¿Cuanto Cuesta? Market-Based Solutions to Forest Conservation in Costa Rica

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Abstract

Caught in the debt crisis that gripped most of Latin American in the late 1970s, Costa Rica implemented aggressive export-led growth policies such as the creation of tax-free zones for foreign investment and domestic tax breaks for activities such as farming and cattle ranching. As the economic crisis subsided in the late 1980s, Costa Rica had an environmental rude awakening: half of the country's forested land, and a full 25 percent of its total landmass, had been stripped of its trees between 1970 and 1987.

In the years that followed, and continuing through today, Costa Rica's government, NGOs active in the region ,and donor countries have turned their focus to preserving the remaining tropical rainforests, implementing several innovative market-based conservation initiatives. This paper examines the viability of such solutions over of 38-year period beginning in 1962.

Market Based Conservation in Costa Rica: General Overview

The export-led growth and rapid industrialization strategies that have dominated economic development theory for the last thirty years have had dire consequences for the environmental health of much of the developing world. Particularly in Latin America, tropical forests have been cleared at an alarming rate since 1970, opening land for agriculture, ranching, industrial parks and urban development. This deforestation results in loss of habitats for forest dwelling animals and plants, erosion, desertification and ultimately global warming. The environmental crisis caused by rapid forest degradation is emerging as one of, if not the, most critical issues facing developing economies today.

The experience of Costa Rica, as its economic policy has moved from promoting environmentally destructive export-led growth to fully embracing innovative, market-based conservation solutions, is instructive of the future potential of such approaches for slowing, and ultimately stopping, environmental degradation without sacrificing economic growth.

Costa Rica is something of an anomaly in Latin America: a representative democracy for more than a century, the small Central American nation (Costa Rica's land area is only 5,106,000 hectares – approximately the size of West Virginia) not only escaped the political instability and military coups that enveloped much of the region during the 1980s, but it has had no military at all since 1948, when it was abolished in the aftermath of a 44-day civil war.[1]

Despite Costa Rica's political stability, the global recession of 1979 – 1983 sunk the country into a debt crisis caused by spikes in oil prices and international interest rates, as banana and coffee prices – traditional Costa Rican exports – hit an all-time low.[2] Aggressive export-led growth policies were implemented, including the creation of tax-free zones for foreign investment and domestic tax breaks for activities such as farming and cattle ranching, in the early 1980s.

The environmental impact of these policies on Costa Rica's tropical forests was extraordinary: more than half of the country's landmass was covered with forest in 1970 (2,570,000 hectares); by 1987, more than 1,000,000 hectares—25 percent of the country's land—had been converted to non-forest uses.[3]

As Costa Rica began to emerge from the economic crisis in the late 1980s, the socially progressive government of President Oscar Arias began to focus on the environment, seeking *sustainable* development initiatives. The reorganization of the country's 75 fragmented conservation and protected wild areas into seven administrative districts under SINAC, a national conservation and park system, in 1989 was the

first step in this transformation.[4] The next several years saw a series of progressive initiatives implemented by public-private partnerships, such a new fuel tax funding forest plantations on fallow pastures[5] and the creation of an international market in carbon offsets.

The United States Agency for International Development's (USAID) $7.5 million commitment to establish and maintain FUNDECOR[6] (the Foundation for the Development of the Central Volcanic Cordillera), an NGO dedicated to restoring forests in the "buffer zone" surrounding several disjointed conservation areas in the Central Volcanic Cordillera (ACCVC), is an illustrative example of this new focus on sustainable development[7].

FUNDECOR was established in 1990 by a joint agreement between USAID and the Costa Rican government. It is an independent non-governmental organization dedicated to promoting sustainable forestry and agroforestry in the non-protected (i.e. privately held) forested land surrounding the conservation areas of the ACCVC, as well as to support, through training and provision of funds, the management of these protected areas. The USAID commitments to the program included an initial funding grant of US$5.5 million in 1990, a second and final grant in 1996 of US$2 million, and administrative and technical support through March 1996. The Costa Rican contribution to FUNDECOR came in the form of a US$10 million local currency endowment to establish a trust fund.[8]

The establishment of the trust fund provides FUNDECOR with considerable financial independence and security. According to USAID projections, the interest from the fund should be enough to cover all administrative costs without touching the principal and without seeking any additional financing through the first 11 years of operation. Although program growth has exceeded expectations, FUNDECOR has compensated for these increased costs by securing additional funding sources – most notably through a $2 million sale of carbon offsets to the Norwegian government[9] through a program known as CARFIX[10].

FUNDECOR's activities can be divided into four main programs: the CARFIX program referred to above, which was initiated in 1996 under the Ley Forestal 7575, forest management, reforestation and environmental education[11].

FUNDECOR's reforestation and forest management programs support sustainable forest use by contracting with small landholders for forest management projects. FUNDECOR helps tree farmers develop forest management plans and to secure the best price on the market for their timber, in exchange for commitments to harvest at a sustainable rate, once every 10 years. The organization pays farmers an annual fee for

every year they do not harvest timber.

The environmental education program works with the Costa Rican Public Education Ministry and the Ministry of Energy and Environment (MINAE) to educate young people about the value of the forests.

Finally, CARFIX, established under the Ley Forestal 7575 in 1996, compensates landowners for the environmental services provided by their forests. An international market for the trade of carbon offsets has been established. The Ley Forestal also provides a payment for domestic environmental services through a fuel tax.

The Focus of This Study: *¿Cuanto Cuesta -- How Much Does It Cost?*

Throughout Costa Rica's environmental awakening in the late 1980s and continuing on until today, the establishment of various systems of payments for conservation and environmental services appeared as a recurrent theme. FUNDECOR pays farmers who sign sustainable forestry contracts in non-harvest years; the Ley Forestal provides direct transfer payments to landowners who agree to protect their forest; CARFIX "sells" the carbon sequestration benefit of forested land on the commodities market.

Considerable research has been done to calculate how much these environmental services are *worth*, most notably the 1997 article by Robert Costanza and co-authors, "The Value of the World's Ecosystem Services and Natural Capital," which provides an itemized breakdown of services and the corresponding dollar value. But the focus of this study is not the *value,* but the *price.* How much do farmers and landowners need to be compensated in order to protect their forests?

Using the Costa Rican experience as a model, this time-series study will examine the interaction of market forces and rates of change in forest coverage over the 37-year period 1962 – 1999.

Research hypothesis:

$$\Delta forest = \beta_o + \beta_1(PopGrowth) + \beta_2(NonFor^*) - \beta_3(SustFor^*) - \beta_4(1989) + \beta_5(Agri\%) + \beta_6(GDP\%)$$

Where the dependent variable (Y) $\Delta forest$ refers to the absolute value of the change, in thousands s of ha, or forest cover, year-over-year. Using a one-year lag in the dependent variable, the analysis shows the impact of the independent variable values on the change in forest cover. The program variable (X) is *SustFor*,* the expected value of sustainable forestry uses of land.

Control variables (Z) are: *PopGrowth,* the year-over-year percent change in population; *NonFor*,* the expected value or benefit of non-forest uses of the land; *1989,* a dummy variable for years either before or after 1989, which is a year of significant change in the regulatory and political environment impacting the forestry industry; *Agri%* indicates the proportion of GDP generated by agriculture; and GDP% indicates annual growth in GDP excluding agriculture.

The null hypothesis is that market forces do not play into the decision to convert forested land to non-forest uses (including agriculture, cattle ranching, and clear-cut logging, but excluding sustainable timber harvesting); the impact of payments to landowners in exchange for a commitment to sustainable forestry ($ß_3$) is equal to zero.

The alternative hypothesis is that payments to landowners *do* encourage sustainable forestry, or, that β_3 is less than zero[12].

This set of hypothesis calls for a one-tailed t-test. Because of limitations in data accuracy discussed below, a conservative confidence interval of 85 percent will be considered acceptable ($p \leq .15$).

The dependent variable (y): Δforest

Data source:

United Nations Food and Agriculture Organization, FAOSTAT database (1961 – 1994), variable "forest and woodland, 1000s Ha".
After 1994, this data was not collected in the same format. Values for individual years between 1995 – present were pulled from various databases, but obvious differences in the definition of the variable existed.

Variable creation:

The year-over-year change in absolute value is used for the regression. For years of missing data, an average change was calculated by finding the change over the entire period of missing data and dividing by the number of years.[13]

The program variable (x): SustFor*

Data source:

United Nations Food and Agriculture Organization, FAOSTAT database

Index components:

Sustfor* is an index of the average production or yield from sustainable harvesting of timber per Ha. An annual growth rate of 1 cubic meter (cum) per Ha of natural forest per year is substituted for the decennial

harvest to simplify discounting calculations; a constant benefits stream continuing indefinitely is assumed, with a discount rate of 5 percent (based on USAID projections. Annual data is recorded in current US dollars; the index is converted to constant 1995 dollars by multiplying by the ratio of US GDP in constant 1995US$ to us GDP in current US dollars, based on the World Development Indicators database.

Control variables (z):

PopGrowth

Data source: World Development Indicators

*NonFor**

Data source: United Nations Food and Agriculture Organization, FAOSTAT database

Index components: Nonfor* is an index of the average production or yield from agriculture, logging and livestock (cattle) per Ha of land multiplied by the average value of exports, in constant 1995US dollars, of these goods. Cattle ranching yield is calculated as follows: average yield of .89 animals per Ha multiplied by yield per animal in metric tons. Logging yield per Ha is 115.5 cubic meters; for agricultural products, the average yield per Ha is multiplied by average price per metric ton. Annual data is recorded in current US dollars; the index is converted to constant 1995 dollars by multiplying by the ratio of US GDP in constant 1995US$ to us GDP in current US dollars, based on the World Development Indicators database.

1989 (dummy variable)

Agri%

Data source: World Development Indicators

GDP%

Data source: World Development Indicators

Discussion of Results

$$Y(\Delta forest) = 31.21 - 3.05(SustFor^*) + 0.13(NonFor^*) + 0.63(PopGrowth) - 37.88(1989) + 1.35(Agri\%) + 43.73(GDP\%)$$

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.78739272
R Square	0.619987295
Adjusted R Square	0.548734913
Standard Error	20.10873368
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	21110.77109	3518.461849	8.701285157	1.19525E-05
Residual	32	12939.55745	404.3611703		
Total	38	34050.32854			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
10% Confidence Level			$t_{critical\ value} = 1.31$	$P_{critical\ value} = 0.10$
Intercept	31.21358715	36.76720673	0.848951822	0.402214552
SustFor*	-3.050046113	1.698734492	-1.795481359	0.082026502
NonFor*	0.127390082	0.364376814	0.349610834	0.728921232
PopGrowth	0.625566307	5.985649807	0.10451101	0.917416151
1989	-37.88222165	15.45691342	-2.450827058	0.01990019
Agri%	1.353938335	1.258977619	1.07542685	0.290225592
GDP%	43.73267358	92.79630482	0.471276024	0.640640893

The results of the regression concur with the theory, and can be restated as follows:

- *SustFor*:* For every $1000 increase in expected value of sustainable forest uses of land/Ha, 3,050 Ha of forest are preserved.
- *NonFor*:* For every $1000 increase in expected value of non-forest uses of land/Ha, 113 Ha of forest are destroyed.[14]
- *PopGrowth:* For every one percent increase in population, 630 Ha of forest are lost.
- *1989:* An average of 37,880 Ha of forest have been preserved as a result of the reforms initiated in 1989.
- *Agri%:* For every one percent increase in GDP coming from the agricultural sector, 1,350 Ha of forest are lost.
- *GDP%:* For every one percent increase in GDP overall, 43,730 Ha of forest are lost.

Both the program variable *SustFor** and the dummy variable for 1989 are statistically significant at the 10 percent level (t-critical value = 1.31)[15]. The null hypothesis, that market forces do not play into the decision to convert forested land to non-forest uses, is

rejected. Payments to landowners do impact land use decisions.

The adjusted R^2 of 0.549 is also encouraging: this indicates that the model explains roughly 55 percent of the variation in the rate of forest cover change.

However, the other significant variable, *1989*, provides insight into under what circumstances such payments will have the desired impact: *1989* is a proxy variable for the socio-political environment. Prior to 1989, Costa Rican society was in transition; the debt crisis that enveloped Latin America in the early 1980s had put Costa Rica's economic development off track, and aggressive policies were implemented to speed economic recovery and job creation. By 1989, the economic crisis had passed and the socially progressive government of President Oscar Arias began to focus on the conservation and sustainable development Costa Rica. This created the critical condition for successful implementation of market-based forest conservation: a favorable policy environment.

Implications/Conclusions

The results demonstrate that the combination of market incentives and a favorable regulatory and political environment for conservation has had a significant impact on slowing deforestation in Costa Rica – a promising conclusion.

As discussed earlier in this paper, however, the purpose of the model is more specific and, perhaps, more practical than arriving at a general conclusion regarding Costa Rica's past experience. The goal is to answer the question "*how much?*"

What is the price for forest conservation? This regression model provides a tool for deriving a bottom-line for halting deforestation of Costa Rica's rich tropical rainforests today. This is a very practical question that policymakers and implementers are asking in Costa Rica right now, as they develop and implement solutions to compensate small landowners for their conservation efforts.

Based on the model and holding other factors constant, the payment to landowners required to achieve a net-change in forest cover of zero in Costa Rica[16] is:

$$Y(\Delta forest) = 31.21 - 3.05(SustFor^*) + 0.13(NonFor^*) + 0.63(PopGrowth) - 37.88(1989) + 1.35(Agri\%) + 43.73(GDP\%)$$

$$0 = 31.21 - 3.05(SustFor^*) + 0.13(47.10) + 0.63(2) - 37.88(1) + 1.35(9) + 43.73(1)$$

$$SustFor^* = [31.21 + 0.13(47.10) + 0.63(2) - 37.88(1) + 1.35(9) + 43.73(1)]/3.05$$

$$SustFor^* = 44.733 \textbf{ 1995US\$1000 /1,000 Ha.}$$

This can be interpreted as follows: an annual payment of $60,836,545.57 to landowners of Costa Rica's remaining 1,360,000 hectares[17] of forest is required to stop deforestation completely in that country.

So Costa Rica's tropical rainforest has a hefty price tag: $60.8 million annually. But *cost* is not the same as *value.* In a groundbreaking paper published in *Nature* in 1997, Robert Costanza (as well as a dozen co-authors) provided a valuation of ecosystem services, itemized by service and type of ecosystem, in U.S. dollars per hectare per year[18]. Among the benefits of tropical forest ecosystems are listed:

$223/ha in climate regulation
$245/ha in water erosion protection
$922/ha in nutrient cycling
$87/ha in waste treatment
$315/ha in raw materials
$41/ha in genetic resources
$112/ha in recreation
$63/ha in miscellaneous other services

All told, by Costanza's accounting, the earth receives $2,007 in services and other benefits from each hectare of tropical forest, on an annual basis. Applied to the Costa Rican case, this means that the earth receives $2,729,520,000.00 in benefits and services from Costa Rica's remaining 1,360,000 hectares of tropical forest each year.

As much as this valuation may make the $60.8 million required to save the forests seem like a bargain – not to mention a very good idea – coming up with the cash is a challenge for even the wealthiest of governments.

Costa Rica is rising to that challenge with an innovative system of tax credits, direct transfer payments, regulation of the timber/forestry sector, and market-driven solutions. The government stands by its commitment to sustainable development, even forgoing short-term financial gains in the interest of environmental conservation and protection.[19]

The international community, for its part, has responded. Not only have other developed and developing nations partnered with the Costa Rican government to meet its sustainable development goals – for example, the Norwegians' $2 million purchase of carbon offsets[20] and FUNDECOR – but individuals worldwide have recognized the advances this small Central American nation has made. In 1992, tourism overtook agriculture as the largest industry in Costa Rica's economy.[21]

However, results for the program variable *SustFor** are tenuous: although the t-statistic is significant at the 10 percent level, this result has a confidence level of less than 85 percent. When other permutations of the model were attempted, the strength of the relationship between *SustFor** and *Δforest* weakened. The only consistently strong relationship between variables in the model is that between *Δforest* and the year dummy variable, *1989,* which in the final regression equation has a valid t-statistic at the 2.5 percent significance level and 99 percent confidence level.

These facts point to the critical importance of a strong institutional and political basis for conservation efforts before market-based solutions can hope to have an impact, and raise doubts about the likelihood of Costa Rica's success being repeated in other, less rich tropical developing nations.

By the standards of developed countries like the Untied States, Costa Rica is undoubtedly poor. However, with an adult illiteracy rate of only four percent, universal primary education, an average life expectancy of 76.6 years, and per capita GDP of $3,977, Costa Rica is light-years ahead of its Central American neighbors in terms of human development and political stability.[22]

While conservation has taken hold in the national psyche of the *ticos*, the citizens of neighboring Nicaragua, Guatemala, Bolivia and Columbia are more concerned with battling guerrilla warfare and narco-terrorists, obtaining enough food for their families and coming up with the money to pay for their children's education.

Where families must choose between education and food, the fate of the rainforests often takes a back seat to security – economic, political and physical. Until that security is established, efforts to implement market-based solutions to forest conservation have no chance of achieving a measurable impact.

Endnotes

1. U.S. Department of State, *Background Note: Costa Rica,* (August 2003).

2. Mary A. Clark, "Transnational Alliances and Development Policy in Latin America: Nontraditional Export Promotion in Costa Rica," *Latin American Research Review,* Vol. 32, Iss. 2 (1997): p 71.

3. United Nations Food and Agriculture Service, FAOSTATS database. (See data tables attached for details).

4. USAID Evaluation Highlights No. 53, "Forestry and the Environment: Costa Rica Case Study,"

Center for Development Information and Evaluation (April 1996).

5. Farmers participating in the program receive payments (funded by the fuel tax) for either protecting currently forested land or replanting old pastures through a new branch of the Ministry of Energy and Environment, the National Forestry Financing Fund, established to manage the program. "Costa Rica's Experimental Environmental Services Program: Paying a Fee for what Forest do for Free," *Eco-Exchange,* The Rainforest Alliance (March 2001).

6. USAID Project Paper, "Forest Resources for a Stable Environment," Project Number 515-0243 (1989).

7. The original goal of this study was to determine the impact of FUNDECOR's various activities on rates of deforestation throughout Costa Rica; however, data inconsistencies and simultaneity issues conspired to make this an impossible task. The time and financial constraints of this study precluded gathering original data, and a breakdown of forest cover by conservation region, was not available. In addition, at the time of FUNDECOR's inception massive changes were taking place in Costa Rican society: SINAC was established, a new presidential administration with strong environmental commitments took office, and the Ley Forestal 7575, establishing a new series of fuel taxes aimed at energy conservation and environmental service payments (PSAs) was implemented during the project period.

8. USAID Project Paper No. 515-0243. The ultimate source of the $10 million Costa Rican contribution to the fund was also USAID: the funds were transferred from another, discontinued USAID program into the FUNDECOR trust fund.

9. Susan Subak, "The Case of Costa Rica's 'Carbon Commodity,'" *Forest Trends Workshop: New Market Mechanisms for Managing Forests,* The National Resources Defense Council (July 15, 1999).

10. "Project CARFIX: Sustainable Forest Management," USIJI Uniform Reporting Document: Activities Implemented Jointly Under the Pilot Phase, USAID.

11. Cornelia Miller, FUNDECOR, personal communication (December 2, 2003).

12. Because the hypothesized effect of payments on deforestation is a reduction in the number of hectares deforested, a negative value for $\square_3$ is anticipated.

13. This approximation, as well as the use of multiple data sources, introduces measurement error into the model.

14. The relationship between *NonFor** and $\Delta forest$ is contrary to theory. Two potential explanations for this are collinearity and omitted variable bias.
Collinearity and *NonFor*:* The very low coefficients and insignificant t-statistics for *NonFor*, Agri%* and *GDP%,* indicates that collinearity may be a problem. The source of the problem is

most likely covariation with the related variable, *SustFor**; both are based on the same inflation calculations, and are subject to the cyclical variation that is inherent in economic data.

15. The simple correlation coefficient for *NonFor*, SustFor** is $r = 0.668$, a fairly high, although not extraordinary, value. Because both of these variables play a central role in the hypothesis, omitting one or the other was ruled out as a correction for collinearity. Instead, *SustFor** and *NonFor** were transformed into rate of change variables Δsf^* and Δnf^*. However, this correction did not improve the model – the direction of the relationship between Δnf^* and $\Delta forest$ remained negative, contrary to theory, while the t-statistic for Δsf^* fell below the critical value for the 10 percent significance level of 1.31.
Omitted Variable Bias: The *NonFor** variable may also be impacted by omitted variable bias in the model. Some proportion of the reduction in $\Delta forest$ is the result of the shrinking proportion of currently forested land that is suitable for agriculture or other non-forest purposes, a variable we will call *landqual.* Unfortunately, without plot-level information about soil quality, gradient, and other factors, it is impossible to control for *landqual.* The effects of this missing variable are incorporated to some extent in *NonFor**, in the form of decreasing expected returns from non-forest uses of land, as well as contributing to the overall error in the model.

16 Serial Correlation, Functional Form and Measurement Error: A graph of the residuals for the regression equation produces a nearly perfect sin wave, with a bell-shaped series of positive values followed by a bell-shaped series of negative values. The results of the Durbin-Watson d Test confirm the visual impression of serial correlation: $d = 0.918$, well within the rejection range of < 1.22 for the null hypothesis of no serial correlation. This first order serial correlation is most likely the result of the reliance on cyclical economic data in calculation of the variables for the model, which indicates that the functional form of the regression may be non-linear, and t-statistics may be overestimated.
However, there is also a potentially high incidence of measurement error, due to the reliance on multiple data sources and use of imprecise estimates to fill gaps in data. The raw data for the dependent variable $\Delta forest$ as well as the program variable *SustFor** and control variable *NonFor**, in particular, were derived from numerous publicly available databases, which employed a wide range of methods as well as varying definitions of the item being measured. This measurement error is most likely a contributing factor in the marginal significance of the test statistic for *SustFor**and other variables, as well as the contrary-to-theory relationship between $\Delta forest$ and *NonFor** discussed above.

17. 2001 values of explanatory variables are used for this calculation.

18. Forest Resource Assessment 2000: www.FAO.org/forestry.

19. Robert Costanza et al, "The Value of the World's Ecosystem Services and Natural Capital ," *Nature* (1997).

20. When Costa Rican President Jose Maria Figueres took office in January 1994, he flexed his pro-environment muscle by halting development of two major foreign business investments

due to environmental sustainability concerns; one was a large, Cancun-style resort on Costa Rica's Pacific Coast, hitting the country's leading source of external revenue (tourism). David Tenebaum, "The Greening of Costa Rica," *Technology Review,* Cambridge (October 1995).

21. Subak.

22 The Economist Intelligence Unit (EIU), *Costa Rica at a glance: 2003-2004* (September 2, 2003).

SOURCES

"Costa Rica's Experimental Environmental Services Program: Paying a Fee for what Forest do for Free," *Eco-Exchange,* The Rainforest Alliance (March 2001).

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World Development Indicators.