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Abstract

We estimate local effects of Payment for Environmental Services (PES) programs on poverty in Costa Rica between 2007 and 2009. Using household surveys and spatial geographic data, we are able to control for socioeconomic and geographic characteristics at the individual and census tract level. We find that the effects are insignificant at a national level. However, this reflects countervailing forces. We find that PES coverage increases poverty in low-slope places and decreases poverty in high-slope places. These results are robust to demographic characteristics of the individuals. However, the magnitudes of the impacts are very low, even when they are statistically significant. We conclude that the PES program has not increased or decreased poverty substantially in Costa Rica. Policymakers could increase the impact on poverty by focusing their efforts in low-slope areas; however, as others have shown, such a focus could also reduce the impact on avoided deforestation.

Key Words: payment for environmental services, poverty, impact evaluation, conservation policies, heterogeneous effects

JL Codes: Q58, Q56, Q24

Contents

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1. Introduction

Programs of payments for ecosystem services are policy instruments that compensate those who provide those services for the costs they incur. The first program at the national level in a developing country started in Costa Rica in 1997. Since then, this type of initiative has been adopted in different countries around the world. One of the most attractive characteristics of this type of program is that it can increase the generation of ecosystem services while simultaneously reducing the negative economic and social costs that local people might face from land use restrictions. Authorities are frequently tempted with the dual promise of improving environmental conditions while reducing poverty with a single policy instrument. However, there is little evidence about the impact of these programs on economic and social outcomes. The goal of this paper is to estimate the impact of the Costa Rican Payments for Environmental Services (PES) Program on selected indicators of poverty.

The fact is that these programs might positively or negatively affect social outcomes (Zilberman et al. 2006). For instance, if the program targets those below the poverty line and if the compensation is large enough, one could expect that poverty rates would decrease. But if the payments are received by those who are not poor or compensation levels are low, one might expect that the effects on the poverty rates would be insignificant. Moreover, if the program is large enough, and restricts the use of land for agricultural activities, there might be a decrease in the demand for agricultural labor, leading to increases in poverty (Robalino 2007).

Estimating the effects of PES on social outcomes is challenging because payments are endogenously located, given that landowners in Costa Rica have to apply for the program and that the implementing agency then has to select which applicants will participate. This implies that localities where the program has a strong presence and localities without the program will vary in different dimensions that might in turn act as confounders and hence need to be controlled for. Using national household survey data allowed us to control for important

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individual and locality characteristics that affect location decisions and, therefore, affect the impact of the program (Pfaff and Robalino 2012).

We find that the effect of PES on poverty outcomes at a national level is not statistically significant and/or the magnitude is very low. The fact that the effects on poverty are low could reflect a combination of two countervailing effects. PES might increase poverty in some places but decrease it in others. When we split the sample according to the slope of the terrain, we find that, as PES coverage increases, poverty decreases in high-slope places. In flatter places, PES coverage is associated with higher poverty. These results are robust when we analyze men and women and young and older individuals.

We draw two important conclusions. First, despite their statistical significance, the magnitudes of these effects are low. Therefore, we conclude that the PES program has not increased poverty in Costa Rica. Second, poverty will decrease in places where land use decisions are less affected (forest would have been forest in the absence of the policy), while poverty will increase in places where the protection has more effect on land use decisions (forest would have been deforested in the absence of the policy). This suggests that a decrease in poverty will have to be at the expense of environmental impact, and vice versa.

In Section 2, we present the background and explain the Costa Rican program. In Section 3, we describe the data. We present the identification strategy in Section 4 and results in Section 5. Finally, the conclusions are presented in Section 6.

2. Background

2.1 PES Experiences around the World

There are concerns about the existence of trade-offs between conservation and poverty alleviation goals (Sanderson and Redford 2003; Adams et al. 2004). On one hand, conservation strategies can negatively affect socioeconomic outcomes (Robalino 2007). On the other hand, including social goals as part of conservation strategies might make these conservation strategies less effective. In evaluating the impact of Protected Area Systems on poverty in developing countries, Ferraro et al. (2011) find that spatial characteristics associated with the most poverty alleviation are not necessarily those associated with the most avoided deforestation.

PES is an attractive strategy of conservation compared to "command and control" policies (Landell-Mills and Porras 2002; Engel et al. 2008). For instance, in developing countries, traditional regulation can be deterred by such problems as weak governance, high

transaction costs, and information problems (Engel et al. 2008). So, the popularity of PES as a market-based initiative for environmental services has increased. Countries such as Ecuador and Bolivia have adopted user-financed PES programs, while Costa Rica, China, Mexico, Africa, USA, United Kingdom, and Zimbabwe have adopted government-financed PES programs (Pagiola and Platais 2007).

Another advantage is that PES can potentially address poverty issues as a conditional cash transfer, reducing or eliminating the tradeoff. Because the program transfers money to landowners, PES can directly increase the income of program participants, and so contribute to reducing the poverty of poor landowners (Engel et al. 2008; Pagiola et al. 2005; Landell-Mills and Porras 2002; Ferraro and Simpson 2002; Persson and Alpízar 2011). The potential socioeconomic impact depends on the size of the operation, on the household's dependence on its land, and on the household's access to income from non-forest activities (Porras et al. 2008), among other factors. For example, in Ecuador, payments can represent an important fraction of household income. In contrast, for Nicaragua and Honduras, payments do not compensate for the opportunity cost of non-conservation alternative economic activities (Porras et al. 2008).

PES might affect not only the participants who receive the payments but also individuals who do not directly receive payments in places where PES contracts are implemented. For example, the conversion from other land uses to forest can reduce the possibilities of employment in the agricultural sector and, therefore, reduce employment and increase poverty. However, the conservation of forest could increase employment related to tourist activities and therefore reduce poverty (Villalobos 2009; Robalino and Villalobos 2010).

2.2 PES Literature in Costa Rica

The literature about the effects of PES on poverty in Costa Rica is scarce. Some studies argue that the impact of PES on social outcomes is very small. Ortiz et al. (2003) surveyed 100 holders of forest protection contracts nationwide. They argue that a big percentage of contracts are from entrepreneurs who do not live near the protected parcel. Also, for most surveyed households, incomes from PES represented less than 10% of their total income, and 50% do not work in agricultural activities. Based on these results, they conclude that PES has neither reduced poverty nor increased employment.

Miranda et al. (2003) surveyed 35 landowners with PES contracts and 15 landowners without PES contracts in Cuenca del Río Virilla. They find that most of the payments were received by relatively large and well-off landowners who do not depend on land, and that

payments represent around 15% of incomes. Even then, they conclude that PES does have significant impacts on the household budget.

More recently, studies have focused on analyzing whether some changes incorporated in the program starting in 2003 have contributed to the poor and to small landowners. Porras (2010) suggests that, even when social criteria have been specifically included in the program, this has had limited scope. Some authors have found that most payments go to owners with large tracts of land, businessmen and solvent landowners (Porras 2010; Sierra and Russman 2006; Ortiz 2011). Similar results have been found in case studies, where participation in the program is determined by factors such as opportunity cost of land, availability of income sources outside the parcel, education, family size and level of information (Zbinden and Lee 2005; Arriagada et al. 2009; Hope et al. 2005). However, there is evidence that indicates that the number of PES contracts held by small landowners increased as a result of the creation of new type of contracts: agroforestry systems and regeneration of forests.

Even though those first studies of PES are not statistically representative for the whole country, they give insights into the characteristics of land owners. Even though those studies took place in different areas, the arguments and conclusions are similar. That could indicate that a national scale study will find similar results.

Moreover, people who are not directly involved in the program can be affected. So it is important to evaluate the indirect effects. For instance, Miranda et al. (2003) found that reforestation promoted through the PES program has had a small positive impact on local employment, infrastructure and micro-enterprise development.

In this paper, we use statistical matching methods to assess the relationship between payments for ecosystem services and poverty indicators at the national scale. We also focus on indirect effects, such as local poverty, as this is one of the indicators most often mentioned as potentially affected by this type of program.

2.3 The PES Program in Costa Rica

Costa Rica was the first developing country to establish a Payment for Ecosystem Services Program at a national scale. The program is part of several measures taken to achieve the goals to which Costa Rica committed itself in Cumbre de la Tierra in Rio de Janeiro, in 1992, to guarantee national environment sustainability. The country already had Programs of Incentives to the Forest Sector and a System of Protected Areas. But it was not until 1996, with the promulgation of the third Forestry Law No. 7575, that a legal framework was created to pay

forest owners for environmental services. This was how the program of Payments for Environmental Services was created.

Currently, the National Forestry Financing Fund (FONAFIFO) is the leading institution in charge of the program. Funding for the program comes from several sources, including the national budget through a 3.5% tax on fuel. Other sources include the private sector – in the case of PES targeted at a specific watershed or region – and donations and loans from international agencies (FONAFIFO 2012a).

PES gives a monetary payment to those land owners who maintain forest and agroforestry plantations, which provide environmental services. The Program includes four modalities: Forest Protection, Reforestation, Regeneration, and Agroforestry Systems. The Program recognizes the following services: mitigation of emissions of greenhouse gases, protection of water, protection of biodiversity and natural scenic beauty (Forestry Law No. 7575). Forest protection contracts pay between $640 and $800 per hectare (ha) distributed in 10 years; reforestation contracts pay between $980 to $1,470, for 10 to 15 years (depending on the species planted); regeneration contracts pay between $410 and $640 and agroforestry systems pay between $1.30 and $2.60 per tree, distributed in 3 years (FONAFIFO 2012b). The minimum size for a contract is 1 ha, while the maximum that can be paid for in an individual contract is 300 ha.

The program has gone through administrative and design changes. FONAFIFO assumed the role as the leading institution in 2003. Regional offices were created that year too. In 2003 and 2006, respectively, FONAFIFO started paying for agroforestry systems and forest regeneration. Also, the amount of payments and duration of forest protection contracts changed in 2006. In 2011, an evaluation matrix was introduced that gives higher priority to areas with a high provision of ecosystem services and areas that are less socioeconomically developed.

Between 1997 and 2008, around $206 million were distributed on 10,000 contracts (Porras 2010). In 2011, the program spent money on more than 72,000 ha and 598,000 trees, distributed over 1,126 contracts (FONAFIFO 2012c). Even though the size of the program is large, there is not enough evidence about the social impacts.

3. Data

3.1 Data and Sources of Analysis

We obtained the data from different sources at different aggregation levels. Our data sources are: the 2007-2009 Household Surveys for Multiple Purposes (HSMP) and the 2000 Population Census at the individual level from the National Institute of Statistics and Census; maps from 2000 from the Costa Rican Institute of Technology; and maps of the PES contracts from 2003 to 2009 from FONAFIFO.

The sample used in the analysis includes people older than 12 years old who were surveyed in the HSMP in 2007, 2008, or 2009. The most disaggregated information about location in the household survey is the census tract. We consider only the individuals who lived in a rural census tract outside of National Parks. The resulting sample contains 56,896 individuals, who lived in 7,855 rural census tracts. Even though the HSMP does not survey the individuals in all the census tracts of Costa Rica, the sample is representative of rural areas. Because the sample includes only people who live in a rural census tract, the conclusions will be made at the rural level.

3.2 Defining the Independent Variable of Interest

Our independent variable of interest is the fraction of the area of the census tract covered by PES. The available information about the location of households is at the census tract level, so we aggregate the PES information at that level. Also, the PES information is available by year and includes all categories within the program. Because the validity period of a PES contract is at least five years, we consider all new contracts assigned within a census tract from 2003 to 2007 to determine the coverage level by 2007. Similarly, we obtained coverage levels for 2008 and 2009. For example, the percentage of land covered by PES in 2007 includes the area of the parcel of new contracts for Forest Protection, Reforestation, Agroforestry Systems and Regeneration assigned during the last five years.

In some census tracts, there are parcels with PES contracts, while in others there are not. That allows us to define two groups of individuals: the treated group, formed by those who live in a census tract with PES; and the untreated group, formed by those who live in a census tract without PES. That means that, even if an individual does not receive PES directly, he can be in the treated group. In Table 1, we show that the mean of percentage of PES coverage in treated census tracts by year is around 17%. The percentage of coverage of PES on untreated census tracts is, of course, 0%.

3.3 The Outcome Variable

We analyzed the effect of PES on poverty and extreme poverty. The poverty variables include two categories: poverty and extreme poverty. An individual is considered in a condition of poverty when the income of the household is below the poverty line. An individual is considered in extreme poverty when the household income is less than or equal to the cost of the Basic Food Basket.

Table 2 shows the mean of outcome variables by treatment status and by year. It can be seen that the treated group has a higher percentage of people in poverty and extreme poverty than the untreated group. However, those differences cannot be completely attributed to PES. There could be differences in other geographic or socioeconomic variables that can explain the differences in the outcomes.

3.4 Control Variables

We also include control variables that could be correlated with PES and the outcome variables. Those variables are called control variables because they allow us to eliminate their effects on the dependent variable in order to find an unbiased estimate of PES effects. Those control variables are geographic characteristics of the census tracts and demographic characteristics of individuals. In Table 1, we show that census tracts without PES are smaller, and a lower percentage of the area is still covered by forest than those census tracts with PES. Places with PES have larger slopes and higher precipitation; they are situated farther from San José and school centers; they also have a majority of employees in the primary sector, a higher unemployment rate and lower education than those census tracts without PES. However, there are no significant differences in individual's independent variables such as sex, age, education and whether the individual was born in Costa Rica (see Table 2).

4. Empirical Strategy

The fundamental problem of identifying the impact of any policy is that we cannot observe what the outcome for the treated individual would have been if he or she had not been treated (see Ferraro and Pattanayak 2006). Therefore, we cannot compute the difference between what happened and the counterfactual.

In our case, this implies that we cannot observe what would have happened to those individuals who lived in places with PES contracts if they lived in places without PES contracts. Therefore, we empirically estimate what would have happened if a treated individual lived in a

place without PES by searching for adequate comparison individuals or groups. The idea is to find a counterfactual situation by letting the occurrence of the event (or treatment) be the only difference between one individual and another. The counterfactual situation comes from individuals who live in a census tract without area covered by PES.

We use the Ordinary Least Squares Method (OLS) to estimate the effect of PES on poverty and extreme poverty of those individuals who reside in a census tract with some area covered by PES. The following equation shows how the outcome variable is affected by the fraction of census tract covered by PES, $\boldsymbol{PES_S}$; a set of individual's characteristics $\boldsymbol{X_i}$ such as age, sex, education, and whether the individual was born in Costa Rica; and the characteristics of the census tract where the individual lives, $\boldsymbol{Z_i}$, such as geographic, socioeconomic and market access characteristics. $\boldsymbol{u_i}$ is the error term that includes all the factors that are not included in the model, but affect the outcome variable (Y_i)

$$Y_i = \beta_1 PES_S + \sum_{l=1}^{L} \propto_L X_{iL} + \sum_{s=1}^{S} \partial_s Z_{is} + u_i$$

To obtain an unbiased estimate of β_1, the correlation between the fraction covered by PES and u_i should be zero. In order to satisfy that assumption, independent individual and census tract characteristics that can be related to different poverty outcomes are included to the model.

Second, as a robustness test, we apply matching to compare similar census tracts with and without PES coverage. This reduces the difficulties of defining the adequate choice of the specification. We use Propensity Score Matching (PSM), which calculates a score for every observation; this represents the probability of being treated for an intervention or treatment (Rosenbaum and Rubin 1983).

However, a remaining challenge is the presence of the omitted variable problem. If there is a variable correlated with the presence of PES and the dependent variable that is not included in the regression, that is, if $cov(PES, u_i) \neq 0$, it is not possible to isolate the accurate effect of PES on the outcome variable. As under the OLS approach, we control for various individual and census tract characteristics.

Another challenge is that, because this is an estimation of aggregate effects, we ignore potential effects at the individual level experienced by those who actually received the payment. This implies that there could be an effect at the household level on the treated individuals, but that effect would be averaged down when we aggregate the effects of those individuals on census

tracts with PES. This is a problem, especially when, at the census tract level, the intensity of the treatment is not large enough. In this case, we would conclude that there are no aggregate effects, although effects could exist at the individual level.

5. Results

5.1 General Results

We analyze the variables that affect the presence of PES in the census tract (Table 3). We find that the number of hectares and the fraction covered by forest in the census tract are positively correlated with PES presence. Slope, precipitation, distance to school centers, distance to markets and the 2000 unemployment rate also have a positive relationship with PES presence. The density of roads is negatively related. Places where manufacture and the services sector are dominant compared to the primary sector seem to be negatively related to PES presence too. We also test whether the presence of PES was related to characteristics of the individuals (see Table 4). Most of the individuals' variables are not associated with the presence of PES. However, as described before, the association of some geographic and market characteristics shows that it is necessary to control for those variables to obtain an unbiased estimate of the effect of PES on the socioeconomic outcomes.

Next, we estimate the effect of PES on poverty outcomes. The effect at a national level is not statistically significant (see Table 5). Then, we find the effect on poverty by applying the matching method. Therefore, we include in the analysis only those untreated individuals who are similar to treated individuals. The effect on poverty was still insignificant; however, the magnitudes are slightly larger than when using the whole sample (Table 5).

5.2 Effects by Geographic Characteristics

The fact that effects on poverty are insignificant could reflect a combination of two countervailing effects. PES might increase poverty in some places but decrease it in others. So, we explore whether the effect of PES on poverty was different according to geographic characteristics of the regions (see also Table 5). When we split the sample between areas close to and far from markets (defined by distance to San José and distance to national roads), we find that the distance to markets does not affect the results. Coefficients are not statistically significant. However, when we split the sample according to slope, we find that, when the area covered by PES increases by 10%, poverty decreases by 0.013% in high-slope census tracts. In flatter places, PES coverage is associated with higher poverty. Increasing the area covered by

PES by 10% increases poverty by around 0.016%. However, even if statistically significant, the magnitude of the estimated effects is clearly low.

This result is consistent with other results found when analyzing the effects of protected areas. Ferraro et al. (2011) and Robalino (2007) suggest that the poverty reduction generated from those programs will increase in places where the land use is less affected (deforestation threat is lower). By contrast, in places where protection has a greater effect on the use of land (deforestation threat is higher), poverty will increase. This implies that the increase in poverty reduction will have to be at the expense of environmental impact.

5.3 Effects by Geographic and Demographic Characteristics

We also explore how the effects on poverty can vary by sex and age. We find that PES does not have a significant effect on poverty when we split the sample by sex. However, there seem to be different effects by age groups. An increase of 10% in the area covered by PES decreases poverty by 0.006% for the group of people older than 35, but increases poverty by 0.005% for people younger than 35. Even extreme poverty increases by 0.004% for those younger than 35.

Geographic characteristics might exacerbate the differences between the effects on poverty by groups. So, we explore how the effects on poverty in places with high slope and places with low slope vary by demographic groups (see Table 6). We find that, in low slope census tracts, when PES coverage increases by 10%, poverty increases for both men and women by 0.014% and 0.020%, respectively. However, this effect is stronger for those younger than 35 years old reaching 0.024%. In census tracts with high slopes, poverty decreases by 0.011% for men and 0.017% for women. For those under and over 35 years old, poverty decreases around 0.013% and 0.016%, respectively.

The differences in direction (increase or decrease) of the effect of PES on poverty outcomes seem to be more related to local geographic characteristics than demographic characteristics. Those results indicate that demographic groups are similarly affected when they live in places with similar deforestation pressure.

6. Conclusions

We estimated local effects of Payment for Environmental Services (PES) on poverty in Costa Rica. Using household surveys and spatial geographic data, we were able to control for socioeconomic and geographic characteristics at the individual and census tract level. We found

that the effects are insignificant at a national level. This result was robust when we split the sample by sex and age.

However, the insignificant effect reflects countervailing forces. We find that PES coverage increases poverty in low-slope places and decreases poverty in high slope places. This result was also robust to the demographic characteristics of the individuals. It has been shown that high slopes are highly associated with low opportunity costs, low deforestation threat and, therefore, low deforestation impact, and low slopes are highly associated with high opportunity costs, high deforestation threat and, therefore, high deforestation impact (Pfaff et al. 2009). Therefore, we conclude that efforts to increase the program effectiveness in reducing poverty will provoke a reduction of its environmental impact. However, the magnitudes of the effects are very small.

References

Adams, W.M., R. Aveling, D. Brockington, B. Dickson, J. Elliott, J. Hutton, D. Roe, B. Vira, and W. Wolmer. (2004) "Biodiversity Conservation and the Eradication of Poverty." *Science* 306: 1146-1149.

Arriagada, R., E. Sills, S. Pattanayak, and P. Ferraro. (2009) "Combining Qualitative and Quantitative Methods to Evaluate Participation in Costa Rica's Program of Payments for Environmental Services." *Journal of Sustainable Forestry* 28(3): 343-367.

Engel, S., S. Pagiola, and S. Wunder. (2008) "Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues." *Ecological Economics* 663-674.

Ferraro, P., and D. Simpson. (2002) "The Cost-effectiveness of Conservation Payments." *Land Economics* 78: 339-353.

Ferraro, P., and S. Pattanayak. (2006) "Money for Nothing? A Call for Empirical Evaluation of Biodiversity Conservation Investments." *PLoS Biol* 4(4).

Ferraro, P.J., M.M. Hanauer, and K.R.E. Sims. (2011) "Conditions Associated with Protected Area Success in Conservation and Poverty Reduction." *Proceedings of the National Academy of Sciences* 108(34): 13913-13918. doi: 10.1073/pnas.1011529108

FONAFIFO (2012a) "Pilares fundamentales del Programa por Pago de Servicios Ambientales Financiamiento." From: http://www.fonafifo.go.cr/paginas_espanol/servicios_ambientales/sa_pilares_fundam.htm

FONAFIFO (2012b) "Montos asignados al Pago de los Servicios Ambientales por Modalidad, para el año 2012." From: http://www.fonafifo.go.cr/paginas_espanol/servicios_ambientales/sa_estadisticas.htm

FONAFIFO (2012c) "Distribución de las Hectáreas Contratadas en Pago de Servicios Ambientales, por Año y por Modalidad. Período 1997-2011." Departamento de Gestión de Servicios Ambientales, Informes WEB-SIAP.

Hope, R., I. Porras, and M. Miranda. (2005) "Can Payments for Environmental Services Contribute to Poverty Reduction? A Livelihoods Analysis from Arenal, Costa Rica."

Landell-Mills, N., and I.T. Porras. (2002) *Silver Bullet or Fools' Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor. Instruments for Sustainable Private Sector Forestry Series*. London: International Institute for Environment and Development.

Miranda, M., I. Porras, and M.L. Moreno. (2003) The Social Impacts of Payments for Environmental Services in Costa Rica. A Quantitative Field Survey and Analysis of the Virilla Watershed." In: Environmental Economics Programme (Ed.), Markets for Environmental Services No. 1. London: International Institute for Environment and Development (IIED).

Ortiz, E., L. Sage, and C. Borge. (2003) *Impacto del Programa de Pago de Servicios Ambientales en Costa Rica como medio de reducción de la pobreza en los medios rurales*. San José, Costa Rica: Unidad Regional de Asistencia Técnica (RUTA).

Ortiz, E. (2011) Informe Final de Consultoría. Caracterización del Programa Forestal Huetar Norte (PFHN): Impacto Social y fijación de C02.

Pagiola, S., A. Agustin, and P. Gunars. (2005) "Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America." *World Development* 33(2): 237-253.

Pagiola, S., and G. Platais. (2007) *Payments for Environmental Services: From Theory to Practice. Initial Lessons of Experience*. Washington, D.C.: World Bank.

Persson, M., and F. Alpízar. (2011) "Conditional Cash Transfers and Payments for Environmental Services: A Conceptual Framework for Explaining and Judging Differences in Outcomes." Discussion Paper Series EfD DP 11-06. Environment for Development and Resources for the Future.

Porras, I., M. Grieg-Gran, and N. Neves. (2008) "All that Glitters: A Review of Payments for Watershed Services in Developing Countries." Natural Resource Issues 11. London: International Institute for Environment and Development (IIED).

Porras, I. (2010) *¿Justo y Verde? Impactos Sociales de los Pagos por Servicios Ambientales en Costa Rica*. London: International Institute for Environment and Development.

Pfaff, A., and J. Robalino. (2012) "Protecting Forests, Biodiversity and the Climate: Predicting Policy Impact to Improve Policy Choice." *Oxford Review of Economic Policy* 28(1): 164-79.

Pfaff, A., J. Robalino, G.A. Sanchez-Azofeifa, K. Andam, and P. Ferraro. (2009) "Park Location Affects Forest Protection: Land Characteristics Cause Differences in Park Impacts across Costa Rica." *The B.E. Journal of Economic Analysis & Policy* 9(2): (Contributions), Article 5.

Robalino, J. (2007). "Land Conservation Policies and Income Distribution: Who Bears the Burden of our Environmental Efforts?" *Environment and Development Economics* 12(4): 521-533.

Robalino, J., and L. Villalobos. (2010) "Evaluating the Effects of Land Conservation Policies on Labor Markets using Matching Techniques." EfD-RFF working paper series.

Rosenbaum, P.R., and D.B. Rubin. (1983) "The Central Role of the Propensity Score in Observational Studies for Causal Effects." *Biometrika* 70(1): 41-55. doi: 10.1093/biomet/70.1.41

Sanderson, S.E., and K.H. Redford. (2003) "Contested Relationships between Biodiversity Conservation and Poverty Alleviation." *Oryx* 37, 389390. doi: 10.1017/S003060530300070X

Sierra, R., and E. Russman. (2006) "On the Efficiency of Environmental Service Payments: A Forest Conservation Assessment in the Osa Peninsula, Costa Rica." *Ecological Economics* 59: 131-141.

Villalobos, L. (2009) "The Effects of National Parks on Local Communities' Wages and Employment in Costa Rica." CATIE.

Wooldridge, J. (2006) "Introducción a la Econometría. Un Enfoque Moderno."

Zbinden, S., and D. Lee. (2005) "Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program." *World Development* 33(2): 255-272.

Zilberman, D., L. Lipper, N. Mccarthy. (2006) "When Could Payments for Environmental Services Benefit the Poor?" *Environment and Development Economics* 13: 255-278.

Tables

Table 1. Characteristics of rural census tracts that are not in National Parks, by treatment groups, 2007-2009

Chracteristics	**Entire sample**	**Treated**[a] 2007	**Treated**[a] 2008	**Treated**[a] 2009	**Control Group**
Area covered by PES in 2007 (%)	2.55	17.45	15.04	13.69	0.00
Area covered by PES in 2008 (%)	2.93	18.27	17.68	16.35	0.00
Area covered by PES in 2009 (%)	2.91	16.42	16.23	16.94	0.00
Area covered by forest in 1997 (%)	15.80	34.25	32.73	32.16	12.04
Area (ha)	469.98	1,370.00	1,310.00	1,260.00	290.46
Density of primary roads	0.11	0.04	0.04	0.03	0.13
Density of secondary roads	0.26	0.05	0.05	0.05	0.30
Density of urban roads and neighborhood roads	2.08	0.88	0.91	0.92	2.35
Slope	13.21	15.69	15.82	16.07	12.62
Average precipitation	3,181	3,460	3,467	3,468	3,111
Distance to the nearest school (m)	1,332	2,098	2,088	2,055	1,170
Distance to San José (m)	75,252	98,668	96,684	94,449	70,477
Workers in sector 1[b] in 2000 (%)	49.05	70.37	69.99	70.14	44.30
Workers in sector 2[c] in 2000 (%)	17.78	9.10	9.19	9.38	19.68
Workers in sector 3[d] in 2000 (%)	33.17	20.54	20.82	20.48	36.02
Unemployment average rate in 2000 (%)	5.52	6.26	6.33	6.01	5.38
People with incomplete primary in 2000 (%)	49.40	56.65	56.40	56.22	47.85
People with complete primary in 2000 (%)	42.31	39.13	39.34	39.50	42.96
People with complete secondary in 2000 (%)	6.27	3.30	3.35	3.37	6.93
People with complete university in 2000 (%)	2.01	0.91	0.91	0.91	2.26
Province San José	17.20	18.85	20.86	22.64	16.18
Province Alajuela	26.98	21.55	20.56	20.49	28.51
Province Cartago	8.78	2.18	2.80	3.56	10.03
Province Heredia	6.65	4.80	4.38	4.16	7.16
Province Guanacaste	10.29	19.20	17.76	16.48	8.76
Province Puntarenas	15.80	17.19	16.93	16.11	15.56
Province Limón	14.31	16.23	16.70	16.56	13.80
Number of census tracts	7855	1146	1323	1347	6383

Notes:
a/There is some sort of PES in the census tract in that year
b/ Agriculture, Livestock, Hunting and Silviculture, Fishing, Mining and Quarrying
c/Manufacturing, Electricity, Gas and Water, and Building Activities
d/Trade, Hotels and Restaurants, Transport, Storage and Communications, Financial Intermediation, Real Estate, Renting and Business, Public Administration, Education, Health and Social Services, Private Households with Domestic, and Extraterritorial Organizations and Agency

Table 2. Descriptive characteristics of people over 12 years old living in rural census tracts outside of National Parks, by treatment groups, 2007-2009

	Entire sample	2007		2008		2009	
		Treated Group	Untreated Group	Treated Group	Untreated Group	Treated Group	Untreated Group
Dependent variables							
Poverty	0.20	0.28	0.18	0.27	0.19	0.28	0.20
Extreme poverty	0.05	0.06	0.04	0.08	0.04	0.10	0.05
Number of Observations	53,198	2,203	15,253	2,617	14,700	3,212	15,213
Control variables							
Sex (Men =1)	0.50	0.51	0.50	0.50	0.50	0.51	0.50
Age	35.02	34.67	34.90	35.50	35.09	35.01	35.05
Years of education	7.28	6.70	7.21	6.88	7.36	6.95	7.49
Born in CR	0.92	0.93	0.92	0.90	0.92	0.89	0.91
Number of Observations	56,896	2,336	16,062	2,905	16,089	3,346	16,158

Source: Authors.

Table 3. Presence of PES in the census tracts, 2007-2009

Dependent variable: Presence of PES on the census tract			
Control variables	2007	2008	2009
Area covered by forest in 1997 (%)	0.0118***	0.0108***	0.0107***
Area (km2)[1]	4.19e-05***	4.63e-05***	4.38e-05***
Density of primary roads	-0.1975**	-0.1912**	-0.2418***
Density of secondary roads	-0.2246***	-0.2555***	-0.3004***
Density of urban roads and neighborhood roads	-0.1249***	-0.1233***	-0.1344***
Slope	0.0087***	0.0095***	0.0083***
Average precipitation	0.0005***	0.0005***	0.0007***
Average precipitation (squared)[1]	-4.74e-08 *	-3.84e-08	-6.31e-08***
Distance to the nearest school (log)	0.1433***	0.1585***	0.1557***
Distance to San José (log)	0.1822***	0.1887***	0.1819***
Workers in sector 2 in 2000 (%)	-0.5455***	-0.5646***	-0.4320**
Workers in sector 3 in 2000 (%)	-0.4106***	-0.3689**	-0.5536***
Unemployment average rate (%)	0.9372***	1.0171***	0.8367***
People with complete secondary in 2000 (%)	-0.6525	-0.5086	-0.0419
People with complete university in 2000 (%)	-1.1314	-1.5799	-1.2927
Constant	-5.2809***	-5.2434***	-5.2770***
Include province variables	Yes	Yes	Yes
Number of observations	7,855	7,855	7,855

Note: ***, ** , * indicates significant at 1%, 5%, 10% respectively.

1/ Numbers are in scientific notation.

Source: Authors.

Table 4. Presence of PES in the census tract associated with demographic characteristics, 2007-2009

Dependent variable	Presence of PES in the census tract			
Variables independent	Entire sample	2007	2008	2009
Years of education	0.0054**	0.0016	0.0147***	0.0010
Age	-0.0003	0.0001	0.0009	-0.0020
Age (squared)[1]	2.00e-05	-5.40e-06	2.73e-05	3.64e-05
Sex (Men =1)	-0.0136	0.0131	-0.0432	-0.0098
Born in CR	-0.0103	0.1364**	-0.0230	-0.0855**
Constant	-1.4917***	-2.8315***	-3.3009***	1.0767**
Include census tract variables	Yes	Yes	Yes	Yes
Include province variables	Yes	Yes	Yes	Yes
Include time variables	Yes	No	No	No
# Observations	56,896	18,398	18,994	19,504

Note: ***, ** , * indicates significant at 1%, 5%, 10% respectively.

1/ Numbers are in scientific notation.

Source: Authors.

Table 5. Estimated effect of increasing coverage of parcels with PES in 10% of census tract area on the percentage of people in poverty and extreme poverty conditions by geographic characteristics, 2007-2009

Method	Poverty	Extreme poverty
OLS	0.001%	0.001%
Matching[1]	-0.004%	-0.003%
Split by geographic characteristics		
Distance to San José[2]		
High	0.002%	0.001%
Low	-0.003%	0.003%
Distance to national roads[3]		
High	-0.004%	0.001%
Low	0.005%	0.002%
Slope[4]		
High	-0.013%***	-0.001%
Low	0.016%***	0.002%

Note: ***, ** , * indicates significant at 1%, 5%, 10% respectively.

1/ We used Propensity Score Matching methods to find control observations.

2/ Threshold: 85,000 m

3/ Threshold: 2,726.93 m

4/ Threshold: 13 elevation grades

Source: Authors.

Table 6. Effects of PES on poverty by demographic and geographic characteristics

Groups by demographic and geographic characteristics	Poverty	Extreme poverty
Sex		
Men	0.002%	0.001%
Women	-0.001%	0.001%
Age		
35 or less	0.005%**	0.004%**
Over 35	-0.006%*	-0.002%
Slope		
Low slope[1]		
Sex		
Men	0.014%***	0.000%
Women	0.020%***	0.004%
Age		
35 or less	0.024%***	0.003%
Over 35	0.005%	0.001%
High slope[2]		
Sex		
Men	-0.011%***	0.000%
Women	-0.017%***	-0.002%
Age		
35 or less	-0.013%***	0.001%
Over 35	-0.016%***	-0.004%*

Note: ***, **, * indicates significant at 1%, 5%, and 10%, respectively.

1/ Places with slope less than 13 elevation grades

2/ Places with slope higher than 13 elevation grades

Source: Authors.