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Assessing the Impact of Institutional Design of Payments for Environmental Services

The Costa Rican Experience

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Introduction

During the last few decades, the role that land use and land-use change have played in protecting biodiversity and in carbon sequestration has been widely recognized. This has led to a significant increase in the implementation of conservation policies around the world. Among these, policies that can simultaneously improve environmental outcomes and reduce poverty levels have gained special attention. It is under this context that researchers and policy-makers have focused their efforts on programmes of payments for ecosystem services.

By now, these programmes have been implemented in many countries of the Latin American region (e.g. Mexico, Ecuador and Colombia). But Costa Rica was one of the first developing countries to implement this policy nationwide, recognizing legally that forests generate services that need to be compensated. This pioneering effort was called the Payment for Environmental Services (PES) programme. It officially started in 1997 and is still under way.

This programme has been successful in different ways. However, there is an important measure of success that requires special attention. How much deforestation was the programme able to avoid? This is an issue that has continuously appeared as a potential problem in the design of conservation policies (Andam et al, 2008; Sims, 2010) and specifically for this programme (Pfaff et al, 2007; Robalino et al, 2008; Sierra and Russman, 2006).

If the programme has not been effective, policy-makers should consider strategies to address this problem. One strategy that has been discussed in the literature is improved targeting of high-threat areas. This consists of paying only those parcels with higher likelihood of deforestation. The amount of ecosystem services will increase if deforestation is actually reduced.

In this chapter, we describe the evolution of the PES programme payments in Costa Rica. The first years of implementation set the basis for what the programme has become. Important changes have been made since the beginning, such as the institution in charge of implementing the programme (2003), parcels selection criteria, and new offices that were opened in different areas of the country with the objective of reducing application costs.

Using 2003 as the starting point of when these changes took place, we discuss if they had a programme efficiency effect on reducing deforestation. We focus on forest conservation contracts because it is the most important category of the programme in terms of budget and amount of land enrolled. We use matching techniques, geographic information systems (GIS), characterize the areas where payments were implemented in each of the time periods using a long list of variables, and look for similar areas that did not receive payments. We find that, as other studies have found for this period (Robalino et al, 2008; Arriagada, 2008), the impacts are low but significant. While it seems that, overall, institutional changes have not had a significant effect on impact, we also look at the impacts of forest conservation contracts per office. We find that those offices located in areas with high deforestation tend to have higher impacts.

Efforts towards improving targeting based on the likelihood of deforestation will easily improve the programme's effectiveness. Evidence of this is that office contracts in areas where deforestation is high are significantly more effective. Shifts in budget distribution to these offices could lead to further impacts. Additionally, information such as distance to roads and markets can also be used to estimate the likelihood of a parcel to be deforested, which in turn can lead to an increase in the amount of avoided deforestation of future contracts.

The chapter is organized as follows: first we describe the evolution of the programme and then present our data. We discuss the methods used to estimate the impacts, before presenting the results. We then discuss our findings and finally present our conclusions.

Evolution of the Programme

The concept of PES as it is currently conceived is the result of a long policy process that Costa Rica has gone through for many decades. The country started to design policies to prevent deforestation with the inception of the first forestry law in 1969 (see Rojas et al, 2003, for evolution of forest incentives); but at the same time, agriculture and cattle activities were favoured as a strategy for rural development, which hindered the forest policies' success (Moreno-Díaz, 2005).

By 1996, two important events had occurred:

1 The country had to reduce subsidies to productive sectors, including the forestry sector, as a part of the structural adjustment programme negotiated with the World Bank.
2 The forestry sector had developed an influential institutional framework and exerted pressure against the elimination of their privileges (Rojas et al, 2003).

In 1996, Forestry Law 7575 introduced two important policies. First, the law prohibited land-use change. This clearly was going to hurt the forestry sector; therefore, the development of compensation mechanisms for retaining forest cover seemed a fair and reasonable next step. The Forestry Law therefore introduced the current PES system.

This law applies the user pays principle. The objective targeted small and medium-sized farmers who had a sustainable forest management plan certified by a licensed forester (Sierra and Russman, 2006) and compensated them in order to provide an incentive for retaining forest. The four environmental services recognized by the new forest law included:

1 mitigation of greenhouse gas emissions;
2 hydrological services, including provision of water for human consumption, irrigation and energy production;
3 biodiversity conservation; and
4 provision of scenic beauty for recreation and ecotourism.

The institution initially in charge of payments management was the National Conservation Areas System (SINAC). SINAC was formally created by the Biodiversity Law of 1998[1] as the institution responsible for forestry, wildlife and protected areas management. In 1996 the Forestry Law also formally established the National Forestry Financing Fund (FONAFIFO) as a fund aimed at financing the forestry sector for reforestation, protection and management activities that were included in the PES programme. When the PES became operational in 1997 and until 2002, SINAC was in charge of the PES programme management using FONAFIFO as the financing fund.

In 2002, Decree No 30762 MINAE of the Forestry Law was reformed so that FONAFIFO assumed administration of the PES contracts. According to the decree, SINAC would concentrate on its habitual responsibilities (conservation policies through protected areas management) and use the experience acquired by FONAFIFO during the past five years to expand the PES programme by improving the quality of the service to landowners.

This decree consigns FONAFIFO the regulation and determination of the administrative and technical procedures for PES, including the procedure manual, beneficiary selection, documents review and contracts formalization, the definition and extent (in hectares) of priority areas, and the terms of payment. According to this law, SINAC will help FONAFIFO in supervising the approved contracts through its regional offices.

Relevant changes in the programme took place in FONAFIFO. At the beginning of the programme, the PES programme reimbursed three types of actions by landholders:

1 forest protection;
2 sustainable forest management; and
3 reforestation activities.

In 2003, a forest management category was eliminated and agroforestry systems were introduced; in 2004, a natural regeneration category was also included (see www.fonafifo.com).

During the 2000 to 2002 period, SINAC also operated through ten regional offices, which are located according to the 11 conservation areas that divide the country. There are no PES contracts in the Isla del Coco Conservation Area.

In 2003, under FONAFIFO's administration, seven new offices were opened in strategic locations around the country (the main office remains in San José, the capital city). This reduces the costs of application for people in remote rural areas. Both the conservation areas of the SINAC administration and FONAFIFO's offices are illustrated in Figure 14.1.

Another important change in the programme was the amount and currency of the payments. Since the payments are distributed over a certain number of years (forest protection and reforestation are five-year contracts and agroforestry spans three years), landowners would receive a lower total payment amount because of inflation. Therefore, in 2005, higher payment amounts were approved and they were fixed in dollars currency instead of colones, the local currency, in order to compensate for inflation.

In order to finance the forestry sector, FONAFIFO receives funds through different financing sources: public funds in the national budget, donations, credits conceded by international organisms, private funds, own-generated funds, and timber and fuel taxes (see Chapter 12 in this volume and www.fonafifo.com). Also, in 2001 FONAFIFO created the Environmental Services Certificate (ESC), which is a financial instrument where FONAFIFO receives funds from companies and institutions interested in compensating forest owners for preserving them.

In 1997, US$21 million in payments were allocated to 88,830ha of forest protection, 9325ha of forest management and 4629ha of reforestation. By 1998, there was a substantial excess demand for participation in the programmes; the formal waiting list may be in excess of 70,000ha (Chomitz et

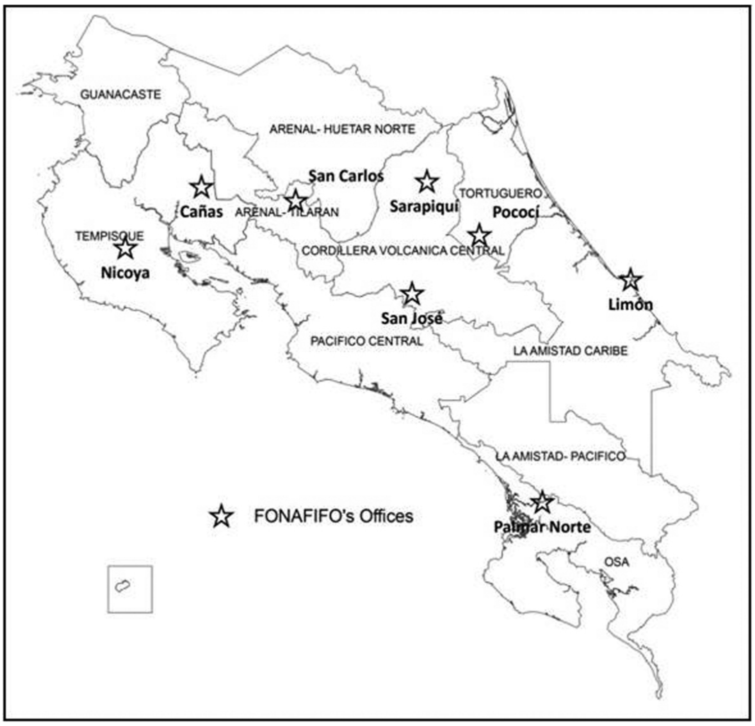

Figure 14.1 *Map of Costa Rica's conservation areas and FONAFIFO's offices*

Source: information from FONAFIFO

al, 1998). By 2007, US$24.8 million was allocated with 1180 contracts, 66,000ha (91 per cent in forest protection) and 541,531 trees.

When the PES programme started in 1997, targeting was ambiguous and the local offices were responsible for contract assignments according to their

Table 14.1 *Assigned amounts per hectare and/or trees for payment for environmental services, 2000–2008 (US$)*

Year	*Forest protection*	*Reforestation*	*Agroforestry systems (trees)**	*Exchange rate****
2000	214	548	-	308
2001	221	565	-	329
2002	220	563	-	360
2003	218	559	0.80	399
2004	219	559	0.80	438
2005–2008**	320	816	1.3	

Notes: * The amount of payment is per tree.
** Amounts fixed in US$.
*** Ministerio de Planificación de Costa Rica (MIDEPLAN) based on Banco Central de Costa Rica (BCCR).
Source: www.fonafifo.com

Table 14.2 *Distribution of hectares for payments for environmental services, 2000–2007*

Year	*Forest protection (ha)*	*Reforestation (ha)*	*Agroforestry systems (trees)*	*Total number of contracts**
2000	26,583	2457	–	271
2001	20,629	3281	–	287
2002	21,819	1086	–	297
2003	65,405	3155	97,381	672
2004	71,081	1557	412,558	760
2005	53,493	3602	513,684	755
2006	19,972	4866	380,398	619
2007	60,567	5826	541,531	1180

Note: * Includes contracts in forest management and established plantations.
Source: www.fonafifo.com

own land priorities. For instance, in 1997 the priority area for the assignment of payments was the entire country, although there were some general priority criteria that the offices could take into account when targeting. As the learning process developed, these criteria became simpler and clearer. From 2003 to the present, priority areas were confined to those lands that fit five specific criteria:

1 areas inside biological corridors;
2 projects which have expired contracts from prior years;
3 forest areas that function as watershed protection;
4 private areas inside protected areas;
5 within the above criteria, priority is given to those districts with a Social Development Index below 40 per cent.

The objective of introducing the last criteria was to reach the poorest landowners in rural areas, so that the programme could achieve both conservation and social outcomes. This is a noteworthy effort to improve the programmes' impacts. Nevertheless, it can be argued that targeting the poorest districts does not necessarily guarantee that the poorest are enrolled, since the spatial scale of reference and the district might, in some cases, be too general.

Methods of Evaluation

Identifying the overall net effect would be a simple task if payments for environmental services were randomly distributed across Costa Rica. Then, deforestation rates in areas that were not enrolled in the programme would be good estimates of the impacts. All other observable and unobservable factors that affect deforestation would, in all expectation, be identical in the two groups.

However, PES is not randomly distributed. Governments and policymakers have specific objectives and restrictions when choosing these sites. As discussed in the previous section, there are some prioritization criteria and,

Table 14.3 *Comparison of parcels enrolled and not enrolled in the PES programme (selected characteristics)*

Variables	*Parcels not enrolled in PES*	*Parcels enrolled in forest protection contracts*				*Parcels not enrolled matched with enrolled parcels*			
	(1)	*(2) SINAC*	*Difference in means (1) versus (2)*	*(3) FONAFIFO*	*Difference in means (1) versus (3)*	*(4) SINAC*	*Difference in means (2) versus (4)*	*(5) FONAFIFO*	*Difference in means (3) versus (5)*
Deforestation (fraction)	0.0251	0.0000	–0.0251*	0.0000	–0.0251***	0.0306	0.0306***	0.0338	0.0338***
Implied annual deforestation rate+	0.51%					0.62%		0.69%	
Land characteristics:									
Distance to local roads (logarithm) (m)	7.32	7.46	0.14	7.82	0.50***	7.41	–0.05	7.80	–0.02
Distance to national roads (logarithm) (m)	7.79	8.09	0.30***	8.35	0.56	8.10	0.01	8.34	–0.01
Distance to rivers (logarithm) (m)	6.82	6.94	0.12	6.90	0.08	6.97	0.03	6.77	–0.13*
Distance to San José (logarithm) (m)	11.52	11.48	–0.04	11.37	–0.15***	11.47	–0.01	11.37	0.00
Distance to Pacific (logarithm) (m)	10.01	10.32	0.31**	10.75	0.74***	10.32	0.00	10.73	–0.02
Distance to Atlantic (logarithm) (m)	11.35	11.14	–0.21**	11.00	–0.36***	11.18	0.04	10.99	–0.01
Distance to towns (logarithm) (m)	7.77	7.99	0.22***	8.16	0.39***	7.98	–0.01	8.16	0.00
Distance to sawmills (logarithm) (m)	9.70	9.73	0.03	9.76	0.06*	9.70	–0.03	9.76	0.00
Distance to schools (logarithm) (m)	9.37	9.47	0.10*	9.65	0.28***	9.42	–0.05	9.63	–0.02
Precipitation (mm^{-1} y^{-1})	3366.27	3668.70	303***	3601.73	235.45***	3659.0	–10.00	3619.0	18.00
Elevation (metres above sea level)	430.84	435.38	4.54	529.44	98.60***	472.0	36.70	531.0	2.00
Slope (%)++	59.43	60.80	1.37	44.63	–14.80***	66.69	5.89	46.15	1.52
Stock of forest (%)	50.57	57.31	6.74***	61.05	10.48***	57.08	–0.23	61.64	0.59

Notes: Statistical significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. No asterisk means no significant difference.
+ We calculated the implied annual deforestation rate using the following formula: total deforestation in 5 years = $(1 – \text{annual deforestation rate})^5$
++ 100% slope = 45°.

within these criteria, payments are assigned on a first come, first served basis. Therefore, it could be argued that not every landowner has the same probability of being chosen; rather, only those with better access to information, lower transaction costs and certain geographic conditions are enrolled.

Therefore, if the impacts of the programme were to be estimated by just comparing deforestation in the parcels enrolled in the programme with the deforestation payments outside the programme, a selection bias would be included in the effect (see Lee, 2005, and Caliendo and Kopeining, 2005, for how to estimate policies' effects).

This selection bias can be observed in our data. In order to determine if parcels enrolled in the programme are similar to those parcels outside the programme, we compared the mean characteristics of each of the groups (compare column 1 versus columns 2 and 3 in Table 14.3). Parcels not enrolled in the programme and parcels enrolled by SINAC have similar slopes and elevations. However, parcels enrolled by FONAFIFO have lower slopes and elevations. Parcels not enrolled in the programme are closer to local and national roads, towns, sawmills and schools than parcels enrolled by both FONAFIFO and SINAC. This suggests that the parcels enrolled in the programme are located in more remote areas, where the opportunity costs of land are lower.

This analysis illustrates that systematic differences exist in the characteristics of the groups. It is thus not easy to infer if the programme caused the differences in deforestation or if these differences are related to these characteristics. We used matching techniques to address the bias originated by the non-random allocation of PES contracts across Costa Rica.

Economists have applied matching techniques to overcome these problems (for reviews see Dehejia and Wahba, 2001; Caliendo and Kopeining, 2005). Within environmental economics, matching strategies have been used to evaluate the effect of air quality regulations on environmental outcomes (Greenstone, 2004) and on economic activity (List et al, 2003). However, just recently, matching techniques have been used to evaluate the direct effects of land restriction policies (Andam et al, 2008; Pfaff et al, 2007, 2009; Robalino et al, 2008; Sims, 2010).

The principle of this technique is to find an adequate control group by matching each treated observation to the most similar untreated observations. For example, parcels enrolled in PES are located far away from roads. Therefore, we will compare the deforestation rates of areas far away from roads enrolled in PES contracts with deforestation rates of areas far away from roads not enrolled in PES contracts. This eliminates the bias caused by the accumulation of PES contracts in areas far away from markets. Matching applies this principle to a multidimensional space of characteristics.

There are many matching strategies. We use propensity score matching (PSM) developed by Rosenbaum and Rubin (1983). One key advantage of using propensity score matching estimates is that results are less sensitive to the choice of functional form in the model (Rosenbaum and Rubin, 1983; Dehejia and Wahba, 2001; Ho et al, 2007). In other words, when using parametric methods, how other independent variables are included in the model (linearly, with squares or cubes) can affect the estimates of the effect of the policy. But given that before estimating the effect we make sure that treated and untreated observations are balanced in relation to those variables, the inclusion of different functional forms does not affect the result.

However, as with all approaches, matching requires certain conditions for the identification of the effect. All relevant characteristics that might affect both the likelihood of being treated and the pre-treatment outcome must be included when selecting the control group.

We first estimated a probability of being enrolled in the PES programme for all treated and untreated observations, based on a set of characteristics (see following section). Using this probability, we determined how similar treated (enrolled parcels) and untreated (parcels not enrolled) observations were. For each treated parcel, we looked for four untreated parcels with the most similar probability of being enrolled in the programme. In order to avoid choosing observations that were too different, of those four observations chosen we only used those that were within a 0.1 per cent probability distance.

Using this approach, we generated adequate control groups for the parcels that were enrolled by SINAC and for the parcels that were enrolled by FONAFIFO. When we compare the characteristics of the parcels enrolled in conservation contracts by SINAC and the characteristics of our chosen control group, we can see that they are, in general, more similar than when we compare SINAC's parcels with the rest of the parcels outside payments.

After the control group was properly chosen, we obtained two groups that were similar except for the fact that one received payments and the other did not. Therefore, we could compare the average deforestation among the groups and conclude that if there was any significant difference, the programme had an effect.

However, note that even after matching there might still be significant differences among the samples. For example, the distance to rivers for the parcels enrolled by FONAFIFO is statistically different compared to the distance to rivers of the matched control group for FONAFIFO. Slopes of parcels enrolled by SINAC are also different from the slopes of SINAC's matched control group. This indicates that in spite of the improvement, there are some characteristics that systematically differ between the samples, and additional corrections are needed to take out the effect these characteristics might have on the outcome. To account for this, we ran an additional regression, again using the control variables (e.g. distance to rivers) to reduce their role in the estimation of the impact (Ho et al, 2007).

Data

Using GIS, we randomly drew 50,000 locations across Costa Rica. Each of these locations is our unit of analysis and represents a parcel. On average, we sampled one parcel for each square kilometre across Costa Rica. We used forest cover maps for 2000 and 2005 (see Sanchez et al, 2007; Pfaff et al, 2007) that were based on aerial and satellite pictures. This information allowed us to determine the presence of forest in each of the 50,000 randomly drawn parcels for each year and, therefore, the dynamics of deforestation for 2000 to 2005. We dropped the parcels that were flagged as problematic due to the uncertainty about the presence of forest. We were left with 47,241 observations. Of those observations, we focused on deforestation decisions and therefore we only considered points that were covered by forest in 2000 (20,760 observations).

Maps of the PES contracts across Costa Rica are also available. Given that we studied only areas that potentially received payments for environmental services, we only considered locations outside protected areas or government land. Therefore, we were left with 9107 observations.

As previously discussed, there are different types of PES contracts. This analysis focused only on forest protection contracts. We eliminated sample parcels that were enrolled in other types of contracts. Contracts that were implemented before 2000 were also eliminated from the control group.

We were finally left with 604 observations that were enrolled in PES forest protection contracts between 2000 and 2005. Out of those locations with contracts, 72 were implemented in 2000, 61 in 2001, 19 in 2002, 166 in 2003, 190 in 2004 and 113 in 2005. This means that we have 152 locations selected by SINAC (2000 to 2002) and 469 selected by FONAFIFO (2003 to 2005).[2] We were left with 7523 observations that were untreated – that is, observations that did not receive payments.

GIS was also used to obtain parcel characteristics. Parcel characteristics allowed us to find an adequate control group. We obtained accurate measures of slopes of the terrain, precipitation, elevation, and distance to rivers and oceans that we classified as natural characteristics. We also computed distances to San José, population centres, sawmills, schools, national roads and local roads. Finally, we obtained the forest stock for each grid. All of these variables comprise the characteristics we used to find an adequate control group. The natural characteristics are related to the productivity of land, and the distances to relevant points indicate access to markets and the availability of infrastructure.

Impacts

As discussed in the section on 'Methods of evaluation', if payments were allocated randomly, we could use the deforestation in parcels not enrolled as an estimate of the counterfactual of deforestation with payments. In other words, the effect of the programme would be the difference between the deforestation of parcels with payments and the deforestation of parcels without payments. In Costa Rica, between 2000 and 2005, this difference is 2.51 per cent – that is, we would conclude that the programme prevented 2.51 per cent of the land enrolled from being deforested in a five-year period, or that the programme

Table 14.4 *Mean comparison and matching estimates of the impact of forest protection contracts during PES (by institution)*

Approach	*SINAC (2000–2002)*	*FONAFIFO (2003–2005)*
Mean comparison	–0.0251*	–0.0251***
Standard error	[0.0129]	[0.0073]
Annual impact (%)	0.50%	0.50%
Mean comparison after matching	–0.0306***	–0.0338***
Standard error	[0.0077]	[0.0051]
Annual impact (%)	0.61%	0.67%
Lineal regression after matching	–0.0301***	–0.0340***
Standard error	[0.0075]	[0.0053]
Annual impact (%)	0.61%	0.69%

Note: Statistical significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

prevented 0.5 per cent of the land enrolled from being deforested every year (see Tables 14.3 and 14.4).[3]

As discussed in previous sections, since contracts are not randomly assigned, the deforestation of parcels not enrolled is not a good estimate of what would have happened with the enrolled parcels if there were no programme, and the estimated impact presented in the previous paragraph is therefore biased. After using matching to find an adequate control group, we again compared the mean deforestation rate between treated and control groups. We found that during SINAC's administration from 2000 to 2002, deforestation decreased by 0.61 per cent annually, and FONAFIFO stopped deforestation in 0.69 per cent of the land enrolled annually from 2003 to 2005. This suggests that the institutional and operative changes introduced by FONAFIFO's administration improved the programme's impact according to a small but significant magnitude.

Our conclusions did not change even after running a regression analysis using the control variables for any remaining imbalance (see Table 14.4). After comparing the treated observations with the matched untreated observations using other variables, the results were very similar. The parcels chosen by SINAC between 2000 and 2002 avoided 0.61 per cent of deforestation per year of the land enrolled, while the parcels chosen by FONAFIFO between 2003 and 2005 avoided 0.67 per cent of deforestation per year.

When we looked in detail at FONAFIFO's work by evaluating the impact that each office has had (see Table 14.5), we found that the annual effect of the parcels enrolled in Cañas, Limón and Nicoya is virtually negligible. This implies that virtually all of the parcels enrolled in the programme through these offices would not have been deforested anyway. In other words, these parcels have characteristics that result in no deforestation threat, so they would have remained in forest independent of the payment. This is an important result, since it suggests that for the additionality criteria to be met, better targeting has to be achieved so that payments are used to block actual deforestation.

Table 14.5 *Reduced deforestation of forest protection contracts by FONAFIFO's offices during 2000–2005*

Office	*Effect*
Cañas	0.0000
Standard error	0.0000
Limón	0.0000
Standard error	0.0000
Nicoya	0.0000
Standard error	0.0000
Palmar Norte	–0.0103
Standard error	–0.0078
Pococí	–0.0028
Standard error	–0.0132
Sarapiquí	–0.0238*
Standard error	–0.0129
San Carlos –0.0460***	
Standard error	–0.012
San José	–0.0205*
Standard error	–0.0106

Note: Statistical significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Palmar Norte and Pococí follow similar levels of impacts. In contrast, the offices located in Sarapiquí, San Carlos and San José were able to choose parcels with characteristics that our evidence shows would have been deforested if they had not enrolled in the programme. There is an important issue that we should point out. If deforestation around Limón, for example, is insignificant, even with large efforts of targeting, the officers from Limón would not have been able to improve their impact. However, in San Carlos, for example, where deforestation rates are extremely high, it is easier for officers to choose those that are highly likely to be deforested.

Conclusions

We find that PES for forest conservation in Costa Rica between 2000 and 2005 has had a significant effect in reducing deforestation. When comparing the results from previous periods to these new results, we can certainly conclude that these policy efforts have become more effective over time. However, there is still room for improvement. The levels of impact are still low. We find that the reduction in yearly deforestation ranges between 0.6 and 0.7 per cent of the land enrolled in the programme. In other words, between the start and the end of a typical forest conservation contract (five years), deforestation would have been avoided in 3 to 3.5 per cent of the land enrolled.

Improving these numbers can be a difficult task given the low levels of deforestation across the country and the lack of accurate opportunity costs data. Efforts towards improving targeting based on the likelihood of deforestation will improve the programme's effectiveness. An example of this is that the contract offices in areas where deforestation is high are significantly more effective.

Moreover, information such as was used in the analysis (e.g. distance to roads, rivers and markets, and costs) can be used to estimate the likelihood of a parcel to be deforested and therefore increase the amount of avoided deforestation in future contracts.

Finally, we emphasize the importance of estimating the impacts of a policy by finding an adequate comparison group. This method has been particularly useful when evaluating the impacts of PES since it allows us to determine what would have happened if the parcels were not enrolled in the programme. According to our results, the programme's impact was higher once we controlled for other factors that could have an effect on the deforestation outcome. Therefore, policy-makers can use more precise information when learning and making decisions on how to improve the programme's impacts.

Notes

1 Even though SINAC was formally established in 1998, PES operations started in 1997.
2 There are 17 observations that had payments both with SINAC and FONAFIFO. Therefore, the sum of SINAC and FONAFIFO contracts is more than the observations enrolled in PES forest protection contracts.
3 We calculated the implied annual deforestation rate using the following formula: total deforestation in 5 years = $(1 – \text{annual deforestation rate})^5$.

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