

**Evaluating Policy Impacts  
on Tropical Deforestation:  
*implications for REDD costs***

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# Many Contributors

- empirical work on deforestation in Costa Rica & Brazil:
  - Suzi Kerr was co-initiator for Costa Rica deforestation work
  - Arturo Sanchez leads on data in all the Costa Rica analyses
  - grants: NSF, HIID, NCEAS, Tinker & NASA for Amazon
  - PIs on Amazon grants: Robert Walker and Eustaquio Reis
- parks evaluations:
  - Andam & Ferraro leading first paper on within-boundaries
  - Robalino leading our work on outside-boundary spillovers

## THE FIVE QUESTIONS -- *quick answers*

1. How estimated OC of REDD? *a multiple of land OC, based upon our estimate of what % of policies have impact*
2. What component(s) of REDD costs are included?
  - (a) opportunity costs? *yes (multiple parcels')*
  - (b) implementation costs? *could call excess that*
  - (c) transaction costs? *could call excess that*
3. What is REDD supply curve?  *$X * \text{land OC}$  ( $X$  varies)*
4. How reliable are results (given all inputs)? *robust*
5. Method should be used in FCPF? *it seems relevant*

## Why? (lack of) Targeting, Policy Location & Matching

- much policy discussion; less empirical evaluation & little attention to *where* the policies are implemented
- *where* is determined by agency & land owner choices which we argue likely respond to factors we observe
- empirically examine the implications of those choices
  - LOCATIONS REALLY LOOK NON-RANDOM
  - THIS REALLY MATTERS FOR EVALUATION; MATCHING ESTIMATES REALLY DIFFER...  
(*note: they do not address the un-observables*)

## **Find? 2 Countries, 3 Famous Policies, 4 Results**

- payments for eco-services (Costa Rica)
  - impact very low, in part due to other policy success
  - matching finds significant role of enrollment design
- parks, within boundaries (Costa Rica)
  - impact varies with time, i.e. with clearing trends
  - matching always greatly reduces impact estimate
- parks, outside boundaries (Costa Rica)
  - ‘leakage’ if anything in recent spatial interactions
  - matching reverses spatial patterns found in naive
- roads (Amazon): are ‘endogenous’ & impacts vary

## How? Background Deforestation Empirical Work

- Costa Rica
- initially deforestation over time, for carbon 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 and a set of useful covariates: rain, temperature, soil, slopes (neighbor slope instrument for spatial interactions)
- distance to markets / roads also a key characteristic

## **Policy 1 -- 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 Payment Impacts – Data

- using pixels, draw 10,000 locations across Costa Rica
  - examine the locations covered by forest in 1986, 1997, 2000
  - initially do not look at locations inside of the protected areas
  - missing some observations due to clouds blocking satellites
- dependent variable is deforestation (86-97, 97-2000)
- control for non-policy characteristics of the locations:
  - distances to: cities, roads, rivers, schools, sawmills
  - biophysical characteristics: rain, elevation, slope

# Making Sure We Compare Apples To Apples

Want exactly the same Xs:

- if not same Xs, the functional form may matter a lot
- naïve with bias adjustment may or may not be right

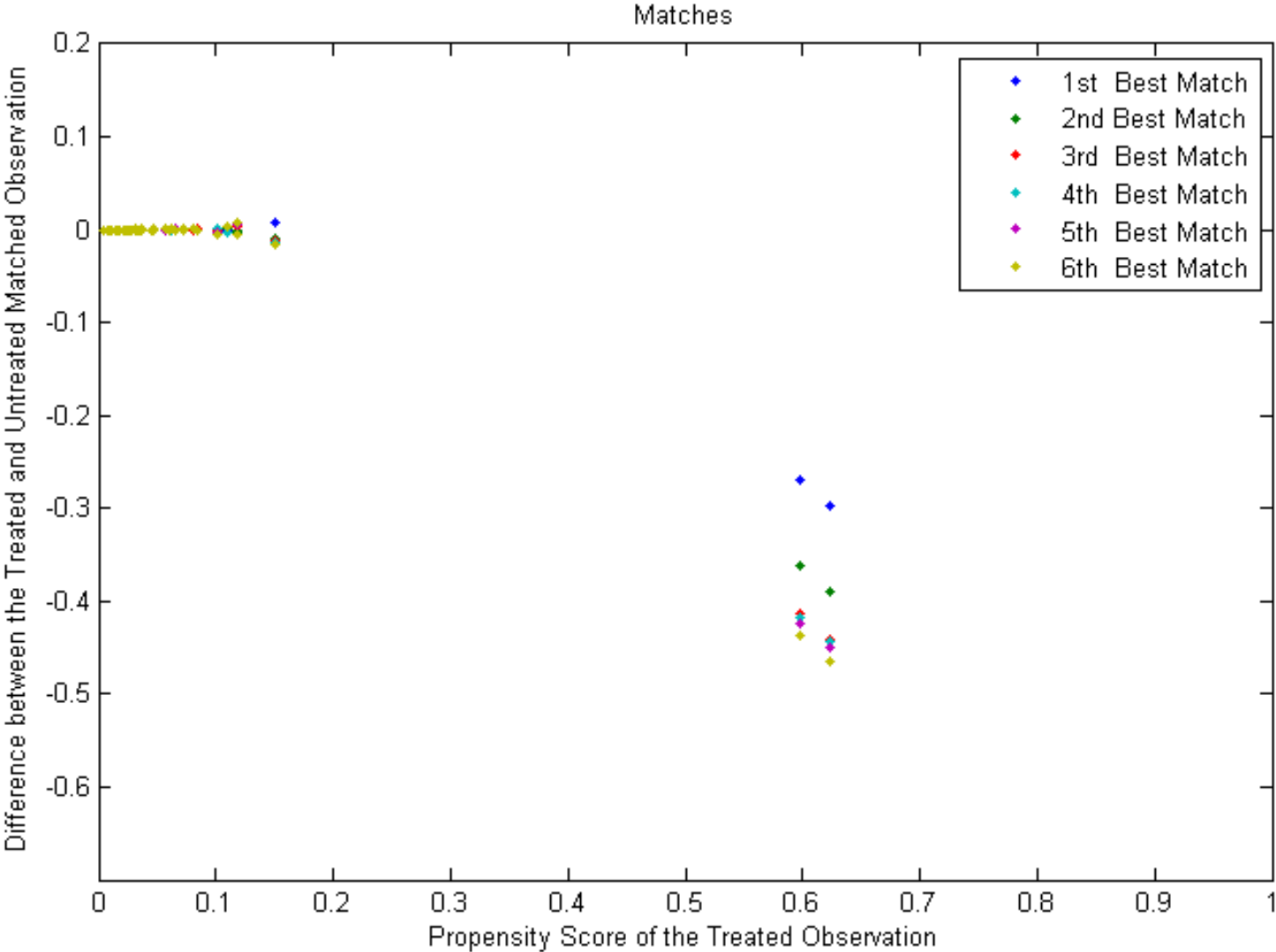
Else matching is like naïve:

- if no such Xs in the untreated, always extrapolating
- example: Payments vs. Parks (larger & spillovers); latter have many fewer untreated points per treated
- this raises the issue of dropping the poor matches

## Matching Improves The Comparison (PSM, n=6)

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

# Yet Poor Matches for Places Likely To Get Paid



# Impact Small & Non-randomness Lowers More

|                  | Not Adjusted      |                   | Bias Adjusted     |                   |
|------------------|-------------------|-------------------|-------------------|-------------------|
|                  | <u>3-year (%)</u> | <u>Annual (%)</u> | <u>3-year (%)</u> | <u>Annual (%)</u> |
| <u>Naive</u>     | -0.63 (-0.51)     | - 0.21            | -0.42 (-0.33)     | - 0.14            |
| <u>PSM (n=6)</u> | -0.29 (-0.30)     | - 0.10            | -0.46 (-0.46)     | - 0.15            |
| <u>PSM drops</u> | -0.43 (-0.41)     | - 0.14            | -0.48 (-0.45)     | - 0.16            |
| <u>CM (n=6)</u>  | -0.40 (-0.81)     | - 0.13            | -0.00 (-0.02)     | - 0.00            |

## **Robustness (at least in our data)**

- F. Tattenbach finds large impacts (see his presentations)
- S. Pagiola notes ‘additionality’ was not a requirement and that studies use different time periods and scales
- did 5x5k grids & subregions (Sanchez et al. 2007) & find no statistically significant impact in regressions
- then apply both pixels & grids to the post-2000 PSA (Robalino et al. 2007, sent to Pagiola’s special issue):
  - net reforestation in 2000-2005 but deforestation is higher
  - oversubscribed & more agency selection yields unbiased

## **Policy 2 -- Protected Areas**

- since 1970, significant expansion of reserves and also paying for a suite of environmental services
- decisions on new reserves are currently pending, including if C payments arrive (w/ other benefits)
- GRUAS proposal within Meso American planning intended to cover varied vegetation or ecosystems and thus to save various species (or ‘biodiversity’)

## **Expect Non-Random Reserve Location**

- as discussed above concerning eco-payments, targeting threatened forest could raise impact; in other words, *we advocate non-randomness*
- further, *other “non-random motivations”* exist, e.g. long-lasting or uncontentious/cheap parks
- in either case of optimization by the park creator, we would not expect a random park distribution

# Park Impacts within boundaries: PSM & CM

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

*(Andam & Ferraro examining from 1963 forward; per trends, estimated impact is higher though matching again reduces it)*

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| <b>Strategy</b>                    | <b>Difference in Means</b> | <b>Adj. Diff. in Means</b> |
|------------------------------------|----------------------------|----------------------------|
| 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**

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

# Park Impacts within boundaries: PSM & CM

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

NOW ONLY **FAR FROM** SAN JOSE

i.e. over 85km (562 observations)

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

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# Park Impacts within boundaries: PSM & CM

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

NOW ONLY **CLOSE TO SAN JOSE**

i.e. under 85km (396 observations)

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

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# Discussion 1

- Forest Transitions? be concerned about leakage !!  
(New England forest back but Midwest/other gone)  
(noting Amazon exports soy, beef, timber to others)
- What if National Baselines w / Perfect Monitoring?
  - if globe pays only for actual changes, targeting perfect
  - however, points hold for those acting to earn payments
  - this surely matters for participation and overall supply

## Discussion 2

- Ongoing Extensions: detailed work in Costa Rica plus at this point early results on parks in Mexico; additionally, just starting Brazil as well as Global
- Inefficiencies Increase Costs: one should EXPECT that policies will not be perfectly targeted for impact; measured land OC underestimates total REDD costs
- Policy Perspective: as seen for payments & parks, choices that are the provenance of agencies matter, such that adjustments to policies could lower costs