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Deforestation Spillovers from Costa Rican Protected Areas

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Abstract/Resumen

Spillovers can significantly reduce or enhance the effects of land-use policies, yet there exists little rigorous evidence concerning their magnitudes. We examine how national parks within Costa Rica affect the clearing of forest nearby. We find that average deforestation spillover impacts are not significant within 0-5km and 5-10km rings around parks. However, we argue that this average blends multiple spillover effects, each of which is likely to vary in magnitude across the landscape, yielding varied net effects. We distinguish these effects using distances to roads and park entrances, given the importance of transport costs and, for Costa Rica, tourism. We find large and statistically significant leakage close to roads in areas without tourism, i.e., far from the park entrances. In contrast, no leakage is found far from roads or close to park entrances. In sum, the combination of low transport costs and low returns to forest is conducive to deforestation leakage around the parks

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1. Introduction

Covering 12% of the earth's surface (WDPA 2012), protected areas (PAs) are the leading policy to reduce deforestation. Thus, an understanding of all their impacts on deforestation is important for future conservation policy (see, e.g., Brunner et al. 2001, Andam et al. 2008, Sims 2008, Pfaff et al. 2009, Joppa and Pfaff 2010a, Blackman et al. 2015, Robalino et al. 2015). Most analyses to date examine the deforestation impact of PAs only within their borders, despite the acknowledged fact that a PA's forest impact can also depend significantly on any impact outside of its borders.

There are numerous hypotheses about how parks might affect nearby rates of deforestation. Some argue that land restrictions could displace development to unprotected areas nearby (e.g., Wu 2000, Leathers and Harrington 2000, Wu 2005, Fraser and Waschik 2005, Armsworth et al. 2006, Robalino 2007, Alix-Garcia et al. 2012). Even expected land-use restrictions in the future could lead landowners nearby to deforest, in order to avoid potential future restrictions (Newmark 1994, Fiallo and Jacobson 1995). These hypotheses suggest that PAs could increase the rates of deforestation in nearby areas. If such "leakage" were large, deforestation reductions in PAs might be offset by spillovers.

However, it has also been hypothesized that parks could decrease the rates of deforestation in nearby forested areas. Protection could generate incentives for eco-tourism activities near parks, which support conservation of forest outside of, but near, PAs. Some have argued, in addition, that PAs increase environmental awareness (Scheldas and Pfeffer 2005). There is also evidence that neighbors' deforestation decisions in Costa Rica reinforce each other, i.e., private land-use choices that conserve forest can shift the incentives for nearby private land uses towards additional forest conservation (Robalino and Pfaff 2012). Should PAs generate similar local spillovers, then their total impacts are above their internal gains.

Estimates of parks' local spillovers could well blend multiple land-use interactions, which could include positive and negative effects. Further, any of the effects' magnitudes, and thus the magnitude and even the sign of the net spillovers, may well vary across space. PAs may increase nearby deforestation on net in one location but lower it on net in another. A large enough single PA may even generate different net effects in different areas nearby.

We examine deforestation spillovers from Costa Rica's National Parks from 1986 to 1997, the most recent time period during which deforestation rates in Costa Rica were significant. To go beyond prior empirical work (see Andam et al. 2008), we distinguish the forest locations that are near PAs by their distances to both the nearest road and the parks' entrances. We expect both the existence and the intensity of spatial spillovers to vary over space and, specifically, to be affected by transport costs and proximities to factors facilitating tourism.

The spatially detailed data also let us better control for parcel characteristics, as the recent literature on PA impacts has done. Protected parcels differ significantly, on average, from unprotected forests (Joppa and Pfaff 2009 show this globally); thus, the forest parcels near PAs also are likely to differ in relevant characteristics from other unprotected forest parcels to which they are compared in estimating spillovers.[1] We employ matching and regression to lessen potential biases due to the non-random allocation of the PAs across Costa Rica. In environmental economics, matching strategies have been used for some time as tools for evaluation, e.g., with the effects of air quality regulations upon environmental outcomes (Greenstone 2004) and economic activities (List 2003). More recently, they have been applied to land restrictions (see Andam et al. 2008, Joppa and Pfaff 2010b, Sims 2010, Arriagada et al. 2011, Ferraro et al. 2011, Alix-Garcia et al. 2012, Pfaff et al. 2012, Carnavire-Bacarreza and Hanauer 2013, Robalino and Pfaff 2013, Robalino and Villalobos 2015, and Robalino et al. 2015).

Following Andam et al. 2008, we confirm that for entire rings of forest immediately around Costa Rica's National Parks, there are no significant deforestation spillovers. However, we argue that this finding blends multiple spillover effects resulting from influences of roads and park entrances, each of which is likely to vary in magnitude across the landscape with proximity to the roads and entrances, thus yielding varied net effects. Thus, for further testing of varied net spillovers, we separate nearby forestland using distances to roads and entrances.

[1] Governments and policy makers are likely to be pursuing specific objectives when choosing PA locations. They might minimize conflicts with advocacy groups, target for impact (i.e., additionality) by choosing areas facing higher baseline deforestation threats (as suggested in Pfaff and Sanchez 2004) or, instead, maximize environmental benefits conditional upon impact (Costello and Polasky 2004, e.g., extend a large literature).

Close to national roads, we find significant "leakage," i.e. a 10% increase in deforestation rate when far from the entrance within a 0-5km ring. In the absence of tourism's influence, that inner ring seems to capture the pressure for leakage that pushes out from inside the park. When far from an entrance within a 5-10km ring, we find no impact on deforestation rates.

When close to park entrances in a 0-5km ring and close to national roads, where tourism should have its greatest influence, we find no spillover at all. Yet moving out to 5-10km while close to the entrance, we find leakage close to roads, i.e. an 8.8% increase in the rate of deforestation. For this outer ring, tourism may be less influential in promoting private forest.

These results show not only the potential importance of spillovers in evaluating PA impact but also the value of delineating specific mechanisms that are likely to underlie spillovers. Looking only inside PAs can be misleading if PAs have positive or negative spillovers to nearby forests, as in Costa Rica, and where spillovers occur to an extent that seems predictable. That spillovers exist, and where they are most likely, inform policies that complement PAs.

Below in Section 2, we present background concerning forest conservation in Costa Rica and estimation of spillovers. In Section 3, we present our data and empirical approach. We present our results in Section 4 and, finally, we present our conclusions in Section 5.

2. Background

2.1. Deforestation and Conservation in Costa Rica

While deforestation rates in Costa Rica had decreased significantly by the end of the 1990s, during the early eighties Costa Rica had one of the highest deforestation rates in the world (Sanchez-Azofeifa et al. 2001). There are multiple possible reasons for such a change over these periods of time.

One set of factors is economic. For instance, beef prices fell, while ecotourism activity rose. Other traditional products such as coffee and bananas are also deforestation drivers and, for any period, where they generate profits helps to determine where deforestation will occur. A significant factor in profit is transport costs. Thus, roads should matter and they have been confirmed empirically as important factors in deforestation differences across a landscape (see Chomitz and Gray 1996, Pfaff 1999 and Pfaff et al. 2007).

Throughout these time periods, however, areas under protection in Costa Rica greatly increased, now covering 25% of the country. The great majority of that land is within protected areas, featuring different types of protection. National Parks is the largest category, covering 10% of the country (Pfaff et al. 2009). One characteristic of National Parks is that they receive visitors, which in turn generates related economic activities, such as rapidly increasing ecotourism. By 1995, tourism was the country's main source of foreign revenue (Inman et al. 1997) and a significant fraction of foreign visitors come for ecotourism, which includes visiting parks.

Parks within Costa Rica have been shown to reduce deforestation significantly on average, even if far less than many might assume (Andam et al. 2008). However, their effectiveness depends on location, i.e., characteristics of the land. Protected areas close to roads, close to San Jose and on less steep land avoided significantly more deforestation (Pfaff et al. 2009). One remaining question is whether parks affected deforestation in their surrounding areas.

2.2. Empirical Estimation of Deforestation Leakage

Various hypotheses exist for how parks might affect deforestation rates in nearby areas. Some authors argue that parks can increase environmental awareness (Scheldas and Pfeffer 2005) and bring tourists, thus promoting the ecotourism that requires the protection of forest in private lands. If this is the case, then deforestation can decrease as a consequence of a park.

Others argue that land restrictions displace deforestation toward unprotected nearby areas. Individuals might be displaced from protected areas (Cernea and Schmidt-Soltau 2006) and in turn, then clear land outside protected areas. Landowners could also preemptively deforest to prevent the expansion of such land restrictions to their properties (Newmark 1994, Fiallo and Jacobson 1995). Thus, deforestation that would not have occurred had the parks not existed in the first place, would in fact take place close to them.

Additionally, markets could help to generate spillover effects (Armsworth et al. 2006 and Robalino 2007). Restricting land uses could increase the prices of agricultural goods and the returns from development, raising the benefits from deforesting in areas where there are no restrictions (Armsworth et al. 2006 and Robalino 2007). Spillover deforestation takes place where such increases in the benefits of deforestation make it newly profitable. Thus, forested areas with lower transport costs are likely to be most affected (Robalino 2007).

There exists limited empirical analysis of spillovers, in particular from parks. Globally, restrictions on timber harvest in one region are expected to increase timber harvest in other regions (Sohngen et al. 199). There is also evidence of large leakage effects from the Conservation Reserve Program involving direct payments to farmers in the United States (Wu 2000). For every 100 hectares retired under the program, 20 hectares were converted to cropland (Wu 2000). Other papers have also shown evidence of leakage in forest carbon sequestration (Murray et al. 2004, Chomitz 2007 and Sohgen and Brown 2004).

For Mexico, there is evidence of leakage from the national ecoservices payments program (Alix-Garcia et al. 2012). Landowners who enrolled in the program increase deforestation on other property belongings. This effect is stronger in poorer municipalities and with those given less access to commercial banks, where credit constraints are higher (Alix-Garcia et al. 2012).

In Costa Rica, park spillovers have been explored (Andam et al. 2008). Average net effects of parks on nearby forests are not significant (Andam et al. 2008), as we confirm. Yet, as we show in this paper, that average can mask significant leakage effects in particular areas, especially where small changes in deforestation incentives could increase the activity, such as forest close to roads within areas where the returns to forest due to tourism are low.

3. Data & Empirical Approach

3.1 <u>Data</u>

Using the spatial detail offered by data in a GIS (Geographic Information System), we randomly drew 50,000 points from across Costa Rica, i.e., one per km^2, as our units of analysis.

3.1.1. Forest & Sample

We use forest-cover maps for 1986 and 1997 to determine the deforestation in the period 1986-1997. The maps were developed by the Tropical Science Center from aerial and satellite pictures and permit us to estimate forest presence or absence in each of our randomly drawn points. To study deforestation, we drop from the sample those points with uncertain presence of forest (leaving 47,241 points, see Table 1). We also drop 2,864 observations covered by clouds or shadow. We then analyze only observations in forest in 1986 (42% or 21,087). The focus of this analysis is non-protected private forest. Therefore, we also drop the points inside parks and in all of the public areas within which government chooses the land uses, leaving 9,480 observations. One important variable we use is distance through roads to park entrances. However, some points are too far away from roads, so that our calculations of proximity to park entrances through roads are not adequate. Thus, we dropped observations that are not reachable by roads (466 observations). The total number of forest observations left is 9,014.

The dependent variable is deforestation. To calculate the deforestation in each point, we examine whether forest points in 1986 were cleared or remained in forest by 1997.

3.1.2. National Parks & Nearby Areas

Maps of all protected areas (PAs) in Costa Rica were digitalized by the GIS Laboratory at the Instituto Tecnológico de Costa Rica. We focus on National Parks because they cover the largest total area, have one of the strictest types of protection, and include tourism as an activity. We drop all other types of PAs and, to analyze neighboring areas, all points in the Parks as well. To determine which points in our sample are neighbors of National Parks, i.e., “treated,” we compute linear distances from each of the forested points to each of the National Parks.

That leaves three sets of observations (see Table 1). First, we consider the 1,253 forested locations within 5km of the nearest National Park border (Ring 1). Second, we consider the 1,486 forest locations between 5km and 10km from the nearest border of a National Park (Ring 2). Finally, 6,275 observations are over 10km from a National Park (Far From Parks).

We define proximity to the entrance of a National Park as a road distance of less than 20km from the nearest entrance. Within Rings 1 and 2, we split treated observations into close to entrance (503 observations in Ring 1 and 408 observations in Ring 2) versus far (750 observations in Ring 1 and 1,078 observations in Ring 2).

Finally, we distinguish observations closer versus farther than 1km from a national road. We consider the rings separately. Within each, we distinguish: close to entrance and road (125 in Ring 1 and 92 in Ring 2); far from entrance but close to road (84 in Ring 1 and 190 in Ring 2); close to entrance but far from road (378 in Ring 1 and 316 in Ring 2); and far from entrance and road (666 in Ring 1 and 888 in Ring 2). All are compared with untreated. Of the 6,275 observations 10 km or farther from National Parks, 1,136 observations are located close to National Roads, while 5,139 are located far from national roads[2].

3.1.3. Parcel Characteristics

Spatially specific information within a GIS was also used to obtain parcel characteristics helpful for improving comparisons, i.e., finding untreated points most similar to the treated. We obtained measures of slope, precipitation, elevation, distances to rivers and oceans that we classify as natural characteristics. We also computed distances to San Jose, population centers, sawmill and schools. Finally, we computed the fraction of forest in 1986 at the census track level and assign it as a measure of forest stock in the general neighborhood. We can compare treated and untreated observations on these dimensions, as shown in Table 2.

3.2. Empirical Approach

To determine the impact of National Parks on deforestation rates in neighboring areas we must answer the question: "What would the neighboring deforestation rate have been had a Park not been established nearby?" The simplest estimation strategy to try to answer this baseline question is to consider the average deforestation rate in untreated forest locations (i.e. the "naïve" estimation in Morgan and Winship 2007). This approach is relatively common (Joppa and Pfaff 2010a list

[2] We also dropped 119 observations that are within the 20km distance via roads but farther than 10km from parks linearly.

examples) but clearly may be inadequate if the treatment group and the untreated group differ in terms of characteristics that also affect deforestation rates.

We do observe some differences of this kind. Compared to the controls, parcels within 0-5km of the nearest National Park have steeper slopes, more precipitation, higher elevation, higher census-tract forest in 1986, and longer distances to roads, rivers, cities, coasts, sawmills and schools (Table 2). In sum, Ring 1 points are more remote and likely face less deforestation pressure than does the average unprotected forest parcel that is not located near a PA. Ring 2 also differs from unprotected forest far from PAs but it is less remote than Ring 1 is.

Table 2 suggests that National Parks blocked deforestation in the range of 0-5km (Ring 1) but may have increased it in the 5-10km range (Ring 2). However, the observed differences in deforestation rates might be caused by the differences in land characteristics, i.e., not the presence of Parks. To control for land characteristic influences, we use matching (to compare treated to similar untreated points that do not differ in average land characteristics), as well as regressions.

Matching selects as controls the most similar untreated observations, then uses the control deforestation to estimate what would have happened in areas near Parks without the Parks. Compared to standard regression, which nonetheless can be employed after such matching, this imposes fewer assumptions about the functional forms for controlling for influences of characteristics that affect the outcome (Rubin 2006). Such assumptions affect the estimated treatment effects: if the treated are far from roads, e.g., the estimated treatment effect is likely to depend on the functional form assumed for distance to roads (e.g. linear or log-linear). Matching directly reduces the difference in distance to roads between treated and untreated, as shown below, which reduces the effect of functional form assumptions on the estimates.

However, matching relies upon an identification assumption, which is that there are no unobservable factors – factors not in the data − that affect deforestation and the chance of being treated, i.e., of being near a Park. Given finite data, many possible influences may go unmeasured, though our relatively rich data set should help to reduce the extent to which this is violated.

Matching also requires a definition of the term "similar." One is the distance in the characteristics space between any two points[3] (Abadie and Imbens 2006). This definition is employed in the matching strategy referred to as Covariate Matching. One advantage of this matching strategy is that standard errors are consistently estimated (Abadie and Imbens 2006). Table 3 examines balance, i.e., differences between the treated and matched untreated points. Covariate matching reduced the number of covariates that differ significantly[4].

4. Results

4.1. <u>No Spillovers On Average</u>

We test first whether there are deforestation spillovers on average near National Parks. The naïve estimator shows a difference in means in deforestation rates between treated and untreated observations in the first two columns of Table 4. Lower deforestation rates are found within the 5 km ring, in particular near Park entrances and far from roads. In the second ring, overall we find no statistically significant difference, yet do find higher deforestation far from parks' entrances. However, as discussed, land characteristics can explain variation in deforestation rates between the treated and the untreated observations. Therefore, from these estimates, we cannot conclude that Parks generated these differences in deforestation rates.

To address this issue, we include land characteristics in the estimation using both ordinary least squares and covariate matching. They explain the differences in the naïve estimator. However, OLS results show some leakage in the 5-10 km ring, especially far from Park entrances. When using covariate matching (CVM), we do not find any significant effects in either ring, whether or not we distinguish subsets by the distance to entrance or roads. This statistically insignificant result confirms previous results for Costa Rica (found in Andam et al. 2008).

However, this average might blend effects of different magnitudes. As discussed previously, National Parks might reduce deforestation in nearby areas in some conditions, yet deforestation

[3] This distance between points in the land characteristics or covariate spaces specifically is defined as $((x_1-x_2)' V (x_1-x_2))^{1/2}$ where x_1 and x_2 are the vector of land characteristics for any two observations and V is a positive-definite weight matrix.

[4] We also tested PS matching but balances were worse than covariate matching. Thus, we choose to focus on covariate matching.

near parks might not be affected under other conditions. Thus, the average findings in Table 4, in principle, could result from overlapping and offsetting heterogeneous effects.

4.2. <u>High Agricultural Returns & Low Forest Returns</u>

We might expect more leakage where the differential between the returns to agriculture and forest conservation returns is higher. A powerful determinant of agricultural returns is distance to the nearest road. A powerful determinant of tourist activities, which can raise returns to forest, is likely to be proximity to the entrance of the park. Table 5 combines these factors.

Following the logic of more leakage where agricultural returns are relatively high compared to forest returns, we would expect an increase in deforestation near parks when farther from the entrances − i.e., not affected by tourism − while at the same time close to roads. We find large and significant leakage effects under exactly these conditions in Ring 1, within 5km of parks (see the upper left cells in Table 5). Looking across the three Ring 1 columns in the upper row, we can see that this leakage result is robust to the three strategies used, generating an impact estimate from 8.59% to 13.27% (estimates rising with more controls).

The forces generating that leakage appear to be absorbed in the initial ring, as we can see in the final three columns of Table 5's first row. There are no significant effects in Ring 2, even when close to roads (low transport costs) and farther from the entrance (low tourism). In the second row of Table 5, we show that for Ring 1 as well as for Ring 2, no impacts are found far from roads.

We might also expect that even with Ring 1 and close to roads, any pressures for leakage could be blunted by tourism's influence when close to the entrance. Table 5 shows that result in its third row (first three columns). However, if we remain in the areas close to roads but move away from the entrance (for the 5-10 km Ring 2 in Table 5's last three columns), we again see leakage in the rest of that third row. These impacts are also large and significant: estimates of increases in deforestation rates, for these areas, range from 6.32% to 16.82%.

In sum, by breaking down the areas near parks using two measures likely to be correlated with the returns to agriculture and to tourism, respectively, we find that the leakage from Parks is significant and largely close to roads. Tourism can reduce leakage when close to an entrance but the impacts are not eliminated, as increases in deforestation simply take place farther away.

5. Discussion

Spillovers can significantly reduce or multiply the effects of land conservation policies. We examined empirically how Parks affect the deforestation rates in forested lands near them, using the most similar parcels far from Parks to estimate counterfactual deforestation rates. To find similar comparison parcels, in light of non-random allocation of protection over the landscape by policymakers, we employed covariate matching using parcel characteristics.

We confirmed insignificant average net spillovers within both 0-5km and 5-10km of Parks, when controlling land characteristics differences with matching and regression techniques. However, we then showed that these can result from blends of heterogonous Park impacts across the landscape. Spillovers close to Park entrances associated with higher tourism are insignificant but large increases in deforestation (around 9%) are found near roads in the areas less affected by tourism.

Such results help to evaluate the overall deforestation impacts of National Parks. Impacts within Parks can be misleading, as measures of efficiency, if they have positive or negative effects nearby. Our approach and results also help to identify where deforestation may leak once protection is implemented, and that might require extra attention.

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Table 1. Forest and Sample

	Number of observations	Percentage
Observations (total)	**50000**	**100**
Drop if there was not forest in 1986	23290	46.58
Drop if it is not private land	11607	23.21
Drop if undefined distance by roads to Parks	466	0.93
Drop if uncertain about presence of forest	2759	5.52
Drop if there are clouds or shadows	2864	5.73
1986 private forest observations for analysis	9014	18.03
Ring 1: 0-5Km	**1253**	**100.00**
Close to the entrance	*503*	40.14
Close to National Roads	125	9.98
Far from National Roads	378	30.17
Far from the entrance	*750*	59.86
Close to National Roads	84	6.70
Far from National Roads	666	53.15
Ring 2: 5-10Km	**1486**	**100.00**
Close to the entrance	*408*	27.46
Close to National Roads	92	6.19
Far from National Roads	316	21.27
Far from the entrance	*1078*	72.54
Close to National Roads	190	12.79
Far from National Roads	888	59.76
Beyond 10km	**6275**	**100.00**
Close to National Roads	1093	17.42
Far from National Roads	5063	80.69
Dropped if close to the entrance (20km through roads)	119	1.90

Table 2. Land Characteristics & Group Mean Differences

	Untreated	0-5 km		5-10 km	
		Treated	*t-stat*[1]	*Treated*	*t-stat*[1]
Dependent Variable					
Deforestation rate	13.42	10.61	-2.70	14.87	1.47
Control Variables					
Slope (percentage)	44.85	64.93	7.66	55.01	4.19
Precipitation (mm)	3.30	3.73	15.15	3.67	14.02
Elevation (m)	0.35	0.75	27.08	0.43	6.53
Dist. to local roads (Km)	0.78	1.01	8.34	0.99	8.15
Dist. to national roads (Km)	3.90	4.35	3.96	3.69	-2.11
Dist. to rivers (Km)	1.42	1.61	4.80	1.25	-4.83
Dist. to capital city (Km)	105.70	104.01	-1.14	116.42	7.81
Dist. to Pacific coast (Km)	52.30	50.45	-1.44	55.70	2.80
Dist. to Atlantic coast (Km)	110.23	104.99	-2.49	96.75	-6.79
Dist. to towns (Km)	2.82	3.36	9.51	3.10	5.49
Dist. to sawmills (Km)	18.34	22.28	11.55	22.06	11.49
Dist. to school (Km)	15.21	14.32	-2.98	13.37	-6.58
Percentage of forest 1986	52.17	58.86	9.08	55.05	4.15

[1] Test of means against untreated.

Table 3. Matching Balances -- Statistically Different Covariates (at 5%)

	Pre-match	**After CVM**
Ring 1	11	2
Close to Entrance	10	0
Close to Roads	6	0
Far from Roads	10	0
Far from Entrance	13	2
Close to Roads	5	0
Far from Roads	12	2
Ring 2	12	0
Close to Entrance	9	0
Close to Roads	5	0
Far from Roads	10	0
Far from Entrance	9	0
Close to Roads	5	0
Far from Roads	12	0
Ring 1 and 2	11	2
Close to Entrance	9	0
Close to Roads	6	0
Far from Roads	10	0
Far from Entrance	11	2
Close to Roads	5	0
Far from Roads	10	2

Table 4. Initial Estimates of National Park Impact on Nearby Deforestation

	Naive		**OLS[1]**		**Covariate Matching[1]**	
	Ring 1 **0-5 Km.**	**Ring 2** **5-10 Km.**	**Ring 1** **0-5 Km.**	**Ring 2** **5-10 Km.**	**Ring 1** **0-5 Km.**	**Ring 2** **5-10 Km.**
Overall Effect	-0.0280***	0.0145	0.0071	0.0199**	0.0079	0.008
	[0.010]	[0.010]	[0.011]	[0.010]	-0.013	-0.013
Far from Park Entrance	-0.0137	0.0255**	0.0186	0.0211*	-0.0001	0.0059
	[0.013]	[0.011]	[0.014]	[0.011]	-0.018	-0.015
Close to Park Entrance	-0.0515***	-0.0173	-0.0017	0.0065	0.0081	0.0186
	[0.016]	[0.017]	[0.014]	[0.015]	-0.015	-0.019
Far from Roads	-0.0424***	0.0034	0.0038	0.0148	0.0070	0.0064
	[0.011]	[0.011]	[0.012]	[0.011]	[0.014]	[0.014]
Close to Roads	0.0387	0.0579**	0.0280	0.0420*	0.0435	0.0234
	[0.026]	[0.024]	[0.027]	[0.023]	[0.032]	[0.027]

***, ** and * represent significance at 1, 5 and 10% level respectively. [1] The control variables used are shown in Table 1. Distances are in logs.

Table 5. Additional Matching Estimates of National Park Impact on Nearby Deforestation

	Ring 1: 0- 5 Km			**Ring 2: 5 - 10 Km**		
	OLS	**CVM**	**CVM Trimmed**[a]	**OLS**	**CVM**	CVM **Trimmed**[a]
FAR FROM ENTRANCE						
Close to a Roads Effect	0.0859**	0.1039**	0.1327**	0.0269	-0.0145	-0.0313
	(0.040)	(0.052)	(0.057)	(0.028)	(0.034)	(0.040)
Far from Roads Effect	0.0110	0.0114	-0.0289	0.0192	0.0072	-0.0217
	(0.015)	(0.018)	(0.023)	(0.012)	(0.016)	(0.018)
CLOSE TO ENTRANCE						
Close to Roads Effect	-0.0008	0.0161	0.0187	0.0632*	0.0882**	0.1682**
	(0.032)	(0.035)	(0.054)	(0.037)	(0.039)	(0.070)
Far from Roads Effect	0.0084	0.0125	0.0310*	0.0060	0.0083	-0.0149
	(0.018)	(0.016)	(0.019)	(0.019)	(0.021)	(0.024)

Using only observations in the interval of 0.1 and 0.9 of the propensity score as suggested by Crump et al. 2009.

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