# Farmland Investment in Africa: What's the Deal?

Luca Di Corato[1], Sebastian Hess[2]

[1] Department of Economics - Swedish University of Agricultural Sciences
PO Box 7013, SE-75007 Uppsala. Email address: luca.di.corato@slu.se

[2] Department of Economics - Swedish University of Agricultural Sciences
PO Box 7013, SE-75007 Uppsala. Email address: sebastian.hess@slu.se

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**Abstract -** We present a dynamic stochastic programming model that reflects the typical bargaining situation concerning large land deals in Africa. The model allows assessing the effect of market- and country-specific risks and taxation. It shows that commodity price volatility increases the value of the land development option, but slows down the land development process. Furthermore, it shows that host country attempts to negotiate fixed commitments to the speed of project development may run counter to the structure of economic incentives at the project site. Finally, the applicability of the model is demonstrated for a recent 10,000-hectare cotton project in Ethiopia.
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## 1 Introduction

Foreign direct investment (FDI) by multinational corporations or governments in the agricultural land of developing and least developed countries[1] is an ongoing trend (e.g. Visser and Spoor, 2011; Cotula et al., 2009) which appears to be driven by the rising and increasingly volatile prices of agricultural commodities (see e.g. von Braun and Meinzen-Dick, 2009; Collier and Venables, 2012; Deininger et al., 2011; Hall, 2011a). Ideally, this type of FDI would benefit not only investors but also the host countries, since it may lead to infrastructure development, technology transfer and job opportunities in rural areas (see e.g. von Braun and Meinzen-Dick, 2009).

In Africa, such investment projects are typically established as long-term land leases and the host countries usually aim to benefit through negotiated investor commitments towards certain infrastructure projects, through taxation of the project, or through a combination of both (Hall, 2011b). However, from the perspective of the African host countries, several such projects have proved to be disappointing (see e.g. Collier and Venables, 2012), since investors either failed to take the acquired land under cultivation at all, or cultivation has been developing slowly compared with the expectations that were raised when the contract was signed. In addition, it is frequently observed that expected and contractually established benefits from project-related investments in the development of infrastructure do not seem to be delivered by the investors (Cotula et al., 2009). From an economic perspective, there are several potential reasons why a large-scale FDI project in African farmland may only sluggishly deliver the expected benefits to the host country. While some authors blame exploitative or speculative intentions by investors (see e.g. Borras and Franco, 2010), official reports of international organizations tend to attribute such failures to the institutional difficulties and governance problems encountered by foreign investors in the host countries (von Braun and Meinzen-Dick, 2009; Cotula et al., 2009).

The objective of this article is to analyze whether, and under what policy settings, the interest of both parties to maximize the project value may lead to an outcome that also maximizes their respective payoff from the investment project. The article aims to contribute to the discussion surrounding such large-scale land deals by developing a dynamic stochastic programming model. This model includes many aspects of the typical bargaining situation between host country and investor. In fact, as for many large-scale land deals in Africa, the model involves a foreign investor willing to invest in land development and corresponding agricultural activities, and a host country land owner potentially willing to provide access to land on the basis of a long-term leasing contract. Access to land is costly, however. The foreign investor must pay a fixed rent to the host country which is negotiated by the parties. In addition, taxes may be levied on the investor's profits. Once the lease contract is signed, the investor has full control of the land development process. However, the investor must take land development decisions by accounting for 1) uncertainty about global market conditions for agricultural products, 2) the risk of adverse natural or political events in the host country, and 3) a fixed sunk capital cost for the activation of land as input for the production of agricultural goods. We solve the underlying land development problem by determining the optimal time trajectory for land conversion to agriculture and the value of the land development

[1]Large acquisitions in sub-Saharan Africa concern projects with more than 1000 ha but include examples of a 452,500 ha biofuel project in Madagascar, a 150,000 ha livestock project in Ethiopia, and a 100,000 ha irrigation project in Mali.

project. Once the value of a hypothetical land development project has been assessed, we proceed by determining the optimal rental payment that the host country should require. This is done by assuming that the actual investment contract negotiations occur in a cooperative setting.[2]

The article makes the following contributions: First, we analyze the typical situation of many large-scale farmland investments in Africa through a theoretical model that reflects the economic incentives for investor and host country government under risk and uncertainty. Insights from this analysis can debunk some of the myths around large-scale land deals by identifying the role that economic incentives play for land development under uncertain conditions, and this may also inform and guide a concerned public in African countries when critically assessing the negotiation strategies of their governments. Second, it is possible to use the modeling framework presented for numerical assessments of the actual value of a specific investment project. Empirical specifications in this context necessarily involve a lot of incertitude and therefore we use stochastic Monte Carlo-type simulations with plausible ranges of key parameters rather than purely deterministic simulations. We demonstrate this approach by calibrating our model to a large-scale land contract signed between the government of Ethiopia and the Indian "Whitefield Cotton" company for an investment concerning 10,000 hectares of cotton in the Ethiopian district of Dasenech Nebremus. We use response surface design to evaluate the sensitivity of the model with respect to exogenous parameters that may vary in certain plausible ranges, and we infer the degree of bargaining power the respective parties were able to exert during negotiation of this contract. Any indication of very unequal bargaining power may provide a concerned public with valuable information about the way its government trades away domestic land resources. Third, we contribute to the literature[3] on FDI under uncertainty through introduction of a novel way to model the pricing of the investment option, and we introduce econometric response surface estimation as a convenient way to assess the response behavior of the dynamic stochastic programming model.

In the next section we explain how the project value is determined and what role the timing of the land conversion process plays in this respect. In Section 3 we derive implications for the optimal rental payment and the optimal profit taxation. In the last two sections we introduce our empirical implementation, and discuss and draw conclusions on the implications of our analysis. Proofs and figures are available in the Appendix.

## 2 The Model

Consider a risk-neutral host country (hereafter, HC) where a certain surface, $\overline{L}$, of land still in pristine condition, e.g. savannah, forestland, wetland, etc., is available. Assume that HC is financially constrained and cannot fund a project for the development of this land for the purpose of agricultural production, say marketable crops for food or bioenergy production. A risk-neutral foreign investor (hereafter, FI) is willing to invest in such a project if conveniently rewarded. Suppose that at a generic time period $t$ the two parties can reach a bilateral agreement for the lease of $\overline{L}$ hectares of land. On the basis of this agreement, HC leases land to FI for a fixed and certain total rental payment, $R \geq 0$.[4] FI then has the right to develop the land and devote it to agriculture. A corporate income tax, $s \in (0, 1)$, must be paid on each unit of profit accruing from the land once developed.

Denoting the hectares of land developed and under agriculture by $A_t$ and the extent of land still in its pristine state by $L_t$, at each $t \geq 0$ land is allocated as follows,

$$A_t + L_t = \overline{L}, \text{ with } A_0 = 0 \tag{1}$$

[2] We abstract from the analysis of a non-cooperative setting since such a situation is extremely unlikely. In the real world, in fact, HC must compete with other countries in order to attract FDI. Thus, competition for capital leads, by increasing the bargaining power of foreign investors, to the development of negotiations where the two parties must play cooperatively.

[3] See among others Pennings, 2005; Yu et al., 2007; Sarkar, 2012.

[4] This amount may be thought of as the net present value (hereafter NPV) of a periodic rental payment, $r$, per hectare paid over the entire contract duration. So, assuming that the contractual agreement has a term sufficiently long that can be approximated by infinity, we can set $R = (r/\rho)\overline{L}$ where $\rho$ is the discount rate. This can be done at no loss in terms of generality for our results given the generally long duration of such projects in Africa.

Assume that land under cultivation guarantees the following profit flow:[5]

$$\pi(\theta_t, A_t) = \theta_t A_t^{1-\phi}/(1-\phi) \tag{2}$$

where $0 < \phi < 1$ is a constant term representing the degree of decreasing returns to scale (DRTS) and $\theta_t$ is a random variable shifting profits, $\pi(\theta_t, A_t)$, over time.[6]

Let $\theta_t$ evolve according to the following diffusion:

$$d\theta_t = \mu\theta_t dt + \sigma\theta_t dZ_t, \text{ with } \theta_0 = \theta \tag{3}$$

where $\mu$ and $\sigma$ are drift and volatility parameters and $dW_t$ is the increment of a Wiener process with $E[dZ_t] = 0$ and $E[dZ_t^2] = dt$.

Finally, we complete our set-up by including the following assumptions:

1. Land development is costly and irreversible. In particular, we assume that land development requires a sunk investment in capital costing $k$ per hectare.

2. Land development is undertaken in the presence of country-specific risk. In this respect, our definition of risk includes all socio-political factors (war, riots, crime, etc.) and natural events (as drought, floods, etc.) reducing the profitability of the land development project initiated by FI. We regulate the occurrence of such adverse events by a Poisson process (see e.g., Clark, 1997) with intensity $\lambda \in (0, \infty)$ and denote by $\omega \in (0, 1]$ the percentage of project value lost due to the adverse event.[7]

*2.1 Project value and optimal land conversion policy*

In this section, we view FI as holding the option to develop land. We study the optimal land development policy to be followed once the contract is signed and determine the value attached to the land development project. As one can easily see, the opportunity of developing land does not depend on the rental payment once the contract has been signed, since $R$ must be paid irrespective of the development state of the land. However, the opportunity does depend on 1) the random fluctuating convenience of agriculture, and 2) the threat of adverse events that may partially or totally destroy the value of the development project.

Suppose that at the generic time period $t$ a surface $A_t \leq \overline{L}$ is developed while the remaining area, i.e., $L_t = \overline{L} - A_t$, is still undeveloped. Hence, assuming that $\pi(\theta_t, A_t)$ is such that the optimal strategy is to maintain the current land allocation, the value of the investment project for FI is given by the following Bellman equation:[8]

$$V^{FI}(\theta_t, A_t) = (1-s)\pi(\theta_t, A_t)dt + (1-\omega\lambda dt)E[V^{FI}(\theta_t + d\theta, A_t)]/(1+\rho dt) \tag{5}$$

where $\rho(> \mu)$ is the discount rate.[9]

Solving Eq. (5), we show in the appendix that:

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[5] Our profit function is consistent with a standard setting such as a price-taking farm whose production technologies show decreasing returns to scale (see Appendix). Note that it may also apply to the case of a monopolist using a constant returns to scale technology and facing a demand curve with $-1/\phi$ as constant elasticity and a multiplicative shocks $\theta_t$. In our model $\phi = 1/[c(\iota - 1) + 1]$ where $c$ and $1 - c$ are the cost shares for each specific input factor of a Cobb-Douglas production function and $\iota > 1$ indicates the degree of decreasing returns to scale, see Appendix A.1.

[6] For simplicity, we assume that no benefit accrues to the landholder when land is undeveloped. This assumption comes at no cost in terms of the generality of our results. Note in fact that our model may be easily adjusted in order to account for a potential source of income from undeveloped land (e.g., carbon credits).

[7] Note that this means that at each generic $t$, for each \$ of project's value, a loss equal to $\omega$ may occur with probability $\lambda dt$.

[8] Note that $e^{-\lambda dt}$ is the probability that a drop in the project's value, due to expropriation, does not occur over the next $dt$ whereas $(1-e^{-\lambda dt})$ is the probability that a portion $\omega$ is seized. Hence, in expected terms, for each \$ of project's value we have: $e^{-\lambda dt} \cdot 1 + (1-e^{-\lambda dt})(1-\omega) \simeq (1-\lambda dt) + \lambda dt(1-\omega) = 1 - \omega\lambda dt$.

[9] Note that $\rho > \mu$ is needed in order to guarantee that the discounted stream of profits converges. In addition, note also that, in order to account for risk aversion, one may use CAPM and calculate a risk-adjusted discount rate.

**Proposition 1** - *FI develops land ($dA_t > 0$) every time the process $\{\theta_t : t \geq 0\}$ reaches the barrier*

$$\theta^*(A_t) = \frac{\beta}{\beta - 1}\frac{k}{1 - s}(\delta - \mu)A_t^{\phi} \tag{6.1}$$

*or, rearranged in terms of profit, whenever current profit, $\pi(A_t)$, reaches the critical threshold profit level*

$$\pi^*(A_t) = \frac{\beta}{\beta - 1}\frac{k}{1 - s}(\delta - \mu)\frac{A_t}{1 - \phi} \tag{6.2}$$

*where $\delta = \rho + \omega\lambda$ and $\beta(> 1)$ is the positive root of the equation $\Phi(\beta) = (\sigma^2/2)\beta(\beta - 1) + \mu\beta - \delta = 0$.*

**Proof** - See Appendix.

The critical profit threshold, $\pi^*(A_t)$, is linearly increasing in $A_t$. That is, the larger the surface under agriculture, the higher the agricultural profit inducing additional land conversion should be. This implies that the expected timing for the development of the next marginal unit of land increases as land is developed. This makes intuitive sense considering that agricultural profits are concave in the degree of DRTS. Note also that $\partial\pi^*(A_t)/\partial\phi > 0$. That is, the lower the degree of DRTS ($\phi \to 0$), the earlier land development occurs in expected terms. As can be expected, the critical threshold in (6.2) is also increasing in $s$, which means that the higher the corporate tax rate, $s$, the slower the land development. A further element deterring conversion is represented by higher capital investment costs $k$, since the critical profit threshold is rising in higher fixed costs that are associated with the investment, i.e., $\partial\pi^*(A_t)/\partial k > 0$.

Let us now discuss the corresponding effect of a change in the remaining parameters $\sigma$, $\mu$, and $\delta$.[10] In order to do so, we rearrange (6.2) as follows:

$$(1 - s)\theta^*(A_t)A_t^{-\phi} = [(\sigma^2/2)\beta + \delta]k \tag{6.3}$$

The LHS of (6.3) shows the marginal net benefit from developing a hectare of land, while the RHS shows the corresponding marginal cost. Note that the marginal cost is represented by the rental cost of a unit of capital, $\delta$, adjusted by adding the term, $(\sigma^2/2)\beta$, to account for market uncertainty. The impact of expected profit growth, $\mu$, and profit volatility, $\sigma$, on the critical conversion threshold is in line with findings in the real options literature. In particular, we note that as future agricultural net returns become more volatile, the critical conversion threshold rises and land development is postponed, i.e., $\partial\theta^*(A_t)/\partial\sigma^2 > 0$. In contrast, the higher the expected profit growth rate, $\mu$, the lower the critical threshold that triggers additional land conversion, i.e., $\partial\theta^*(A_t)/\partial\mu < 0$. Note also that $\lim_{\sigma\to 0}[(\sigma^2/2)\beta + \delta] = \delta$, i.e., as market uncertainty vanishes, land conversion occurs whenever marginal profits cover the rental cost of capital, $\delta k$. Finally, a higher discount induces delayed land conversion, i.e., $\partial\theta^*(A_t)/\partial\delta > 0$. This result deserves further comment on each specific component of the discount rate $\delta$. A higher $\rho$ implies a higher rental cost for the capital, $\rho k$, while a higher $\lambda$ and $\omega$ imply a more likely loss in the project value and a larger loss due to adverse events, respectively. It is immediately apparent that all these considerations lead to a more prudent land development strategy for FI.

Now, let us determine the values of the land development project for both parties. In the Appendix we show that:

**Proposition 2** - *For any land allocation $A \leq \overline{L}$, the value functions of FI and HC are given, respectively, by:*

$$V^{FI}(\theta, A) = \frac{k}{\beta - 1}\int_A^{\overline{L}}(\frac{\theta}{\theta^*(\xi)})^{\beta}d\xi + (1 - s)\frac{\pi(\theta, A)}{\delta - \mu}, \text{ and} \tag{7.1}$$

$$V^{HC}(\theta, A) = \frac{\beta}{\beta - 1}\frac{s}{1 - s}k\int_A^{\overline{L}}(\frac{\theta}{\theta^*(\xi)})^{\beta}d\xi + s\frac{\pi(\theta, A)}{\delta - \mu} \tag{7.2}$$

[10] Note that $\partial\beta/\partial\delta > 0$, $\partial\beta/\partial\mu < 0$ and $\partial\beta/\partial\sigma^2 < 0$. See section A.3 in the appendix.

*where* $\theta^*(\xi) = \frac{\beta}{\beta-1}\frac{k}{1-s}\,(\delta-\mu)\xi^{\phi}$.

**Proof** - See Appendix.

In (7.1) the first term represents the value of the option to develop the surface $\overline{L}-A \geq 0$ , while the second term represents the expected present value of the project if the current land allocation $A \leq \overline{L}$ is kept forever. A similar interpretation can be given to the terms in (7.2). However, it is worth highlighting that the main difference between the two parties is that only FI has control over the development process. In fact, while FI, on the basis of the contractual agreement, keeps under its own control the land development process, $dA$, HC may attach to the surface potentially developable only the expected value of the potential earnings which can be obtained through the taxation of the profits. Note that the term $(\theta/\theta^*(\xi))^{\beta}$ is a stochastic discount factor which discounts future potential earnings accruing from the future development of the surface $\overline{L}-A$.

Finally, let us conclude this section by studying the factors determining the dynamics of land development in the long run. Using (6.1) and denoting the long-run average growth rate of land development by $E\left[d\ln A\right]/dt$, we can prove that:

**Proposition 3** - *For any land allocation $A \leq \overline{L}$ the expected long-run growth rate of land development is given by:*

$$\frac{1}{dt}E\left[d\ln A\right] \simeq \begin{cases} (\mu-\sigma^2/2)/\phi & \text{for } \mu > \sigma^2/2 \\ 0 & \text{for } \mu \leq \sigma^2/2 \end{cases} \tag{8}$$

**Proof** - See Appendix.

It is worth highlighting here that expected profit growth must be strong enough to have a positive long-run average development rate, i.e., $\mu > \sigma^2/2$. Otherwise, due to the deterring effect of profit volatility, the rate is null. In line with these considerations, note that the long-run development rate is increasing in $\mu$ and decreasing $\sigma^2$. Note also that, as one could expect, land development speed is decreasing in the degree of DRTS, $\phi$. Finally, from (15), an immediate consideration is that the expected land development rate is independent of the rate of corporate taxes, $s$.[11]

## 3 The optimal rental payment

The value of the project for both parties depends on the timing of land development. This is in turn dictated by the optimal development trigger, $\pi^*(A)$, which, as highlighted above, is set by the party having control over the development process, i.e., FI. However, it is important to stress the role that other two crucial aspects have on the development process: 1) the rental payment, $R$, to be paid by FI in order to have access to the exploitation of land surface $\overline{L}$, and 2) the tax rate, $s$, set by HC on FI's profits.

First, concerning $R$, as one can immediately see, the start of the land development project is conditional on the two parties reaching agreement on the terms of the contract. Once such agreement is reached, the contract is signed and the project can start. In this respect, setting $R$ is crucial. The rental payment must in fact be set in order to satisfy a basic set of participation constraints. That is, at $t=\widetilde{t}$ where $\widetilde{t}$ is the time at which the contract agreement is reached, the following conditions must hold:

$$W^{FI}(\widetilde{\theta},R) = V^{FI}(\widetilde{\theta}) - R \geq 0; W^{HC}(\widetilde{\theta},R) = V^{HC}(\widetilde{\theta}) + R \geq 0 \tag{9.1-9.2}$$

where $\theta_{\widetilde{t}} = \widetilde{\theta}$.

Note that by [9.1-9.2] we are simply requiring that for both parties the expected value attached to the project is non-negative. Second, note that:

**Proposition 4** - *At $t=\widetilde{t}$, given a certain tax rate, $s$, an agreement between FI and*

[11] Note in fact that the change in the optimal developed land surface is random because $\theta$ evolves randomly. In contrast, the corporate tax is constant over time and thus it does not affect the long-run optimal development path. This in turn implies that as concerns long-run dynamics, HC's fiscal policy has a neutral impact.

*HC over R always entails the immediate development of the following land surface:*

$$\widetilde{A} = \{(1-s)\widetilde{\theta}/[(\sigma^2/2)\beta + \delta]k\}^{1/\phi} \tag{9.3}$$

The interpretation of (9.3) is straightforward. By (6.1), the level of $\theta$ at $t = \widetilde{t}$ is high enough to support some land development, $\widetilde{A}$. Note in fact that for any $\theta > 0$, land should be developed up to the amount at which the control $\theta^*$ stops the conversion process, i.e., $\theta^* > \theta$. The magnitude of this amount of land depends, via (6.1), on, among other parameters, As shown by (9.3), the relationship between $\widetilde{A}$ and $s$ is negative, i.e., $\partial\widetilde{A}/\partial s < 0$. That is, the higher the corporate tax rate, the lower the land area that FI finds profitable to develop in the first place. Hence, in technical parlance, by viewing $\overline{L}$ as a set of options to develop, HC is splitting it into a subset composed of $\widetilde{A}$ options "*in-the-money*" and a subset composed of $\overline{L} - \widetilde{A}$ "*out-of-the money*". The first group of options must be exercised as soon as the contract is signed, while the remainder may be exercised later using (6.1). Changing perspective, HC, by fixing $s$, is implicitly 1) setting short-run goals concerning the development of the land surface $\overline{L}$, and 2) setting the amount of land over which FI would exercise control. These considerations seem in line with what is observed in the reality, where HC are often willing to concede tax holidays to foreign investors.[12]

Meeting the goal of fast and vast land development would, however, come at a cost in terms of tax revenues. As pointed out, this would in fact require a lower tax rate on profits accruing to FI. This loss may be balanced (or reduced) by setting a proper rental payment, $R$. Clearly, as stressed above, this is not a trivial issue, since $R$ must be set such that FI's initiative is not deterred. In the following, we proceed to the analysis of this choice by studying, given a certain taxation regime, the definition of an optimal rental payment in a cooperative setting.

Assume that HC and FI are engaged in a cooperative cake-splitting game where 1) both parties are neutral to the risk of internal conflicts and 2) have bargaining power, $\psi$ and $1-\psi$ with $\psi \in (0,1)$, to each of them, respectively.[13] As is well known, we can solve the underlying game by applying the Nash bargaining solution concept (Nash, 1950).

A feasible Nash bargaining solution, $R_1^* \geq 0$ solves the following maximization problem:[14]

$$\max_{R_1 \geq 0} \Omega_1 = \psi \ln[W^{FI}(\widetilde{\theta}, R_1)] + (1-\psi)\ln[W^{HC}(\widetilde{\theta}, R_1)] \tag{10}$$

In the Appendix, we show that:

**Proposition 5** - *At $t = \widetilde{t}$, when FI and HC jointly decide upon the optimal rental payment, $R_1^*$, in a Nash-bargaining frame, then the optimal payment is set as follows*

$$R_1^* = (1-\psi)V^{FI}(\widetilde{\theta}) - \psi V^{HC}(\widetilde{\theta}) \tag{10.1}$$

The interpretation is straightforward. The optimal payment is set on the basis of the relative strength of the two parties. Note in fact that, as expected, $R_1^*$ is increasing in HC's bargaining power and decreasing in FI's strength. Note also that given a certain power allocation $(\psi, 1-\psi)$, a lower $R_1^*$ is paid as the expected value of tax revenues, $V^{HC}(\widetilde{\theta})$, increases. Consistently, a higher payment is due when a higher expected value

[12] In this respect, note that, depending on $\widetilde{\theta}$ and $\overline{L}$, it may be feasible to set $s$ such that $\widetilde{A} = \overline{L}$.

[13] Note that our frame may easily apply to the analysis of a Nash bargaining game where the two parties are characterized in terms of risk aversion. It would in fact suffice to set the Nash product equal to $(W^{FI})^p(W^{HC})^q$, where $0 < p \leq 1$ and $0 < q \leq 1$, measure the level of risk aversion for each of the parties involved.

[14] The objective function (10) is defined on the net gains from bargaining. Disagreement pay-offs are null, since without agreement the land development project is not activated.

is attached to FI's net revenues, $V^{FI}(\widetilde{\theta})$. Substituting (10.1) into (9.1-9.2) yields:

$$W^{FI}(\widetilde{\theta}, R_1^*) = \psi V(\widetilde{\theta}),\ W^{HC}(\widetilde{\theta}, R_1^*) = (1-\psi)V(\widetilde{\theta}) \tag{10.2-10.3}$$

where $V(\widetilde{\theta}) = V^{FI}(\widetilde{\theta}) + V^{HC}(\widetilde{\theta})$.

That is, the two parties share the total value at stake, $V(\widetilde{\theta})$, in shares which are given by their respective bargaining powers. It is worth highlighting that, by bargaining, the two parties are basically setting an optimal risk-sharing contract. Note in fact that HC's revenues include a certain component represented by $R_1^*$ and a volatile component represented by tax revenues, $V^{HC}(\widetilde{\theta})$. In this respect, one may also view the tax rate $s$ as HC's share of FI's volatile profits.

In addition, as can be easily shown, a sufficient condition for $dR_1^*/ds < 0$ is:[15]

$$s < 1/[1 + \psi(\beta - 1)] \tag{10.4}$$

This means that within this specific range of values for $s$, a lower rental payment should be paid if HC sets a higher tax rate. Note that, by lowering the rental payment, HC may be seen as implicitly subsidizing FI. This is done in order to provide better contractual conditions and encourage the signing of the lease contract. In fact, without an agreement land would not be developed. This initial transfer will be repaid later by higher taxes. It is important to stress that by doing this, HC assumes a more risky position. In fact, he will share with FI the uncertainty surrounding future profits and consequently the tax revenue. From FI's perspective, sharing risks and paying a lower rental payment is beneficial and covers the cost of facing higher tax rates. In this respect, note in fact that as $\sigma \to \infty$ ($\beta \to 1$) condition (10.4) holds for any $0 \leq s < 1$. Basically, as uncertainty soars up, the advantage attached to risk sharing increases. In contrast, the impact of higher taxes is lower due to 1) land development occuring only when profits are very high and 2) the effect of discounting. In fact, the higher the uncertainty, the slower the land development process.

Let us conclude this section by checking the impact that corporate taxation has on the final payoffs. By taking the derivative of $V(\widetilde{\theta})$ with respect to $s$ we obtain:

$$\frac{\partial V(\widetilde{\theta})}{\partial s} = \frac{\partial V^{FI}(\widetilde{\theta})}{\partial s} + \frac{\partial V^{HC}(\widetilde{\theta})}{\partial s} = -\beta \frac{s}{(1-s)^2} k \int_{\widetilde{A}}^{\overline{L}} (\frac{\theta}{\theta^*(A)})^{\beta} dA + \frac{\partial \widetilde{A}}{\partial s} k < 0 \tag{11}$$

This in turn implies that

$$\frac{\partial W^{FI}(\widetilde{\theta}, R_1^*)}{\partial s} = \psi \frac{\partial V(\widetilde{\theta})}{\partial s} < 0 \text{ and } \frac{\partial W^{HC}(\widetilde{\theta}, R_1^*)}{\partial s} = (1-\psi) \frac{\partial V(\widetilde{\theta})}{\partial s} < 0 \tag{11.1-11.2}$$

That is, a complete tax exemption would maximize both total value and each party's payoff. The effect of no taxation would be two-fold in that, firstly, taxes would not distort the definition of land development timing, and, secondly, the value of the land project would be maximized. By setting $s = 0$ we would have:

$$W^{HC}(\widetilde{\theta}, R_1^*) = (1-\psi)V(\widetilde{\theta}) = (1-\psi)V^{FI}(\widetilde{\theta}) \text{ and } W^{FI}(\widetilde{\theta}, R_1^*) = \psi V(\widetilde{\theta}) = \psi V^{FI}(\widetilde{\theta}) \tag{12.1-12.2}$$

That is, each party receives a portion of the value generated by the foreign initiative, $V^{FI}(\widetilde{\theta})$, which is proportional to its own bargaining power. Note, however, that in this case the agreement will not entail any risk-sharing between the two parties, since once HC has cashed the payment $R_1^*$ the whole uncertainty characterizing the project will only affect FI's net benefits.

## 4 Empirical implementation

[15] In the interval $s < 1/[1+\psi(\beta-1)]$ the sign of the derivative depends on the amount of land developed as soon as the contract is signed, i.e., $\widetilde{A}$.

Calibrating the modeling framework to an actual investment project is straightforward as long as some core data about size, duration, location-specific variable costs of the planned agricultural production and fixed costs of establishing the farm and development of the land are known. For new projects, our framework can serve as a rule-of-thumb planning tool that allows both investors and host country negotiators to compute the expected value of an investment by explicitly taking market uncertainty and risk in the host country into account. Furthermore, contracts that already exist can be assessed by our framework if negotiated annual rental payments and profit tax rates are known. With this information, one can for instance assess the host country's share of the expected total value of the investment, or one can determine the distribution of bargaining power between host country and foreign investor. Both can provide transparency and can support local interest groups and the concerned public in the host country who may not be directly involved in the negotiations. We therefore demonstrate the applicability of our model by analyzing an existing large-scale investment project in Ethiopia:

As a visible outcome of growing critical public awareness about large-scale land deals, individual governments have yielded to public pressure in a few instances and now publish the contractual details of some recently signed large-scale land deals (Ethiopian Land Portal, 2012). We demonstrate that our model closely reflects the conditions stated in some such publicly available contracts. Specifically, we calibrate the model to a land lease contract that has been signed between the Government of Ethiopia and the Indian company "Whitefield Cotton" (Ethiopian Land Portal, 2012). The contract covers 10,000 hectares for cotton production. The agreement between Whitefield Cotton and the Ethiopian government was signed on August 1, 2010 and the contract duration is 25 years. According to the contract, the annual rent amounts to 158 Birr/ha. Furthermore, the contract requires 25% of the land to be developed in year 1 and 100% by year 4. Both parties can terminate the contract within 6 months unless grand majeure forces (e.g. draught, civil conflict, etc.) are the reason. However, the contract does not contain any information on potential refunding of the investor in the event of grand majeure forces. This most likely means that the investor bears the full risk of such events.

**Table 1**: Exogenous Parameters Used for Simulation of the Whitefield Cotton Project

| *Variable* | *Description* | *Value or Range* | *Assumptions* |
|---|---|---|---|
| $\bar{L}$ | Project size | 10,000 ha | from Whitefield's contract |
| $t$ | Duration | 25 years | from Whitefield's contract |
| $k$ | Cost of developing 1ha | 13.48 TBirr | plowing 2.1TBirr/ha and fixed cost to set up farm |
| $w$ | Total Average Cost / ha | 6.472 TBirr | for an assumed yield of 3000kg/ha |
| $\sigma$ | cotton price volatility | [0.05;0.5] | randomly drawn |
| $\mu$ | cotton price drift | [0.005;0.04] | randomly drawn |
| $p_t$ | starting price cotton | [11,14] | Average world cotton price (2010 in TBirr/ha) |
| $\iota$ | Degree of DRTS | [2;60] | higher $\iota \rightarrow$ CRTS |
| $c$ | Cobb-Douglas | 0.25 | Factor elasticity for non-land inputs |
| $\rho$ | risk-free interest rate | 0.05 | |
| $\lambda$ | loss (probability) | [0.04;0.08] | Poisson process; lower bound: one event in 25 years |
| $\omega$ | loss (share) | [0.5;1] | share of investment lost due to political event |
| $s$ | Corporate income tax | [0;0.5] | Ethiopian tax office |

The total net present value for Ethiopia, after taking the negotiated 3-year grace period into account, amounts to 15426.8 thousand Birr (TBirr) for the whole farm, which is equivalent to 2.9 TBirr/ha (own computations based on Ethiopian Land Portal 2012). With this information, we can calibrate the contractual part of the model. Furthermore, in order to determine the profitability of the cotton production process, we use output and input price data for cotton production around the time when the contract was signed. Table 1presents all parameters that are exogenous to the model, some of which can only be considered within plausible ranges due to incertitude or lack of precise information available.[16]

### *4.1 Simulation Experiment 1: Response Surface*

[16]The incertitude attached to these parameters is explicitly incorporated into the numerical implementation of the model by allowing them to vary stochastically within the specified ranges according to uniform distributions. See the Appendix for additional details concerning the calibration.

Below we illustrate the effect of each of the exogenously chosen parameters on the project value to the foreign investor at the moment of signing the investment deal. For this purpose, 500 investment projects were generated under parameter settings that were simultaneously and randomly chosen from the ranges specified in Table 1 ("Monte Carlo simulations"). Based on these data, an econometric response surface is estimated. Specifically, the econometric response surface is an Ordinary Least Squares (OLS) regression model that takes the following form:

$$y_i = \alpha_0 + \alpha' X_i + \epsilon_i \tag{13}$$

where $X_i$ is a vector containing the elements $\sigma_i, \mu_i, p_{t_i}, \iota_i$ ,$\lambda_i, \omega_i$, $s_i$ for every investment project $i = 1, ..., 500$ and $\epsilon_i$ is a term capturing random disturbances that are assumed to follow a standard normal distribution. The coefficients $\alpha_0$ and $\alpha$ represent, respectively, a constant term and a vector of regression coefficients to be estimated on the elements of $X_i$. The dependent variable in this regression model is expressed as the logarithm of the project value to FI. Furthermore, we opted to approximate the nonlinear functional relationships within the model by expressing the explanatory variables in $X_i$ as their logarithmic values.

Our results indicate that initial land development according to our model takes the overall characteristic of an 'everything or nothing' strategy (see Figure 1 in the Appendix). The government of Ethiopia may therefore need to reconsider its current practice of contractually requiring initial land development during the first four years (Ethiopian Land Portal, 2012). Fixing the land development path in this artificial way may address the Ethiopian desire to avoid projects under which foreign investors acquire land without actually getting any development started. However, our model suggests that the economic driving forces of land development on the side of the investor are likely to be very strong, making land development either profitable or not, and a contract that tries to regulate this may interfere severely with the investor's perceived risk situation. In other words, if the investor finds the project convenient overall, land development will in most cases be conducted as soon as possible. However, there is also the possibility that the investor initially does not find land development on a large scale profitable. According to the model, such a situation indicates that the combination of uncertainties at the time after signing suggests holding the option to develop the land later instead.

Table 2 shows econometric response surface estimates based on the Ordinary Least Squares Estimator and the experimental set-up for the exogenous model parameters according to Table 1. Table 2 contains results from two different response surface estimations, both using the same data and explanatory variables. The first set of columns in Table 2 refers, as described, to the log of the project value to the foreign investor at the moment of signing. Almost all regressors are significant at the 5% level or better, and the coefficient of determination suggests a satisfactory fit to the data. One advantage of the log-log transformation is that estimated regression coefficients can be directly interpreted as the corresponding partial elasticities, with a 1% change in the regressor inducing a corresponding percentage change in the dependent variable. The estimated coefficient of the intercept has to be interpreted as the log of the mean model response when all other regressors take zero values. A closer inspection of the estimated coefficients in Table 2 reveals that the partial elasticities of the market price of cotton, the drift of this market price and the DRTS technology parameter each have a positive effect on the project value from the viewpoint of the foreign investor. In line with expectations from the theoretical properties of the model, the estimated project value will ceteris paribus be higher if the natural conditions of the investment project allow for milder rather than stronger degrees of DRTS. In other words, the closer the production technology in reality to constant returns to scale, the higher the expected project value.

In contrast, the estimated elasticities confirm that the share of the investment lost due to a potential adverse event and due to the corresponding probability of this event occurring decrease the project value. The same holds for the introduction of corporate profit taxes. It is interesting to note that a 2.8% corporate tax can roughly offset the value gains from a 1% increase in the market price of cotton at the time of signing the contract. The sign of the estimated coefficient on cotton price volatility (log of sigma) appears negative and significant. This contradicts reports in the literature (see introduction) that rising price volatility would, among other factors, actually attract global land deals. Due to the interplay of various factors in our model, however, the positive role of market price volatility on project value is dominated by the negative role that price volatility has on land development and initial land conversion (compare Figure 1). In the second set of regression results in Table 2 we therefore present a response surface regression with the dependent variable given by the project value to FI at the moment of signing but now divided by $\widetilde{A}$. This dependent variable can be interpreted as the per hectare project value to the foreign investor (Whitefield Cotton) that it would immediately develop. In this regression, the estimated coefficient on cotton price volatility is positive and significant, which confirms the conventional insight that volatility is driving the project value in a positive way and initial land conversion in a negative way; apparently, the negative effect dominates the positive one for the case of the Whitefield Cotton contract. All other estimated coefficients maintain their previously estimated sign.

**Table 2**: Response Surface Based on Double-log OLS Regressions

| | $\ln[V^{FI}(\widetilde{\theta})]$ | | | $\ln[V^{FI}(\widetilde{\theta})/\widetilde{A}]$ | | |
|---|---|---|---|---|---|---|
| | Estimate | Std. Error | Pr(>\|t\|) | Estimate | Std. Error | Pr(>\|t\|) |
| (Intercept) | 0.3228 | 0.3008 | 0.2838 | -4.3111 | 1.2064 | 0.0004 |
| $\ln[\mu]$ | 0.3673 | 0.0179 | <2e-16 | 0.3968 | 0.0721 | 5.89E-08 |
| $\ln[\sigma]$ | -0.0269 | 0.0082 | 0.0012 | 0.0846 | 0.0331 | 0.0108 |
| $\ln[\widetilde{p}]$ | 4.218 | 0.1006 | <2e-16 | 2.5643 | 0.4035 | 4.74E-10 |
| $\ln[s]$ | -1.4816 | 0.0489 | <2e-16 | -0.5844 | 0.1924 | 0.0025 |
| $\ln[\omega]$ | -0.6388 | 0.0345 | <2e-16 | -0.4371 | 0.1384 | 0.0017 |
| $\ln[\lambda]$ | -0.5691 | 0.0116 | <2e-16 | -0.4336 | 0.0464 | <2e-16 |
| $\ln[\iota]$ | 0.5039 | 0.0359 | <2e-16 | 0.5588 | 0.1441 | 0.0001 |
| Adj.$R^2$ | 0.92 | | | 0.29 | | |

*4.2 Simulation Experiment 2: Estimating Ethiopia's Bargaining Power*

The aim of the second response surface simulation scenario is to assess if the Ethiopian government may have exercised a bargaining power that can be considered in line with the public interest of Ethiopia. Since bargaining power enters the model as a parameter in the range [0,1], intuition may suggest that a bargaining share of 0.5 reflects a balanced negotiating power under which both parties meet 'on eye level'. Major imbalances in this bargaining share instead may reflect either that one party has signed the contract without insisting on getting a near to fair share of the expected total project value, or that this party factors in additional benefits from the contract that are not directly observable. Such additional benefits may reflect the Ethiopian government's hope that a project such as Whitefield Cotton will generate further benefits through forward and backward linkages within the local economy, and that the investor will provide e.g. infrastructure available for public use. However, such unobserved benefits could potentially also reflect the attempt by some host country negotiators to acquire individual shares in this investment project (i.e., corruption) without necessarily passing them on to the public.

In order to determine ex post Ethiopia's bargaining power in the case of the Whitefield Cotton contract, it is therefore necessary to assess all benefits that the host country is definitely going to receive. In this respect, the Whitefield Cotton contract states only the rental payment over the 25-year contract period, which amounts to a total net present value of 15426.8 TBirr for Ethiopia after taking the negotiated 3-year grace period into account. However, a second potential source of revenue, not further specified in the contract, is the taxation of profits once the farm has been established. Since no income tax is mentioned in the Whitefield Cotton contract, we initially assume that no income taxes are levied. However, domestic businesses in Ethiopia certainly face corporate income taxes that progress according to level of profit. Expected profits from the Whitefield Cotton project would usually fall into the highest tax rate of 35%. However, the Ethiopian government frequently grants tax holidays of up to seven years, e.g. for start-up firms. We therefore compare three different scenarios of 500 simulated projects each. All three scenarios use exactly the same specifications for the exogenous parameters as in the previous response surface experiment (Table 1). However, the first of the three bargaining share scenarios fixes the corporate income tax at zero, the second at 24% (which is equivalent to 35% under a 7-year tax holiday) and the third scenarios taxes at 35%. The last two scenarios represent the most generous possible and the maximum possible taxation scenario, respectively, as long as the official taxation rules for domestic firms are also applied to the Whitefield Cotton project.

On assuming zero corporate tax, Table 3 reveals that this would correspond to a rather low bargaining share of Ethiopia, with a mean around 3%. However, based on kernel density estimates Figure 2 illustrates that this first scenario, despite its rather low mean, can still reflect bargaining shares of around 10-15% in few instances. For the second and third scenarios, Figure 2 demonstrates that the distribution of simulated bargaining shares is much wider than for the first scenario, making a 'fair' (0.5) or near to fair bargaining share certainly realistic. However, Figure 2 also indicates that, in rare events of bargaining shares exceeding 50%, Ethiopia may actually have negotiated with Whitefield Cotton a deal that would be especially favorable for Ethiopia.

In summary, the results from the simulations indicate that for the case of the Whitefield Cotton contract: The Ethiopian public can be assured that Ethiopia may very well have negotiated with the investor 'on eye level' only under the assumption that Ethiopia applies a 35% corporate tax on the Whitefield Cotton project.[17]

**Table 3**: Inferred Mean Bargaining Share of Ethiopia under the Whitefield Cotton Contract

| *Corporate Tax* | *n* | *Median* | *Mean* | *Comment* |
|---|---|---|---|---|
| 0% | 500 | 0.027 | 0.033 | Whitefield contract does not mention taxes |
| 24% | 500 | 0.270 | 0.257 | 35% adjusted for initial 7-year tax holiday |
| 35% | 500 | 0.383 | 0.430 | Relevant Ethiopian corporate income tax |

## 5 Conclusions

The theoretical model developed in this article reflects the typical bargaining situation between a foreign investor and a host country for many currently ongoing or recently signed large-scale land deals in Africa. We solve the underlying cooperative game between the parties and determine the optimal rental payment. This is done taking into account potential sources of market- and country specific risks. It is shown that 1) the parties share the total value generated by the land development project on the basis of their relative bargaining strength, 2) the optimal rental payment should be such that, once added to tax revenues, the value accruing to the host country is equal to its share of the total value, and 3) the land lease contract is equivalent to a risk-sharing contract between the parties. In this respect, we show that the host country's payoff includes a riskless component represented by the rental payment and a volatile component represented by taxes on the uncertain profits earned by the foreign investor. This implies that, for instance, by setting higher taxes and a lower rental payment, the host country assumes a more risky position. In contrast, the foreign investor could reduce the risk of the project by obtaining a reduction in the fixed rental payment; such a reduction would function as an implicit subsidy.

We calibrated the model to one specific land contract in Ethiopia. Findings from our simulations indicate that the foreign investor will most likely seek to develop all land immediately, but in about one third of simulated cases it will instead postpone almost the entire land development. Therefore attempts by the host country to fix a specific land development path in the negotiated contract are unnecessary. Our simulations also confirm that, as long as it taxes corporate profits from this investment project according to the rules that apply to domestic Ethiopian firms, the Ethiopian government has on average obtained a near to fair share of the total project value.

With respect to future research, we suggest case studies to clarify the extent to which a higher degree of land development also increases the forward and backward linkages with the local economy for the practice of actually observed land deals. Furthermore, high global food prices may also directly increase the likelihood of political unrest in low-income countries, which suggests that high profitability of farmland investment projects

[17] Of course this does not automatically imply that the implementation of this land lease project may not be unfair to other interest groups (although for the case of Whitefield Cotton we do not have such information); the model only states that the bargaining power exercised can broadly be justified as being in line with the interests of Ethiopian society as a whole.

might be causally related to a high risk of expropriation. If such a relationship between profit and political risk receives empirical support, the results could be used directly in the calibration of our model.

## 6 Appendix

Proofs are available at Appendix_final.

### *6.1 Figures*

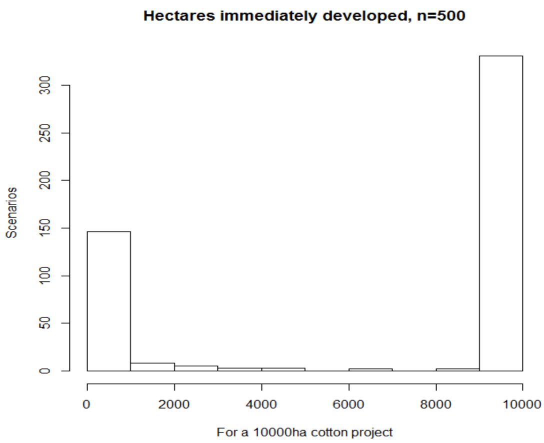


Figure 1: Simulated values of the land immediately developed after signing the contract ($\widetilde{A}$).

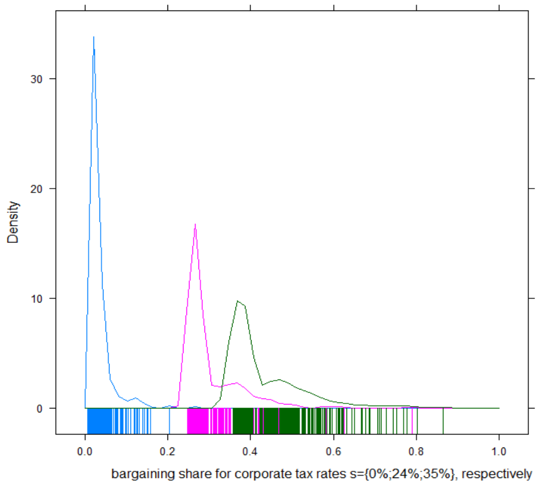


Figure 2: Kernel density estimates of Ethiopia's inferred bargaining share

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