FOREIGN INVESTMENT IN FARMLAND UNDER UNCERTAINTY

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1. Introduction: A Model of Large Scale Land Deals

Foreign direct investment into agricultural land in Developing Countries is an ongoing trend which seems to be led by the rising and increasingly volatile prices of agricultural commodities (e.g. VON BRAUN AND MEINZEN-DICK, 2009). We formalize the discussion surrounding such large scale land deals through a dynamic stochastic programming model[1]. In this model, a foreign investor (*FI*) is willing to undertake direct investment for the development of a certain land surface, *L*, still in its pristine state. However, this opportunity is conditional on the signature of a bilateral agreement between *FI* and the government (*HC*) of the host country. Once an agreement has been reached, *FI* has the right to develop the leased land and destine it to agriculture in front of a rental payment, *R*. Land development is assumed to require an investment in capital costing *k* per hectare. Denoting by A_t the hectares of land developed and cultivated, and by L_t the extent of land still undeveloped, land is at each $t \geq 0$ allocated as follows: $A_t + L_t = L$, with $A_0 = 0$. Once developed, cultivated land guarantees a profit flow, $\pi(\theta_t, A_t)$, which is a function of the area under cultivation and of random variable $\{\theta_t\}$. By the latter variable we let profit fluctuate over time on the basis of the diffusion process $d\theta_t = \mu\theta_t\, dt + \sigma\theta_t\, dW_t$, where μ and σ are drift and volatility parameters, and dW_t is the increment of a standard Wiener process. We also assume that *FI* pays a corporate income tax, *s*, over each unit of profit earned. Finally, we consider the negative effect of country-specific political risk. Our definition of political risk includes all political decisions and events which may reduce the profitability of the land development project (see CLARK, E., 1997). We regulate their occurrence by a Poisson process with intensity $\lambda \in (0,\infty)$ and denote by $\omega \in (0,1]$ the percentage of project's value lost.

In this frame, we first determine the value of the land development project and then investigate the bargaining process leading to the signature of the bilateral agreement. In this respect, we view the two parties as engaged in a cooperative cake splitting game that is solved by applying the Nash bargaining solution (NASH, 1950). We assign to *HC* and *FI* bargaining powers ψ and $1 - \psi$ respectively, with $\psi \in (0,1)$. We then let them bargain over the rental rate, *R*, and tax rate *s*. The outcome of this cooperative bargaining game is the optimal pair (R^*, s^*) which maximizes the total value associated to the land development project.

2. Empirical Application: Ethiopia's bargaining power in the "Whitefield" contract

For the real case of an Indian firm ("Whitefield") that has recently invested into a 10 000 ha cotton project in Ethiopia we compare calculated values from our model against official annual rental payments as they have been agreed upon in the corresponding contract (see ETHIOPIAN LAND PORTAL 2012). Table 1 summarizes the details of this contract.

Table 1: Details of a 25 year land leasing contract for 10 000 ha in Ethiopia, signed 1.8.2010

Company	*NPV/ha (Birr)*	*total NPV for Ethiopia (Birr)*	*Share of land to be developed in year 1*	*All land has to be developed after*	*Rental payment revision?*
Whitefield Cotton (India)	2937,07	15 426 828	25 %	4 years	"as need may arise"

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[1] A detailed presentation of our theoretical frame is beyond the scope of this text but is available upon request.

In order to have our model calibrated to this contract, several exogenous variables had to be parameterized using information provided by the Ethiopian government to foreign investors. As it can be seen in Table 2, most variables take plausible and robust empirical values. Due to the lack of knowledge about an appropriate representation of the production technology, however, the model is sensitive to the degree of assumed decreasing returns to scale (DRTS).

Table 2: The 'Whitefield' Contract between India (*FC*) and Ethiopia (*HC*)

Parameter[#]	*Description and assumptions*	*Value*
μ, σ	Global cotton price drift (and estimated volatility) since 1990	0,0366 (0,24)
k	Cost of developing 1 ha; estimated for deep ploughing + fixed cost to set up the farm expressed per hectare	2100 Birr/ha
p	Revenue/ha; specified as base price cotton/ha = Birr 3.5/kg * 3000kg/ha (= typical yield for commercial farms)	10500 Birr/ha
w	Variable cost of production per hectare at 3000 kg yield	455.48 Birr/ha
γ	Cobb-Douglas parameter for variable inputs (= calculated cost share of labor & maintenance of machinery)	0.25
ρ	Risk-free interest rate	2%
λ	Policy risk parameter for Ethiopia based on World Bank estimates	5%
ω	Share of value lost due to political events (war, seizure, etc.)	100%
ι	Scale parameter for degree of decreasing returns to scale	< 500

[#] *All other parameters within the model are endogenous.*

3. Analytical Results and Simulation

The value of the project depends on the timing of land development which is under *FI*'s control. As future agricultural profits become more volatile, *FI* postpones land conversion. In contrast, a higher expected profit growth rate triggers a faster land conversion. As expected, political risk (λ) and consequent losses (ω) slow down development. A similar effect is associated to income taxation. We show that in a Nash-bargaining frame the best policy for *HC* is to require the optimal rental payment R^* and to not levy any tax on profits. The intuition is straightforward: By trading off rental payment with tax revenue, HC would exchange a riskless payment against an implicit "share" of the uncertain profit from agriculture. Finally, we prove that this no income tax policy is optimal in terms of project value maximization.

For a simulated scenario without income tax, Table 1 shows that the total NPV for Ethiopia is contractually fixed at 15,4 million Birr, while our corresponding simulated total NPV for Ethiopia (Birr) could under moderate degrees of DRTS amount up to 725,6 million Birr. This would imply a calculated *ex post* bargaining power (ψ) for Ethiopia equivalent to 0,01 while *ex ante* a value of 0,5 could have been expected within a fair negotiation. Thus, as long as one is willing to accept that the 'true', yet unobserved, cotton technology operates under moderate degrees of DRTS, Ethiopia has in our case study -according to the officially agreed rental payments- significantly failed to raise a near-to-fair bargaining power.

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