# Effective Investments for Habitat Conservation

**Paul J. Ferraro**

**Department of Economics**
**Andrew Young School of Policy Studies**
**Georgia State University**
**University Plaza**
**Atlanta, GA 30303-3083**
**USA**

**R. David Simpson**
**Resources for the Future**
**1616 P Street NW**
**Washington, DC 20036**
**USA**

**March 2002**

**Cost-Effective Conservation Payments**


**Abstract**

People are sometimes surprised to learn that international conservation payments are often made in the form of subsidies to purportedly eco-friendly enterprises rather than as payments for the acquisition of property rights in imperiled habitats. We demonstrate that direct payments for the acquisition of habitat are always more cost-effective than indirect payments for the acquisition of complementary inputs. In contrast to earlier work, we assume in this paper that an "eco-entrepreneur" may have market power. Market power is shown to compound the advantage of direct payments. We calculate the incremental cost of habitat acquisition as the cost of a subsidy either to habitat acquisition or to the purchase of complementary inputs less the increase in profits afforded the eco-entrepreneur. By this measure, a subsidy for habitat acquisition is always less expensive than would be simply buying the incremental area of habitat outright. In contrast, subsidies intended to achieve habitat conservation by encouraging the acquisition of complementary inputs can be spectacularly inefficient. In some cases it would be cheaper simply to buy the land outright. In some more extreme cases, no subsidy would be sufficient to induce a desired increase in habitat conservation.



**Keywords:** Biodiversity; conservation; cost-effective; incentives; subsidy; direct; indirect

**JEL classification:** H21; Q28

## Introduction

People are sometimes surprised to learn that international conservation policy often focuses on *indirect* as opposed to *direct* mechanisms for maintaining protected areas. By indirect mechanisms, we mean payments made to commercial enterprises felt to have an interest in conserving the natural "asset base" they employ in conjunction with purchased inputs to produce an "eco-friendly" output. In contrast, a direct mechanism is a payment for the conservation of land *per se*. While quantification is difficult, a report from the Center for International Forestry Research finds that indirect approaches have "become the predominant approach to most large-scale internationally financed conservation efforts in developing countries" (CIFOR 1999).

The impetus for conservation typically comes from the wealthier nations. Intact ecosystems may provide important global services, including the regulation of climate and the protection of biodiversity. The most biologically diverse ecosystems are typically located in low-income countries. The citizens of these countries have often not felt compelled to preserve natural ecosystems for their own purposes, and are reluctant to provide ecological services to the international community *gratis*. Thus some form of payments from the wealthier to the poorer nations are required if biodiversity is to be conserved.

As a matter of economic theory, it is curious that such payments have so often been structured as indirect mechanisms. In an earlier paper we demonstrated that they are not a cost-effective means of motivating a competitive eco-entrepreneur to conserve (Ferraro and Simpson, 2002). An international donor could always achieve the same conservation objective at a lower cost by providing a direct incentive.

One might take exception to the characterization of eco-entrepreneurs as competitors, however. Those engaged in nontimber forest product collection and marketing or the provision of ecotourism experiences, to give two examples, often have market power as a result of their location and/or the unique resources they command. As it turns out, however, market power considerations make the argument for the cost-effectiveness of direct incentives *a fortiori*.

The intuition is straightforward. The basic argument underlying the cost-effectiveness of direct incentives arises from considerations of diminishing returns. We consider below a two-input case. The greatest threat to biodiversity is felt to be conversion of natural habitats to agricultural and other uses (Primack, 2000). Most of the land about which international funders are concerned is found in moist tropical forests. Hence, we refer to one input as "forestland". The other input we call "capital," although it could, by adding notation without generating any important new insights, be decomposed into a vector of other purchased inputs. There are decreasing returns to both forestland and capital. Purchasing forestland is essentially a "one-for-one" proposition; put colloquially, "you get what you pay for". Subsidizing capital, though, involves encouraging the acquisition of an input subject to diminishing returns, and hoping that such acquisitions will motivate the recipients of the subsidy to acquire more forestland, in which they also experience diminishing returns. Inasmuch as market power induces further diminishing returns—the gap between marginal revenue and price is greater the greater is the market power of the seller—indirect mechanisms are still less effective.

They may, in some instances, be spectacularly ineffective. Our measure of cost effectiveness is the amount of the subsidy required in order to induce a given increase in the amount of forestland protected *less* the increase in the profit the entrepreneur receives as a result of the subsidy. One could motivate this specification by imagining a donor who cares in equal measure about the costs of conservation and the welfare of the eco-entrepreneur. Alternatively, one could think of the donor as paying a subsidy to “buy” the incremental amount of forestland and then “selling” to the entrepreneur the right to operate her enterprise on the land.

By this measure, a subsidy to forest land is necessarily less expensive than would be outright purchase: increased profits offset cost. We demonstrate in numerical examples that not only are indirect subsidies not cost effective, but that they may be worse than simply buying land outright and not conducting *any* activity on it. It is, in fact, not difficult to construct examples in which no indirect subsidy would motivate even relatively modest increases in conservation. The marginal revenue product of additional forestland essentially vanishes.

The next section of the paper introduces the model with which we work and derives the basic cost-effectiveness result with market power. The second section following provides another interpretation of our result, and the third investigates the implications of market power and other considerations using a numerical example. Some broader considerations are discussed in the final section.

## II. The Model

We compare direct and indirect conservation interventions in a simple, yet general, model. An “eco-entrepreneur” produces a quantity $Q$ of an “eco-friendly” product using a production technology, $Q(K, F)$. The production technology represents an economic activity (e.g., tourism) that allows ecosystem services (e.g., biodiversity) to flow relatively unimpeded from the ecosystem used in eco-production. We will refer to *F* as forest, but it can be any ecosystem that the entrepreneur uses in her eco-production activities. We will refer to *K* as capital, but it might be more broadly interpreted as any input or aggregate of other inputs. The model is easily generalized to consider multiple inputs and quality-adjusted quantities of output.

The prices of capital and forest, are $p_K$ and $p_F$, respectively. We suppose that the eco-entrepreneur may have market power: that is, that the price at which it can sell its output is a function of the quantity of that output it produces.

Suppose that the eco-entrepreneur's profit objective is

$$p(K, F) \; = \; p(Q)Q(K, F) - \; p_K K \; - \; p_F F \,. \qquad (1)$$

Differentiating with respect to choices of inputs *K* and *F*, we have

$$p_K \; = (p + p'Q)Q_K \; - \; p_K \; = \; 0\,, \qquad (2)$$

and

$$p_F \; = \; (p + p'Q)Q_F \; - \; p_F \; = \; 0\,. \qquad (3)$$

We needn't continue in explicit detail in order to derive comparative statics. Differentiate with respect to $p_K$ to determine the changes in *K* and *F* induced by the *indirect* incentive of subsidizing the price of capital:

$$p_{KK} \frac{\partial K^I}{\partial p_K} + p_{KF} \frac{\partial F^I}{\partial p_K} \; = \; 1\,, \qquad (4)$$

and

$$p_{KF} \frac{\partial K^I}{\partial p_K} \; + \; p_{FF} \frac{\partial F^I}{\partial p_K} \; = \; 0\,. \qquad (5)$$

Solving,

$$\frac{\partial K^{I}}{\partial p_{K}} = \frac{-p_{FF}}{(p_{KF})^{2} - p_{KK}p_{FF}}, \tag{6}$$

and

$$\frac{\partial F^{I}}{\partial p_{K}} = \frac{p_{KF}}{(p_{KF})^{2} - p_{KK}p_{FF}}. \tag{7}$$

Assuming the satisfaction of second-order conditions for profit maximization, $¶K^{I}/¶p_{K} < 0$; the monopolist's demand for capital is decreasing in its price. We will *assume*—it need not always be the case—that $¶F^{I}/¶p_{K} < 0$. That is, the indirect policy is, in fact conducive to conservation. This assumption is made in order to "give the benefit of the doubt" to a policy we ultimately find is not cost-effective. It remains an open and important empirical question as to whether indirect approaches can be not only ineffective, but counterproductive as well.

We also assume that the indirect approach is, in fact, in fact, "eco-friendly". A number of writers have argued that it may not be (Peters 1994; Honey 1999). Again, we are giving the approach we find wanting the benefit of the doubt, and our results would hold *a fortiori* if we relaxed this assumption.

Calculations entirely analogous to (6) and (7) yield the corresponding figures for "direct" incentives, that is, incentives generated by subsidizing the price of purchase of forest land.

$$\frac{\partial K^{D}}{\partial p_{F}} = \frac{p_{KF}}{(p_{KF})^{2} - p_{KK}p_{FF}}, \tag{8}$$

and

$$\frac{\partial F^{D}}{\partial p_{F}} = \frac{-p_{KK}}{(p_{KF})^{2} - p_{KK}p_{FF}}. \tag{9}$$

Now consider the thought experiment of providing a subsidy sufficient to motivate the preservation of one more hectare of forest land. That is, consider the size of the capital price subsidy required to induce $\Delta F^{I} = 1$. For relatively small $\Delta K^{I}$,

$$1 \; = \; \Delta F^{I} \; \approx \; \frac{\partial F^{I}}{\partial p_{K}} \Delta p_{K} \,, \tag{10}$$

or

$$\Delta p_{K} \; \approx \; \frac{(p_{KF})^{2} - p_{KK} p_{FF}}{p_{KF}} \,. \tag{11}$$

Corresponding to an increase in forestland of this magnitude will be an increase in capital of

$$\Delta K^{I} \; \approx \; \frac{\partial K^{I}}{\partial p_{K}} \Delta p_{K} \; = \; -\frac{p_{FF}}{p_{KF}} \,. \tag{12}$$

An entirely analogous set of calculations develops the conditions under which a subsidy in the price of the purchase of forest land results in a one-hectare increase in the size of the forest area conserved:

$$1 \; = \; \Delta F^{D} \; \approx \; \frac{\partial F^{D}}{\partial p_{F}} \Delta p_{F} \,, \tag{13}$$

or

$$\Delta p_{F} \; \approx \; -\frac{(p_{KF})^{2} - p_{KK} p_{FF}}{p_{KK}} \,; \tag{14}$$

and the implications for the increase in capital stock:

$$\Delta K^{D} \; \approx \; \frac{\partial K^{D}}{\partial p_{F}} \Delta p_{F} \; = \; -\frac{p_{KF}}{p_{KK}} \,. \tag{15}$$

There is a simple logic by which we can conclude that the total cost of conserving a hectare of land is greater under the indirect than the direct approach if the use of capital is greater. We have, by construction, described a situation in which the total amount of forest conserved is the same. It is, under either the direct or the indirect approach, the amount that would be conserved absent subsidies, call it $F^0$, plus one hectare. We have also assumed, by construction, that the total amount of capital employed absent subsidies is that which maximizes profit. The amount of capital employed when direct incentives are offered maximizes profit conditional on the amount of forest land available be $F^0 + 1$ hectare. In a straightforward notation, $K^0 + \Delta K^D$ maximizes $\pi(K, F^0 + 1)$. Thus, if $\Delta K^I > \Delta K^D$, the marginal revenue product of the larger amount does not cover its price.

Comparing (12) and (15 ), this is exactly what we find:

$$\Delta K^I - \Delta K^D \approx \frac{(\pi_{KF})^2 - \pi_{KK}\pi_{FF}}{\pi_{KK}\pi_{KF}} > 0 . \qquad (16)$$

The inequality results from two considerations. First, the numerator is negative by the second-order conditions for profit maximization. The second partial derivative $\pi_{KK}$ is also negative by the same principle. Finally, from expression (7), the second-order conditions, and the assumption that subsidizing capital does, in fact, conduce to more forest conservation, $\pi_{KF} > 0$.

## III. An Alternative Interpretation

A related way of seeing why we obtain (16) can be developed by starting from a second-order approximation to profits under indirect and direct subsidies. We could write the profit earned by the eco-friendly entrepreneur as a function of the prices he faces for inputs. Doing so, we can derive the second-order approximations

$$\pi\left(p_K + \Delta p_K,\ p_F\right) \approx \pi\left(p_K,\ p_F\right) + \pi_{p_K}\Delta p_K + \frac{1}{2}\pi_{p_K p_K}\left(\Delta p_K\right)^2 \qquad (17)$$

and

$$p\left(p_K,\ p_F+\Delta p_F\right)\ \approx\ p\left(p_K,\ p_F\right)\ +\ p_{p_F}\Delta p_F\ +\frac{1}{2}p_{p_F p_F}\left(\Delta p_F\right)^2 . \tag{18}$$

As we are assuming that inputs are purchased in competitive markets, we could write

$$p\left(p_K,\ p_F\right) = \max_{K,\ F}\quad p(Q)Q(K,\ F) -\ p_K K\ -\ p_F F\ , \tag{19}$$

which may be rewritten equivalently as

$$p\left(p_K,\ p_F\right) =\ p(Q)Q\ -\ C(Q,\ p_K,\ p_F). \tag{20}$$

Thus

$$p_{p_K}\ =\ \left(p\ +\ p'Q - C_Q\right)\frac{\partial Q}{\partial p_K}\ -\ C_{p_K}\ \ =\ -K\ , \tag{21}$$

since the first term following the first equal sign is zero by the envelope theorem and the derivative of cost with respect to factor price is factor demand, by Shephard's Lemma. Using the same arguments,

$$p_{p_F}\ =\ -F\ . \tag{22}$$

Using (21) and (22) in (17) and (18),

$$p\left(p_K+\Delta p_K,\ p_F\right)\ \approx\ p\left(p_K,\ p_F\right) -\ K^0\Delta p_K\ -\frac{1}{2}\frac{\partial K}{\partial p_K}\left(\Delta p_K\right)^2 \tag{23}$$

and

$$p\left(p_K,\ p_F+\Delta p_F\right)\ \approx\ p\left(p_K,\ p_F\right)\ -\ F^0\Delta p_F\ -\frac{1}{2}\frac{\partial F}{\partial p_F}\left(\Delta p_F\right)^2 . \tag{24}$$

using (12) and (15), (23) and (24) may be again rearranged as

$$p\left(p_K+\Delta p_K,\ p_F\right) - p\left(p_K,\ p_F\right) + \left(K^0\ +\Delta K^I\right)\Delta p_K\ \ \approx\ \ \frac{1}{2}\Delta K^I\Delta p_K \tag{25}$$

and

$$p\left(p_K,\ p_F+\Delta p_F\right)-p\left(p_K,\ p_F\right)\ +\ \left(F^0\ +\Delta F^D\right)\Delta p_F\ \ \approx\ \ \frac{1}{2}\Delta F^D\Delta p_F\ . \tag{26}$$

Expressions (25) and (26) have familiar interpretations. The left-hand side of each consists of the increase in the eco-entrepreneur's profit (the difference of the first two terms), less the cost of the subsidy (the third term—recall that the $\Delta p$'s are negative, as they represent reductions in the price of the input to the eco-entrepreneur). The term on the right-hand of each expression is a "welfare triangle": the deadweight loss of the subsidy.

Subtracting the right-hand side of (26) from that of (25),

$$\frac{1}{2}\left(\Delta K^I\Delta p_K\ -\Delta F^D\Delta p_F\right)\ =\ \frac{1}{2}\left(\Delta K^I\Delta p_K\ -\Delta p_F\right)\ =\ \frac{\Delta p_K}{2}\left(\Delta K^I\ -\Delta K^D\right). \tag{27}$$

The first equality results from the fact that $\Delta F^D$ is one by construction, the second from substituting from (11) and (15).

What (27) shows, then, is a somewhat more formal derivation of the informal result summarized in (16): the indirect approach is less efficient because it employs excessive capital to accomplish its conservation objective.

## IV. Some Numerical Examples

The analysis above suggests that the curvature of the profit relationship determines the relative advantage of direct as opposed to indirect incentives. Decreasing returns can arise from three sources: from diminishing returns in physical production, from limitations in the elasticity of substitution between forestland and capital, or from the limitations imposed by the extent of markets. To consider these factors, differentiate (2) and (3) with respect to *K* and *F* again, to obtain

$$p_{KK} = (p + p'Q)Q_{KK} + (2p' + p''Q)Q_K^{\,2}, \tag{28}$$

$$p_{FF} = (p + p'Q)Q_{FF} + (2p' + p''Q)Q_F^{\,2}, \tag{29}$$

and

$$p_{KF} = p_{FK} = (p + p'Q)Q_{KF} - (2p' + p''Q)Q_K Q_F. \tag{30}$$

Expressions can be rendered somewhat more compact by employing the abbreviations

$$e = \frac{\partial Q/Q}{\partial p/p} \tag{31}$$

for the price elasticity of demand and

$$h = \frac{2p' + p''Q}{p + p'Q}Q \tag{32}$$

or the quantity elasticity of marginal revenue.

Using (2), (3), (22) and (23) in (19) – (21),

$$p_{KK} = p(1 + 1/e)\left[Q_{KK} + hp_K \frac{Q_K}{Q}\right], \tag{33}$$

$$p_{FF} = p(1 + 1/e)\left[Q_{FF} + hp_F \frac{Q_F}{Q}\right], \tag{34}$$

and

$$p_{KF} = p_{FK} = p(1+1/e)\left[Q_{KF} + hp_F \frac{Q_K}{Q}\right] = p(1+1/e)\left[Q_{KF} + hp_K \frac{Q_F}{Q}\right]. \tag{35}$$

Now it is easily verified that if $\eta = 0$—if demand is perfectly elastic—expression (16) is an equality: the conservation donor would be indifferent between approaches. Thus, capital subsdidies to a competitive eco-entrepreneur are an inferior conservation strategy if the eco-entrepreneur faces decreasing returns to scale in production. This ought generally to be the case. Favorable sites for eco-friendly commercial activities are limited by the proximity of transportation networks. “Natural” sites are, almost by definition, those that are not well served by extensive road systems. Adding more land and more capital will be of little use if one cannot, in effect, change the location of an area.

It is more difficult to come up with a concise expression to describe the outcome in the polar opposite case in which the elasticity of marginal revenue is nonzero and there are constant returns to scale in physical inputs. One can, by manipulating (16), arrive at the following expression,

$$\frac{p_{KF}}{p_{KK}} - \frac{p_{FF}}{p_{KF}} = \frac{K}{F}\frac{h\left(p_K K + p_F F\right)Q_{KF}}{\left(-Q_{KF}F + hp_K\frac{Q_K K}{Q}\right)\left(Q_{KF}K + hp_F\frac{Q_K K}{Q}\right)}. \qquad (36)$$

Other than suggesting that a complicated relationship exists, however, it does not appear to yield any particular insights.

Let us, then, proceed with a simple example. Suppose that the eco-entrepreneur faces a constant-elasticity of demand function such that

$$p(Q) = p_0 Q^{-e}. \qquad (37)$$

Suppose that the production function is of the form

$$Q = \left(b_K K^{\frac{h}{1-e}} + b_F F^{\frac{h}{1-e}} + \left(1 - b_K - b_F\right)R^{\frac{h}{1-e}}\right)^{1/h}, \qquad (38)$$

where $R$ is a fixed factor. It will be convenient in what follows to abbreviate $r = h/(1 - e)$. The elasticity parameter, ε, must be positive and greater than one: a monopolist would never operate on the inelastic portion of its demand curve. We will assume $h < 1 - e$ to assure well-behaved solutions.[1]

With this notation, profit is

$$p_0\left(b_K K^r + b_F F^r + (1 - b_K - b_F)R^r\right)^{\frac{1}{r}} - p_K K - p_F F \,. \tag{39}$$

First-order conditions are

$$p_0 b_K K^{r-1}\left(b_K K^r + b_F F^r + (1 - b_K - b_F)R^r\right)^{\frac{1-r}{r}} = p_K \tag{40}$$

and

$$p_0 b_F F^{r-1}\left(b_K K^r + b_F F^r + (1 - b_K - b_F)R^r\right)^{\frac{1-r}{r}} = p_F \,, \tag{41}$$

or

$$K^r = \frac{\left(\dfrac{p_K}{p_Q b_K}\right)^{\frac{r}{r-1}}}{1 - b_K\left(\dfrac{p_K}{p_Q b_K}\right)^{\frac{r}{r-1}}}\left(b_F F^r + (1 - b_K - b_F)R^r\right) \tag{42}$$

and

$$F^r = \frac{\left(\dfrac{p_F}{p_Q b_F}\right)^{\frac{r}{r-1}}}{1 - b_F\left(\dfrac{p_F}{p_Q b_F}\right)^{\frac{r}{r-1}}}\left(b_K K^r + (1 - b_K - b_F)R^r\right). \tag{43}$$

Solving for *K* and *F*,

---

[1] It is somewhat problematic to suppose that $0 \le \varepsilon \le 1$, as this would imply that the production technology exhibits increasing returns in *K*, *F*, and the fixed factor *R* jointly. By supposing that *R* is "large enough," however, we can obviate this concern.

$$K = \left( \frac{1 - b_K - b_F}{1 - b_F \left( \frac{p_F}{p_Q b_F} \right)^{\frac{r}{r-1}} - b_K \left( \frac{p_K}{p_Q b_K} \right)^{\frac{r}{r-1}}} \right)^{\frac{1}{r}} \left( \frac{p_K}{p_Q b_K} \right)^{\frac{1}{r-1}} R \tag{44}$$

and

$$F = \left( \frac{1 - b_K - b_F}{1 - b_F \left( \frac{p_F}{p_Q b_F} \right)^{\frac{r}{r-1}} - b_K \left( \frac{p_K}{p_Q b_K} \right)^{\frac{r}{r-1}}} \right)^{\frac{1}{r}} \left( \frac{p_F}{p_Q b_F} \right)^{\frac{1}{r-1}} R . \tag{45}$$

The cost of conservation consists of two components. The first is the cost of the subsidy required to induce the indicated increase in forest area, whether it is in the form of a subsidy for the acquisition of forestland or a subsidy for the acquisition of capital complementary with forest land in the production of the eco-friendly output. The second, offsetting, component of the cost of conservation is the increase in profit afforded to the eco-friendly enterprise. One might think of this measure arising from the thought experiment of offering the eco-friendly enterprise the subsidy but requiring it to pay its full gain in profit from obtaining it.

Clearly, paying a subsidy for the acquisition of forestland is necessarily less expensive than would be purchasing an additional hectare of land outright. As the subsidy is a transfer between donor and eco-entrepreneur, it can be neglected in computing overall costs. The cost of acquisition is, then, the full cost of purchasing an additional hectare of forestland less the gain in variable profits (gross of land expenses) afforded by the extra hectare of forestland.

This upper bound does not hold for the cost of acquiring land by subsidizing complementary capital. Here the donor does not underwrite the acquisition of land, but rather, subsidizes capital acquisition. The more easily substitutable is capital for forestland, the less effective is the strategy of subsidizing capital acquisition.

These notions are illustrated in Table 1. The two sets of numbers in each cell are cost ratios. They indicate the ratio of the expense of conserving land by providing subsidies to land acquisition to that of outright purchase. As indicated above, the cost of protection via "direct"subsidies is necessarily lower than that of both outright purchase and of protection via "indirect" subsidies. An interesting thing to note in the table, though, is that it is not at all difficult to construct examples in which the costs of protection via outright purchase are less than those of protection via capital subsidies. In many instances—and here we believe we are making both a conceptual and an empirical statement—conservation donors would be better off forgetting about eco-friendly enterprises *entirely*, and simply buying land for protected areas. The asterisks in the table also point to an interesting possibility. For some, not obviously implausible, parameter values and objectives, the cost of an indirect approach is astronomical. No matter how heavily subsidized capital becomes, eco-entrepreneurs may not "demand" as much forestland as donors would want them to.

The figures in the table also show the expected effect. Note that, the way we have set up the functional form, the effects of an increase in the quantity flexibility of price (i. e., $\varepsilon$, the inverse elasticity of demand) are symmetric with those of an increase in the parameter of the production function, $h$. The greater is $e$, the greater is market power. Consequently, the less effective are incentives to induce greater forestland use. Similarly, cost effectiveness is in all instances greater the greater is $b_K + b_F$. This sum proxies for returns to scale. The greater the returns to scale become, the more effective are incentives of either variety.

## Table 1:

## Incremental Cost of Habitat Conservation Relative to Purchase Price of Land

| Parameters | | | Percentage Increase in Forest Area Desired | | |
|---|---|---|---|---|---|
| $ß_k$ | $ß_f$ | ? | 10% | 50% | 100% |
| 0.167 | 0.500 | -3.0 | 0.093, 0.681 | 0.373, * | 0.572, * |
| 0.333 | 0.333 | -3.0 | 0.095, 0.572 | 0.378, * | 0.578, * |
| 0.500 | 0.167 | -3.0 | 0.104, 0.692 | 0.402, * | 0.599, * |
| 0.450 | 0.450 | -3.0 | 0.085, 0.373 | 0.351, * | 0.550, * |
| 0.167 | 0.500 | -1.0 | 0.037, 0.557 | 0.187, 4.387 | 0.319, * |
| 0.333 | 0.333 | -1.0 | 0.047, 0.222 | 0.200, 1.999 | 0.333, 2865 |
| 0.500 | 0.167 | -1.0 | 0.056, 0.310 | 0.231, 2.500 | 0.375, 22.1 |
| 0.450 | 0.450 | -1.0 | 0.035, 0.097 | 0.156, 0.651 | 0.269, 2.21 |
| 0.167 | 0.500 | -0.1 | 0.022, 0.118 | 0.093, 0.716 | 0.160, 1.80 |
| 0.333 | 0.333 | -0.1 | 0.026, 0.109 | 0.111, 0.578 | 0.188, 1.21 |
| 0.500 | 0.167 | -0.1 | 0.034, 0.178 | 0.142, 0.894 | 0.237, 1.79 |
| 0.450 | 0.450 | -0.1 | 0.012, 0.020 | 0.051, 0.092 | 0.090, 0.173 |

***Too large to compute.**

## V. Discussion

Discontent with the limitations of indirect approaches to conservation is not a new development (Wells and Brandon 1992; Ferraro et al. 1997; World Bank 1997; Oates 1999). Approaches based on eco-friendly commercial activities are plagued by their ambiguous impact on conservation incentives, by their complex implementation needs, and by their lack of conformity with the temporal and spatial dimensions of ecosystem conservation objectives (Ferraro et al. 1997; Southgate 1998; Chomitz and Kumari 1998; Simpson 1999; Ferraro 2001).

The suggestion that more direct interventions would be more effective has also been made for many years (e.g., Barbier and Rauscher 1995; Simpson and Sedjo 1996; Ferraro 2001). It cannot now be dismissed as impractical, as direct incentives are now being put into practice (Ferraro 2001). Agricultural land diversion programs in Europe and the U. S. spend approximately $2.5 and $1.5 billion, per year, respectively, to divert some 20 million and 12 million hectares into long-term set-aside and forestry contracts (OECD 1997).

Successful experiments with direct payments have also begun in some less-developed countries. In Guatemala, the Forestry Incentives Program (PINFOR) delivers direct payments to forest stewards who manage forests for conservation goals (World Bank 2000). In Costa Rica, local, national, and international beneficiaries of ecosystem services compensate those who protect ecosystems (Castro et al. 1998; Calvo and Navarrete 1999). Similar programs are underway in El Salvador, Colombia, Honduras, and Panama (Stefano Pagiola, World Bank, per. comm. 2000).

There are, of course, some barriers to implementing the approach in low-income nations. Markets for intact ecosystems are often absent, or are imperfect in that the costs of enforcing property rights are prohibitive. A host of other issues that might be clumped under the rubric of "transactions costs". In this respect, however, a system of conservation performance payments is no worse than direct interventions. Both require institutions that can monitor ecosystem health, resolve conflict, coordinate individual behavior, and allocate and enforce rights and responsibilities.

A direct approach is much more streamlined, however. Conservation practitioners adopting indirect approaches must allocate their resources across many more tasks. While the direct incentive approach presumes the establishment of an institutional context in which it can be implemented—but so do indirect approaches. Moreover, they require greater sophistication on the part of donors in, for example, anticipating market trends and predicting the conservation effects of specific investments. We do not dispute the wisdom of making *profit-maximizing* investments in eco-friendly commercial activities. Our point is only that if such investments are not financially wise, as we suspect is the case in many instances, they will not be cost-effective in promoting conservation either.

References

Barbier, E. B. & M. Rauscher. 1995. Policies to Control Tropical Deforestation: trade intervention versus transfers. Pages 260-282 in C. Perrings, K.-G. Mäler and C. Folke, editors. Biodiversity Loss: economic and ecological issues. Cambridge University Press, Cambridge**.**

Calvo, A., and G. Navarrete. 1999. El desarrollo del sistema de pago de servicios ambientales en Costa Rica. FONAFIFO and UNDP, San Jose, Costa Rica.

Castro, R., L. Gamez, N. Olson, and F. Tattenbach. 1998. The Costa Rican Experience with Market Instruments to Mitigate Climate Change and Conserve Biodiversity. FUNDECOR, MINAE, and the World Bank, San Jose, Costa Rica.

Chomitz, K. and K. Kumari. 1998. "The Domestic Benefits of Tropical Forests: A Critical Review," World Bank Research Observer **13**(1): 13-36.

CIFOR, UNESCO, UNESCO World Heritage Centre. 1999. World heritage forests: The world heritage convention as a mechanism for conserving tropical forest biodiversity. CIFOR Ad Hoc Publication. Bogor, Indonesia: CIFOR, UNESCO, UNESCO WHC.

Ferraro, P.J. 2001. "Global Habitat Protection: limitations of development interventions and the role for conservation performance payments." Conservation Biology (In Press, August 2001).

Ferraro, P. J., and R. Tshombe, R. Mwinyihali, J.A. Hart. 1997. Projets Intégrés de Conservation et de Développement : un cadre pour promouvoir la conservation et la gestion des ressources naturelles. Working Paper no. 6. Wildlife Conservation Society, Bronx, New York.

Ferraro, P. J., and R. D. Simpson, "The Cost-Effectiveness of Conservation Payments," *Land Economics* **78**, 3 (August, 2002), forthcoming.

Honey, M. 1999. Ecotourism and Sustainable Development: Who Owns Paradise? Washington, DC: Island Press.

Oates, J. F. 1999. Myth and Reality in the Rain Forest: how conservation strategies are failing in West Africa. University of California Press, Berkeley, California.

OECD. 1997. The environmental effects of agricultural land diversion schemes. OECD, Paris.

Peters, C. M. 1994. Sustainable Harvest of Non-timber Plant Resources in Tropical Moist Forest: An Ecological Primer. Landover, MD: Corporate Press.

Primack. R., "Extinction, Causes of," in Simon Levin (editor), *Encyclopedia of Biodiversity*, Volume 2 (San Diego: Academic Press), 697-713, 2000.

Simpson, R. D. 1999. “The Price of Biodiversity,” Issues in Science and Technology **XV** (3): 65-70.

Simpson, R. D. and R.A. Sedjo. 1996. Paying for the Conservation of Endangered Ecosystems: a comparison of direct and indirect approaches. Environment and Development Economics **1**:241-257.

Southgate, D. 1998. Tropical Forest Conservation: An Economic Assessment of the Alternatives in Latin America. New York: Oxford University Press.

Wells, M., and K. Brandon, with Lee Hannah. 1992. People and parks: Linking protected area management with local communities. World Bank, World Wildlife Fund, and U.S. Agency for International Development, Washington, D.C.

World Bank. 2000. Project Proposal: Guatemala Western Altiplano Natural Resources Management Project. Project ID GTPE64883. Latin America and Caribbean Region.

World Bank, Indonesia and Pacific Islands Country Department. 1997. Investing in Biodiversity: a review of Indonesia's Integrated Conservation and Development Projects. World Bank, Washington, D.C.