalitarian. Since the minimum land-labor ratio of the distribution is $s_m = \frac{\delta-1}{\delta} S_T$, increasing δ also raises the endowment of the poorest family.

2.2 Classes of farmer

The particular configuration described above gives rise to two types of market equilibrium: a fully autarkic equilibrium and an equilibrium with three classes of farmers. Consider $s_1 = \frac{\beta}{\alpha} \frac{w}{q}$. This is the efficient land-labor ratio under the Cobb-Douglas technology described in (1). Consider also $s_m = \frac{\delta-1}{\delta} S_T$, the minimum land-labor ratio a family can possibly be endowed with.

If $s_m > s_1$, every family has an endowed land-labor ratio higher than the efficient land-labor ratio. Families are then faced with two possibilities to decrease their endowed land-labor ratio: to hire labor on the farm, or to rent land out to other smaller farms. One of these solutions, hiring labor, is excluded by assuming that it is too costly to supervise labor on the farm. The only remaining choice is for these families to rent out land on the market. But every family is willing to rent out and no family is willing to rent in, so there cannot be any land rental market. Besides, no family is willing to employ part of its labor outside the farm. Thus there is no manufacturing employment and the total labor force is employed in agriculture. This is the **full autarky equilibrium**.

If $s_m < s_1$, the land rental market can emerge and some families will be willing to employ labor outside the farm. In what follows, any reference to classes of farmers means that the assumption $s_m < s_1$ implicitly holds. In this setting, each family i belong to a unique class of farmers depending on its initial endowment s_i of land per family labor. A family of farmers having an endowment lower than s_1 is compelled to attain this efficient ratio by renting land in, and by sending labor to off farm occupations. This is why the first class of farmers, those that have an initial endowment lower than s_1, are **tenants** and **part-time** farmers. I will name this class of farmers as **tenants** for short.

Any family starting with the initial endowment s_1 does not need to trade on the land and labor markets. Its initial endowment allows it to achieve efficient production already. Now, if the family starts with an endowment $s_i > s_1$, in the absence of transaction costs it will rent out land to decrease the input ratio to the efficient level. But because of the presence of transaction costs in the land rental market, this gives rise to two additional classes of farmers.

First, there are farmers who do not find it profitable to rent out land because of transactions costs, even though this would allow them to reach the efficient ratio s_1. These farmers participate neither in the labor market nor in the land market. I will name this class **autarkic farmers**. Strictly speaking, autarky is meant only in the labor and land markets, since these farmers can still sell their production to other families and buy capital goods. These farmers have an initial endowment s_i with $s_1 < s_i < s_2$ and $s_2 = s_1 \theta^{-\frac{\alpha+\beta}{\alpha}}$.

Second, families with endowments higher than s_2 will find it profitable to bear the transaction costs of the land market and will rent land out. This is because the marginal productivity of the land operated on the family farm has become too small. These families rent out land up to the point of reaching the ratio s_2, at which no further renting is profitable. Given this feature, I will name these farmers **landlords**. Like the autarkic farmers, landlords do not participate in the labor market since every unit of labor is more profitable to use on the farm.

One immediate and simple insight is that the size of the autarkic class depends upon the extent of transaction costs: if θ diminishes, then s_2 rises and more and more farmers will belong to the autarkic class. In the event that the transaction costs disappear ($\theta = 1$), then the autarkic class disappear and only landlords and tenants remain. Let me now give details on the behavior of each class in turn.

2.2.1 Tenants

The central feature of tenants is that returns to scale are constant within this class. The productivity of land is the same for all tenants and there is no optimal farm size. Consequently, the class of tenants can be treated as one unique farm where all tenants work. The optimal production of tenants is a linear function of labor used. Their optimal usage of land is defined through the ratio s_1.

If $\underline{s_i < s_1 = \frac{\beta}{\alpha}\frac{w}{q}}$,

$$Y_i^A = A\left(\frac{w}{\alpha}\right)^{1-\alpha}\left(\frac{\beta}{q}\right)^{\beta}\left(\frac{1-\alpha-\beta}{p_K}\right)^{1-\alpha-\beta} L_i^A\,, \tag{3}$$

$$\frac{S_i^A}{L_i^A} = \frac{\beta}{\alpha}\frac{w}{q} = s_1\,. \tag{4}$$

The amount of labor in off-farm employment and the amount of land rented in is in turn determined by the initial endowment of the family.

$$L_i^O = 1 - L_i^A\,; \quad S_i^I = S_i^A - S_i\,. \tag{5}$$

Given that tenants have access to a constant returns to scale technology, their equilibrium profits must be zero. This in turn imposes a constraint on the equilibrium land rent:

$$q = \beta\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{\beta}}\left(\frac{1-\alpha-\beta}{p_K}\right)^{\frac{1-\alpha-\beta}{\beta}}(A\,p_A)^{\frac{1}{\beta}}\,. \tag{6}$$

Any other value of the land rent would lead to either an infinite demand for land or no demand at all. Because the full autarky equilibrium has been dismissed, this equality must hold. It proves, as claimed before, that the demand for land is perfectly elastic.

2.2.2 Autarkic farmers

Autarkic farmers are endowed with a land-labor ratio higher than s_1 and so produce inefficiently. This inefficiency grows with the size of the land endowment, which translate into a lower land productivity for bigger farms. This class therefore exhibits the well known inverse relationship between land productivity and farm size.
If $\underline{s_1 < s_i < s_2 = s_1 \theta^{-\frac{\alpha+\beta}{\alpha}}}$,

$$Y_i^A = A\,(p_A A)^{\frac{1-(\alpha+\beta)}{\alpha+\beta}} \left(\frac{1-\alpha-\beta}{p_K}\right)^{\frac{1-\alpha-\beta}{\alpha+\beta}} S_i^{\frac{\beta}{\alpha+\beta}}\,, \tag{7}$$

$$L_i^A = 1\,; \quad S_i^A = S_i\,, \tag{8}$$

$$\frac{\partial y_i^A}{\partial S_i} < 0\,, \quad \text{with} \quad y_i^A = \frac{Y_i^A}{S_i}\,. \tag{9}$$

2.2.3 Landlords

Landlords are constrained by the size of their labor endowment. Given a labor endowment of 1, there is a unique optimal farm size (i.e. a value of S_i^A) that maximizes profits. Given that the labor endowment is assumed constant across families, every landlord chooses the same farm size and produces the same quantity. However, given that the endowment of land differs across families, the amount of land rented out differs.
If $\underline{s_2 < s_i}$,

$$Y_i^A = A\,(p_A A)^{\frac{1-\alpha}{\alpha}} \left(\frac{\beta}{\theta q}\right)^{\frac{\beta}{\alpha}} \left(\frac{1-\alpha-\beta}{p_K}\right)^{\frac{1-\alpha-\beta}{\alpha}}\,, \tag{10}$$

$$\frac{S_i^A}{L_i^A} = \frac{\beta}{\alpha}\,\frac{w}{q}\,\theta^{-\frac{\alpha+\beta}{\alpha}} = s_2\,, \tag{11}$$

$$L_i^A = 1\,; \quad S_i^O = S_i - S_i^A\,. \tag{12}$$

2.2.4 The inverse relationship between farm size and land productivity

Until now, I have shown that there is an inverse relationship between farm size and land productivity in the class of autarkic farmers. But this relationship also holds across classes. Put simply,

$$y_i^{\textbf{Tenants}} > y_i^{\textbf{Autarkic farmers}} > y_i^{\textbf{Landlords}}, \tag{13}$$

where $y_i = \frac{Y_i^A}{S_i^A}$. Therefore the only efficient class of producers are tenants, followed by autarkic farmers and landlords. Note that the class of autarkic farmers is the only class where land productivity varies with land endowment; tenants and landlords each have a unique land productivity.

2.3 The behavior of aggregate variables

Using distribution (2), it is possible to solve for the aggregate level of production, labor used in agriculture and outside of agriculture.

2.3.1 Aggregate labor and land rental

I denote by S^O the aggregate level of land rented out, which in equilibrium must be equal to S^I, the aggregate level of land rented in. L^A is the aggregate level of agricultural employment, and L^M, the aggregate level of off-farm employment (here identified with manufacturing and services employment) is equal to the total amount of labor 1 diminished by L^A.

$$S^O = \int_{s_m}^{\infty} S_i^O \, dF(s_i) = \frac{s_1}{\delta - 1}\left(\frac{\delta - 1}{\delta}\frac{S_T}{s_1}\right)^{\delta} \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)} \tag{14}$$

$$L^A = \int_{s_m}^{\infty} L_i^A \, dF(s_i) = \left\{\frac{S_T}{s_1} - \frac{1}{\delta - 1}\left(\frac{\delta - 1}{\delta}\frac{S_T}{s_1}\right)^{\delta}\left(1 - \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}\right)\right\} \tag{15}$$

$$L^M = \int_{s_m}^{\infty} L_i^O \, dF(s_i) = 1 - L^A \tag{16}$$

Some noticeable results emerge at this stage. They are summarized in Proposition 1 below. The proofs for this proposition, as well as for Proposition 2 and 3 *infra* are to be found in Appendix A.

Proposition 1 *In the partial equilibrium setting of (H1-H4) where agricultural prices (p_A) and* *intermediate input prices (w, p_K) are exogenous variables, the following results hold.*

(a) A decrease in transaction costs in the land market creates a movement of labor out of manufacturing and into agriculture:

$$\frac{\partial L^A}{\partial \theta} > 0 \qquad \frac{\partial L^M}{\partial \theta} < 0. \tag{17}$$

(b) Provided $S_T \leq s_1$, the efficient level of agricultural employment (i.e. no transaction costs in the land market) can be achieved either with perfectly equal or with perfectly unequal distribution of land ownership:

$$\lim_{\theta \to 1} L^A = \lim_{\delta \to \infty} L^A = \lim_{\delta \to 1} L^A = \frac{S_T}{s_1}. \tag{18}$$

In partial equilibrium, it is clear that a better functioning of the land rental market should lead us to expect *more* labor in agriculture, and not *less*. As to the effect of land redistribution on efficiency, Proposition 1 part b) sets a clear message: unequal land distribution does not necessarily mean inefficient allocation. In fact, both perfectly equal and perfectly unequal land distributions lead to an efficient outcome, which means that land redistributing policies can lower efficiency if starting from a very unequal distribution. The hypothesis $S_T \leq s_1$ in part (b) is intuitive: market prices p_A and w are restricted so as to ensure that the efficient level of agricultural labor $\frac{S_T}{s_1}$ is lower than 1, the total supply of labor. It provides some minimal guarantee of market clearing on the labor market.

I plotted the aggregate level of land rented as a proportion of the total land supply in Figure 1. As expected in panel (a), an increase of θ—a decrease in transaction costs—increases the share of land rented. This same effect can be obtained by increasing inequality, and panel (b) shows that perfect equality and perfect inequality coincide with respectively 0% and 100% of land rented. In this panel, the shape parameter δ has been replaced by the Gini index $g = \frac{1}{2\delta - 1}$ so that the graph can span the full spectrum of inequality.

In Figure 2, panels (a) to (f) illustrate the allocation of labor between different classes of farmers and between agriculture and manufacturing for varying levels of θ and δ. Panel (a) pictures the allocation of agricultural labor between tenants, autarkic farmers and landlords when θ goes from zero to one. As θ increases, more and more autarkic farmers are being converted into landlords, and land supply on the rental market increases. This increased land supply in turn motivates tenants to increase the size of their farms and to spend more hours on agricultural work, explaining the positive relationship between the share of labor in agriculture and θ pictured in Panel (b).

As shown in Panels (c) to (f), the relationship between agricultural labor and land ownership distribution is non-monotonic. Panels (c) and (d) show what happens when transaction costs are high. In this setting, the class of landlords is negligible and insensitive to land ownership distribution. The class of autarkic farmers reaches a maximum at some middle ground between perfect equality and perfect inequality. Why? When the Gini index is zero and there is perfect equality, every family is a tenant; it uses its land endowment fully on the farm and devotes some of its work to off farm activities. Since tenancy is the most efficient class, aggregate efficiency is realized. When the Gini index is one and there is perfect inequality, one family owns all the land. Everyone else has a land-labor ratio of zero and for that reason belongs to the class of tenants. In this situation, one unique landlord rents out the entire land endowment of the economy into the hands of every other family. In turn, each family of tenants rent in the amount of land necessary to reach the efficient ratio s_1. Since every family is a tenant except for the unique landlord family which has a mass of zero, aggregate efficiency is realized. To reach full efficiency, no amount of land must be trapped into the hands of autarkic farmers. This means that either land must be distributed equally so that no one needs the land rental market, either it must be given to a single family so that all the land is distributed through the land rental market. The maximum of autarkic farmers has to occur somewhere in between, when neither equality nor inequality are strong enough to funnel land into the hands of tenants. This mechanism translates into a non-monotonic relationship between the share of labor in agriculture and inequality, as depicted in Panel (d).

Panels (e) and (f) show what happens when θ is high, so that the rental market functions well. In this setting, a large class of landlords will emerge as inequality rises, while the class of autarkic farmers will quickly drop to low levels. These landlords redistribute land to tenants and prevent large amounts of land to be stuck in inefficiently large farms. As a consequence, the effect of inequality on agricultural labor is much smaller, as evidenced by Panel (f).

2.3.2 Aggregate production

The main insight from production is that, as could be expected, a reduction in transaction costs will raise agricultural output. But once again, redistributing land will not necessarily improve

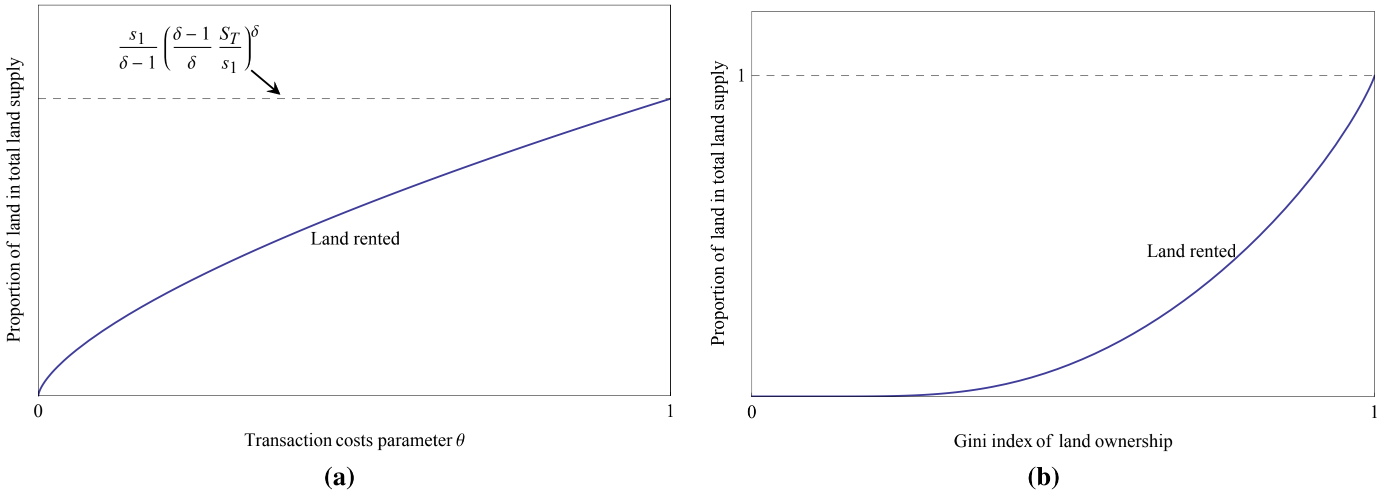


Figure 1: *The behavior of the rental market*

agricultural production. As in Proposition 1, the two poles of perfect equality and perfect inequality both lead to efficient production.

In what follows, aggregate agricultural production is denoted Y^A and is written as the product of an efficient output $\tilde{Y}^A$ and an efficiency index I. As before, efficient output is defined as output achieved in the absence of transaction costs in the land rental market.

$$\begin{aligned} Y^A &= \int_{s_m}^{\infty} Y_i^A \, dF(s_i) = \tilde{Y}^A I, \\ \tilde{Y}^A &= \frac{w}{\alpha p_A} \frac{S_T}{s_1}, \\ I &= 1 + \left(\frac{\delta-1}{\delta}\frac{S_T}{s_1}\right)^{(\delta-1)} \left[\left(1-(\delta-1)\theta\frac{\beta}{\delta(\alpha+\beta)-\beta}\right)\frac{\theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}}{\delta} - \frac{\alpha}{\delta(\alpha+\beta)-\beta}\right], \\ 0 &< I \leq 1 \quad \text{(proof of this inequality in Appendix A).} \end{aligned} \tag{19}$$

Proposition 2 below gives results analogous to Proposition 1 on agricultural labor.

Proposition 2 *In the partial equilibrium setting of (H1-H4) where agricultural prices (p_A) and intermediate input prices (w, p_K) are exogenous variables, the following results hold.*
(a) A decrease in transaction costs in the land market increases agricultural production:

$$\frac{\partial Y^A}{\partial \theta} > 0 \tag{20}$$

(b) Provided $S_T \leq s_1$, the efficient level of agricultural production can be achieved either with

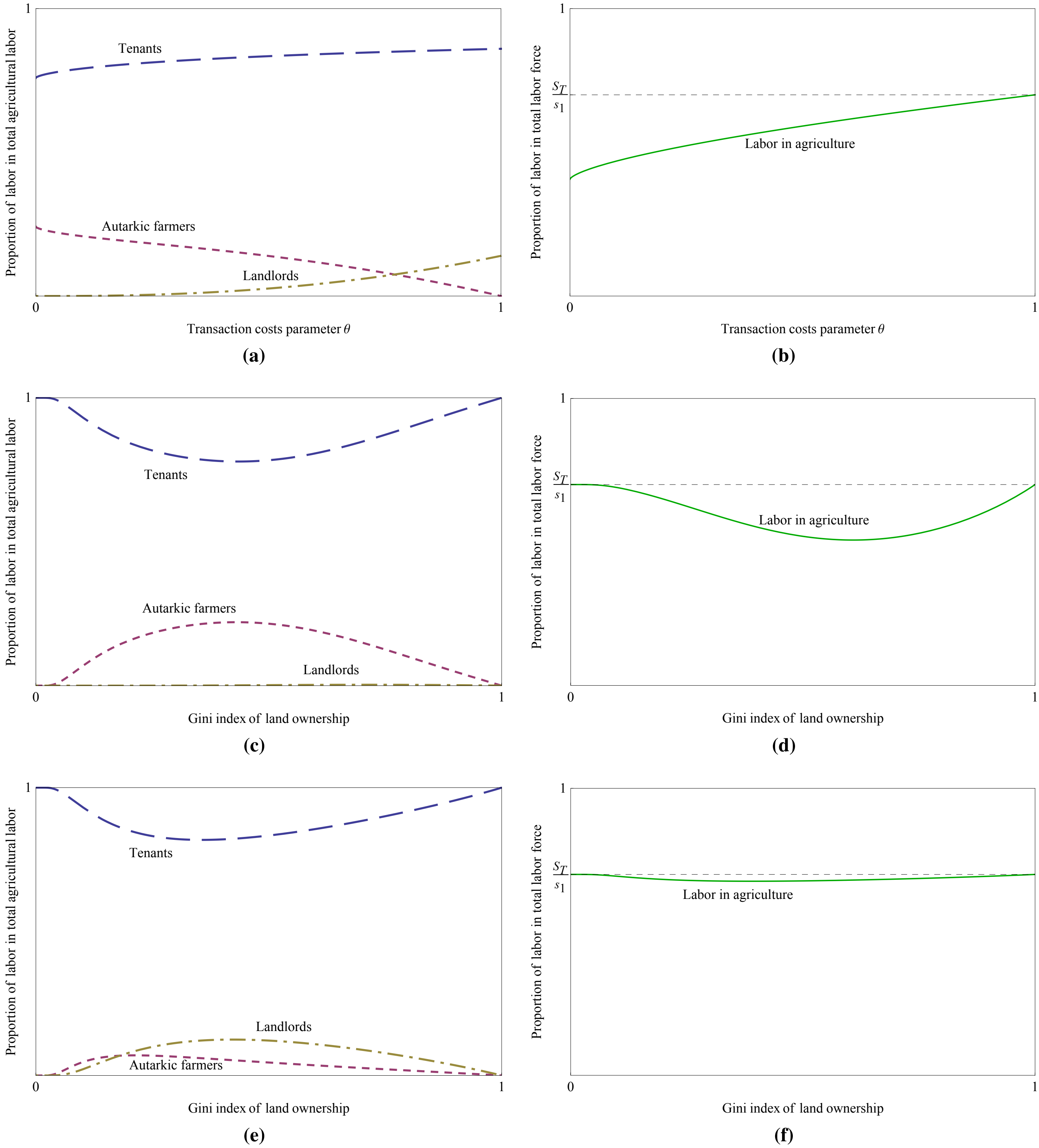


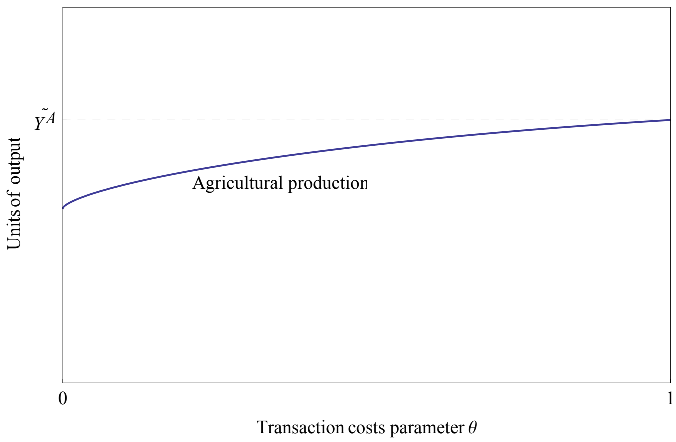
Figure 2: *The behavior of aggregate labor*

perfectly equal or with perfectly unequal distribution of land ownership:

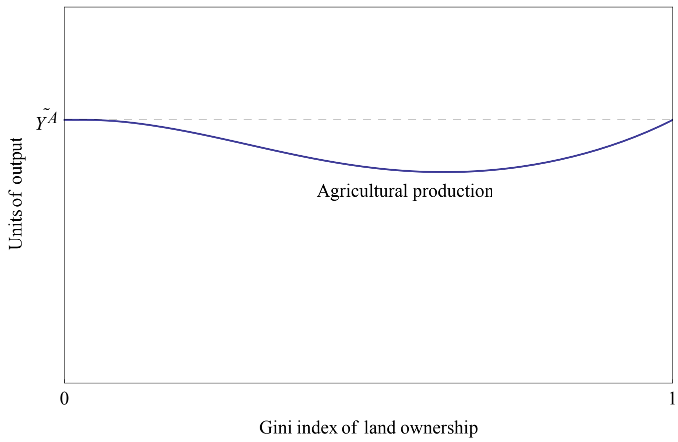
$$\lim_{\theta \to 1} Y^A = \lim_{\delta \to \infty} Y^A = \lim_{\delta \to 1} Y^A = \tilde{Y}^A. \tag{21}$$

In Figure 3 below, panels (a) and (b) show that the behavior of agricultural production is roughly the same as agricultural labor: aggregate production is rising with θ, but is a U-shaped function of the Gini index of land ownership.

In partial equilibrium, I have shown that one can expect a better functioning of the land market to attract more labor in agriculture and to raise agricultural production. As a result, policies aimed at reducing transactions costs on the land market should not be expected to lead to a transfer of labor from agriculture to the rest of the economy, but quite the contrary. But is this still the case once one allows for the possibility of endogenous agricultural prices? This is the concern of the next section.



(a)



(b)

Figure 3: *The behavior of aggregate production*

3 General equilibrium

3.1 Specification of the rest of the economy

Only three ingredients remain to fully specify the economy. The production technology of manufacturing and services (named manufacturing for short), the production technology of capital goods, and consumer preferences. In keeping with the spirit of simple and tractable assumptions, I assume that the manufacturing sector Y^M uses only labor L^M and has constant returns to scale.

$$\mathbf{H5} : Y^M = M\,L^M. \tag{22}$$

Capital goods fully depreciate after use and are produced out of manufacturing goods with no transformation cost.

H6: One unit of manufacturing goods can be transformed costlessly into $\frac{1}{\eta}$ capital goods for agriculture.

H5 and **H6** immediately imply

$$w = M\,; \quad p_K = \eta. \tag{23}$$

And the only remaining endogenous price is p_A, the price of agricultural goods. Next, I assume the existence of a representative consumer with the simplest form of non-homothetic preferences (originally due to Laitner (2000))[1].

$$\mathbf{H7} : U(C^A, C^M) = \begin{cases} C^A & \text{if} \quad C^A \leq \lambda \\ C^M + \lambda & \text{if} \quad C^A > \lambda \end{cases} \tag{24}$$

C^A and C^M are the aggregate consumptions of respectively agricultural and manufacturing goods. These preferences imply that the representative consumer will buy λ units of agricultural goods and then spend the rest of his income on manufacturing goods. Assumptions (**H5**-**H7**) combined with the assumption of a closed economy can be summarized with the following market clearing conditions:

$$\begin{aligned} Y^A &= C^A = \lambda\,, \\ Y^M &= \eta K + C^M = M\,L^M, \end{aligned} \tag{25}$$

where I have assumed that the production of λ agricultural goods is feasible. K is the aggregate production of capital goods for agriculture.

Equations (6), (15), (16), (19), (23) and (25) together define the general equilibrium for this economy.

[1] Note that these preferences are not of the Gorman form. However, these preferences can still be aggregated provided the distribution of wealth is restricted so as to ensure that every household can afford the subsistence level λ.

3.2 The behavior of aggregate labor with general equilibrium effects

Using equations (6), (19) and (23), aggregate agricultural production can be written solely in terms of agricultural prices. Once this is done, the first equation in (25) defines implicitly p_A in terms of the exogenous parameters:

$$\begin{aligned} \tilde{Y^A}\, I &= \lambda, \\ \tilde{Y^A} &= \left(\frac{\alpha}{M}\right)^{\frac{\alpha}{\beta}} \left(\frac{1-\alpha-\beta}{\eta}\right)^{\frac{1-\alpha-\beta}{\beta}} (A)^{\frac{1}{\beta}} (p_A)^{\frac{1-\beta}{\beta}} S_T\,, \\ I &= 1 + g\left(\frac{\delta-1}{\delta}\left(\frac{\alpha}{M}\right)^{\frac{\alpha}{\beta}+1}\left(\frac{1-\alpha-\beta}{\eta}\right)^{\frac{1-\alpha-\beta}{\beta}} (A\, p_A)^{\frac{1}{\beta}}\, S_T\right)^{\delta-1}, \end{aligned} \tag{26}$$

where g is the term in square brackets in equation (19). I can now state the main results of the allocation of labor in a general equilibrium.

Proposition 3 *In the general equilibrium setting of (H1-H7), the following results hold.*
(a) A decrease in transaction costs in the land market causes a drop in agricultural prices:

$$\frac{\partial p^A}{\partial \theta} < 0. \tag{27}$$

(b) Provided $S_T \leq s_1$, a drop in agricultural prices causes labor to move out of agriculture and into manufacturing:

$$\frac{\partial L^A}{\partial p_A} > 0 \qquad \frac{\partial L^M}{\partial p_A} < 0. \tag{28}$$

Proposition 1 previously stated that the *partial equilibrium* effect of a decrease in transaction costs was to *increase* labor in agriculture. Proposition 3 now adds that the *general equilibrium* effect of a decrease in transaction costs is to *decrease* labor in agriculture, through a drop in agricultural prices.

In the short run, while prices are fixed, a decrease in the transaction costs causes labor to move *in* agriculture. This is because the increased supply of land on the land rental market creates an incentive for farmers to work longer hours on the farm. In the long run, once agricultural production has increased and has passed on agricultural prices, the drop in agricultural prices induces labor to move *out* of agriculture. This is because of a decrease in the farm shadow wages. The net effect of both mechanisms is ambiguous and is purely a quantitative matter.

Is it possible to derive a general equilibrium effect of land redistribution policies? In the section on partial equilibrium, I emphasized that land redistribution policies have an ambiguous effect on the allocation of labor as well as agricultural production. This ambiguity passes on to general equilibrium analysis: redistributing land may increase agricultural production and decrease agricultural prices, or decrease agricultural production and increase agricultural prices. As shown in Figure 3, it depends on whether a minimum level of agricultural production has already been reached.

4 Model calibration

4.1 Methodology

The previous section has emphasized that in general equilibrium, an improvement in the rental market functioning may encourage labor to move out of agriculture if the drop in agricultural prices is sufficiently strong. This creates an ambiguity, at least in the long run, as to the labor movement to be expected from a rental market reform. This section now calibrates the general equilibrium model presented in Section 3 to seek a practical answer as to the effect of a rental market reform: does the ambiguity remain when simulating the effect of a land rental market reform on national economies? The answer is mostly yes.

The model is first calibrated to match the current economic situation of 15 countries. These countries are chosen primarily on the basis of data availability, but are also meant to represent a large spectrum of income levels. Then, I simulate for each country the impact of a land rental market reform through an increase in the parameter θ. Two types of reforms are tested: one that increases the parameter θ by 0.1, one that increases θ up to $\theta = 1$. Because the topic of land reform is equally important to this paper, I also simulate the impact of a redistribution of land through a decrease of the Gini index by 0.1.

The key equation of the model is equation (26), whose purpose is to determine equilibrium prices. Once the equilibrium prices are determined, every other quantity can be computed by using the equilibrium prices and the exogenous parameters. Table 2 describes the data sources for the various parameters of the model. Total factor productivity in agriculture A and the price of capital goods η are normalized to one, without loss of generality. The parameter δ

is chosen to match the Gini index of land distribution of each country. The land and labor factor shares are derived from previous econometric works and the land-labor ratio is readily available from external sources. The remaining three parameters are calibrated to match key economic features of the data. The value of θ is chosen to match the share of rented land out of total land use. This boils down to computing $\frac{S^O}{S_T}$ and aligning its value with data from the FAO over the 2005-2016 period. The value of λ is chosen to match the 2016 agricultural output in 2010 international dollars. Finally, the value of M is chosen to match the 2016 share of total employment in agriculture. The resulting choice of parameters and external data for other parameters are summarized in Table (3).

4.2 Results

The results for each country are given in Table (4) to (7) at the row ”current situation”. The headings ”Labor in agriculture”, ”Share of area rented”, and ”Agricultural output” all corresponds to actual data when evaluated at the row ”current situation”. All other headings are inferred from the model. The row ”Rental market reform” simulates an increase of θ by 0.1 from the initially calibrated θ. The row ”Rental market fully efficient” simulates an increase from the same inital θ but up to the value $\theta = 1$. The row ”Land reform” simulates a decrease of the Gini coefficient by 0.1. For three countries, namely the United States, Uruguay and Namibia, the share of area rented was too high to be matched closely by the model, even with $\theta = 1$ (with $\theta = 1$, the remaining difference is respectively 2.4, 6.3 and 8.5 percentage points for the United States, Uruguay and Namibia). For these countries, I assume that $\theta = 0.9$ so that the rental market reform can still be tested. The true value of the share of area rented is put in parentheses next to the calibrated value.

One of the odd things of the model is that some countries have negative consumption levels. This is the consequence of assuming that the capital fully depreciates annually and must be repaid in its entirety each year. As a result, the poorest countries do not have enough manufacturing goods to repay the capital annually and must dissave manufacturing goods. Of course, the annual payments of actual economies to maintain and augment the capital stock are much smaller and this should not be taken at face value. Besides, it is possible to force the model to exhibit only positive consumption levels. But that would imply the constraint that each economy produces at least as much manufacturing goods as the capital stock in agriculture, in effect pushing economies to exhibit abnormally high saving rates. This would likely push the model further away from the behavior of actual economies.

What are the main observations from the model calibration? First the calibrated θ is usually around 0.4 to 0.8 in developing countries, while around 0.9 for developed countries. This is in line with the idea that developed countries have more efficient land markets. Within the developing world, some regions exhibit exceptionally low θ's. These are Latin America, with Brazil and Nicaragua, North Africa and the Middle East, with Egypt, Morocco and Jordan and finally India.

The low θ for India (θ=0.09) is not surprising since India is known for its very restrictive land market. Land rental is forbidden virtually everywhere in India, and only some population categories (minors, widows, physically disabled, imprisoned etc.) are allowed to rent out their land. Some Indian states permit renting but only if tenants acquire ownership rights after some specified period. The only exceptions to this quasi-prohibition are Madhya Pradesh and West Bengal. The low θ reflects the fact that one would expect a much higher share or area rented than what is currently observed (2.4%), given the characteristics of India, and especially its Gini coefficient of 0.6. For example Bangladesh has a Gini coefficient of 0.62 and similar economic features, but its current share of area rented is almost ten times higher at 23.2%[2].

Other countries with low θ's have similar restrictions on the ability to rent out. In Brazil for example, there is a widespread fear of tenancy among landowners. This could result from restrictive legislation that make evictions of tenants difficult, from the fact that rented land has been periodically targeted by land redistribution and loss of ownership, and generally by the prevalence of land-related violence throughout Brazil.

What should one expect from an increase in θ, that is, a reduction in transaction costs in the land rental market? In this model, an increase in θ increases welfare through a higher consumption of manufacturing goods. This must be so since by assumption the consumer's need for food is already satiated. When rental market transaction costs decrease, the efficiency of agricultural production increases. This greater efficiency translates into a lower demand for capital goods (e.g. machines, fertilizers, pesticides) and a greater consumption of manufacturing goods. Tables 4 to 7 reveal that full efficiency in the land rental market generates increases of

[2]This conclusion is potentially undermined by the large prevalence of informal rental agreements in India, not taken into account in the data.

manufacturing consumption that are substantial for developing countries, typically between 5% and 10%. India and Nicaragua even have increases (a decrease of negative consumption for India) over 20%. Given the assumption of full capital depreciation, theses numbers reflect the expected gains of manufacturing consumption over the whole capital life cycle. By contrast, developed countries in Table 7 and Namibia in Table 6 have little to gain from achieving efficiency reforms, with increases in manufacturing consumption of less than a tenth of a percent.

Do rental market reforms achieve further industrialization? The evidence is mixed. When θ is increased by 0.1, only 8 out of the 15 countries experiment decreasing agricultural employment, while others experiment increasing agricultural employment. Furthermore, the drop in agricultural employment is usually of moderate size. Only two countries, Brazil and Nicaragua, experiment drops in agricultural employment greater than one percentage point. The drop is approximately of 2 percentage points for Brazil and of 2.6 percentage points for Nicaragua. If full efficiency in the rental market is achieved, the drop is of 2.2 percentage points in Brazil and of 3.2 percentage points in Nicaragua.

But is it possible to conclude that countries with a heavily restricted rental market—like Brazil and Nicaragua—will industrialize through reform? Unfortunately the answer is no. India, in Table 5, has a very low starting θ as explained before. A rental market reform decreases employment in agriculture in India by 0.22 percentage point. But going further in the reform to achieve full efficiency results in an *increase* in agricultural employment by 3.66 percentage points. Here, the partial and the general equilibrium effects combine to create a non-monotonic relationship between θ and employment in agriculture. This non-monotonic relationship can also be seen for Ethiopia and Lao.

Overall, except for Brazil, Nicaragua and to some extent Egypt, the main impact of rental market reform is not greater industrialization but greater efficiency in agricultural production. This is of course favorable to welfare but it is not logically sound to infer from it that more agricultural workers are going to quit their jobs. As could be expected, the gain in efficiency in agriculture is particularly strong for countries with low estimated θ's. In Brazil for example, the model infers that efficiency in agricultural production is currently at 44%. A rental market reform is predicted to boost efficiency at nearly 85%.

Interestingly, the low income countries (Table 4) have efficiency scores of 90% or higher. Though their shares of area rented are low compared to high income countries, these shares are deemed ”fit” to their levels of development and Gini coefficients. Another remarkable result is that the efficiency score of high income countries (Table 7) is very close to 100%[3]. These results suggest that both low and high income countries do not have dysfunctional rental markets, while middle income countries are problematic cases.

Finally, what can one expect from land redistribution? When land is redistributed, almost all countries experiment an increase in production efficiency. The only exceptions are the European Union and Uruguay, for which production efficiency slightly decreases (Table 7). Theoretically then, land redistribution can decrease production efficiency but in practice, this phenomenon seems of limited importance. Once again, the largest increases in efficiency are found in countries that start with a low θ such as in the regions of Latin America, North America & Middle East, and India. For example, in India (Table 5), land reform implies a rise in efficiency from 76,1% to 83,7%. In Brazil (Table 6), efficiency rises from 44,3% to 59%.

If the effect of land redistribution on efficiency is substantial, its effect on industrialization is very limited. 10 out of 15 countries experiment a decrease in agricultural employment when subject to a land reform. However, in any case, the absolute variation is small. Most countries experiment an absolute variation of agricultural employment of less than a tenth of a percentage point. Two countries, Brazil and Nicaragua, experiment drops in agricultural employment of more than one percentage point (respectively 1,05 and 1,62 percentage points).

5 Conclusion

The decomposition of land rental market reform into its partial equilibrium effect and its general equilibrium effect has highlighted two key insights. In partial equilibrium, a rental market reform prompts tenants to allocate more labor in agriculture to benefit from the increased volume of land rented out. In general equilibrium, the drop in agricultural prices can possibly offset the partial equilibrium effect by inducing farmers to allocate more labor in the manufacturing sector. In practice, when calibrating the model, the effect of both rental market reform and land reform

[3]For high income countries, one might ask if hypothesis **H1** of no hired labor is still approximately valid. In the European Union, it probably is, as non-family workers represent only 7.8% of the regular labor force (European Commission, 2013). In the United States, 35% of the labor force is made of hired workers (hired directly or indirectly through a labor contractor) as of 2001 (USDA, National Agricultural Statistics Service, Farm Labor Survey). If anything however, this large amount of hired labor should bring the United States even closer to full efficiency than estimated by the model.

on the sectoral allocation of labor remains of limited importance, except for countries that have highly dysfunctional rental markets such as Brazil, Nicaragua and India. For these countries, the effect of various reforms needs to be treated on a case-by-case basis.

One important insight of the calibration is that rental market and land reforms generally have a sizable effect on production efficiency in agriculture, which in turn causes a reduction in the capital stock of agriculture and a sizable increase in manufacturing consumption. Thus, the point of agreement with previous econometric work is that one should expect rental market and land reforms to bring substantial improvements within agriculture. Yet the point of disagreement brought by the present paper is that these reforms should bring limited labor movements to the industrial and service sectors.

Table 2: *Data sources of the calibration*

Parameter	Definition	Data source
δ	Shape parameter of the Pareto distribution of land	Gini coefficient: FAO Yearbook 2010, Europe: Kay et al. (2015)
α, β	Labor and land factor share	Nin-Pratt and Yu (2008) (Bangladesh, Nepal, Lao, Egypt, Lebanon, Morocco, Uruguay: continental average from constrained estimations), United States: Keith (2015) (2011-2012 estimates); Europe: Wang et al. (2012)
S_T	Land-labor ratio	Agricultural land: FAO; employment in agriculture: ILO estimates
θ	Transaction costs in the land market	Target: share of land rented in. Data source: author's computations using data from the World Programme for the Census of Agriculture 2010, FAO.
λ	Agricultural output & consumption	Target: value added in agriculture divided by total employment. Data source: Worldbank and ILO estimates.
M	Labor productivity in the manufacturing sector	Target: employment in agriculture in percentage of total employment. Data source: ILO estimates.
A, η	Total factor productivity in agriculture, price of capital goods	Normalized to 1

Table 3: *Initial parameter values of the calibration*

Country	Gini coefficient	δ	α	β	S_T	θ	λ	M
Bangladesh	0.62	1.30645	0.16	0.53	0.0015	0.66	0.1225	129
Brazil	0.85	1.08824	0.36	0.29	0.0313	0.0000002	1.07	3533
Egypt. Arab Rep.	0.69	1.22464	0.37	0.32	0.0014	0.08	0.455	1725
Ethiopia	0.47	1.56383	0.31	0.40	0.0076	0.53	0.484	154.5
European Union	0.82	1.10976	0.30	0.08	0.0080	0.82	15.71	8166
India	0.60	1.33333	0.15	0.39	0.0037	0.09	1.347	184
Jordan	0.81	1.11728	0.37	0.32	0.0052	0.009	0.2485	5660
Lao PDR	0.41	1.71951	0.30	0.40	0.0067	0.44	0.543	208
Morocco	0.62	1.30645	0.37	0.32	0.0287	0.16	1.3745	1103
Namibia	0.36	1.88889	0.30	0.39	0.5658	0.9	3.19	1942
Nepal	0.49	1.52041	0.16	0.53	0.0027	0.79	0.1853	83
Nicaragua	0.72	1.19444	0.38	0.25	0.0183	0.00002	1.53	642
Senegal	0.5	1.50000	0.37	0.35	0.0242	0.61	0.81	841
United States	0.78	1.14103	0.13	0.25	0.0262	0.9	14.43	11090
Uruguay	0.79	1.13291	0.37	0.27	0.0896	0.9	2.246	9365

Table 4: *Consequences of rental market and land reforms in* ***low income*** *countries*

Country	Reform	Gini coefficient	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output	Manufact. output	Capital stock in agriculture	Manufact. consump-tion	Manufact. consump-tion growth
Ethiopia	Current situation	0.47	0.53	68.25	14.3	89.7	373.0	49.1	108.2	-59.1	
	Rental market reform		0.63	68.21	17.4	92.4		49.1	106.1	-57.0	-3.6
	Rental market fully efficient		1	69.63	29.3	100		46.9	100.6	-53.7	-9.1
	Land reform	0.37	0.53	68.23	6.8	90.7		49.1	107.4	-58.3	-1.4
Nepal	Current situation	0.49	0.79	71.44	20.1	95.7	412.5	23.7	127.9	-104.2	
	Rental market reform		0.89	73.05	25.7	97.9		22.4	124.6	-102.2	-1.9
	Rental market fully efficient		1	75.64	32.6	100		20.2	121.6	-101.4	-2.6
	Land reform	0.39	0.79	71.39	11.5	95.7		23.7	127.8	-104.0	-0.1
Senegal	Current situation	0.5	0.61	33.14	14.3	94.6	782.0	562.3	219.0	343.3	
	Rental market reform		0.71	33.14	16.4	96.2		562.3	217.0	345.3	0.6
	Rental market fully efficient		1	33.39	22.2	100		560.2	212.5	347.7	1.3
	Land reform	0.4	0.61	33.19	6.8	95.6		561.9	217.7	344.2	0.3

Table 5: *Consequences of rental market and land reforms in* ***lower middle income*** *countries*

Country	Reform	Gini coefficient	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output	Manufact. output	Capital stock in agriculture	Manufact. consumption	Manufact. consumption growth
Bangladesh	Current situation	0.62	0.66	43.24	23.2	93.9	394.3	73.2	122.2	-49.0	
	Rental market reform		0.76	43.59	27.5	96.1		72.8	119.1	-46.3	-5.6
	Rental market fully efficient		1	45.55	38.6	100		70.2	113.8	-43.6	-11.0
	Land reform	0.52	0.66	43.19	13.0	94.1		73.3	121.9	-48.7	-0.7
Egypt. Arab Rep.	Current situation	0.69	0.08	26.10	15.5	76.8	1318.4	1274.8	408.7	866.1	
	Rental market reform		0.18	25.47	21.2	83.2		1285.7	393.7	891.9	3.0
	Rental market fully efficient		1	24.98	40.9	100		1294.1	361.1	933.0	7.7
	Land reform	0.59	0.08	25.76	6.2	79.9		1280.6	401.2	879.4	1.5
India	Current situation	0.6	0.09	45.43	2.4	76.1	717.0	100.4	329.8	-229.4	
	Rental market reform		0.19	45.21	5.7	79.8		100.8	320.1	-219.3	-4.4
	Rental market fully efficient		1	49.09	37.3	100		93.7	277.0	-183.3	-20.1
	Land reform	0.5	0.09	45.50	0.4	83.7		100.3	310.4	-210.1	-8.4
Lao PDR	Current situation	0.41	0.44	69.16	7.1	87.9	534.3	64.1	160.3	-96.1	
	Rental market reform		0.54	69.04	9.7	90.3		64.4	157.4	-93.0	-3.3
	Rental market fully efficient		1	70.69	24.2	100		61.0	147.0	-86.1	-10.5
	Land reform	0.31	0.44	69.28	2.2	90.7		63.9	156.9	-93.0	-3.3
Morocco	Current situation	0.62	0.16	38.54	14.1	80.3	1248.4	677.9	387.0	290.9	
	Rental market reform		0.26	38.02	18.2	84.8		683.6	377.3	306.3	5.3
	Rental market fully efficient		1	37.77	36.4	100		686.4	349.1	337.3	16.0
	Land reform	0.52	0.16	38.24	6.0	82.9		681.2	381.2	300.0	3.1
Nicaragua	Current situation	0.72	0.00002	31.13	1.7	52.7	584.1	442.1	216.1	226.0	
	Rental market reform		0.10002	28.50	23.2	78.9		459.0	188.9	270.1	19.5
	Rental market fully efficient		1	27.93	45.9	100		462.7	174.6	288.1	27.5
	Land reform	0.62	0.00002	29.51	0.2	66.1		452.5	200.4	252.1	11.6

Table 6: *Consequences of rental market and land reforms in* ***upper middle income*** *countries*

Country	Reform	Gini coefficient	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output	Manufact. output	Capital stock in agriculture	Manufact. consump-tion	Manufact. consump-tion growth
Brazil	Current situation	0.85	0.0000002	10.38	5.6	44.3	1120.4	3166.2	392.1	2774.0	
	Rental market reform		0.1000002	8.39	41.7	84.9		3236.4	300.5	2935.9	5.8
	Rental market fully efficient		1	8.18	59.0	100		3243.8	281.1	2962.7	6.8
	Land reform	0.75	0.0000002	9.33	0.4	59.0		3203.3	348.8	2854.5	2.9
Jordan	Current situation	0.81	0.009	3.55	17.3	72.8	575.1	5459.0	178.3	5280.7	
	Rental market reform		0.109	3.34	29.1	85.5		5471.2	165.3	5305.9	0.5
	Rental market fully efficient		1	3.24	46.0	100		5476.7	153.6	5323.2	0.8
	Land reform	0.71	0.009	3.45	5.1	78.2		5464.6	172.4	5292.2	0.2
Namibia	Current situation	0.36	0.9	20.15	5.3 (15.0)	99.4	1313.4	1550.7	407.1	1143.6	
	Rental market fully efficient		1	20.21	6.5	100		1549.5	405.6	1143.9	0.03
	Land reform	0.26	0.9	20.18	1.4	99.7		1550.0	406.3	1143.7	0.01

Table 7: *Consequences of rental market and land reforms in* ***high income*** *countries*

Country	Reform	Gini coefficient	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output	Manufact. output	Capital stock in agriculture	Manufact. consumption	Manufact. consumption growth
European Union	Current situation	0.82	0.82	4.296	48.2	98.9	1172.3	7815.2	726.9	7088.4	
	Rental market reform		0.92	4.300	48.9	99.5		7814.9	726.4	7088.5	0.001
	Rental market fully efficient		1	4.303	49.5	100		7814.6	726.2	7088.5	0.002
	Land reform	0.72	0.82	4.295	30.5	98.8		7815.3	726.9	7088.3	0.000
United States	Current situation	0.78	0.9	1.449	34.5 (38.4)	99.4	1219.3	10929.3	758.4	10170.9	
	Rental market fully efficient		1	1.460	36.0	100		10928.1	757.0	10171.1	0.002
	Land reform	0.68	0.9	1.450	18.9	99.5		10929.2	758.3	10170.9	0.000
Uruguay	Current situation	0.79	0.9	8.229	46.6 (54.0)	99.3	2092.5	8594.4	753.3	7841.1	
	Rental market fully efficient		1	8.246	47.7	100		8592.8	751.4	7841.4	0.004
	Land reform	0.69	0.9	8.227	30.6	99.2		8594.6	753.5	7841.0	0.000

A Proofs

A.1 Proposition 1

Part (a) is easily derived by differentiating (15) and (16) with respect to θ.

Part (b): two useful results for the computation of the limits of (15) are

$$\lim_{\delta\to\infty} \frac{1}{\delta - 1}(\frac{\delta - 1}{\delta})^{\delta} = 0 \quad \text{and} \quad \lim_{\delta\to 1} \frac{1}{\delta - 1}(\frac{\delta - 1}{\delta})^{\delta} = 1. \tag{29}$$

A.2 Proposition 2

Part (a): the efficiency index I is an increasing function of θ:

$$\frac{\partial I}{\partial \theta} = \frac{\alpha + \beta(1-\theta)}{\alpha} \frac{s_1}{S_T} \left(\frac{\delta - 1}{\delta} \frac{S_T}{s_1} \right)^{\delta} \theta^{(\delta-1)\frac{\alpha+\beta}{\alpha} - 1} > 0. \tag{30}$$

Part (b): when evaluating the limiting behavior of the efficiency term I:

$$\lim_{\delta\to\infty}(\frac{\delta - 1}{\delta})^{\delta-1} = e^{-1}; \quad \lim_{\delta\to 1}(\frac{\delta - 1}{\delta})^{\delta-1} = 1, \tag{31}$$

and the term in I delimited by square brackets tends to zero whenever δ tends to one or tends to infinity:

$$\lim_{\delta\to 1,\infty} \left(1 - (\delta - 1)\theta \frac{\beta}{\delta(\alpha+\beta) - \beta} \right) \frac{\theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}}{\delta} - \frac{\alpha}{\delta(\alpha+\beta) - \beta} = 0. \tag{32}$$

A.3 Proposition 3

Part (a): the implicit equation defining p_A can be written as a function of p_A and θ as follows:

$$\tilde{Y^A}(p_A)\, I(p_A, \theta) = \lambda. \tag{33}$$

It can easily be seen from (26) that

$$\frac{\partial \tilde{Y^A}}{\partial p_A} > 0; \quad \frac{\partial I}{\partial p_A} > 0. \tag{34}$$

Finally, differentiate implicitly (33) and use (34) and (30) to find the desired result:

$$\frac{\partial p_A}{\partial \theta} = -\frac{\tilde{Y^A}\frac{\partial I}{\partial \theta}}{\frac{\partial \tilde{Y^A}}{\partial p_A} I + \tilde{Y^A}\frac{\partial I}{\partial p_A}} < 0. \tag{35}$$

Part (b): first, differentiate L^A with respect to $\frac{S_T}{s_1}$ using (15):

$$\frac{\partial L_A}{\partial \frac{S_T}{s_1}} = 1 - \frac{1}{\delta - 1}\left(\frac{\delta - 1}{\delta}\right)^{\delta}\left(1 - \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}\right)\left(\frac{S_T}{s_1}\right)^{\delta-1}. \tag{36}$$

Then, inspect the sign of the derivative:

$$\frac{\partial L_A}{\partial \frac{S_T}{s_1}} > 0 \quad \Leftrightarrow \quad \frac{S_T}{s_1} < \frac{\delta}{\delta - 1}\left(1 - \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}\right)^{-\frac{1}{\delta-1}}. \tag{37}$$

Since $\frac{\delta}{\delta-1}\left(1 - \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}\right)^{-\frac{1}{\delta-1}} > 1$, and provided $S_T \leq s_1$ the following inequality holds:

$$\frac{S_T}{s_1} \leq 1 < \frac{\delta}{\delta - 1}\left(1 - \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}\right)^{-\frac{1}{\delta-1}}, \tag{38}$$

meaning that L^A is an increasing function of $\frac{S_T}{s_1}$. Finally,

$$\frac{S_T}{s_1} = \frac{S_T}{M}\frac{\alpha}{\beta}q, \quad \text{with} \quad \frac{\partial q}{\partial p_A} > 0, \tag{39}$$

meaning that $\frac{S_T}{s_1}$ is an increasing function of p_A, and that L^A is an increasing function of p_A.

A.4 Proof that $0 < I \leq 1$

This proof relies on a study of the function $f(\theta)$:

$$\begin{aligned} I &= 1 + \left(\frac{\delta - 1}{\delta}\frac{S_T}{s_1}\right)^{(\delta-1)} f(\theta), \\ f(\theta) &= \left(1 - (\delta - 1)\theta\frac{\beta}{\delta(\alpha+\beta) - \beta}\right)\frac{\theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)}}{\delta} - \frac{\alpha}{\delta(\alpha+\beta) - \beta}. \end{aligned} \tag{40}$$

First, rewrite $f(\theta)$ as follows:

$$f(\theta) = \frac{1}{\delta}\left[(1 - (1 - y)\theta)\theta^x - y\right], \tag{41}$$

where $x = \dfrac{\alpha+\beta}{\alpha}(\delta-1)$ and $y = \dfrac{\alpha\,\delta}{\delta(\alpha+\beta)-\beta}$. Then, compute the derivative of f:

$$f'(\theta) = \frac{\theta^{(x-1)}}{\delta}\left[x - (1-y)(1+x)\,\theta\right]. \tag{42}$$

f' is positive provided

$$\frac{x}{(1-y)(1+x)} > \theta \quad \Leftrightarrow \quad \frac{\alpha+\beta}{\beta} > \theta \tag{43}$$

which is always true so f is increasing. Finally, using the fact that f is increasing:

$$\begin{aligned} f(0) \leq f(\theta) &\leq f(1) \\ \Rightarrow \quad -\frac{y}{\delta} \leq f(\theta) &\leq 0 \\ \Rightarrow \quad 1 - \left(\frac{\delta-1}{\delta}\,\frac{S_T}{s_1}\right)^{(\delta-1)} \frac{y}{\delta} \leq I &\leq 1 \\ \Rightarrow \quad 0 < I &\leq 1 \end{aligned} \tag{44}$$

where the last line uses the fact that $\dfrac{y}{\delta} < 1$ and that $\left(\dfrac{\delta-1}{\delta}\,\dfrac{S_T}{s_1}\right)^{(\delta-1)} < 1$ provided $S_T \leq s_1$.

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