Payments for Environmental Services: empirical analysis for Costa Rica

OR

conservation & co-benefits lessons from the evolution of the PSA

Alexander Pfaff & Juan Robalino et al.

ACES – 'Payments & Markets for Ecosystem Services'

Naples, Florida *12/10/08*

TAKEAWAY: program design matters !!

- Costa Rica deserves gratitude as very public pioneer & always expected learning and program evolution
- “lessons learned from Costa Rica” are misleading: *deforestation without payments then none with!!!*
- payments for ecosystem services CAN work well; that does NOT mean ANY payments have impact
- the most relevant Costa Rican lesson, for the world, is that details of payment allocation rules do matter

ANALYSIS: non-random location confounds

- discussion of various forest policies but less of <u>where</u>

- <u>where is a choice</u> that *responds to factors we observe*, factors which, in turn, *affect the outcomes of interest*

- we examine payments (protection, roads) empirically:

  1) LOCATIONS NON-RANDOM; WORSE LAND

  2) CORRECTED IMPACTS ARE MUCH LOWER

  3) **BUT** TARGETING CAN INCREASE IMPACTS

Land-Use Analysis In Background

- examine deforestation over time (e.g. for C baseline)
  [1963 aerial photos; 1979, 1986, 1997, 2000, 2005 satellites]

- initially used district and sub-district observations; still some, but focusing on more recent pixel data

- biophysical proxies yield expected results as do the socioeconomic covariates: rain, temperature, slope, soil, distances to markets and national / local roads
  all of these observable factors useful for matching

Payments for Ecosystem Services

- Costa Rica has been a global leader in this arena
- PSA is widely cited & many suggest imitating it
- since 1997, offered 5-year contracts of three types:
  - forest conservation, i.e. in forest and keep that way
  - reforestation (smaller) (its totals move with funds)
  - forest management (some clearing) (was dropped)
- temporally correlated with lower clearing -- causal ?

Other Factors in Costa Rican Land Use

- parks (note the Supreme Court case about compensation)
- ecotourism generally has boomed (including private)
- don’t forget important private or market incentives
  - coffee exports / prices and beef prices matter
  - as in ‘theory’ [Figure 1], may not want to clear
- 1997 law put up barriers to additional forest clearing

Estimating The Payments' Impacts – Data

- using pixels, draw 10,000 locations across Costa Rica
  - examine the locations in forest in 1986, 1997, 2000, 2005
  - missing some observations due to clouds blocking satellites
- dependent variable is deforestation (97 - 00, 00 - 05)
- control for non-policy characteristics of the locations:
  - distances to: cities, roads, rivers, schools, sawmills
  - biophysical characteristics: rain, elevation, slope

1997-99 Contracts: no clearing to be avoided !!

	#cleared	#uncleared	97-99 %	**Annual %**
PSA points	0	60	0.00 %	**0.00 %**
NonPSA points	11	1699	0.63 %	**0.21 %** *

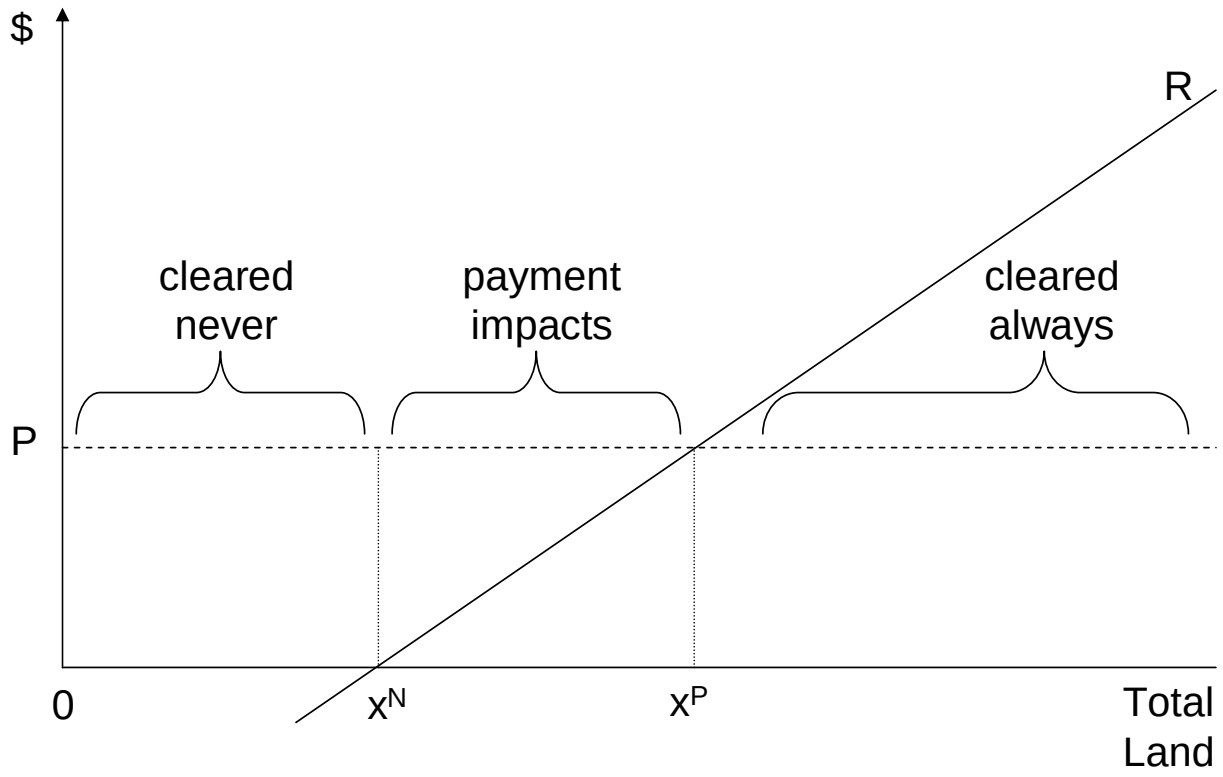
* *for 1770 pixel sample but essentially equals national rate*

This measure suggests little clearing to be prevented;

so randomly distributed payments can't do much.

Land-Use Model & <u>where do</u> payments go ?

- the level of the payments (P) affects the level of the impact
- the distribution of land affects who might be affected by P
- we can see that some land will never be volunteered (at P); critical question: does Never Cleared dominate enrollment?



NOT Targeting Deforestation (predicted from 1986-1997)

Annual Rate of Deforestation	0.00 - 0.15%	0.15 - 0.30%	0.40 - 0.45%	0.45 - 0.60%	0.60 - 0.75%
# observations	1163	348	100	23	3
average % rate	0.05%	0.21%	0.36%	0.51%	0.61%
fraction in PSA*	***4 %***	***3 %***	***1 %***	***0 %***	***0 %***

** 1770 pixel sample but certainly can add additional points*

This calculation suggests a net 97-99 bias to low threat; thus, the average-non-PSA value *overestimates* impact.

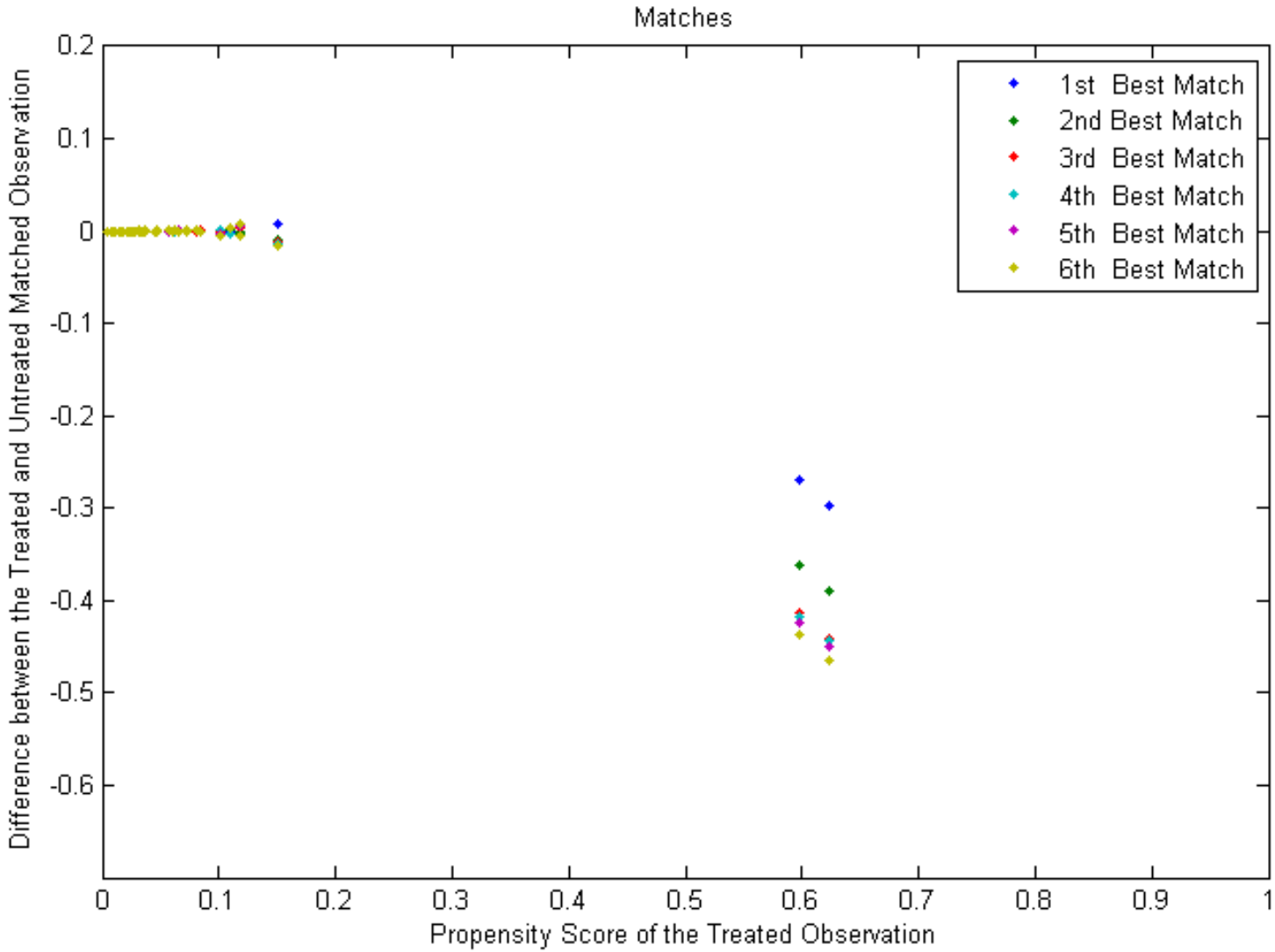
“Matching” (to address non-randomness)

- compare treated to *similar* subset of the untreated
- definition of similarity using plot characteristics:
  - propensity score matching (PSM) compares points in terms of their probabilities of being treated, as seen from a prior regression: Rosenbaum & Rubin 1983
  - covariate matching (CM) does not use such a prior regression for likelihood of treatment, using instead ‘the distance in X space’: Abadie & Imbens 2006

Covariate Balance (PSM, n=6)

	Treated	Untreated	$P^{untreated}$	Matched	$P^{matched}$
R1	0.2439	0.0943	0.0021	0.2033	0.5550
R3	0.0000	0.1533	0.0073	0.0000	-------
R7	0.0488	0.0873	0.3944	0.0407	0.8105
DSJ	92.58	100.68	0.3243	94.16	0.8707
DLR	2.850	2.451	0.2482	2.964	0.7406
DNP	14.03	17.45	0.0931	14.97	0.5831
PTC	0.3662	0.2035	0.0002	0.3287	0.5524
REL	0.5175	0.4113	0.1744	0.4805	0.6112
RAI	3.707	3.433	0.0774	3.6492	0.7753

Yet Poor Matches for High Scores



Examine 2000-2005 Contracts In Same Way

	Treated	Matched Controls	Significance P-value	All Controls
Good L. Zones for Ag.	22%	23%	0.34	32%
Bad L. Zones for Ag.	61%	58%	0.21	43%

Impacts Summary & Policy Implications

- in 00-05 only 2% of enrolled land would have been deforested; thus payments are 50 times as high as with ‘perfect targeting’
- yet this (low) impact is over twice as high as the 0.8% in 97-00
  - despite net reforestation there was actually more gross deforestation
  - unintentionally, it seems, additional top-down ‘targeting of benefits’ removed the bias against targeting threats/impact due to volunteers
- if unintentional shifts can improve forest impacts of payments, surely intentional focus on indicators of threat could do more
- however, targeting higher threat, perhaps with higher payment, could lead the distribution of payments away from the poorest
- ‘bundled policy package’ story implies impact without targets

IF TIME (ELSE SEE POSTER):

lessons from observable factors' effects on forest impacts of protected areas within Costa Rica, 1986 - 1997

AGAIN:

1) LOCATIONS NON-RANDOM; WORSE LAND

2) CORRECTED IMPACTS ARE MUCH LOWER

3) **BUT** TARGETING CAN INCREASE IMPACTS

Park Impacts within boundaries: PSM & CM

Park Effects on 86-97 % Deforestation, n = 4 in each method

(Andam et al. (PNAS) examines 1963 forward; as per trends, estimated impact is higher but matching reduces similarly)

Strategy	**Difference in Means**	**Adj. Diff. in Means**
Using All of the Untreated (Naive)	-9.38**	-1.99*
Propensity Score Matching (PSM)	-0.05	-1.37**
Covariate Matching (CM)	-2.19**	-0.85

PSM vs. CM

Treated Observations with the same match:	3.5%
Similarity between Control Groups	33.4%

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

FAR FROM SAN JOSE

i.e. over 85km

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)	-0.03	-0.60
Covariate Matching (CM)	-0.88**	-0.61*

Protecting places that are not under significant threat may not increase forest much relative to the baseline.

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

CLOSE TO SAN JOSE

i.e. under 85km

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)	-0.72	-5.14**
Covariate Matching (CM)	-3.97**	-2.75**

Targeting places under greater threat, if it is feasible, raises the impact (& the cost?) of keeping it in forest.

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

FAR FROM NATIONAL ROADS

i.e. over 7.53 km

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)		
Covariate Matching (CM)		-0.2

Protecting places that are not under significant threat may not increase forest much relative to the baseline.

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

CLOSE TO NATIONAL ROADS

i.e. under 7.53 km

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)		
Covariate Matching (CM)		-5.0**

Targeting places under greater threat, if it is feasible, raises the impact (& the cost?) of keeping it in forest.

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

ON HIGHER SLOPES

i.e. over 7.12 degrees

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)		
Covariate Matching (CM)		-1.1

Protecting places that are not under significant threat may not increase forest much relative to the baseline.

Park Impacts within boundaries -- comparisons

Park Effects on 86-97 % Deforestation, N = 4 in each method

ON LOWER SLOPES

i.e. under 7.12 degrees

Strategy	Difference in Means	Adj. Diff. in Means
Using All of the Untreated (Naive)	*-9.38***	*-1.99**
Propensity Score Matching (PSM)		
Covariate Matching (CM)		-14.2**

Targeting places under greater threat, if it is feasible, raises the impact (& the cost?) of keeping it in forest.

SPILLOVERS (%) **in 0-2km Rings**

	Naive	OLS	PS Match	NN Match	
ALL	-5.19***	-2.02	-2.2	-4.56**	*blocking?*
Large			-1.1	-4.9**	*blocking?*
Small			-7.1**	-9.1***	*blocking*
Steep			-0.5	3.4	*nothing*
Flat			-8.8**	-12.0***	*blocking*

*** p<0.01
** p<0.05
* p<0.1

<u>next:</u> see 6-8k rings for the subsets too

leaking?