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Financial Sensitivity of Alternative Forestation Incentives in Ecuador

By

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FINANCIAL SENSITIVITY OF ALTERNATIVE FORESTATION INCENTIVES IN ECUADOR

by

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ABSTRACT

McCormick, C.J., and Laarman, J.G. 198_. Financial sensitivity of alternative forestation incentives in Ecuador. For. Ecol. Manage., Vol:pages.

Financial net present value (NPV) was computed for three lowland and three highland plantation species in Ecuador. The estimates of NPV were subjected to systematic sensitivity tests for each of four elements in the plantation cash flow: land costs; establishment costs; management costs; and harvest income. Sensitivity was measured in terms of NPV elasticities over two regions, six species, two site qualities, and three discount rates. The results indicated large variability in the elasticities from one case to another. This illustrates the difficulty of identifying a single form of plantation subsidy that will be universally effective.

INTRODUCTION

Worldwide, a considerable number of recent studies assess the effectiveness and public costs of government subsidies to private forestry (Wood, 1982; Risbrudt et al., 1983; Royer, 1983; Bangman and Goransson, 1984; Boyd, 1984; De Steiguer, 1984; Gregersen, 1984; Watkins, 1984; Brannlund et al., 1985; Brooks, 1985; Harou, 1985; Pitcher and Risbrudt, 1986; Cubbage et al., 1987; Ellefson and Risbrudt, 1987). The countries of Latin America are among those which employ a great number and variety of subsidies for afforestation and reforestation (Bombin, 1975). Programs of tax credits and plantation cost-shares in Brazil and Chile, respectively, have received considerable publicity and some analytical treatment (Beattie, 1975; Berger, 1980; Holmberg, 1984).

The form and level of subsidies for forestry theoretically should reflect sectoral and regional priorities, national ability and willingness to pay, and other high-order political goals. Additional issues include economic efficiency, social equity (i.e., wealth transfer), administrative capacity, and environmental impact (Hickman, 1984).

An important efficiency aspect concerns the varying effect of a forestry subsidy across different subregions, species, and management cycles. This is among the key questions linking forest investment with forest ecology. However, this link is little explored. Presumably, most analyses either assume that a particular subsidy has an "average" effect, or ignore the matter

altogether. Yet a non-varying subsidy may have highly uneven consequences for different beneficiaries (Romm et al., 1987).

The present study examimes the variation issue empirically for plantation forests in Ecuador. Ecuador exhibits major contrasts in elevational zones, climatic zones, and hence the biophysical and economic environments for forest plantation species. This heterogeneity provides an ideal exploration of the sensitivity question.

METHODOLOGY

Base financial models

Financial net present value (NPV) was computed for three lowland and three highland plantation species (Table 1). The computations required the gathering and synthesis of a large quantity of data and assumptions. The major components were recommended silvicultural practices, management timetables, costs of all inputs, expected timber yields, and expected timber prices. Four experts worked as a team on this project, and their complete study is published separately as a monograph (McCormick, 1987).

For many reasons, the figures on NPV cannot be regarded as highly reliable. Plantation practices are still evolving in Ecuador, with over half of the country's planting having occurred only within the last ten years (AIMA, 1985). Silvicultural prescriptions are still debated; variations in site productivity are not fully researched; and markets for plantation wood are

still immature. Despite these reservations, the study is the most comprehensive of its kind to date, incorporating the best available current knowledge and perspectives.

Sensitivity Tests

The base NPVs in Table 1 were subjected to systematic sensitivity tests for each of four important elements in the plantation cash flow: (1) land costs; (2) establishment costs; (3) management/maintenance costs; and (4) harvest income. These are the principal cash flow elements normally affected by government-funded incentives programs (Table 2). That is, governments attempt to improve financial returns for private landowners by either lowering plantation costs (subsidizing elements 1, 2, and 3), or supporting harvest income (element 4). Other categories of incentives (e.g., most fiscal measures) have effects on financial returns which are not easily identified (element 5).

Sensitivity of NPV to changes in the cash flow elements was measured in terms of arc elasticities, as follows:

$$E(x_i) = \frac{\Delta NPV/NPV}{\Delta x_i \ /x_i}$$

where $E(x_i)$ is the arc elasticity of NPV with respect to the different cash flow elements (i=1,2,3,4) of Table 2. The greater is the elasticity, the more sensitive is NPV to changes in that element. The elements which produce the greatest response in NPV are those most critical to examine from the perspective of an incentives policy.

EMPIRICAL RESULTS

Tables 3 and 4 report the elasticities of NPV over the two regions, six species, two site qualities, and three discount rates. The map of elasticities can be studied across any of these four dimensions. A critical feature concerns asymptotic characteristics with respect to the discount rate, since the elasticity approaches infinity as NPV approaches zero (i.e., as the chosen discount rate approaches the internal rate of return). Despite this radical behavior for movements within certain local ranges of the discount rate, the map of elasticities facilitates a number of comparisons.

Analysis by discount rates

Analysis of Tables 3 and 4 from the perspective of discount rates provides some of the clearest interpretation. At a low (2%) discount rate, NPV is uniformly most sensitive to harvest income for all regions, species, and site qualities. The elasticity for harvest income is no less than 2.5 times greater than all other elasticities.

As the discount rate increases to 10%, the relative ordering of the elasticities begins to change in a number of cases. Each model becomes increasingly sensitive to elements which constitute major costs early in the investment cycle. For example, as the discount rate rises, the NPV of *P. radiata* on poor sites becomes sensitive to establishment costs. For lowland species like *C. alliodora* and *S. parahyba*, the critical element becomes management costs, since these new plantations may have to be entered numerous times for weed control.

Analysis by region

Table 5 compares lowland with highland species for the 2% and 10% discount rates. Elasticities are ranked in descending order, from largest to smallest. At the 2% discount rate, NPV is uniformly most sensitive to harvest income. However, there is almost no discernible pattern when the discount rate reaches 10%. At that higher rate, NPV is relatively sensitive to land costs for some highland species but no lowland species. The result seems reasonable, since land prices in the highlands exceed those in the lowlands by a considerable margin (approximately double at the time of study).

Analysis by site quality

In Table 5, the cash flow element which generates the greatest sensitivity in NPV is different on high site qualities than on low site qualities for four of six species. The two exceptions are *T. grandis* and *C. alliodora*, where the most important elements are harvest income and management costs, respectively, regardless of site quality.

IMPLICATIONS AND DISCUSSION

The elasticities discussed in the previous section demonstrate pronounced intra-country variability in the response of plantation NPV to changes in different cash flow elements. This occurs because the cash flow elements shift in absolute and relative importance across regions, species, site qualities, and discount rates. While this shifting can be deduced *a priori*, the example of Ecuador shows the results empirically. The results have important implications for public policy.

If the discount rate is as low as 2%, Ecuadorean landowners benefit most if the government helps support their harvest income. This conclusion holds for all species surveyed, and on sites of both high and low quality. The appropriate incentive (disregarding differences in administrative and operational costs) might be direct cash grants to landowners to cover harvest costs; provision of publicly-funded harvesting equipment and technical services (e.g., volume estimation and timber marking); or price guarantees for plantation timber.

However, the case of the low discount rate is the least interesting and the least realistic. First, the real cost of capital is high in low-income countries, especially when evaluating opportunity cost rather than market cost. Typical real rates are 8-15% (Gittinger, 1982, p. 314). Secondly, at low discount rates, landowners consistently obtain positive NPV (refer back to Table 1). The need for government subsidy is more apparent when the cost of capital is as high as 10%, leaving all NPVs negative unless there is public intervention.

At the higher and generally more relevant discount rate, it is no longer uniformly true that the greatest response in NPV derives from a single approach such as supporting harvest income. With future income discounted heavily, many plantation owners are better off if the subsidies concentrate on reducing initial costs. In the Ecuadorean highlands where land costs are high, an attractive incentives policy might focus on subsidizing land costs. Yet this policy would not be as well accepted in the

tropical lowlands, where land is still relatively inexpensive. Plantation owners in the lowlands would be better off if the incentives policy focused on reducing management and maintenance costs during the first few years of stand development.

Many of these conclusions are intuitively obvious to practicing foresters. This study helps make them explicit. The results imply that a single form of government assistance, equally applied, produces unequal returns for different groups of plantation owners. The first challenge for government policymakers is to closely examine ecological foundations across the range of different plantation investments. The second is to compare the increased benefits of adopting multiple subsidy approaches with the increased costs of administering that more complex program.

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TABLE 1

Financial net present value (NPV) for forest plantations in Ecuador, converted from Ecuadorean sucres to U.S.A. dollars

		NPV (US$/ha.) at discount rates:		
		2%	6%	10%
Lowland Species				
Tectona grandis	H	6,010	1,140	-318
	L	2,970	1,200	-523
Cordia alliodora	H	1,550	-130	-780
	L	760	-280	-660
Schizolobium parahyba	H	2,240	440	-410
	L	1,010	-30	-500
Highland Species				
Pinus radiata	H	2,430	800	-50
	L	520	-110	-300
Pinus patula	H	2,370	360	-140
	L	1,340	240	-20
Eucalyptus globulus	H	2,940	330	-160
	L	1,780	370	-110

H: high sites
L: low sites

150 sucres = 1 U.S.A. dollar (May 1986)

TABLE 2

Effect of different plantation subsidies on plantation cash flow elements:
1-Reduce land costs
2-Reduce establishment costs
3-Reduce management/maintenance costs
4-Support harvest income
5-Indirect or indeterminate

TYPE OF SUBSIDY	EFFECT ON CASH FLOW
I. Direct to landowner	
A. Cost share programs	
1. Cash grants	1,2,3,4
2. Payments in kind	
a. Land	1
b. Equipment	2,3,4
c. Seedlings	2
d. Chemicals	2,3
3. Services	
a. Management	2,3
b. Marketing	4
4. Subsidized credit	1,2,3,4
B. Fiscal assistance	
1. Income tax	5
2. Property tax	1
3. Yield tax	4
4. Investment credit	5
5. Inheritance tax	1,5
6. Import/export tax	5
C. Reduction of uncertainty	
1. Rental contracts	5
2. Price guarantees	4
3. Insurance	5
4. Land tenure security	5
5. Loan guarantees	5
II. Indirect for landowner	
A. Market information	5
B. Extension, education	5
C. Research, analysis	5
D. General forest protection	5
E. Infrastructure	5

TABLE 3

Elasticity of net present value (NPV) with respect to changes in plantation cash flow elements, lowland species

Site Quality	Discount Rate	CASH FLOW ELEMENTS: Land Costs	Establishment Costs	Management Costs	Harvest Income
		Elasticities			
Tectona grandis					
H	2%	*	.1	*	1.2
H	4%	.3	.4	.3	2.0
H	10%	1.2	1.3	.9	2.6
L	2%	*	.1	.2	1.3
L	4%	.8	3.7	3.1	9.1
L	10%	.2	.8	.5	.6
Cordia alliodora					
H	2%	.1	.2	.5	1.8
H	4%	2.3	2.4	4.9	9.3
H	10%	.5	.4	.7	.6
L	2%	*	.4	1.0	2.5
L	4%	.3	1.1	2.3	2.9
L	10%	.1	.5	.8	.5
Schizolobium parahyba					
H	2%	.1	.1	.4	1.7
H	4%	.6	.7	1.8	4.2
H	10%	.8	.8	1.6	2.3
L	2%	*	.3	.9	2.4
L	4%	2.2	10.8	26.6	40.8
L	10%	.2	.6	1.3	1.2

H: high sites
L: low sites

*: less than 0.1

TABLE 4

Elasticity of net present value (NPV) with respect to changes in plantation cash flow elements, highland species

Site Quality	Discount Rate	CASH FLOW ELEMENTS: Land Costs	Establishment Costs	Management Costs	Harvest Income
		Elasticities			
Pinus radiata					
H	2%	.1	.1	.1	1.3
H	4%	.7	.3	.3	2.2
H	10%	13.9	4.4	3.4	21.1
L	2%	.1	.4	.5	2.0
L	4%	.7	1.9	1.5	3.3
L	10%	.3	.7	.4	.5
Pinus patula					
H	2%	.1	.1	.1	1.3
H	4%	1.7	.6	.5	3.8
H	10%	1.5	.5	.3	1.3
L	2%	*	.2	.2	1.4
L	4%	.5	1.0	.6	3.2
L	10%	.8	1.2	.5	1.7
Eucalyptus globulus					
H	2%	.2	.1	*	1.3
H	4%	2.3	.5	.2	4.1
H	10%	1.9	.4	.1	1.4
L	2%	.1	.1	.1	1.2
L	4%	.4	.5	.2	2.1
L	10%	3.4	3.4	.8	6.9

H: high sites
L: low sites

*: less than 0.1

TABLE 5

Comparative elasticities of net present value (NPV) by cash flo
elements: l-land costs
e-establishment costs
m-management/maintenance costs
h-harvest income

LOWLAND SPECIES:

	T. grandis		C. alliodora		S. parahyba	
	H	L	H	L	H	L
Ranked at 2% discount rate	h	h	h	h	h	h
	m	m	m	m	m	m
	e	e	e	e	e	e
	l	l	l	l	l	l
Ranked at 10% discount rate	h	h	m	m	h	m
	e	e	h	h	m	h
	l	m	l	e	l	e
	m	l	e	l	e	l

HIGHLAND SPECIES:

	P. radiata		P. patula		E. globulus	
	H	L	H	L	H	L
Ranked at 2% discount rate	h	h	h	h	h	h
	m	m	l	e	l	e
	l	e	e	m	e	m
	e	l	m	l	m	l
Ranked at 10% discount rate	h	e	l	h	l	h
	l	h	h	e	h	e
	e	m	e	l	e	l
	m	l	m	m	m	m

H: high sites
L: low sites

Columns rank elasticities from highest (top) to lowest (bottom)