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**ON VALUING TARGETED LOAN SUBSIDIES
IN RURAL CREDIT MARKETS:
AN OPTION PRICE ANALYSIS**

by

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Abstract

This paper shows that the way in which loan contract conditions are established by development institutions in rural credit markets shifts risks, from one sector (the targeted group of loan beneficiaries) to another (the specialized lender, the government, or an international donor). The paper shows that these risk-shifting properties of rural credit programs create negative incentives, that stimulate targeted borrowers not only to invest in more risky activities than otherwise and to increase the leverage debt financing of their investment projects, but to reduce the effort devoted to their productive activities as well. Those conditions imply free options and subsidies and create incentives for loan default. Thus, rural credit programs in developing countries are characterized by excessive riskiness, excess demands for loans, and low borrowers' productive efforts. The paper uses option pricing in a valuation model designed to examine these issues and it estimates the value of the implicit subsidy received by a sample of borrowers of the Agricultural Development Bank in the Dominican Republic during 1987. Loans granted with funds from more restrictive sources (targeting) experienced higher default rates and thus resulted in higher implicit subsidies.

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I. Introduction

Over the past few decades, governments in developing countries and international donors have emphasized the importance of formal rural credit as an instrument to accelerate the growth of agricultural output and to improve rural income distribution. The strategy has primarily consisted of creating specialized agricultural lending institutions (SLIs), to provide *targeted* rural producers with loans at favorable contract conditions, in advance of demand (Patrick, 1966).

The way in which loan contract conditions are usually structured, however, frequently fails to explicitly consider the fact that agricultural credit has the potential to shift risks from one sector (the targeted group of beneficiaries) to another (the SLI, the government, or an international donor). Typically, the contract conditions offered by SLIs to targeted borrowers allow them to provide the future crop as collateral, according to the following deal: if either crop yields or prices are too low, resulting in revenues below the amount to be repaid, the specialized agricultural lender would implement various special measures, which can range from direct cash subsidies, to the rescheduling of debts or even the outright forgiveness of the loans. Thus, the targeted borrowers appropriate for themselves all of the benefits during high-return years and the SLI or the government subsidize them during the low return years.

These risk-shifting properties of formal rural credit are often ignored by the agricultural credit literature in the analysis of loan repayment problems. The main objective of this paper is two-fold. First, it attempts to analyze how the risk-shifting properties of rural credit affect the loan repayment performance of targeted agricultural borrowers. It argues that the loan contract conditions established by SLIs have free options or implicit subsidies embedded in them that favor targeted agricultural borrowers and that these options create negative incentives for borrowers, thereby establishing the basis for the loan repayment problems faced by SLIs. Second, the paper estimates the value of the implicit subsidy received by a sample of borrowers of the Agricultural Development Bank (BAGRICOLA) of the Dominican Republic during 1987.

II. The Theoretical Valuation Model

The economics literature has recognized the fact that many investment and financing decisions actually have options embedded in them.¹ It has been argued that bank managers and policymakers are, without knowing it, constantly creating and evaluating options. In particular, Montiel [1983] has argued that whenever governments of developing countries *force* specialized agricultural lenders to act as *generous* financial intermediaries, they create options. Suppose, for example, a typical specialized agricultural lender that not only offers targeted borrowers \$1,000 agricultural loans, at 10 percent interest, but the following deal as well: if the gross revenue from the crop is above \$1,100 (equivalent to the price of the

¹ For an extensive analysis of the theory and empirical research in option pricing see Brenner [1983], Mellor [1973], among others.

stock by the end of the harvest), the borrower would pay the bank the amount promised and pocket the difference. If the gross revenue is below \$1,100, the bank would take the crop and forgive the difference. It is as if the lender offered the targeted borrower the right (or the *free* option) to sell the crop for a minimum fixed price, equal to the total loan obligation. In other words, the borrower is essentially receiving a free put option (or *loan subsidy*) with an exercise or striking price equal to the promised payment to the bank of \$1,100. The question this paper addresses is how to determine the value of this subsidy.

Valuing Contingent Claims

Black and Scholes [1973] have shown that if a minimum set of assumptions are met,² the value of a put option (or contingent claim) can be estimated with knowledge only of the riskiness of the underlying asset (proxied by the risk of loan default); the value of the asset (the gross return of the crop), the risk-free interest rate, the time to maturity of the claim (the loan term), and the exercise price of the claim (the loan obligation). That is:

$$P(V_0, t) = V_0 \Phi(d_1) - Le^{-rt} \Phi(d_2) - V_0 + Le^{-rt} \quad (1)$$

where

² The ideal conditions assumed by Black and Schole are the following: (1) the interest rate is known with certainty; (2) the distribution of possible stock prices at the end of the period is log-normal; (3) the option is "European", that is, it can only be exercised at maturity; (4) there are no transaction costs in selling or buying the option.

$$d_1 = \frac{\ln\left(\frac{V_0}{L}\right) + rt + \frac{1}{2}\sigma^2 t}{\sigma\sqrt{t}} \quad (2)$$

$$d_2 = \frac{\ln\left(\frac{V_0}{L}\right) + rt - \frac{1}{2}\sigma^2 t}{\sigma\sqrt{t}} \quad (3)$$

P is the value of the subsidy (or free put option) that targeted borrowers receive from the SLIs; $\Phi(d)$ is the cumulative normal density function; V_0 is the estimated gross revenue of the crop at the moment of requesting the loan (the stock price); L is the value of the financial obligation at harvest (the exercise price); t is the time to harvest (or maturity); σ^2 is the variance of the rate of return of the crop output; r is the continuously compounded risk free rate of interest; and \ln stand for natural logarithm.

Three important propositions follow from expression (1).

1. The value of the subsidy that targeted borrowers receive increases with the increasing risk of the returns on the crop.
2. The value of the subsidy increases with an increasing loan obligation.
3. The value of the subsidy decreases with an increasing expected value of the crop.

Proposition (1) follows from the fact that

$$\frac{P}{\partial\sigma^2} = Le^{-rt} \phi\left(\frac{\ln\left(\frac{V_0}{L}\right) + t[r - \sigma^2/2]}{\sigma\sqrt{t}}\right) \frac{\sqrt{t}}{2\sigma} > 0 \quad (4)$$

One implication is that riskier projects yield a higher expected profit for borrowers and a lower one for the SLI than otherwise.³ The logic behind this proposition is that the targeted borrowers obtain a *floor* on the return of their investment projects, but receive all the return (after loan obligation) in good crop years, while the specialized agricultural lender or the government take all the losses during bad crop years. In other words, borrowers have a distribution of investment project returns truncated to the left. They have everything to gain and nothing to lose by increasing the variance of this distribution.

Proposition (2) follows from the fact that

$$\frac{\partial P}{\partial L} = -e^{-\pi} \phi \left(\frac{\ln\left(\frac{V_0}{L}\right) + t[r - \sigma^2/2]}{\sigma\sqrt{t}} \right) + e^{-\pi} > 0 \quad (5)$$

Since the borrowers have a guaranteed *floor* on the returns of their investment projects, they have everything to gain by increasing the leveraged debt financing of their activities. The higher the degree of leverage, which in this case acts as the strike price, the higher the probability that the put option will be enforced.

Finally, proposition (3) follows from the fact that

$$\frac{\partial P}{\partial V_0} = \phi \left(\frac{\ln\left(\frac{V_0}{L}\right) + t[r - \sigma^2/2]}{\sigma\sqrt{t}} \right) - 1 < 0 \quad (6)$$

The economic interpretation of proposition (3) is that a high-return investment project will require increasing borrower's effort. With decreasing marginal returns to this effort (Clemenz, 1986), borrowers will not benefit by increasing their effort beyond some optimal

³Riskiness is defined in the sense of Rothschild and Stiglitz [1970].

level. This proposition implies that borrowers will devote less effort to their productive activities than will be required in investment projects with higher returns, in order to protect the lender's interests.

In sum, the way in which loan contract conditions are established in formal rural credit markets stimulates targeted borrowers not only to invest in more risky activities than otherwise and to increase the leveraged debt financing of their investment projects, but also to reduce the effort devoted to their productive activities. Thus, rural credit programs in developing countries will be characterized by excessive riskiness, excess demand for loans, and low borrower productive efforts.

III. Empirical Test of the Valuation Model

The primary data utilized for valuing the implicit loan subsidy come from a sample of 2,204 credit dossiers of loans disbursed in 1987 by 18 branches of the Agricultural Development Bank of the Dominican Republic (BAGRICOLA). The data represent a 6 percent of the total number of loans disbursed by the selected branches during that year. BAGRICOLA is an agricultural development institution oriented not only to lend to the agricultural sector of the Dominican Republic, but also to serve as a fundamental instrument of the Government's agrarian policies. As such, BAGRICOLA is provided by the Government and international donors with funds to finance predetermined rural groups and/or agricultural activities. Since different sources of funds impose different restrictions on loan

contract conditions, for the purposes of this paper, BAGRICOLA's different sources of funds have been classified into five categories⁴:

- (1) First, the bank's own resources (OWNR). The only restriction imposed on these funds is to finance agricultural activities in general.
- (2) Second, a credit line created with Government resources to finance the agricultural and livestock activities of agrarian reform beneficiaries (AGREF).
- (3) Third, international funds (World Bank and Inter-American Development Bank-IDB) oriented to finance specific agricultural activities (INTF). For instance, World Bank funds only finance coffee and cacao development projects.
- (4) Fourth, Government and donor social funds (SOCF). These funds are not only oriented to finance small rural producers, but only some specific activities.⁵
- (5) Fifth, international non-targeted funds, provided by the Agency for International Development (USAID).

⁴ For details see Aguilera-Alfred et al. [1990].

⁵ These credit lines are designed more to satisfy political objectives than to accomplish production goals. For instance, in 1987 the Dominican Government designed a credit line to finance the purchase by poor farm-households of one pregnant sow, to initiate a small-scale swine breed that would allow them to improve their income.

TABLE 1

**SELECTED INDICATORS OF THE LOAN ACTIVITY OF THE
AGRICULTURAL DEVELOPMENT BANK OF THE DOMINICAN REPUBLIC
IN 1987, BY SOURCE OF FUNDS.**

SOURCE OF FUNDS	AMOUNT DISBURSED		AVERAGE LOAN (DR Pesos) ²	RETURN OF INVESTMENT (DR Pesos)	AVERAGE LOAN TERM (Months)	LOAN DEFAULT ¹ (percentage)
	DR PESOS (000) (1)	PERCENTAGE (2)				
OWN RESOURCES	4,499	49.4	5,690	17,172	22.29	11.4
AGRARIAN REFORM	1,950	21.4	9,150	25,694	20.62	19.5
INTERNATIONAL	1,082	11.9	9,020	59,125	28.70	40.4
SOCIAL	1,261	13.8	1,230	6,208	25.76	49.3
USAID	322	3.5	4,880	41,154	18.89	5.3

Source: Sample of credit dossiers.

Notes: 1. Loan default is defined as the percentage of the amount disbursed that was delinquent by the end of August of 1989.

2. Dominican Republic Pesos.

As shown in Table 1, loans disbursed with the bank's own resources accounted for about one-half (49 percent) of the total amount disbursed in 1987, while Government-sponsored funds (AGREF and SOCF) accounted for 35 percent of the total volume disbursed. Funds provided by international agencies (INTF and USAID funds), in turn, accounted only for 15 percent of the total amount lent. All loans were disbursed at a fixed annual rate of interest of 12 percent and more than 98 percent of them were granted with only the agricultural output (lien) as collateral.

An important contrast stands out in Table 1, between the risk of default of loans disbursed from the more restrictive sources of funds and those granted from less restrictive

sources. The former consistently presented a higher risk of default. For instance, compare the 5 percent in the case of non-targeted funds provided by USAID, with 40 percent for the World Bank and IDB lines of credit. It has been shown elsewhere, that there is a causal connection between the restrictions imposed on the screening of borrowers by the targeting conditions of governments and donors and the risks of default (Aguilera, 1990).

TABLE 2
 IMPLICIT AVERAGE LOAN SUBSIDY (FREE OPTION)
 RECEIVED BY THE SAMPLE OF BORROWERS OF THE BAGRICOLA IN 1987,
 BY SOURCE OF FUNDS.

SOURCE OF FUNDS	AVERAGE (DR PESOS)		PROPORTION OF LOAN SUBSIDY
	SUBSIDY	LOAN	(1)/(2)
	(1)	(2)	(3)
OWN RESOURCES	1,147	5,690	0.20
AGRARIAN REFORM	2,014	9,150	0.22
INTERNATIONAL	4,750	9,020	0.53
SOCIAL	794	1,230	0.65
USAID	840	4,880	0.17

Source: Sample of credit dossiers.

Since loans funded with OWNR and USAID funds impose less restrictions on the activities of the BAGRICOLA, the implicit subsidy provided by these sources should be lower than those provided by the more restrictive credit lines (INTF and SOCF). As shown in Table 2, the average implicit subsidy provided by loans funded with OWNR and USAID represented about one-fifth of the average amount lent (20 and 17 percent, respectively). On the other hand, the average implicit subsidy for the more restrictive sources of funds,

INTF and SOCF, represented more than one-half of the average volume lent (53 and 65 percent, respectively). In other words, borrowers receiving INTF and SOCF loans implicitly received an average subsidy of DR\$ 520 and DR\$ 640 per each DR\$ 1,000 loan, while those that received OWNR and USAID loans obtained an average subsidy of only DR\$ 200 and DR\$ 170. The surprising high average loan size and low average loan subsidy obtained by agrarian reform beneficiaries are mainly explained by the bank's attempt to reduce lending costs and risks of default, by lending to associations of agrarian reform beneficiaries rather than to individual reform beneficiaries.⁶

The implicit subsidy would have to be added to the interest rate subsidy that typically accompanies these loans, in order to measure the total transfer and its income distribution implications. Table 2 shows, however, that the largest average subsidy per borrower and the second-highest rate of subsidy are associated with the international (World Bank and IDB) sources of funds. Given the larger size of the beneficiaries of these programs, the subsidy appears to be regressive in its income distribution implications.

⁶ In effect, as shown by Aguilera-Alfred et al., agrarian reform associations received an average loan size of more than DR\$ 51,000, while agrarian reform individuals received an average loan size of only DR\$ 2,900.

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