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

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

Abstract

Recent econometric work suggests that there is a positive link between the development of land rental markets and the migration of workers out of 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. The model studies how the allocation of employment between agricultural and non-agricultural activities is affected by the presence of transaction costs in the land rental market, as well as by the initial distribution of land ownership. Theoretically, a reduction in transaction costs induces outmigration from agriculture if agricultural prices are sufficiently flexible, while rigid agricultural prices may lead to the reverse phenomenon of immigration in agriculture. Practically, the model predicts that for most of the countries tested, a reduction in transaction costs causes little labor movement between sectors. This is equally true concerning the effect of a land redistribution. In spite of this, these reforms are found to increase substantially the production efficiency and welfare of farmers. These results suggest that the main benefit of stimulating land rentals is not in fostering structural transformation, but in improving the livelihoods of farmers.

JEL classification: O11, O13, O14, O41, Q15.

Keywords: structural transformation, agriculture, land rental markets, land reform, transaction costs.

1 Introduction

In the twentieth century, most land reforms redistributed land from large landowners to small farmers by administrative decision. Land owned above a legislated ceiling would be seized by a land authority and later divested to the farmers targeted by the reform (Eastwood et al. (2010)). These administrative tools came to be criticized for their coercive nature, creating a climate of insecure property rights for large landholders, and prohibiting land rentals and sales to avoid reconcentration of land operation and ownership. New designs of land reforms were proposed by the start of the 1990s, with an emphasis on voluntary, market-based transfers of land between buyers and sellers (Deininger and Binswanger (1999), Deininger (1999), Sadoulet et al. (2001)). This reconceptualization of land policy insisted that land reforms were to enhance the functioning of the land markets, and not to inhibit them. The prohibition of land rentals and sales would be abolished, and land titling would increase the security and volume of transactions on the market. While there is still dissension as to whether land markets are an effective tool to reduce poverty¹(Borras (2003), Bobrow-Strain (2004), Lahiff et al. (2007)), the equity and efficiency effects of land markets have been the subject of much of the recent research in agricultural economics (Deininger and Feder (2001), Otsuka (2007), Holden and Otsuka (2014)).

With the increased awareness of the potential of land markets to improve efficiency of agricultural production, another strand of research has questioned their potential to increase labor mobility: can land markets contribute to the reallocation of labor out of agriculture? Indeed, the reallocation of labor to non-agricultural activities has long been seen as an important source of aggregate productivity and growth (Syrquin (1988)), given the existence of a large gap in labor productivity between agriculture and non-agriculture in the developing world (Gollin et al. (2013)). In addition, employment outside agriculture is an important means of income diversification for rural households (Ellis (1998)).

The recent literature has 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.

This topic however has received little attention on the theoretical side. Deininger and Jin (2005) present a simple model of land rental market with off-farm opportunities and show that a reduction in transaction costs improves welfare and rental market activity. Deininger and Jin also conjecture 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 where migrants must 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.

My paper asks: what labor movement can be expected from a reduction in transaction costs in the land 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 a redistribution of land motivate farmers to move out of agriculture? To the best of my knowledge, this paper is the first to study these

questions in a theoretical framework.

Recently, two papers have had close research topics to my own:

– İşcan (2018) studies the effect of land redistribution on structural change in Japan, South Korea, and Taiwan in the post WWII period. İşcan finds that land redistributions toward small landholders were responsible for half of the reallocation of labor out of agriculture, had substantial impact on agricultural productivity but a moderate impact on income per capita. Although my paper studies the impact of land redistributions, it is not focused on land redistributions *per se* but on land rental market mechanisms. That is, I study the impact of transaction costs that prevent farmers to rent land in or out. As a result, the theoretical focus is different, and many hypotheses differ. While my paper does not posit asymmetric information between landlords and tenants, my paper treats the distribution of landlords and tenants as endogenous, introduces transaction costs and assumes an unequal distribution of land even among tenants. The land redistribution mechanism that I study is also different since it is based on a Pareto law. Like İşcan, my results suggest that land redistribution substantially increase agricultural productivity. However, in contrast to İşcan's results, I find this reform to have a small and ambiguous impact on labor reallocation out of agriculture.

– Chen et al. (2021) study the impact of land rentals on agricultural efficiency in Ethiopia, using both a theoretical model and a difference-in-difference empirical strategy. They find that land rentals have a substantial impact on agricultural efficiency via the reallocation of land to more productive farms. While Chen et al. are focused solely on the consequences of rental market activity within the agricultural sector, my paper is focused on the link between rental market activity and the sectoral allocation of labor between agriculture and non-agriculture. In modeling, unlike Chen et al., I do not assume the existence of an unknown and heterogeneous component of productivity across farms. In my paper, differences in productivity across farms are solely the result of market imperfections and land endowment. Despite these differences, our quantitative results coincide in that we both conclude that improvements in the land rental market have a substantial and positive effect on agricultural productivity.

The main idea of the present paper is to study land reforms, either through an improvement

in the land rental market or through a redistribution of land, in the context of imperfections in the land and labor markets. Indeed, a large body of evidence has shown that land and labor markets are largely dysfunctional in the developing world (Deininger and Feder (2001), Otsuka (2007), Eastwood et al. (2010)). As a result, there is a presumption that large farms are inefficient compared to small farms and that redistributing land to small landholders will improve efficiency (*ibid.*). Part of the explanation lies in the low mechanization of agriculture in developing countries (Sheahan and Barrett (2017), Aryal et al. (2021)), 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 (Binswanger and Rosenzweig (1986), Eastwood et al. (2010)). In line with this view, my paper constructs a model where smaller farms are endogenously more productive than larger farms because larger farms, facing the supervision costs of hired labor, cannot adjust their labor input to the optimal level.

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 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 imperfections². 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)). I assume failures to occur in the labor and land markets, ignoring possible failures in the credit market to preserve conceptual clarity.

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 prices. 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, which in turn creates a movement of labor out of non-agriculture and into agriculture. Lower transaction costs enable 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 creates additional agricultural production leading the way for a decrease in agricultural prices. This decrease in agricultural prices mitigates the partial equilibrium effect by inducing workers to move out of agriculture.

If instead of a reduction in transaction costs, a redistribution 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 distribution, a land redistribution induces workers to move out of agriculture, but when staged from an initially more equal distribution, a land redistribution induces workers to move in agriculture.

After having discussed the theoretical results, the model is calibrated to assess the relative importance of partial and general equilibrium effects. That is, I conduct a policy experiment whereby the model is first calibrated to match the current economic situation of 14 countries. I then simulate the effect of a reduction in transaction costs and a redistribution of land on key variables such as agricultural employment and agricultural production efficiency. My results suggest that these land reforms have a small impact on labor reallocation out of agriculture, except in countries with a highly dysfunctional land rental market. Importantly, no clear pattern emerges for the direction of labor reallocation, as some countries experience a decrease in agricultural employment while others experience an increase. This finding contradicts much of the existing literature that takes as granted the link between land reforms and a growing

non-agricultural sector. However, in line with the literature, these reforms are found to contribute significantly to the efficiency of agricultural production and to increase the welfare of farmers substantially.

Since my results predict an important increase in welfare, I conclude the analysis by simulating the impact of these reforms on income inequality, to see if the predicted increase in welfare is likely to be spread across the population of farmers. In most cases, a reduction in transaction costs in the land rental market causes inequality to increase, especially when the transaction costs are fully eliminated. On the other hand, land redistributions induce a substantial reduction in inequality in the poorest countries.

To sum up, the paper's key contribution is in developing and applying a theoretical framework of the link between land reforms and labor allocation between agricultural and non-agricultural activities. In disagreement with the existing literature, I find limited evidence that either a reduction in transaction costs in the land rental market or a redistribution of land might cause a large migration of labor out of agriculture. However, confirming previous findings, I find evidence that these land reforms substantially increase agricultural efficiency and the living conditions of farmers. As an additional contribution, I also study the consequences of land reforms for income inequality and find that a redistribution of land is more likely to decrease income inequality compared to a reduction in transaction costs.

The remainder of this paper is as follows. Section 2 describes the model and solves it in a partial equilibrium setting. 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 studies the effect of land reforms on inequality. Section 6 concludes.

2 Partial equilibrium

In this section the agricultural sector is studied in isolation from the rest of the economy, with output and input prices being treated as exogenous.

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 income I_i 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. I assume for simplicity that supervision and/or search costs for hired labor are such as to prevent each family from hiring any labor at all. 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 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, a landlord will 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. The transaction costs are then the landlord's various efforts to preserve his\her property rights during tenancy³. 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, these costs 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 weigh on the people that supply land to the 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: Landowners 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:

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

where p_A denotes the price of agricultural output, Y_i^A denotes agricultural output and A is total factor productivity; L_i^A refers to on-farm labor use and L_i^O refers to off-farm employment; S_i^A is on-farm land use and S_i^O, S_i^I refer to respectively land rented out, and rented in; w is the wage rate for off-farm labor and q is the land rental rate; K_i is on-farm capital use 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 proportional 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. An increase in θ is associated with a decrease in proportional transaction costs in the land rental market. I will refer to proportional transaction costs as simply transaction costs for short.

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:

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

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.

Throughout this paper, I will refer to an increase of δ as a “land redistribution”. Importantly, since this is an exogenous parameter, no information is given on the precise way in which such land redistribution is to occur. Spontaneously, one could think of a state-led redistribution in which the land would have to be surrendered to a land authority and then redistributed to poor farmers. But it could also be achieved through market-based subsidized transfers, as long as such transfers redistribute land *in a more egalitarian manner* (i.e., reducing the Gini index of land ownership). This is an important point because the typical operation of the land sales market does not produce such results. Absent government interventions to subsidize the purchase of land for the poor, most sales of land occur among big landowners or among small ones, so that land inequality does not naturally diminishes over time⁴. This comment on the *how* of land redistribution is also a warning that the present paper is not meant to settle the debate between the merits of state-led versus market-led land redistributions⁵ (see e.g., Deininger and Binswanger (1999), Deininger (1999), and Sadoulet et al. (2001) for the market approach and Borras (2003), Bobrow-Strain (2004), and Lahiff et al. (2007) for its critique).

2.2 Classes of farmers

The 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). That is, it is the

land-labor ratio that every farmer would choose in the absence of any market imperfections. Consider also $s_m = \frac{\delta-1}{\delta}S_T$, the minimum land-labor ratio a family can possibly be endowed with.

If $s_m \geq s_1$, 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. There are families willing to rent out, but there are no families willing to rent in. As a result, there cannot be any exchange on the land rental market. Besides, no family is willing to employ part of its labor outside the farm. Thus, there is no off-farm 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 belongs to a unique class of farmers⁶ 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. Therefore, 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.

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 out land. 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 belong to the autarkic class. If the transaction costs disappear ($\theta = 1$), then the autarkic class disappears 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. Tenants adjust their land-labor ratio to s_1 and produce efficiently.

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

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

$$\frac{S_i^A}{L_i^A} = \frac{\beta w}{\alpha q} = s_1. \quad (4)$$

$$L_i^O = 1 - L_i^A; \quad S_i^I = S_i^A - S_i. \quad (5)$$

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

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

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. In turn, a perfectly elastic demand means that tenants cannot pay the transaction costs of the rental market. If, for instance, tenants were to be taxed on their land rentals, the land rent q would fully adjust downward so that the real burden of the tax would eventually be paid by landlords.

2.2.2 Autarkic farmers

Autarkic farmers are endowed with a land-labor ratio higher than s_1 and produce inefficiently since they do not adjust their land-labor ratio downward. This inefficiency grows with the size of the land endowment, which translates into a lower land productivity for bigger farms. This class therefore exhibits the well-known inverse relationship between land productivity and farm size.

If $s_1 < s_i < s_2 = s_1 \theta^{-\frac{\alpha+\beta}{\alpha}}$,

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

$$L_i^A = 1; \quad S_i^A = S_i, \quad (8)$$

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

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 landlord families, the amount of land rented out differs. Landlords adjust their land-labor ratio to s_2 and produce inefficiently.

If $s_i > s_2$,

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

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

$$L_i^A = 1; \quad S_i^O = S_i - S_i^A. \quad (12)$$

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,

$$y_i^{\text{Tenants}} > y_i^{\text{Autarkic farmers}} > y_i^{\text{Landlords}}, \quad (13)$$

where $y_i = \frac{Y_i^A}{S_i^A}$. Smaller farms (tenants) have higher land productivity because they can adjust optimally the land-labor ratio. On the contrary, autarkic farmers and landlords are always labor constrained⁷. 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^N is the aggregate level of off-farm employment (here identified with manufacturing and services employment, named non-agriculture for short). L^N is equal to the total supply of labor 1

minus agricultural employment L^A .

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

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

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

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, 3 and 4 *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 rental market creates a movement of labor out of non-agriculture and into agriculture:*

$$\frac{\partial L^A}{\partial \theta} > 0 \quad \frac{\partial L^N}{\partial \theta} < 0. \quad (17)$$

(b) *Provided $S_T \leq s_1$, the efficient, maximum level of agricultural employment can be achieved in three different ways: if there are no transaction costs in the land rental market, if there is a perfectly equal distribution of land ownership, if there is a perfectly unequal distribution of land ownership.*

$$\lim_{\theta \rightarrow 1} L^A = \lim_{\delta \rightarrow \infty} L^A = \lim_{\delta \rightarrow 1} L^A = \frac{S_T}{s_1}. \quad (18)$$

In partial equilibrium, 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 labor, 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. This is an important result since the initial theoretical work of

Eswaran and Kotwal on land redistribution did not find such ambiguity, but instead concluded that land redistribution was to be unambiguously efficient⁸. The efficient level of agricultural employment, in turn, coincides with the maximum level of agricultural employment over the domain $(\theta, \delta) \in [0, 1] \times (1, \infty)$. In part b), the hypothesis $S_T \leq s_1$ is needed in the computation of $\lim_{\delta \rightarrow \infty} L^A$, where it can be interpreted as follows: $\lim_{\delta \rightarrow \infty} s_m = S_T \leq s_1$. That is, the full autarky equilibrium is dismissed for all values of δ but can be reached (if $S_T = s_1$) in the limiting case of a perfectly equal land distribution.

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 $G_S = \frac{1}{2\delta-1}$ so that the graph can span the full spectrum of inequality.

Figure 1 here (two-column fitting).

In Figure 2, panels (a) to (f) illustrate the allocation of labor between different classes of farmers and between agriculture and non-agriculture 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). Note that while tenants have an incentive to increase work on the farm, the newly converted landlords are still undersupplied in labor and have no incentives to seek off-farm employment.

Figure 2 here (two-column fitting).

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 U-shaped relationship between the share of labor in agriculture and inequality, as depicted in Panel (d). Put simply, an inefficient land distribution means that tenants have access to a lower supply of land and therefore employ more labor to off-farm activities.

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 emerges as inequality rises, while the class of autarkic farmers quickly drops to low levels. These landlords redistribute land to tenants and prevent large amounts of land to be stuck in inefficiently large farms. Consequently, 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 raises agricultural output. But once again, redistributing land will not necessarily improve

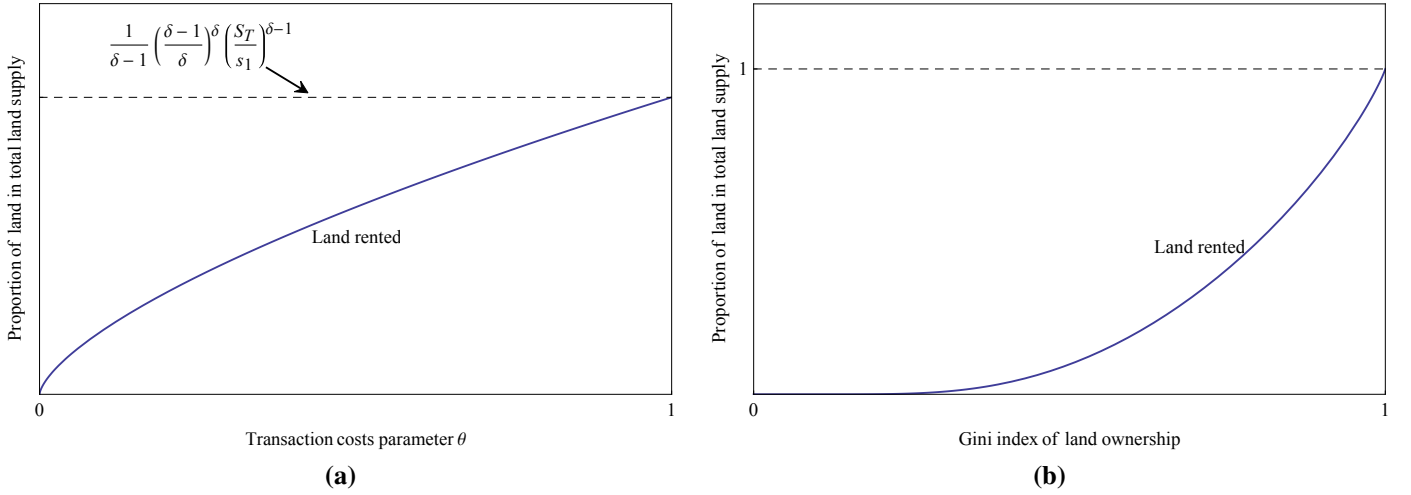


Figure 1: *The behavior of the rental market*

agricultural production. As in Proposition 1, the two poles of perfect equality and perfect inequality both lead to efficient production⁹.

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 E . The efficient production, like the efficient labor allocation, is a situation where every farmer achieves the efficient land-labor ratio s_1 .

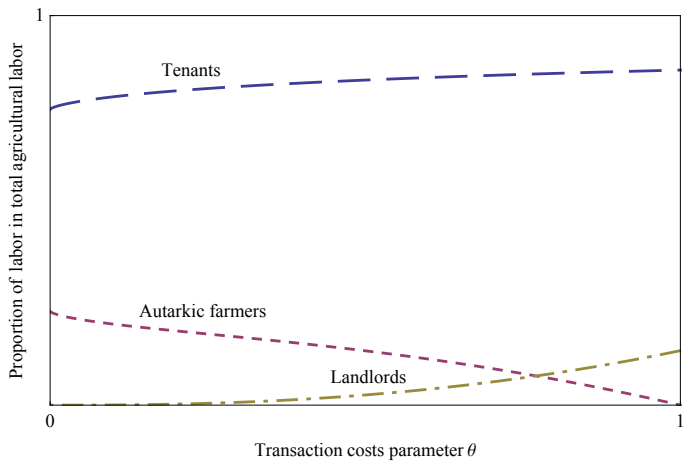
$$\begin{aligned}
 Y^A &= \int_{s_m}^{\infty} Y_i^A dF(s_i) = \tilde{Y}^A E, \\
 \tilde{Y}^A &= \frac{w}{\alpha p_A} \frac{S_T}{s_1}, \\
 E &= 1 + \frac{1}{\delta} \left[\left(1 - \theta \frac{\beta(\delta-1)}{\alpha\delta + \beta(\delta-1)} \right) \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)} - \frac{\alpha\delta}{\alpha\delta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

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

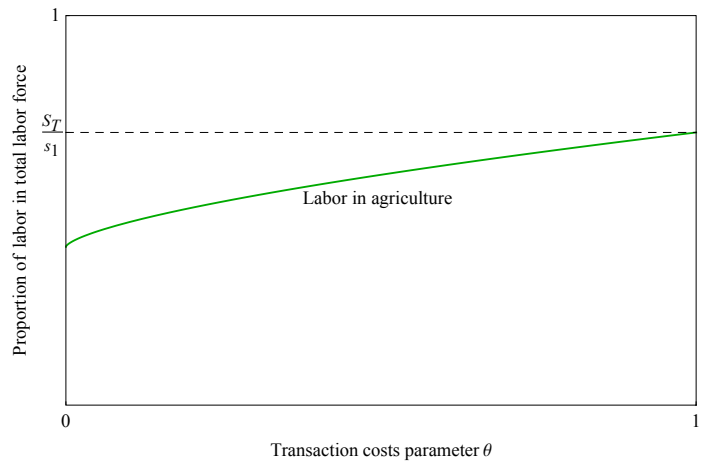
Proposition 2 *In the partial equilibrium setting of (H1-H4) where agricultural prices (p_A) and intermediate input prices (w , p_K) are exogenous variables, the following results hold.*

(a) *A decrease in transaction costs in the land rental market increases agricultural production:*

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



(a)



(b)



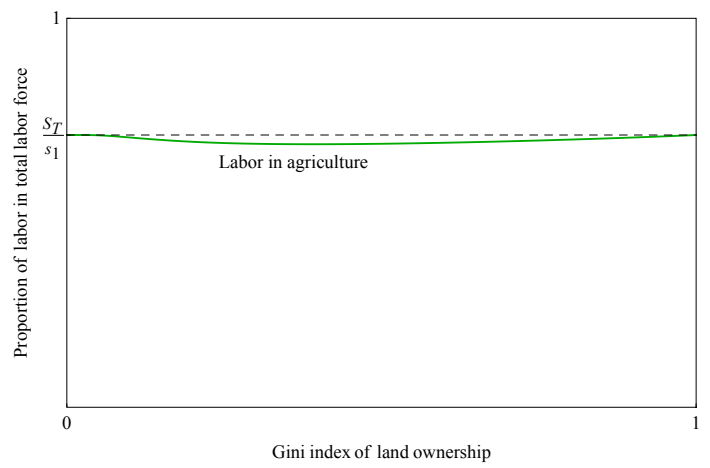
(c)



(d)



(e)



(f)

Figure 2: *The behavior of aggregate labor*
Panels (c) and (d): low θ
Panels (e) and (f): high θ

(b) Provided $S_T \leq s_1$, the efficient level of agricultural production can be achieved in three different ways: if there are no transaction costs in the land rental market, if there is a perfectly equal distribution of land ownership, if there is a perfectly unequal distribution of land ownership.

$$\lim_{\theta \rightarrow 1} Y^A = \lim_{\delta \rightarrow \infty} Y^A = \lim_{\delta \rightarrow 1} Y^A = \tilde{Y}^A. \quad (21)$$

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 my model, the family farm theory is linked with the idea that large farms are undersupplied in labor. The division of large farms into small farms, either through renting out or redistribution of ownership rights, causes both agricultural labor and agricultural production to rise.

Figure 3 here (two-column fitting).

In partial equilibrium, I have shown that a better functioning of the land market leads to a transfer of labor from non-agriculture to agriculture. But is this still the case once one allows for the possibility of endogenous agricultural prices? This is the concern of the next section.

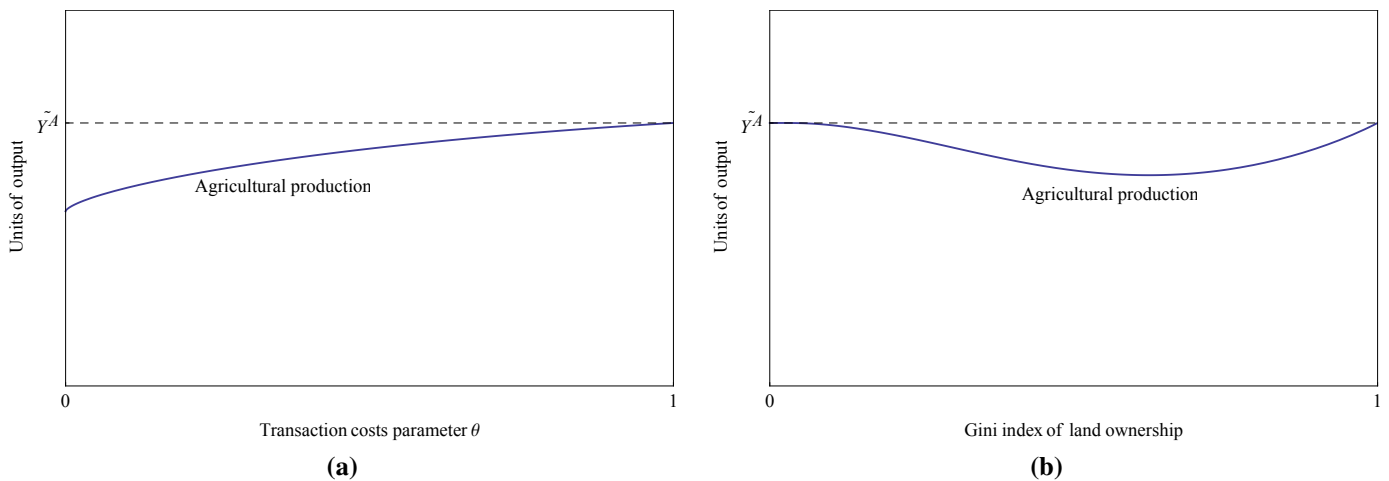


Figure 3: *The behavior of aggregate production*

3 General equilibrium

3.1 Specification of the rest of the economy

Only four ingredients remain to fully specify the economy. The production technology of non-agricultural goods, the production technology of capital goods, the way in which the transaction costs are paid, and consumer preferences. In keeping with the spirit of simple and tractable assumptions, I assume that the non-agricultural sector Y^N uses only labor L^N and has constant returns to scale.

$$\mathbf{H5} : Y^N = N L^N. \quad (22)$$

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

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

H5 and **H6** immediately imply

$$w = N; \quad p_K = \eta. \quad (23)$$

And the only remaining endogenous price is p_A , the price of agricultural goods.

I assume that landlords pay the transaction costs on the land rental market by consuming part of the non-agricultural goods (presumably services) produced by this economy. These non-agricultural goods are wasted, providing no utility to landlords. I will refer to the total amount paid in transaction costs by landlords as the *aggregate* transaction costs.

H7: The aggregate transaction costs $q(1 - \theta)S^O$ are paid by consuming non-agricultural goods.

Next, I assume the existence of a representative consumer with the simplest form of non-homothetic preferences (originally due to Laitner (2000)).

$$\mathbf{H8} : U(C^A, C^N) = \begin{cases} C^A & \text{if } C^A \leq \lambda \\ C^N + \lambda & \text{if } C^A > \lambda \end{cases} \quad (24)$$

where C^A and C^N are the aggregate consumptions of respectively agricultural and non-agricultural goods. These preferences imply that the representative consumer buys λ units of agricultural goods and then spend the rest of his income on non-agricultural goods¹⁰. Assumptions **(H5-H8)** combined with the assumption of a closed economy **(H9)** can be summarized with the following market clearing conditions:

$$\begin{aligned} Y^A &= C^A = \lambda, \\ Y^N &= N L^N = C^N + \eta K + q(1 - \theta)S^O, \end{aligned} \tag{25}$$

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.

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:

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

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-H9), the following results hold.*

(a) A decrease in transaction costs in the land rental market causes a drop in agricultural prices:

$$\frac{\partial p^A}{\partial \theta} < 0. \quad (27)$$

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

$$\frac{\partial L^A}{\partial p_A} > 0 \quad \frac{\partial L^N}{\partial p_A} < 0. \quad (28)$$

In the short run, while prices are fixed, a decrease in transaction costs causes labor to move *in* agriculture (Proposition 1). 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 (Proposition 3). This is because the farm marginal product of labor has dropped. 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 agricultural production. This ambiguity passes on to general equilibrium analysis: redistributing land may increase agricultural production and decrease agricultural prices or may decrease agricultural production and increase agricultural prices.

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? The answer is mostly yes.

The model is first calibrated to match the current economic situation of 14 countries. These countries are chosen primarily based on data availability¹¹ but are also meant to represent a large spectrum of income levels. Though the model is designed for traditional agriculture, some developed countries are included for comparison. 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 redistribution is equally important to this paper, I also simulate the impact of a redistribution of land through a decrease of the Gini index of land ownership by 0.1.

The key equation of the model is equation (26), whose purpose is to determine the equilibrium price of agricultural output. Once this price is set, every other quantity can be computed by using this price and the exogenous parameters. Table 1 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 labor and land factor shares α and β are derived from previous econometric works and the aggregate land-labor ratio S_T 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 so that the share of rented land out of total land use matches its actual value in the data. 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 so that agricultural output in value, $p_A \lambda$, matches the 2016 agricultural output per employed person. Finally, the value of N is chosen so that L^A matches the 2016 share of employment in agriculture. The resulting choice of parameters and external data for other parameters are summarized in Table 2.

Tables 1 and 2 here.

4.2 Results

The results for each country are given in Table 3 to 6 at the row "Current situation". The headings "Gini index of land ownership", "Labor in agriculture", "Share of area rented", and "Agricultural output" all corresponds to actual data (to the nearest unit) when evaluated at the row "Current situation". All other headings are inferred from the model. Data for outputs and their uses are all expressed in 2010 US dollars per employed person. 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 initial θ but up to the value $\theta = 1$. The row "Land redistribution" simulates a decrease of the Gini index of land ownership by 0.1. For two countries, namely the United States and Uruguay, 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 and 6.3 percentage points for the United States and Uruguay). 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.

Tables 3, 4, 5 and 6 here.

A curiosity of the model is that some countries have negative consumption levels of non-agricultural goods. 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 non-agricultural goods to repay the capital annually and must dissave non-agricultural goods. Of course, the annual payments of actual economies to maintain and augment the capital stock are smaller and this should not be taken at face value.

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 and Jordan; and finally, India.

The low θ for India ($\theta=0.05$) is not surprising since India is known for its restrictive land

market. Land rental is prohibited in roughly half of the Indian states, in which only some population categories (minors, widows, physically disabled, imprisoned etc.) are allowed to rent out their land (NITI Aayog (2016)). Other Indian states permit renting but impose restrictive conditions on the termination of tenancy and/or the eviction of tenants. The low θ reflects the fact that one would expect a much higher share of area rented than what is currently observed (2.3%), given the characteristics of India, and especially its Gini index of 0.6. For example, Bangladesh has a Gini index of 0.62 and similar economic features, but its current share of area rented is ten times higher at 23.4%¹². 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 eviction 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 (Hammond (2009), Alston and Mueller (2010)).

What to 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 non-agricultural goods. This must be so since by assumption the consumer's need for food is already satiated. When transaction costs decrease, two mechanisms increase welfare. First, the efficiency of agricultural production increases. Farmers can move their land-labor ratios closer to the optimal land-labor ratio s_1 . This greater efficiency translates into a lower demand for capital goods (e.g., machines, fertilizers, pesticides), a higher income for farmers and as a result a higher consumption of non-agricultural goods. Second, a decrease in proportional transaction costs usually diminishes the aggregate transaction costs paid by landlords. This raises their income and consumption of non-agricultural goods. Note however that for half of the countries a decrease in proportional transaction costs first results in an increase in aggregate transaction costs, as land rental activity is growing rapidly. Then, as proportional transaction costs are reduced further, the aggregate transaction costs tend to zero. This is illustrated in the way the "Rental market reform" and "Rental market fully efficient" rows impact aggregate transaction costs in Tables 3 to 6.

Overall, when the rental market is made fully efficient, these two mechanisms result in

increases of non-agricultural consumption that are typically over 10% (below -10% for negative consumption levels) for low and lower-middle income groups. The growth of total consumption (agriculture and non-agriculture consumption, at constant prices) for these groups ranges between 3.9% and 10.9%, with an average of 6.3%, indicating that a substantial increase in welfare is expected. By contrast, upper-middle and high income groups have little to gain from achieving efficiency reforms, with increases in total consumption ranging from 0.09% to 1.3%. In upper-middle income countries, Brazil is an exception with an expected 3.9% increase in total consumption if transaction costs are fully eliminated.

Do rental market reforms achieve further industrialization (i.e. development of the non-agricultural sector)? The evidence is mixed. When θ is increased by 0.1, only 7 out of the 14 countries experience decreasing agricultural employment, while others experience increasing agricultural employment. Furthermore, the drop in agricultural employment is usually of moderate size. Only two countries, Egypt and Nicaragua, experience drops in agricultural employment of one percentage point or greater. The drop is approximately of 1 percentage point for Egypt and of 1.4 percentage point for Nicaragua. If full efficiency in the rental market is achieved, the drop is of 2.2 percentage points for Egypt, 1.6 percentage point for Nicaragua and Brazil is not far off the mark with a drop of 0.9 percentage point.

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 4, has a low starting θ as explained before. A rental market reform decreases employment in agriculture in India by 0.4 percentage point. But going further in the reform to achieve full efficiency results in an *increase* in agricultural employment by 1.8 percentage point relative to the current situation. Here, the partial and 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 Laos.

Overall, except for Egypt, Nicaragua and to some extent Brazil, the main impact of rental market reform is not greater industrialization but greater efficiency in agricultural production. 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 43%. A rental market reform is predicted to boost efficiency at 86%.

Interestingly, the low income countries (Table 3) have efficiency scores close to 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 indexes. Another remarkable result is that the efficiency score of high income countries (Table 6) is very close to 100%¹³. In my sample of 14 countries, both low and high income countries have relatively efficient rental markets, while the problematic cases belong to the middle income groups.

Finally, what to expect from land redistribution? When land is redistributed, almost all countries experience an increase in production efficiency in agriculture. The only exceptions are the European Union and Uruguay, for which production efficiency slightly decreases¹⁴ (Table 6). 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 . For example, in India (Table 4), land redistribution implies a rise in efficiency from 73% to 81%. In Brazil (Table 5), efficiency rises from 43% to 57%. This rise in efficiency goes along with a decrease in aggregate transaction costs for all countries. Land redistribution causes a drop in the share of area rented which ultimately causes aggregate transaction costs to fall. Both greater efficiency and the fall in aggregate transaction costs induce total consumption to rise by 2.7% on average in low and lower-middle income groups. Once again, increases in total consumption are very limited for upper-middle and high income groups, to the exception of Brazil.

If the effect of land redistribution on welfare is substantial, its effect on industrialization is modest. 11 out of 14 countries experience a decrease in agricultural employment when subject to a land redistribution. However, in any case, the absolute variation is small. Most countries experience an absolute variation in agricultural employment of less than a tenth of a percentage point. The two countries which experience the largest drops in agricultural employment are Nicaragua and Egypt, with a decrease of 0.7 and 0.6 percentage points respectively, followed by Brazil and India with a decrease of 0.4 percentage point for both.

5 Inequality and reforms

The last section concluded that, if land redistribution and rental market reform are predicted to have, in most cases, a small impact on labor movements, they do have a large impact on consumption and welfare. However, such a positive message is potentially undermined by the perspective of rising inequality. That is, the rise in welfare could benefit mostly well-endowed households. This is why I conclude my analysis with an assessment of the impact of land reforms on inequality.

5.1 The Gini index of family income

The metric that I will be using is the Gini index of family income I_i (family income I_i is defined in problem (1)). Proposition 4 below provides the main analytical results regarding this Gini index.

Proposition 4 *Under hypotheses (H1-H4),*

(a) *the Gini index of family income is equal to the following:*

$$G_I = 1 - \frac{w \left\{ 1 - \left(\frac{\delta-1}{\delta} \frac{S_T}{s_1} \right)^{2\delta} \frac{\beta}{(2\delta-1)(\alpha 2\delta + \beta(2\delta-1))} \left(1 - \theta^{\frac{2\delta(\alpha+\beta)-\beta}{\alpha}} \right) \right\} + \frac{2(\delta-1)}{2\delta-1} qS_T}{w \left\{ 1 - \left(\frac{\delta-1}{\delta} \frac{S_T}{s_1} \right)^\delta \frac{\beta}{(\delta-1)(\alpha\delta + \beta(\delta-1))} \left(1 - \theta^{\frac{\delta(\alpha+\beta)-\beta}{\alpha}} \right) \right\} + qS_T}. \quad (29)$$

(b) *Provided $S_T \leq s_1$, it has the following limits:*

$$\begin{aligned} \lim_{\theta \rightarrow 1} G_I &= \frac{qS_T}{w + qS_T} G_S, \\ \lim_{q \rightarrow 0} G_I &= 0, \\ \lim_{\delta \rightarrow \infty} G_I &= 0, \\ \lim_{\delta \rightarrow 1} G_I &= \frac{\theta qS_T}{w + \theta qS_T}, \end{aligned} \quad (30)$$

where $G_S = \frac{1}{2\delta-1}$ is the Gini index of land ownership.

The complexity of the Gini formula makes it difficult to infer intervals in which the Gini index is

increasing or decreasing with respect to θ or δ . But its behavior at various limits is clear. I first describe the relationship between the Gini index of income and transaction costs in the rental market, then describe its relationship with the land distribution.

When the land market operates imperfectly, there is two sources of heterogeneity in family income: the first is the unequal distribution of land endowments, the second is the unequal land rent faced by different classes. To understand this second component, note that an additional unit of land endowed to a tenant brings in an additional income of q (this class has zero profits). But an additional unit of land endowed to an autarkic farmer or landlord brings in an additional income less than q , because the optimal decision to rent it out is costly¹⁵.

When the transaction costs vanish, the land rent is equalized across farmers and the only remaining source of inequality is unequal land ownership. This is exactly the message of $\lim_{\theta \rightarrow 1} G_I = \frac{qS_T}{w + qS_T} G_S$: when rental markets function perfectly, the Gini index of income equals the Gini index of land ownership weighted by the share of land rent in total income.

Outside of this limiting case, it is difficult to predict how a reduction in transaction costs will affect inequality. Suppose for simplicity a partial equilibrium framework. Then only landlords will benefit from an increase in θ , while tenants and autarkic farmers will see their income unchanged. An increase in θ not only makes landlords richer but also expand the class of landlords in the population, while the class of autarkic farmers shrinks. The net effect is ambiguous in redistributive terms.

When extending the analysis to general equilibrium, other interesting features emerge. As θ increases, the price of agricultural goods falls, and this results in a lower land rent q . This lower land rent has two consequences: first, the income from the land rent becomes a smaller share of total income, giving more weight to labor income. Since labor endowments are equally distributed, this will, at least in the limit when q tends to zero, creates an equal distribution of income ($\lim_{q \rightarrow 0} G_I = 0$). The second consequence is that the ratio s_1 increases, expanding the class of tenants, which contribute to equalizing the land rent in the population of farmers.

What can be said about the relationship between the Gini index of income and δ ? Obviously when δ increases land is redistributed more equally so the question is whether the land rent will

equalize across families of farmers.

In partial equilibrium, the ambiguity of redistributing land is that, starting from a perfectly unequal distribution, the proportion of tenants will first decrease and then rise, as illustrated by panels (c) and (e) of Figure 2. Thus, the land rent will first become more unequal across families, before converging to a unique value when the proportion of tenants starts to rise. Without a precise knowledge of when this turn occurs, the effect of redistributing land on inequality is unclear. On the other hand, this turn must occur at some point, which explains that as δ tends to infinity, the Gini index of income tends to zero ($\lim_{\delta \rightarrow \infty} G_I = 0$).

In general equilibrium, the analysis is the same as for transaction costs, but the land rent q might decrease or increase.

Finally, if the perfectly unequal distribution of land is chosen ($\delta = 1$), then the land rent is equalized across farmers and the only remaining source of inequality is unequal land endowments. Once again, the Gini index of income is equal to the Gini index of land ownership (equal to 1) weighted by the share of land rent in total income ($\lim_{\delta \rightarrow 1} G_I = \frac{\theta q S_T}{w + \theta q S_T}$).

5.2 Computation of the Gini index of family income

I now simulate on the Gini index of income the same policy experiments as in Section 4 and I comment the results. Two observations are important to interpret them correctly.

First, the scope of the model in dealing with various forms of inequality is limited, since the only source of inequality here comes from land endowment and the land rent. Labor is homogeneous, and as a result many common determinants of inequality such as education and experience are not considered. Capital is assumed to depreciate fully at each period and so past accumulations of capital cannot affect the current level of inequality. As a result, the Gini index of income of my model is very sensitive to the share of land rent in total income. In fact, in high-income countries the Ginis inferred by the model are less than 5%. This reflects the fact that in these countries the land rent represents a small share of value added and therefore land-based inequalities cannot account for a large share of the actually observed inequalities. Therefore, the purpose of the present policy experiment is not to reproduce actual Gini indexes, but to assess

the sensitivity of land-related inequalities to policy reforms.

Second, as explained in the last subsection, in partial equilibrium only landlords benefit from a reduction in transaction costs. This is a natural consequence of the fact that the burden of transaction costs must weigh entirely on them. Since landlords are, by construction, the richest farmers, a reduction in transaction costs is more likely to cause greater income inequality. Hence, the fact that tenants do not pay transaction costs translates into a *pessimistic* scenario of income redistribution when transaction costs are reduced.

Table 7 shows the Gini index of family income for the 14 countries of Section 4, evaluated at the current situation and for each of the 3 policy experiments (rental market reform, rental market fully efficient, land redistribution). To be clear, once the calibration parameters of Table 2 have been plugged in the Gini formula in equation (29), there are no free parameters left, the Gini index is entirely inferred from the model.

Table 7 here.

The main message of this policy experiment is that a decrease in transaction costs in the rental market will, in general, increase inequality while a land redistribution will, in general, decrease inequality. The rental market reform (an increase of θ by 0.1) makes inequality rise in 9 out of the 14 countries, while the remaining 5 experience a decrease in inequality. However, the impact of the rental market reform on inequality is generally small. Only two countries experience a change in their Gini index of more than 1 percentage point, Brazil and Nicaragua. Interestingly, this is a decrease of the Gini index of respectively 1.3 and 1.1 percentage points.

If the rental market reform has a small impact on inequality, the reform leading to a fully efficient rental market ($\theta=1$) has in most instances a substantial impact on inequality. When the rental market is made fully efficient, all countries experience an increase in inequality and 7 countries experience an increase in their Gini index of more than one percentage point. In fact, among the low and lower-middle income categories, most countries experience an increase in their Gini index of around 2 percentage points or more. While still a moderate increase, this suggests that countries in these income categories that envision an ambitious reform of the rental market should simultaneously take measures to prevent inequalities from rising.

Finally, the impact of a land redistribution (a decrease of the Gini index of land ownership by 0.1) is clear: when land is redistributed, 13 out of 14 countries experience a decrease in inequality. Jordan experiences an increase in its Gini index of income, but the increase is very small at just 0.1 percentage point. Out of the 13 countries that experience a decrease in inequality, 7 countries experience a drop in their Gini index of more than 1 percentage point. In fact, 6 countries experience a large decrease in inequality of around 4 percentage points or more: Nepal (-6.6), Ethiopia (-5.0), Bangladesh (-5.0), India (-3.8), Laos (-3.8) and Pakistan (-3.6).

To sum up, while both policies increase efficiency substantially, rental market reforms run the risk of raising inequality while land redistributions push in the direction of equality. This conclusion put undoubtedly some bright light on land redistribution, and it is important to understand it correctly. In particular, it does not mean that regulatory, state-based interventions should be preferred to market-based interventions. The paper says nothing about this. Rather, this conclusion means that *a transfer of ownership rights* to smaller farmers is more conducive to equality than *a reduction in transaction costs* in the rental market. But it is also important to keep in mind that land redistribution, especially when conducted coercively, can negatively affect the long run incentives to invest in the land. These long run incentives, due to their dynamic nature, are not considered here¹⁶.

6 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 to non-agricultural activities. In practice, when calibrating the model, the effect of rental market reforms and land redistributions on the sectoral allocation of labor remains of limited importance, except for countries that have a highly dysfunctional rental market such as India, Brazil, and Egypt. 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 reforms and land redistributions generally have a sizable effect on production efficiency in agriculture, which in turn causes a reduction in the need for capital goods and intermediate inputs. These lower operating costs translate into additional consumption and welfare. Thus, the point of agreement with the existing literature 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 appear to bring limited labor movements to non-agricultural activities. In so far as the objective of the reform is to remove the obstacles to renting or selling land, the movement of labor either in or out of agriculture is usually of modest size. This naturally leads one to think that the cause of the labor movements observed in the empirical literature is not so much a rise in rental market activity, but rather a diminution in the costs of migration, or a development of off-farm job opportunities.

Finally, the present analysis has also shown that in most circumstances a redistribution of land ownership rights is predicted to reduce income inequality, while a reduction in transaction costs in the land rental market is predicted to increase income inequality. This suggests that reforms aimed at fostering land rentals should be accompanied by redistributive measures for small farmers.

To improve the accuracy of the results, three directions seem promising: First, taking into account the problem of self-selection. If workers have heterogeneous productivities in agriculture and non-agriculture, then each worker self-selects in one sector according to its comparative advantage (Lagakos and Waugh (2013)). Land rental market reforms could make the process of self-selection more efficient, by removing obstacles for those who have a comparative advantage in non-agriculture. It seems natural to believe that at least part of the departures from agriculture observed in empirical studies is linked with self-selection. But conversely, the increased land rental market activity might also push some workers to self-select in agriculture. The net effect on the sectoral allocation of labor is not obvious.

Second, taking into account the distinction between temporary and permanent exit from

agriculture. Beyond the problem of transaction costs, farmer families may decide to maintain their presence on the farm to reduce the risk of dispossession in case future land redistributions were to happen (Deininger et al. (2014)). This creates different motives for temporary and permanent off-farm employment since a temporary occupation means that the family can signal its presence on the farm.

Third, introducing liquidity constraints. This mechanism is likely to be important if the reallocation of labor to non-agricultural activities is synonymous with migration from rural to urban areas. One way in which households finance the cost of migration is by selling or renting the land they own (e.g., Chernina et al. (2014)). An improvement in the land rental or sales market may help them finance their departure, and may also help them finance the setting-up of a non-agricultural business.

Table 1: Data sources of the calibration

Parameter	Definition	Data source
δ	Shape parameter of the Pareto distribution of land	Gini index of land ownership: FAO Yearbook 2010; Europe: Kay et al. (2015).
α, β	Labor and land factor shares	Nin-Pratt and Yu (2010), constrained estimates replicated using the Data Appendix, simple average of factor shares over 1997-2006 (Laos, Lebanon: regional average); United States: Fuglie (2015) (2011-2012 estimates); Europe: Wang et al. (2012).
S_T	Aggregate land-labor ratio	Agricultural land: FAO, 2016. Employment in agriculture: ILO estimates, 2016.
θ	Transaction costs in the land rental market	Target: share of land rented in total agricultural land, various years. Share of land rented: author's computations using data from the World Programme for the Census of Agriculture 2010, FAO (2019) (Holdings operated under two or more tenure forms are treated as rented land; Bangladesh: "Owner-cum-tenant" land tenure is conventionally split in half between rented land and owned land); Ethiopia: Chen et al. (2021), p10, 2015-2016.
λ	Agricultural output & consumption	Target: value added in agriculture divided by total employment. Value added in agriculture: World Bank, 2016. Total employment: ILO estimates, 2016.
N	Labor productivity in non-agriculture	Target: employment in agriculture in percentage of total employment, 2016. Data source: ILO estimates.
A, η	Total factor productivity in agriculture, price of capital goods	Normalized to 1

Table 2: *Initial parameter values of the calibration*

Country	Gini index of land ownership (%)	δ	α	β	S_T	θ	λ	N
Bangladesh	62	1.306	0.15	0.48	0.0015	0.66	0.2431	123
Brazil	85	1.088	0.31	0.15	0.0313	6×10^{-9}	8.665	3208
Egypt	69	1.225	0.32	0.48	0.0014	0.15	0.074	1472
Ethiopia	47	1.564	0.25	0.52	0.0076	0.52	0.1861	120
European Union	82	1.110	0.30	0.08	0.0080	0.82	15.71	8166
India	60	1.333	0.19	0.35	0.0037	0.05	1.685	242
Jordan	81	1.117	0.39	0.28	0.0052	0.006	0.3251	6028
Laos	41	1.720	0.30	0.37	0.0067	0.43	0.734	210
Lebanon	69	1.225	0.34	0.32	0.0030	0.65	0.4769	2010
Nepal	49	1.520	0.15	0.50	0.0027	0.79	0.2957	78.1
Nicaragua	72	1.194	0.50	0.12	0.0183	6×10^{-7}	2.605	889
Pakistan	60	1.333	0.19	0.34	0.0055	0.67	2.1683	291
United States	78	1.141	0.13	0.25	0.0262	0.9	14.43	11090
Uruguay	79	1.133	0.31	0.26	0.0896	0.9	4.67	7850

Table 3: Consequences of rental market reform and land redistribution in low income countries

Country	Reform	Gini index of land ownership (%)	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output & consumption	Non-agricultural output	Capital stock in agriculture	Aggregate transaction costs	Non-agricultural consumption	Growth of total consumption (% compared to current situation)
Ethiopia	Current situation		0.54	68.19	11.3	89.7		38.2	83.7	11.4	-56.9	
	Rental market reform	47	0.64	67.90	14.7	92.3	373.4	38.5	81.1	11.0	-53.5	1.1
	Rental market fully efficient		1	69.53	29.3	100		36.6	74.2	0	-37.6	6.1
	Land redistribution	37	0.54	68.08	4.7	91.1		38.3	82.2	4.6	-48.5	2.7
Nepal	Current situation		0.79	71.15	20.2	95.7		22.5	145.9	9.0	-132.3	
	Rental market reform	49	0.89	72.99	25.8	97.9	411.7	21.1	142.6	5.7	-127.2	1.8
	Rental market fully efficient		1	75.75	32.6	100		18.9	139.7	0	-120.8	4.1
	Land redistribution	39	0.79	71.11	11.6	95.8		22.6	145.8	5.1	-128.3	1.4

Table 4: Consequences of rental market reform and land redistribution in lower-middle income countries

Country	Reform	Gini index of land ownership (%)	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output & consumption	Non-agricultural output	Capital stock in agriculture	Aggregate transaction costs	Non-agricultural consumption	Growth of total consumption (% compared to current situation)
Bangladesh	Current situation		0.66	42.71	23.4	94.0		70.5	145.9	16.0	-91.4	
	Rental market reform	62	0.76	43.21	27.7	96.1	394.3	69.8	142.8	12.8	-85.8	1.9
	Rental market fully efficient		1	45.40	38.5	100		67.2	137.7	0	-70.5	6.9
	Land redistribution	52	0.66	42.68	13.2	94.1		70.5	145.6	9.0	-84.1	2.4
Egypt	Current situation		0.15	25.54	15.0	79.7		1096.0	256.0	102.5	737.5	
	Rental market reform	69	0.25	24.59	19.6	84.7	1317.1	1110.1	242.0	105.3	762.7	1.2
	Rental market fully efficient		1	23.33	40.2	100		1128.6	207.1	0	921.4	9.0
	Land redistribution	59	0.15	24.94	5.9	82.8		1104.9	247.1	37.6	820.2	4.0
India	Current situation		0.05	45.16	2.3	72.8		132.7	332.6	7.7	-207.5	
	Rental market reform	60	0.15	44.72	6.7	77.9	717.0	133.8	320.7	17.7	-204.7	0.6
	Rental market fully efficient		1	46.91	36.7	100		128.5	280.7	0	-152.2	10.9
	Land redistribution	50	0.05	44.79	0.4	81.3		133.6	313.5	1.1	-181.0	5.2
Laos	Current situation		0.43	68.64	7.2	87.7		65.8	175.1	9.3	-118.5	
	Rental market reform	41	0.53	68.57	9.7	90.1	534.4	66.0	172.2	10.0	-116.2	0.6
	Rental market fully efficient		1	70.35	24.1	100		62.3	161.9	0	-99.6	4.5
	Land redistribution	31	0.43	68.82	2.3	90.6		65.5	171.7	2.8	-109.0	2.3
Nicaragua	Current situation		6×10^{-7}	31.27	1.7	49.5		611.0	224.3	2.4	384.2	
	Rental market reform	72	≈ 0.1	29.85	27.9	81.0	584.5	623.6	209.8	20.3	393.5	1.0
	Rental market fully efficient		1	29.64	46.4	100		625.5	203.8	0	421.6	3.9
	Land redistribution	62	6×10^{-7}	30.53	0.2	62.5		617.6	217.3	0.2	400.1	1.6
Pakistan	Current situation		0.67	42.37	25.5	94.7		167.7	327.8	20.9	-181.0	
	Rental market reform	60	0.77	42.77	28.8	96.7	697.9	166.5	324.4	15.9	-173.7	1.4
	Rental market fully efficient		1	44.05	36.0	100		162.8	318.7	0	-155.9	4.9
	Land redistribution	50	0.67	42.36	15.3	94.8		167.7	327.6	12.5	-172.4	1.7

Table 5: Consequences of rental market reform and land redistribution in upper middle income countries

Country	Reform	Gini index of land ownership (%)	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output & consumption	Non-agricultural output	Capital stock in agriculture	Aggregate transaction costs	Non-agricultural consumption	Growth of total consumption (% compared to current situation)
Brazil	Current situation		6×10^{-9}	10.208	5.6	42.8		2880.5	608.1	21.4	2251.0	
	Rental market reform	85	≈ 0.1	9.355	45.0	86.4	1119.5	2907.9	538.8	68.2	2300.9	1.5
	Rental market fully efficient		1	9.347	59.7	100		2908.2	525.4	0	2382.7	3.9
	Land redistribution	75	6×10^{-9}	9.767	0.4	56.8		2894.7	579.2	1.2	2314.3	1.9
Jordan	Current situation		0.006	3.55	17.3	72.2		5814.2	189.5	38.4	5586.2	
	Rental market reform	81	0.106	3.35	30.0	85.9	575.2	5825.9	177.0	47.1	5601.8	0.3
	Rental market fully efficient		1	3.28	46.0	100		5830.4	166.9	0	5663.5	1.3
	Land redistribution	71	0.006	3.46	5.1	77.6		5819.3	184.2	10.3	5624.7	0.6
Lebanon	Current situation		0.65	12.393	29.3	96.3		1760.9	248.3	25.8	1486.8	
	Rental market reform	69	0.75	12.404	31.0	97.5	742.6	1760.7	246.8	19.2	1494.7	0.4
	Rental market fully efficient		1	12.486	35.0	100		1759.0	243.9	0	1515.1	1.3
	Land redistribution	59	0.65	12.397	17.1	96.5		1760.8	248.1	15.0	1497.8	0.5

Table 6: Consequences of rental market reform and land redistribution in high income countries

Country	Reform	Gini index of land ownership (%)	θ	Labor in agriculture (%)	Share of area rented (%)	Efficiency of agricultural production (%)	Agricultural output & consumption	Non-agricultural output	Capital stock in agriculture	Aggregate transaction costs	Non-agricultural consumption	Growth of total consumption (% compared to current situation)
European Union	Current situation		0.82	4.296	48.2	98.9		7815.2	726.9	8.2	7080.1	
	Rental market reform	82	0.92	4.300	48.9	99.5	1172.3	7814.9	726.4	3.7	7084.8	0.06
	Rental market fully efficient		1	4.303	49.5	100		7814.6	726.2	0	7088.5	0.10
	Land redistribution	72	0.82	4.295	30.5	98.8		7815.3	726.9	5.2	7083.1	0.04
United States	Current situation		0.9	1.449	34.5 (38.4)	99.4		10929.3	758.4	10.4	10160.5	
	Rental market fully efficient	78	1	1.460	36.0	100	1219.3	10928.1	757.0	0	10171.1	0.09
	Land redistribution	68	0.9	1.450	18.9	99.5		10929.2	758.3	5.7	10165.2	0.04
Uruguay	Current situation		0.9	8.219	46.5 (54.0)	99.3		7204.9	903.4	25.3	6276.2	
	Rental market fully efficient	79	1	8.242	47.6	100	2092.1	7203.0	901.2	0	6301.8	0.31
	Land redistribution	69	0.9	8.216	30.6	99.2		7205.1	903.6	16.6	6284.8	0.10

Table 7: Consequences of rental market reform and land redistribution on income inequality

Reform	Gini index of family income (%) (inferred from the model. land-based inequalities only)																
	Low income countries				Lower-middle income countries						Upper middle income countries				High income countries		
	Ethiopia	Nepal	Bangladesh	Egypt	India	Laos	Nicaragua	Pakistan	Brazil	Jordan	Lebanon	European Union	United States	Uruguay			
Current situation	25.7	33.2	34.2	16.3	25.7	17.3	4.2	24.3	3.1	1.5	6.4	0.84	1.97	4.8			
Rental market reform	25.9	34.0	34.7	15.7	25.0	17.4	3.0	24.9	1.8	1.3	6.6	0.89	2.04	5.1			
Rental market fully efficient	27.8	35.0	36.7	17.9	27.9	19.2	4.8	26.6	3.6	1.9	7.2	0.93					
Land redistribution	20.6	26.6	29.2	15.1	21.9	13.6	3.7	20.7	3.1	1.6	5.7	0.76	1.74	4.3			

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:

$$\lim_{\delta \rightarrow \infty} \frac{1}{\delta - 1} \left(\frac{\delta - 1}{\delta} \right)^\delta = 0 \quad \text{and} \quad \lim_{\delta \rightarrow 1} \frac{1}{\delta - 1} \left(\frac{\delta - 1}{\delta} \right)^\delta = 1. \quad (31)$$

To see that $\frac{S_T}{s_1}$ is the maximum level of agricultural employment over the domain $(\theta, \delta) \in [0, 1] \times (1, \infty)$, notice that in equation (15) the term $\frac{1}{\delta - 1} \left(\frac{\delta - 1}{\delta} \frac{S_T}{s_1} \right)^\delta \left(1 - \theta^{\frac{\alpha + \beta}{\alpha}(\delta - 1)} \right)$ is positive whenever $\theta \neq 1$. Hence the maximum of L^A is reached when $\theta = 1$.

A.2 Proposition 2

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

$$\frac{\partial E}{\partial \theta} = \frac{\alpha + \beta(1 - \theta)}{\alpha} \frac{s_1}{S_T} \left(\frac{\delta - 1}{\delta} \frac{S_T}{s_1} \right)^\delta \theta^{(\delta - 1)\frac{\alpha + \beta}{\alpha} - 1} > 0. \quad (32)$$

Part (b): when evaluating the limiting behavior of the efficiency index E :

$$\lim_{\delta \rightarrow \infty} \left(\frac{\delta - 1}{\delta} \right)^{\delta - 1} = e^{-1}; \quad \lim_{\delta \rightarrow 1} \left(\frac{\delta - 1}{\delta} \right)^{\delta - 1} = 1, \quad (33)$$

and the following term in E tends to zero whenever δ tends to one or tends to infinity:

$$\lim_{\delta \rightarrow 1, \infty} \frac{1}{\delta} \left[\left(1 - \theta \frac{\beta(\delta - 1)}{\alpha\delta + \beta(\delta - 1)} \right) \theta^{\frac{\alpha + \beta}{\alpha}(\delta - 1)} - \frac{\alpha\delta}{\alpha\delta + \beta(\delta - 1)} \right] = 0. \quad (34)$$

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:

$$\tilde{Y}^A(p_A) E(p_A, \theta) = \lambda. \quad (35)$$

It can easily be seen from (26) that

$$\frac{\partial \tilde{Y}^A}{\partial p_A} > 0; \quad \frac{\partial E}{\partial p_A} > 0. \quad (36)$$

Finally, differentiate implicitly (35) and use (36) and (32) to find the desired result:

$$\frac{\partial p_A}{\partial \theta} = - \frac{\tilde{Y}^A \frac{\partial E}{\partial \theta}}{\frac{\partial \tilde{Y}^A}{\partial p_A} E + \tilde{Y}^A \frac{\partial E}{\partial p_A}} < 0. \quad (37)$$

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

$$\frac{\partial L_A}{\partial \frac{S_T}{s_1}} = 1 - \frac{1}{\delta - 1} \left(\frac{\delta - 1}{\delta} \right)^\delta \left(1 - \theta^{\frac{\alpha + \beta}{\alpha}(\delta - 1)} \right) \left(\frac{S_T}{s_1} \right)^{\delta - 1}. \quad (38)$$

Then, inspect the sign of the derivative:

$$\frac{\partial L_A}{\partial \frac{S_T}{s_1}} > 0 \quad \Leftrightarrow \quad \frac{S_T}{s_1} < \frac{\delta}{\delta - 1} \left(1 - \theta^{\frac{\alpha + \beta}{\alpha}(\delta - 1)} \right)^{-\frac{1}{\delta - 1}}. \quad (39)$$

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:

$$\frac{S_T}{s_1} \leq 1 < \frac{\delta}{\delta - 1} \left(1 - \theta^{\frac{\alpha + \beta}{\alpha}(\delta - 1)} \right)^{-\frac{1}{\delta - 1}}, \quad (40)$$

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

$$\frac{S_T}{s_1} = \frac{S_T}{N} \frac{\alpha}{\beta} q, \quad \text{with} \quad \frac{\partial q}{\partial p_A} > 0, \quad (41)$$

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 $0 < E \leq 1$

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

$$E = 1 + \frac{1}{\delta} f(\theta) \left(\frac{\delta-1}{\delta} \frac{S_T}{s_1} \right)^{(\delta-1)},$$

$$f(\theta) = \left(1 - \theta \frac{\beta(\delta-1)}{\alpha\delta + \beta(\delta-1)} \right) \theta^{\frac{\alpha+\beta}{\alpha}(\delta-1)} - \frac{\alpha\delta}{\alpha\delta + \beta(\delta-1)}. \quad (42)$$

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

$$f(\theta) = [1 - (1-y)\theta] \theta^x - y, \quad (43)$$

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

$$f'(\theta) = \theta^{(x-1)} [x - (1-y)(1+x)\theta]. \quad (44)$$

f' is positive provided

$$\frac{x}{(1-y)(1+x)} > \theta \quad \Leftrightarrow \quad \frac{\alpha+\beta}{\beta} > \theta \quad (45)$$

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

$$\begin{aligned} f(0) &\leq f(\theta) \leq f(1) \\ \Rightarrow -y &\leq f(\theta) \leq 0 \\ \Rightarrow 1 - \frac{y}{\delta} \left(\frac{\delta-1}{\delta} \frac{S_T}{s_1} \right)^{(\delta-1)} &\leq E \leq 1 \\ \Rightarrow 0 &< E \leq 1 \end{aligned} \quad (46)$$

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

A.5 Proposition 4

Part (a): below are the main intermediate results of the Gini index of family income.

Using the definition of family income in problem (1) and the results of Section 2.2, the equilibrium family income is as follows:

$$I_i = \begin{cases} w + qs_i & \text{if } s_1 \geq s_i \geq s_m, \\ (w + qs_1) \left(\frac{s_i}{s_1}\right)^{\frac{\beta}{\alpha+\beta}} & \text{if } s_2 \geq s_i \geq s_1, \\ (w + qs_1) \left(\frac{s_2}{s_1}\right)^{\frac{\beta}{\alpha+\beta}} + \theta q(s_i - s_2) & \text{if } s_i \geq s_2. \end{cases} \quad (47)$$

Combining this result with the cumulative distribution of land in (2) yields the cumulative distribution of family income, denoted $F_I(I_i)$:

$$F_I(I_i) = \begin{cases} 0 & \text{if } I_i \leq I_m, \\ 1 - \left(\frac{\delta-1}{\delta} \frac{qS_T}{I_i-w}\right)^\delta & \text{if } I_1 \geq I_i \geq I_m, \\ 1 - \left(\frac{\delta-1}{\delta} \frac{S_T}{s_1} \left(\frac{I_i}{I_1}\right)^{\frac{\alpha+\beta}{\beta}}\right)^\delta & \text{if } I_2 \geq I_i \geq I_1, \\ 1 - \left(\frac{\delta-1}{\delta} \frac{\theta q S_T}{I_i - I_2 + \theta q s_2}\right)^\delta & \text{if } I_i \geq I_2, \end{cases} \quad (48)$$

with $I_m = w + qs_m$, $I_1 = w + qs_1$ and $I_2 = (w + qs_1) \left(\frac{s_2}{s_1}\right)^{\frac{\beta}{\alpha+\beta}}$.

The Gini index of family income is then computed using Dorfman's formula:

$$G_I = 1 - \frac{1}{\mu} \int_0^\infty (1 - F_I(I_i))^2 dI_i \quad (49)$$

where $\mu = \int_{I_m}^\infty I_i dF_I(I_i)$ is the mean family income.

Part (b): the limits in (31) are used here, in addition to the following:

$$\lim_{\delta \rightarrow \infty} \frac{1}{2\delta - 1} \left(\frac{\delta - 1}{\delta}\right)^{2\delta} = 0. \quad (50)$$

Notes

¹The critique of the market-based approach to land reform revolves around three main arguments (Borras (2003), Lahiff et al. (2007)):

- at the local level, an asymmetry of political power between landlords and landless farmers distorts the negotiations between sellers and buyers in favor of landlords. Landlords are then able to sell overpriced lands, and to sell those lands that are marginal and infertile. Poor farmers are also unable to voice their demand for land effectively.
- the decentralization of land reforms in the hands of regional and local governments is not conducive to more transparency and accountability since power at the local level is more concentrated and less favorable to redistribution than power at the state level.
- the voluntary nature of land transfers has resulted in a small volume of land redistributed in comparison with expropriatory state-led redistributions.

²See also Jin and Deininger (2009), Vranken and Swinnen (2006) and Carter and Yao (2002) for more recent contributions in this strand of research.

³Note that, as Ho and Spoor (2006) pointed out, secure land tenure is not necessarily equivalent to private property rights because tenure security could be granted to a community of users via common property. Land rental and sale are then to occur within the community.

⁴The usual explanation is the existence of liquidity constraints for small farmers and various policy distortions such as tax shelters that drive the price of land upward (Deininger and Feder (2001)). Griffin et al. (2002) also suggest that big landlords refuse to sell their land to preserve a monopsony power in local labor markets.

⁵A more recent approach is "community-led" land reform (Sikor and Müller (2009), Bouquet (2009), Sikor et al. (2009)). This approach emphasizes the need to involve local actors in the conception and implementation of land reforms. Typically, the state grants collective ownership titles to local communities such as villages and indigenous groups, and with it the authority to redistribute land among community members. The aim of this approach is to adapt land policy to local historical conditions, ideally along the lines of customary land tenure.

⁶The definition of the three classes of farmers in this paper is entirely based on their behavior in the land rental market. Tenants are farmers that rent in, landlords are farmers that rent out, and autarkic farmers are farmers that rent neither in nor out. Every other criterion is irrelevant. Thus, a tenant might live in a rural or an urban area, might cultivate a staple crop or a cash crop etc.

⁷Symmetrically, the model predicts that labor productivity increases with farm size, which is also a common empirical observation (e.g., Helfand and Taylor (2021)).

⁸The likely reason for these divergent conclusions is that Eswaran and Kotwal chose a different set of market imperfections, putting emphasis on credit constraints rather than land market transaction costs.

⁹Though both perfectly equal and perfectly unequal ownership of land lead to the same level of agricultural

production, they do not, however, lead to the same level of agricultural *income* (aggregate family income I minus aggregate off-farm income wL^N). When the entire land endowment is owned by a single family, this family must bear the transaction costs of renting out to every other family. Thus, part of the payments this family receives is lost in transaction costs and the total agricultural income is going to be lower than the total agricultural output. By contrast, when land is equally distributed, no family is renting out and therefore no family must incur any transaction costs. Total agricultural income is then equal to total agricultural production. To put it more concretely, when δ tends to infinity, total agricultural income tends to $wL^A + qS_T$ which is simply the market value of aggregate agricultural inputs. However, when δ tends to 1, total agricultural income tends to $wL^A + \theta qS_T$.

¹⁰Note that aggregation of preferences is only possible if each family can afford to buy λ . This may require the existence of lump-sum transfers to the poorest families.

¹¹More precisely, the low and lower-middle income countries in the sample are all those countries for which I have national estimates of the Gini index of land ownership and the share of land rented in total agricultural land. For upper-middle and high income countries, the list is not exhaustive, but I have included a few of them to illustrate their situation.

¹²This conclusion is potentially undermined by the prevalence of informal rental agreements in India, not taken into account in the data.

¹³For 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 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.

¹⁴Both countries have Gini indexes of land ownership of roughly 80%, and they have reached the point where redistributing land isn't efficient anymore. But it doesn't mean that any country with a similar Gini index will experience a decrease in efficiency as well. For example, Brazil has a higher Gini index (85%) and yet experiences an increase in efficiency when land is redistributed. This is because Brazil starts with a much more dysfunctional rental market.

¹⁵To see this point, compute $\frac{\partial I_i}{\partial s_i}$ for each class of farmers in equation (47) in Section A.5.

¹⁶Another argument favorable to land redistribution is that land ownership could be considered a superior form of land tenure compared to land rental (Swinnen et al. (2016)): it transfers full rights to the new user, it improves access to credit through the use of collateral, and it provides permanent security of rights.

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