

ONLINE APPENDIX

Only One Tree from Each Seed? Environmental Effectiveness and Poverty Alleviation in Mexico's Payments for Ecosystem Services Program

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APPENDIX PART B: PARCEL LEVEL FOREST LOSS AND DYNAMIC EFFECTS

In order to corroborate our findings and explore dynamic impacts, we also estimate program impacts using annual forest loss data from 2001-2012 at the parcel level (Hansen et al. 2013). All areas applying for the program were broken into unique parcels in order to code applicant status in each year for each parcel. The estimating equation is:

$$(B1) \text{Loss}_{ist} = \beta(\text{beneficiary}_{ist}) + \delta' \mathbf{X}_i + \alpha_s + \alpha_t + \varepsilon_{is}$$

where *Loss* is the forest loss outcome, measured as a percent of parcel area or in hectares, for parcel *i* in state *s* and year *t*. Hansen's annual data measures only forest loss, not forest gain, so we use Tobit regression with dummies for state and time. Parcels less than 2 ha in size or with less than 10 percent forest cover in 2000 are omitted. Matching is conducted using the same methods as for the NDVI data with covariates from the Thiessen polygon containing each parcel. Results with all data and matched data are shown in Table B1.

We also explore possible event-study versions of the estimates and the impact of exit using both the mean NDVI data and Hansen's forest loss data. We control for the same covariates as in the main specifications equation (1) and equation (B1). Regressions include a series of dummy variables indicating the time before and after application, T_e , for each point or parcel. This is interacted with the variable indicating whether or not the point or parcel is a beneficiary of the program (B_i). The parameters β_e thus measure the average outcome for the rejected applicants for each event-time-year (relative to the omitted T_e) while θ estimates the additional effect for beneficiary properties at that time. The log of mean NDVI is used to reduce

differences between cohorts. For the NDVI data we can include point fixed effects, the omitted category is $T_e = -4$ for both groups. For the forest loss data we cannot include point fixed effects, the omitted category is $T_e = -4$ and $B_i=0$.

The estimating equations are respectively:

$$(B2) \text{Ln}(MNDVI)_{ipst} = \sum_{e=-4}^4 (\beta_e T_e + \theta_e B_i T_e) + \delta' \mathbf{rainfall}_{it} + \alpha_{st} + \alpha_i + \varepsilon_{ipst}$$

$$(B3) \text{Ln}(Loss)_{ist} = \sum_{e=-5}^6 (\beta_e T_e + \theta_e B_i T_e) + \delta' \mathbf{X}_i + \alpha_s + \alpha_t + \varepsilon_{ist}$$

Figure B1 shows year by year impacts for both outcomes and all data while Figure B2 shows year-by-year impacts just for the 2004 and 2005 cohorts, which are the only two cohorts which have the possibility of exiting the program. The dotted line maps out β for each event period, while the solid line shows $\beta + \theta$, and is shaded by the confidence interval for θ . Figure B1 indicates qualitative evidence of similar pre-program trends and greater forest cover or less forest loss following enrollment in the program, after application. Unfortunately, the confidence intervals for the difference indicate a lack of precision in these year-by-year estimates. This is due in part to the fact that the estimates for the early and late years come from a limited number of cohorts (as illustrated in Table B2) as well as the fairly noisy nature of forest loss year to year.

Figure B2 illustrates year-by-year effects for all 2004 and 2005 parcels (panel a) and by their renewal status (b). Again, estimates are noisy, but we see preliminary support for two policy-relevant points. First, the impact of the program appears to be higher for those who apply and renew contracts than for those who apply and are rejected from new contracts. This suggests that long term forest conservation may require long term contracts. Second, the higher forest loss among those who choose not to reapply suggests that the decision to reapply is at least partly endogenous. This is not surprising since exit is a combination of participant choice and the adjustments in targeting strategy that have been made by CONAFOR over time. Future work should explore in detail whether program gains are temporary or whether program beneficiaries permanently shift livelihoods. Longer term data on reapplication and forest change and from more cohorts is needed to study these questions.

TABLE B1- PROGRAM IMPACTS USING HANSEN ET AL. (2013) ANNUAL FOREST LOSS

	Dependent variable: Forest Loss				
	All cohorts				2004-2005 cohorts
	Percent area loss		Ln(hectares) loss		Ln(hectares) loss
	All	Matched	All	Matched	Matched
	(1)	(2)	(3)	(4)	(5)
Beneficiary	-0.1857*** (0.0475)	-0.1608*** (0.0609)	-0.0608*** (0.0129)	-0.0534*** (0.0161)	-0.1072*** (0.0124)
N parcels	291126	149072	291126	149072	29777

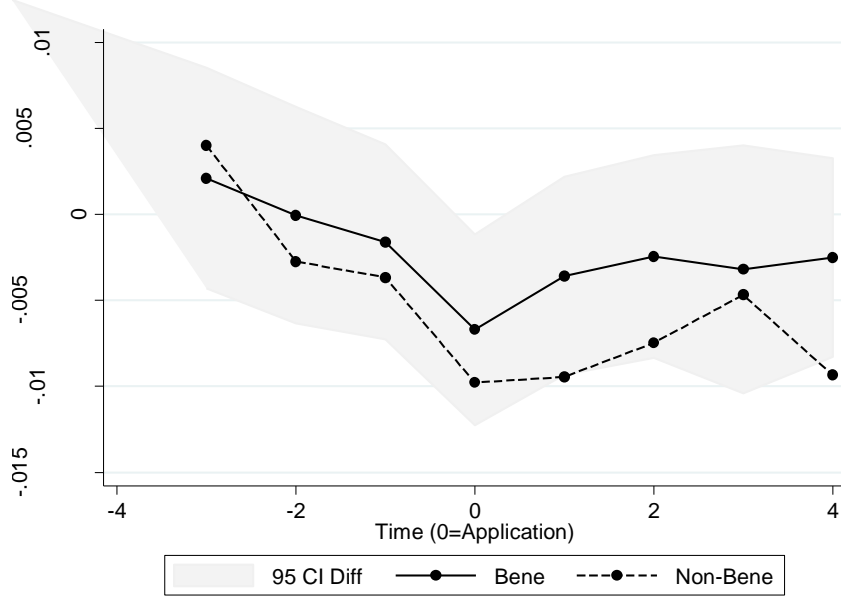
Notes: Estimated coefficients from Tobit model on parcel level data with state and year fixed effects (equation B1) and same controls as Table 4, plus area controls when dependent variable is in hectares.

*** Significant at the 1 percent level ** Significant at the 5 percent level * Significant at the 10 percent level.

TABLE B2 - NUMBER OF COHORTS BY EVENT-STUDY TIME (0=APPLICATION)

Time	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
# cohorts (points data)		3	4	5	6	6	6	6	5	4		
# cohorts (parcels data)	4	5	6	6	6	6	6	6	6	5	4	3

A. Forest cover



B. Forest loss

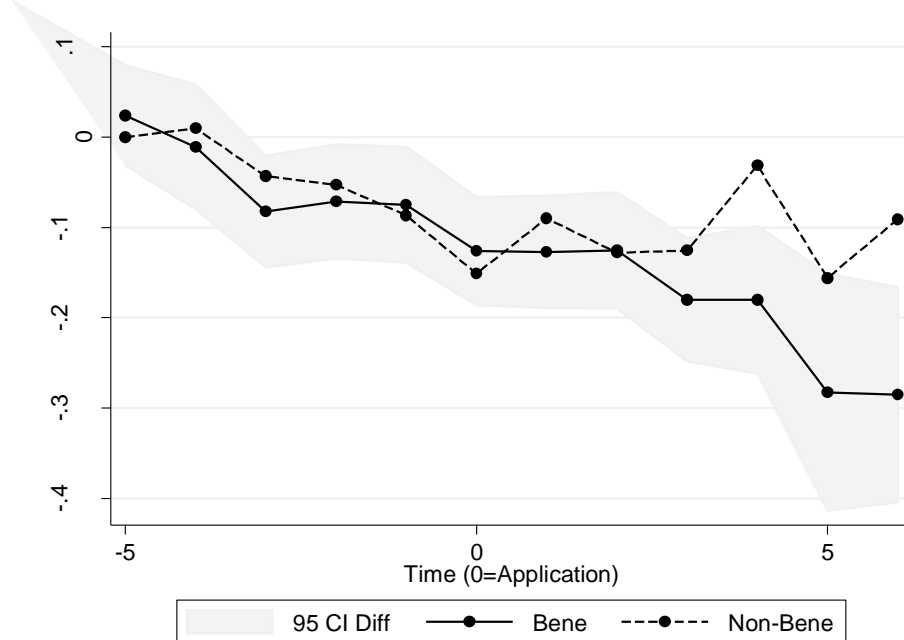
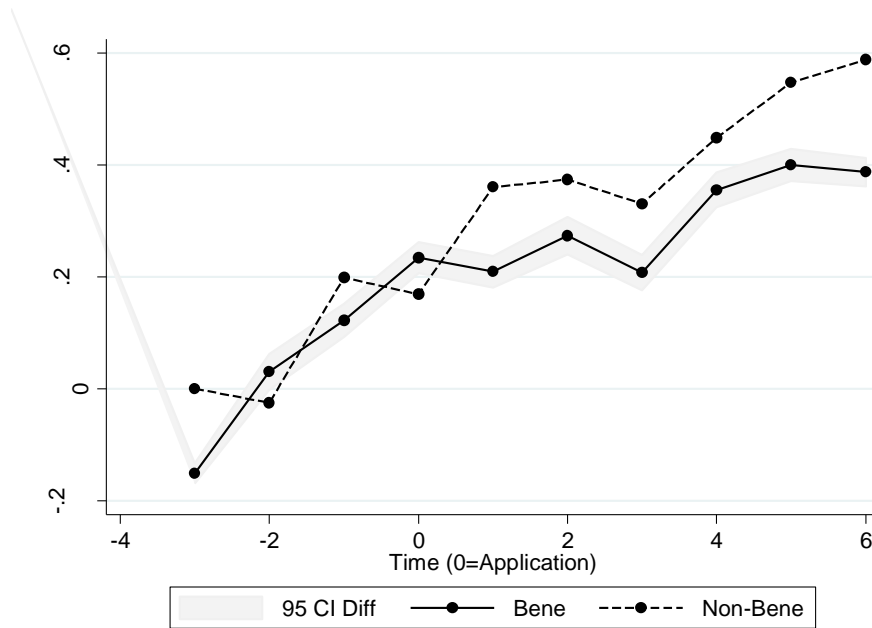


FIGURE B1. YEAR BY YEAR PROGRAM IMPACTS

Notes: Treatment effect given by the difference between the two lines; shaded area indicates 95 percent CI for the difference. a) Dependent variable is the log of mean NDVI. Estimated coefficients from point fixed effects model with year by year differences between beneficiaries and matched controls (equation B2). Omitted category is 4 years prior to application. b) Dependent variable is ln(ha) forest loss. Estimated coefficients from Tobit model on parcel level data with state and year fixed effects and same controls as Table 4 plus area (equation B3). Time indicates years before and after application to the program with year zero = year of application. Dotted line indicates non-beneficiaries; solid line indicates beneficiaries.

A. Forest loss: Beneficiaries vs. non-beneficiaries



B. Forest loss: Beneficiaries that renew, reapply but are rejected, or do not reapply vs. non-beneficiaries

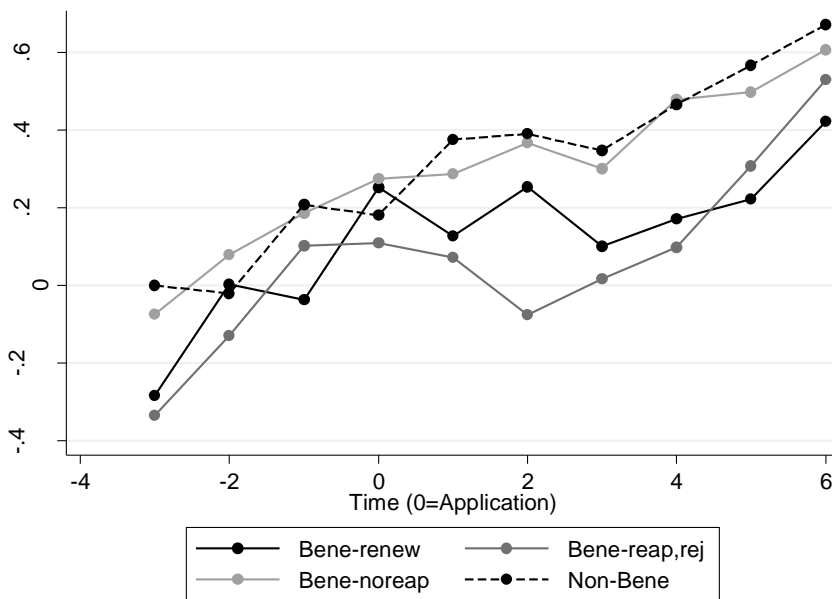


FIGURE B2. YEAR BY YEAR IMPACTS FOR 2004 AND 2005 COHORTS ONLY

Notes: Treatment effect given by the difference between the two lines; shaded area indicates 95 percent CI for the difference. Dependent variable is ln(hectares) of forest loss. Estimated coefficients from Tobit model on parcel level data with state and year fixed effects and same controls as Table 4 plus area. Time indicates years before and after application to the program with year zero = year of application. Dotted line indicates non-beneficiaries; Black line indicates beneficiaries who reapply and renew, dark grey line indicates beneficiaries who reapply but are rejected, light grey line indicates beneficiaries who choose to not reapply.