Comparing Protection Types in the Peruvian Amazon: Multiple-Use Protected Areas Did No Worse for Forests

Jimena Rico Straffon [1] Zhenhua Wang [2] Alexander Pfaff [3]

[1] UC Santa Barbara

[2] University of Missouri

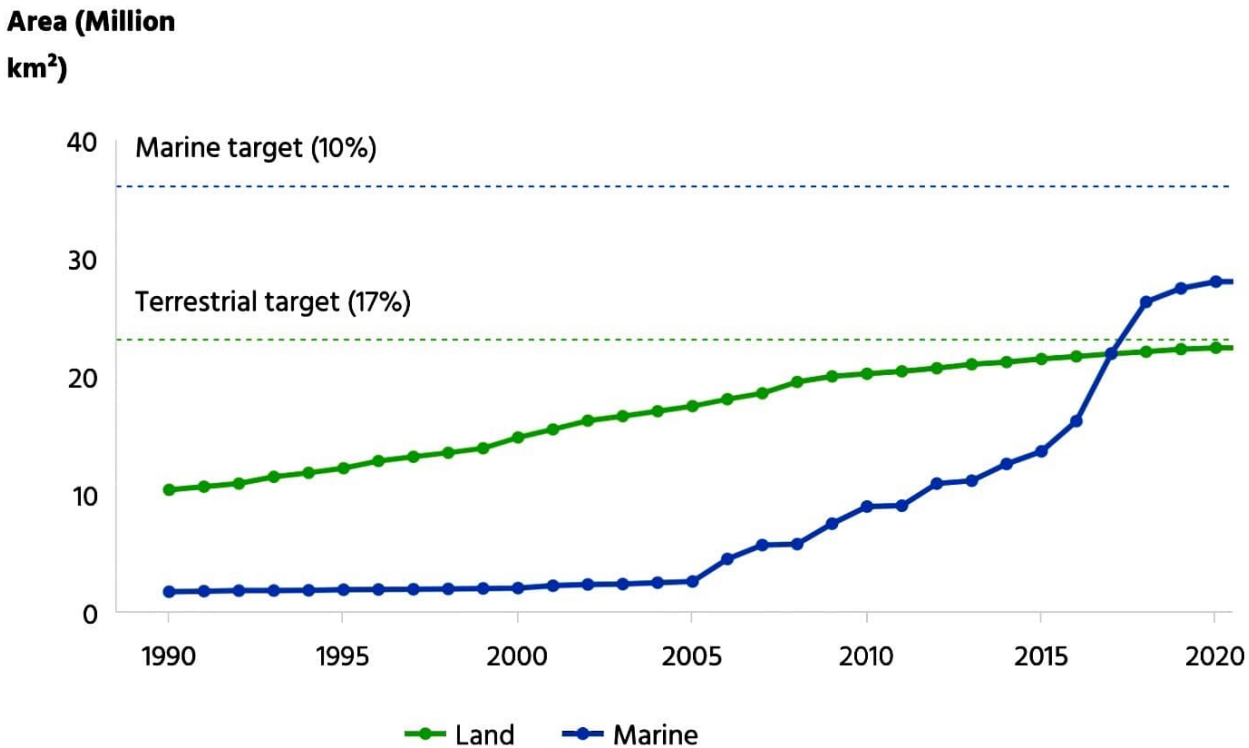
[3] Duke University

LACEA LAMES. November 3, 2022

Forests are key for climate change mitigation & biodiversity

- Forests provide local, regional, and global public goods.
- Protected Areas (PAs) are the world's leading conservation policy.

Fig. 1. Global Protected Area coverage (1990-2020)



Source: Protected Planet Report 2020

Estimating forest loss impacts of Protected Areas

- PAs restrict economic activities.
- Wide range of types that vary in stringency, management, and location.
  - Strict PAs ban all types of extractive activities (local costs)
  - Multiple-Use PAs allow locals to use the forest and play a role in PA management
- Yet for all of those contexts, it is unclear which PA type works best.

Research question

- Did Multiple-Use PAs conserve less or more forest than did the Strict PAs?

Theoretical forest loss impacts

1. **Strict PAs** (ambiguous)
   - Good monitoring and enforcement prevents invasions ($\downarrow$ loss)
   - Bad monitoring and enforcement $\Rightarrow$ PAs subject to invasions ($\uparrow$ loss)
2. **Multiple-Use PAs** (ambiguous)
   Allowing economic activities and supporting local livelihoods
   - could facilitate enforcement and monitoring ($\downarrow$ loss)
   - could lead to unsustainable forest use ($\uparrow$ loss)

Empirics: Methods

First estimates of forest impacts from post-2000 public PAs in Peru

- considerably longer panel of forests (1986-2018) than previous lit
- new Difference-in-Differences (DID) estimators

These data and estimators allow us to:

- remove biases from treatment effect heterogeneity & contamination
- test for the main identification assumption (parallel trends)

Empirics: Preview of Results

- Overall, we find limited forest gains from post-2000 protected areas
- Less strict multiple-use PAs do no worse than strict PAs – if anything, multiple-use PAs may have blocked more forest losses than strict PAs.

Types of PAs in the Peruvian Amazon

Table 1.Types of Protected Areas in the Peruvian Amazon

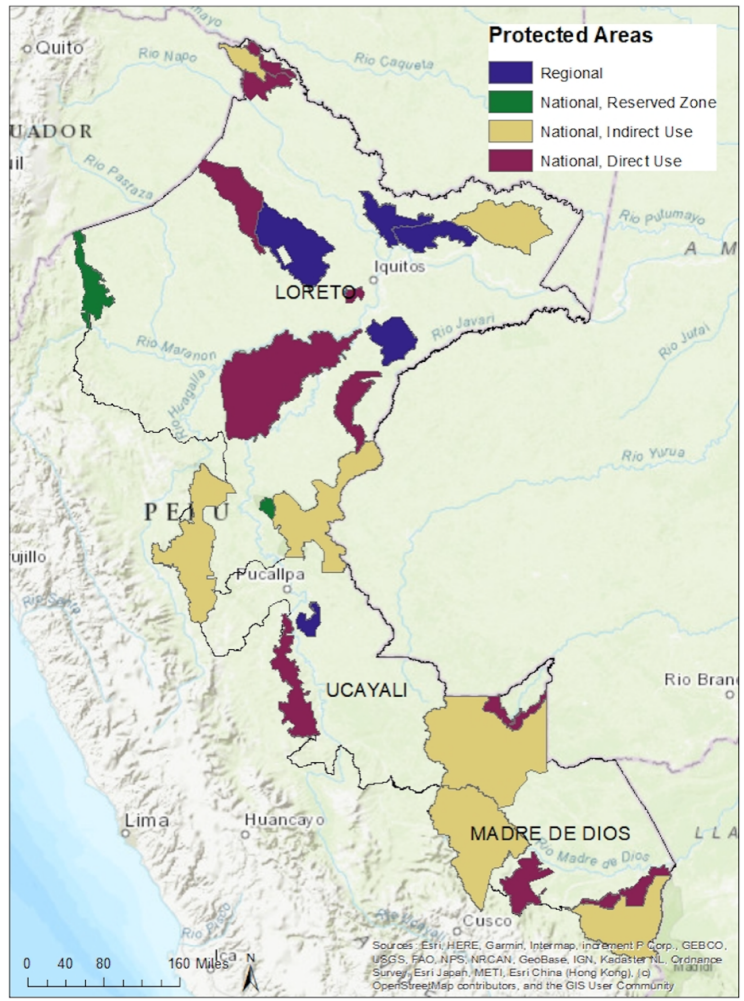
Category	Type	Level	Extraction?	Status	PA Subcategories
Indirect Use	strict	national	no	established	National Parks National Sanctuaries Historical Sanctuaries
Direct Use	multiple-use	national	yes, limited	established	Wildlife Refuges National Reserves Community Reserves Protected Forests Hunting Reserves Scenic Reserves
Regional	multiple-use	subnational	yes, limited	established	–
Reserved	multiple-use	national	yes, limited	in transition	–

Source: We created this table using information from SERNANP(2022)

Data

- **Outcome:** Annual forest loss (MapBiomas Amazon Project)
- **Study period:** 1986-2018
- **Study area:** Peruvian Amazon
  - World's 4^{th} largest tropical forest
  - Largest timber region in Peru

Fig. 2. PAs in Study Area



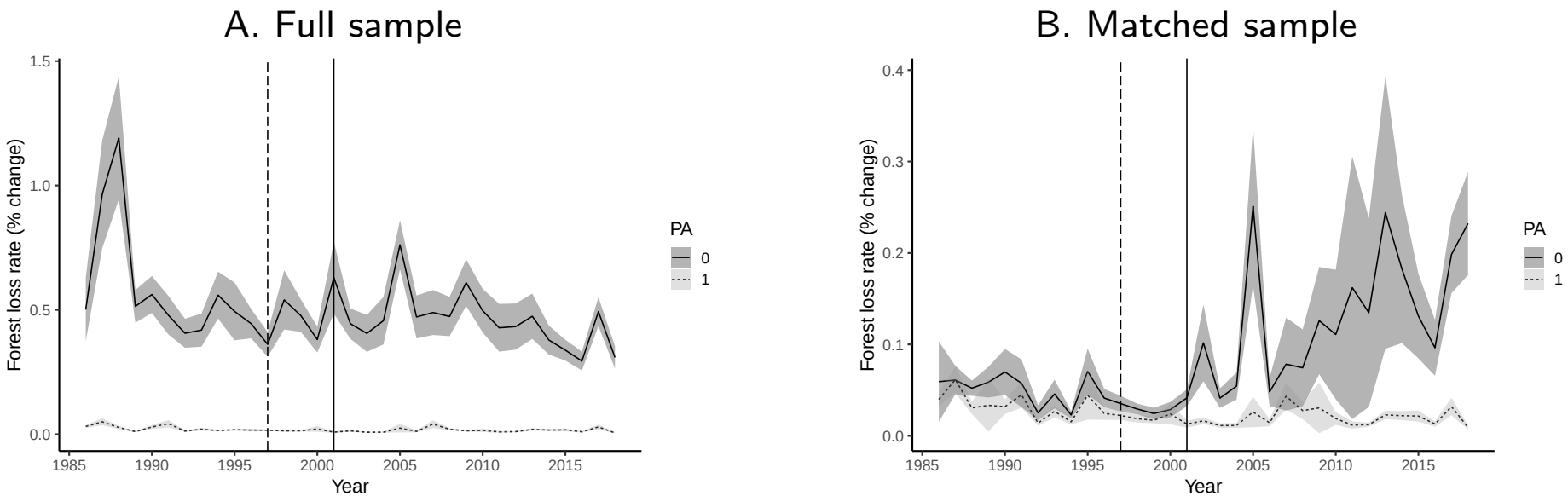
Data

- **Treatments:** strict PAs and 3 types of multiple-use PAs.
- **Control:** not-yet treated forest (will be in a PA later) and 'untreated' forests (outside of PAs, indigenous communities, and logging concessions).
- **Spatial unit of analysis:**
  - Original pixel size is 30x30m. $\Rightarrow$ binary forest-loss outcome
  - We use 9000x9000m aggregated pixels $\Rightarrow$ continuous outcome.

Pre-Estimation Matching

- For each PA type, we match treated aggregated pixels those that were never inside a PA based on pre-treatment forest-loss levels.
- Then we construct a pixel-year panel with the matched sample.

Fig. 3. Mean forest loss trends in forests inside vs. outside Strict PAs

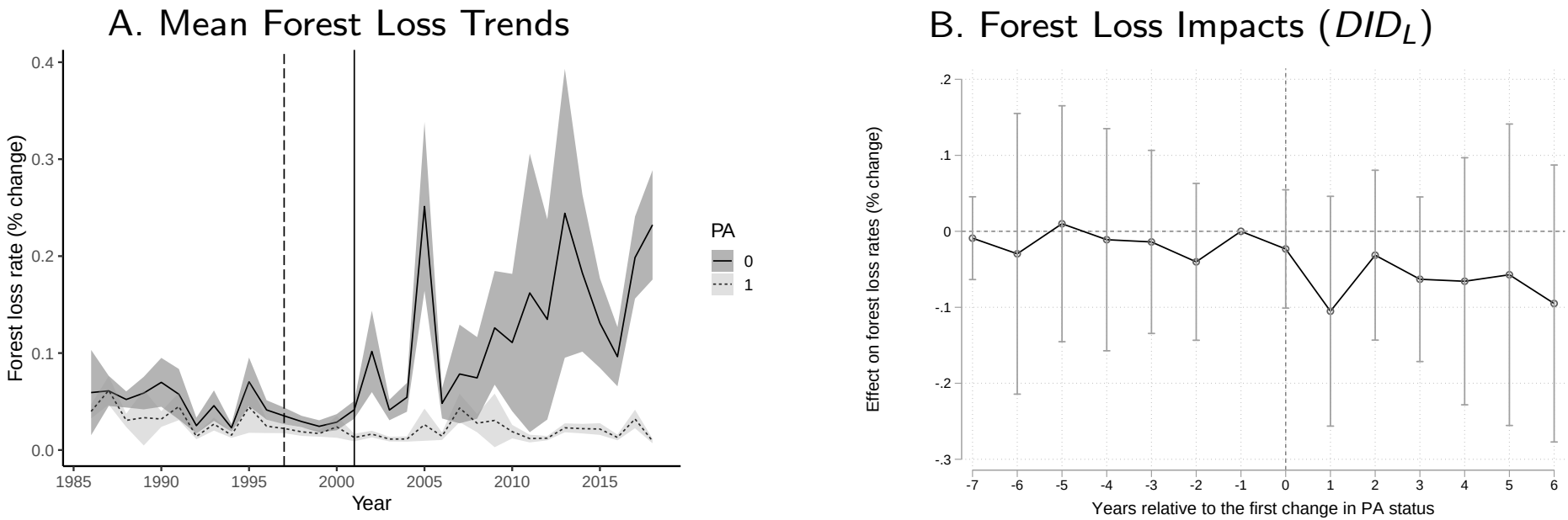


Empirical Strategy

- We exploit space and time variation – in PA creation and forest loss – to identify the effects of 21 public PAs (strict and multiple use) established during 1997-2018 within the Peruvian Amazon.
- We use de Chaisemartin & d'Haultfoeuille's (2021a & 2022b) DID estimators (DID_L)
  - Staggered design – PAs do not go back to untreated.
  - Estimators are robust to heterogenous effects and contamination biases.
  - Handle multiple treatments– if PAs become stricter.
- Key identification assumption: parallel trends

Forest loss impacts: Indirect-Use PAs

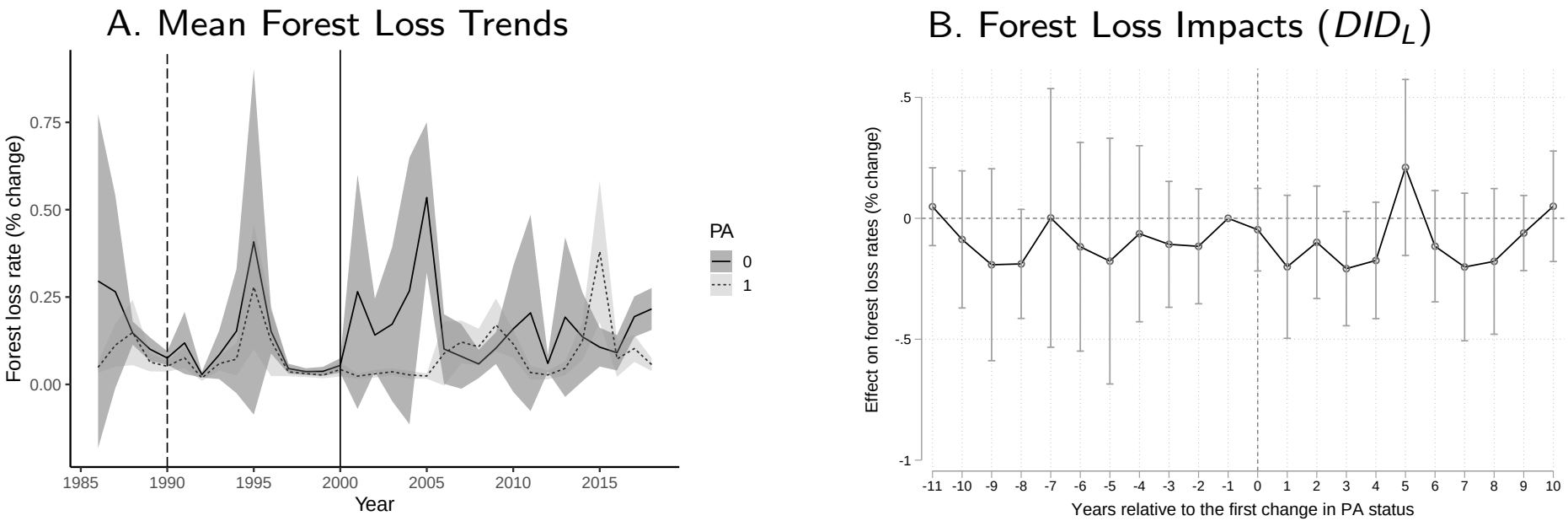
Fig. 4. Forest Loss Impacts of Indirect-Use (Strict) PAs



- Average effect= -0.061%, SE=0.056
- p-value joint significance placebo test= 0.940

Forest loss impacts: Direct-Use PAs

Fig. 5. Forest Loss Impacts of Direct-Use (Multiple-Use) PAs

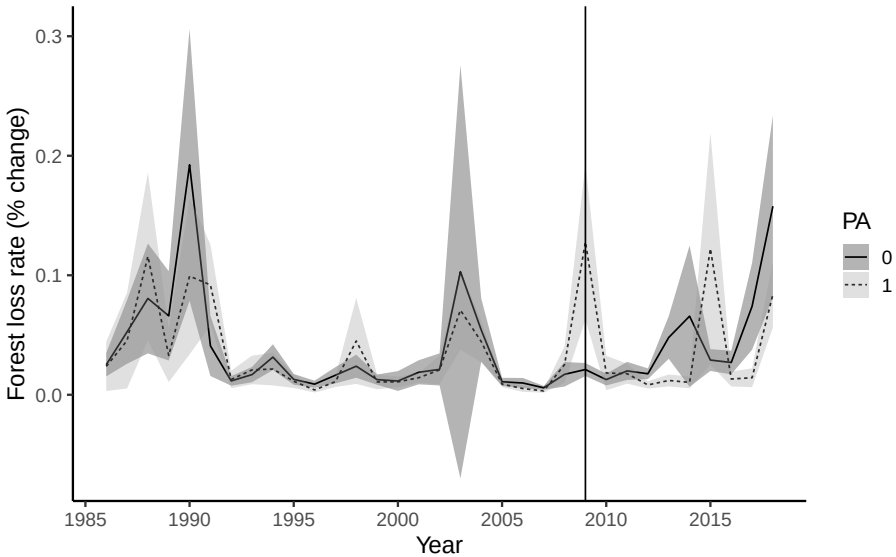


- Average effect= -0.100%, SE=0.089
- p-value joint significance placebo test= 0.477

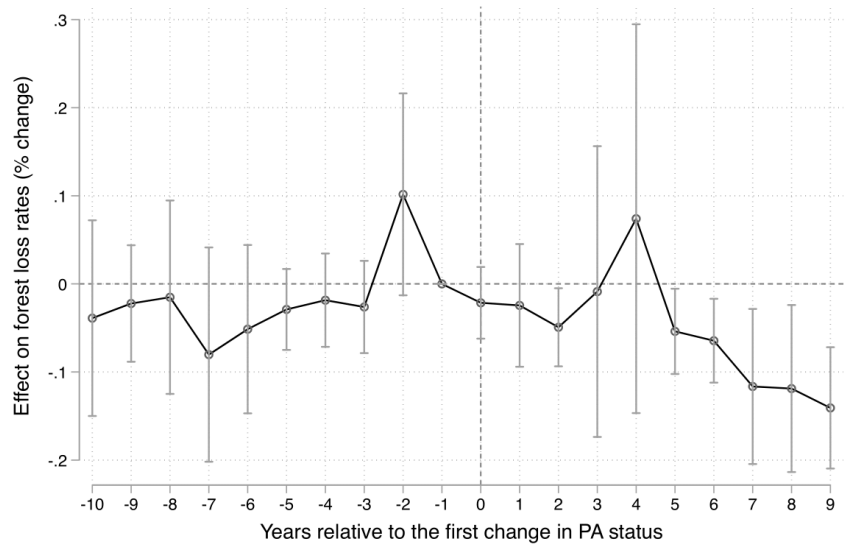
Forest loss impacts: Regional PAs

Fig. 6. Forest Loss Impacts of Regional (Multiple-Use) PAs

A. Mean Forest Loss Trends



B. Forest Loss Impacts (DID_L)

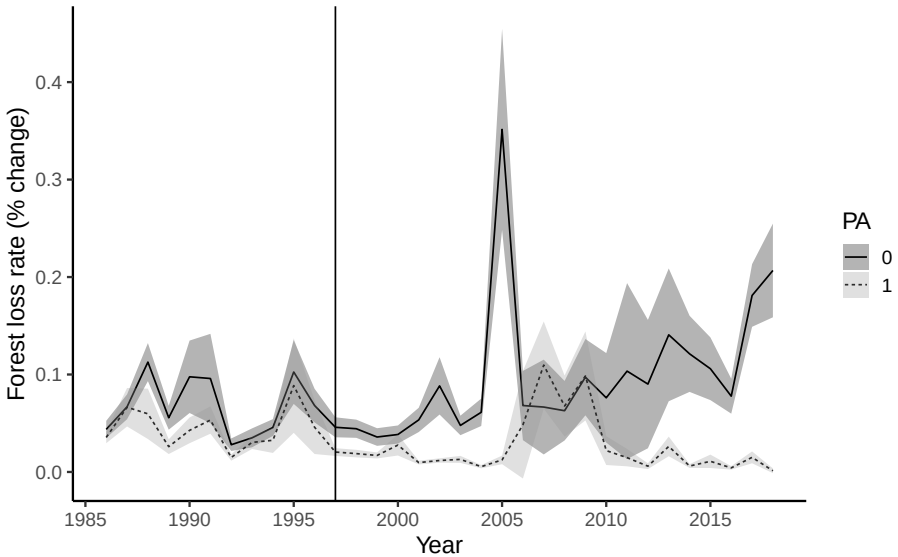


- Average effect= -0.039%, SE=0.025
- p-value joint significance placebo test= 0.141

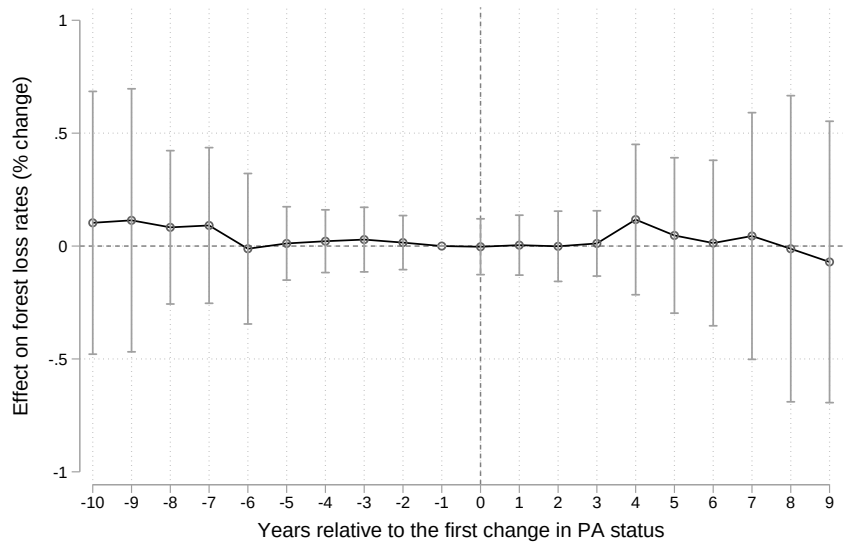
Forest loss impacts: Reserved Zones

Fig. 7. Forest Loss Impacts of Reserved Zones (Multiple-Use)

A. Mean Forest Loss Trends



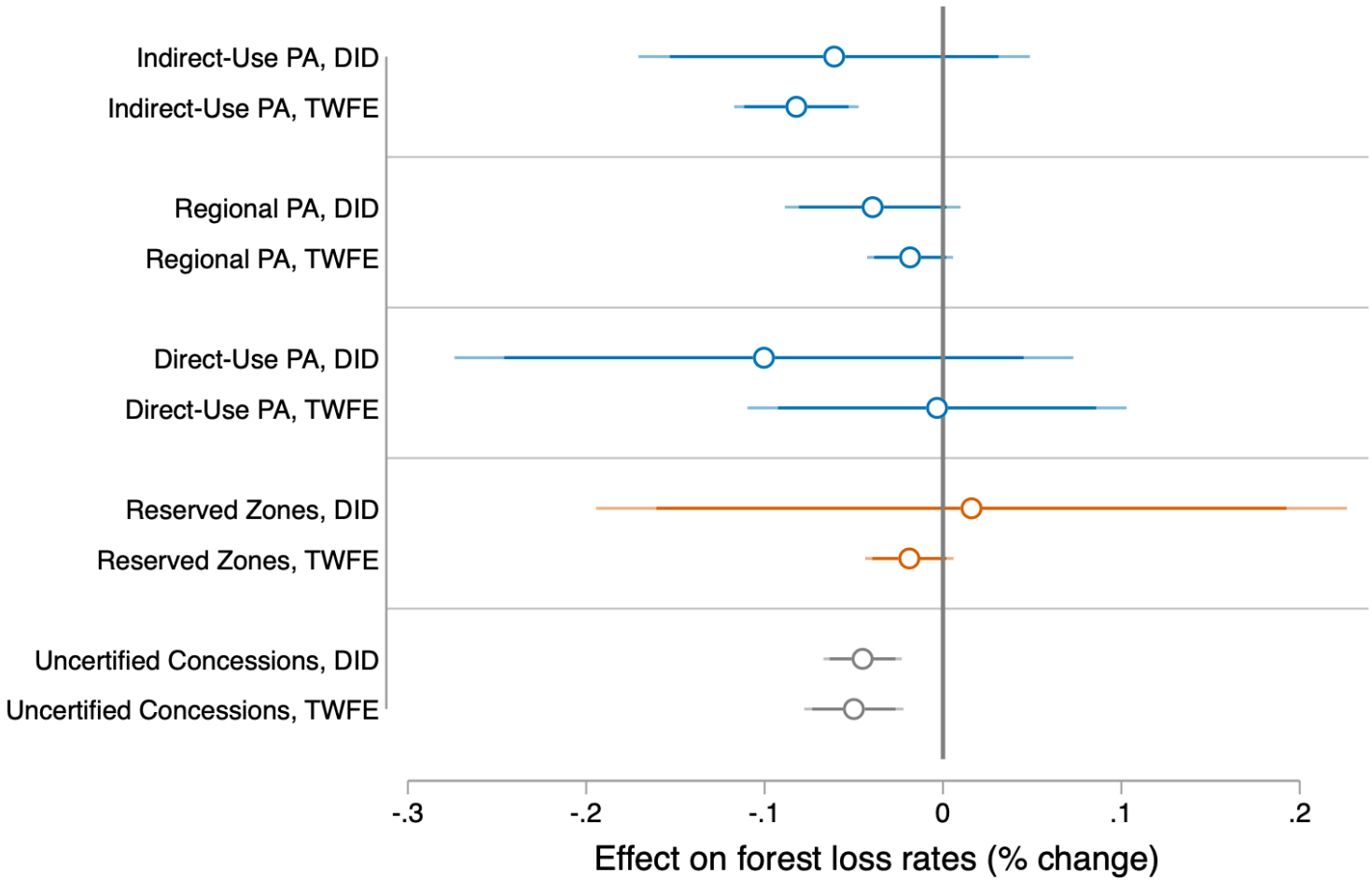
B. Forest Loss Impacts (DID_L)



- Average effect= 0.016%, SE=0.107
- p-value joint significance placebo test= 0.994

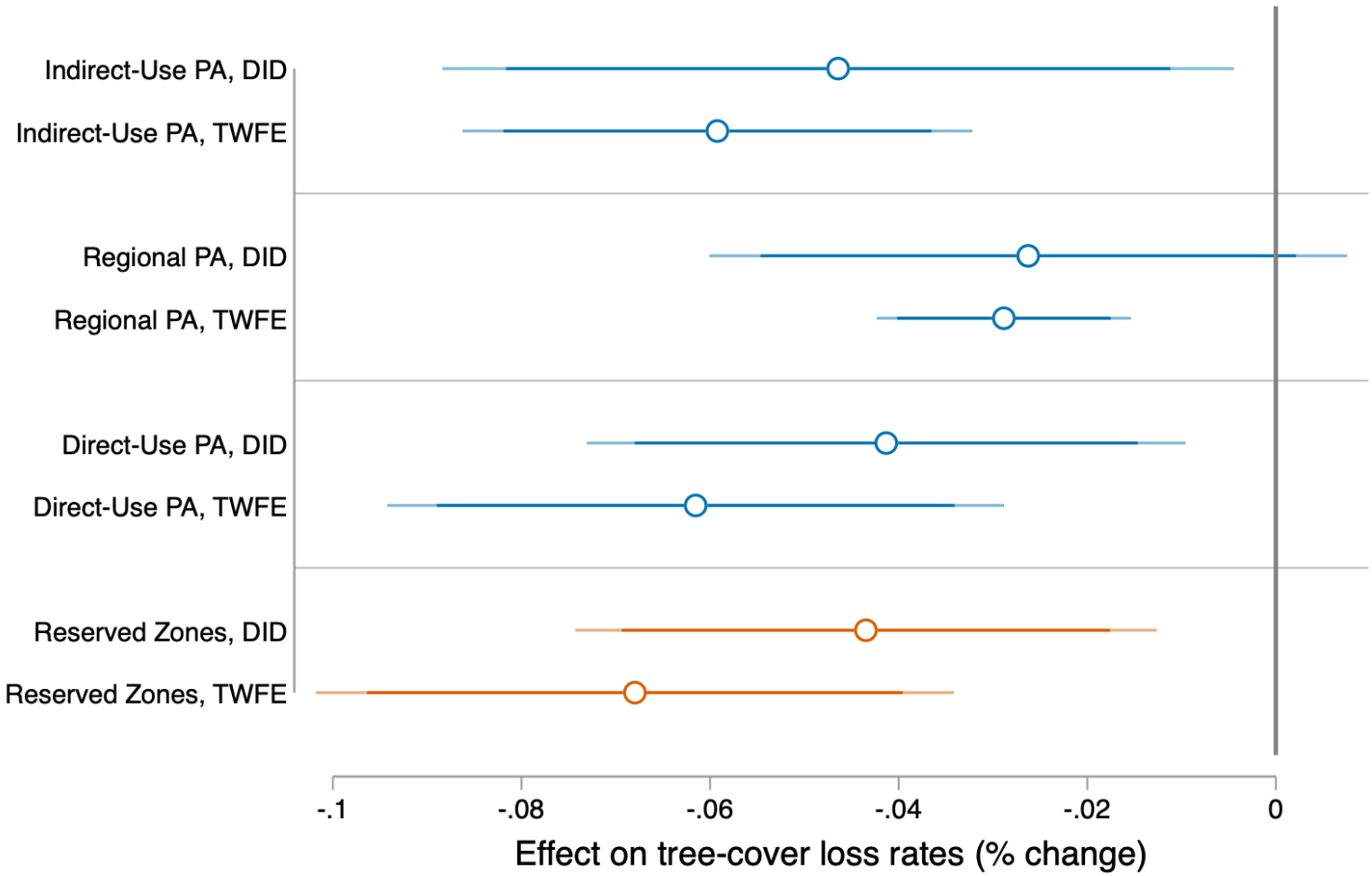
Robustness: Alternative Estimator (TWFE)

Fig. 8. Summary of Effects with DID_L and TWFE Estimators



Robustness: Alternative Forest Outcome

Fig. 9. Summary of Effects with DID_L Estimators with Hansen et al (2013)



Conclusions

- We estimated the forest loss impacts of all PAs established after the 1997 *Natural Protected Areas Act* (a new regime) in our study area, for which we have at least 11 years of pre-protection data on forests.
- We find small forest benefits from all types of PAs.
- Multiple-Use PAs aimed at improving livelihoods did not harm forests, and some blocked more forest losses than strict PAs.
- That suggests some consistency of results for economic activities coexisting with conservation, since that is precisely what was found for logging concessions, which allow regulated timber extraction by firms (Rico-Straffon et al, 2022)

Appendix

Estimators

de Chaisemartin & d'Haultfoeuille's (2021a) DID estimator at period t for first time switchers-in at period $t - l$:

$$\text{DID}_{+,t,\ell} = \sum_{g:F_{g,1}=t-\ell} \frac{N_{g,t}}{N^1_{t,\ell}} \left(Y_{g,t} - Y_{g,t-\ell-1}\right) - \sum_{g:F_{g,1}>t} \frac{N_{g,t}}{N^{nt}_t} \left(Y_{g,t} - Y_{g,t-\ell-1}\right) \tag{1}$$

Two-Way Fixed Effects:

$$L_{it} = \beta_0 + \beta_1 \text{ PA }_{it} + \alpha_i + \lambda_t + \varepsilon_{it} \tag{2}$$

Average Effects

Table A1. DID_L and TWFE Estimators of Forest Loss Impacts of Different PA Types

Estimator	Average Effect	S.E.	N	P-value Joint Placebo Test
Panel A. Indirect-Use PAs				
DID_L	-0.061	0.056	39,748	0.940
TWFE	-0.082	0.018	49,038	–
Panel B. Direct-Use PAs				
DID_L	-0.100	0.089	35,397	0.477
TWFE	-0.003	0.054	20,922	–
Panel C. Regional PAs				
DID_L	-0.039	0.025	14,652	0.141
TWFE	-0.018	0.012	20,625	–
Panel D. Reserved Zones				
DID_L	0.016	0.107	53,682	0.994
TWFE	-0.019	0.013	47,626	–

PAs in our Study Area and Study Period

Table A2. Protected Areas in our Study Area and Study Period

Name	Category	Year Reserved	Year PA	Region(s)
Tambopata	Direct	1990	2000	MDD
Cordillera Azul	Indirect	2000	2001	Loreto & Ucayali
El Sira	Direct	–	2001	Ucayali
Amarakaeri	Direct	2000	2002	MDD
Allpahuayo Mishana	Direct	1999	2004	Loreto
Alto Purús	Indirect	2000	2004	MDD & Ucayali
Purús	Direct	2000	2004	Ucayali
Comunal Tamshiyacu Tahuayo	Regional	–	2009	Loreto
Matsés	Direct	–	2009	Loreto
Ampiyacu Apayacu	Regional	–	2010	Loreto
Imiria	Regional	–	2010	Ucayali
Pucacuro	Direct	2005	2010	Loreto
Alto Nanay- Pintuyacu Chambira	Regional	–	2011	Loreto
Airo Pai	Direct	1997	2012	Loreto
Güeppí-Sekime	Indirect	1997	2012	Loreto
Huimeki	Direct	1997	2012	Loreto
Maijuna Kichwa	Regional	–	2015	Loreto
Sierra del Divisor	Indirect	2006	2015	Loreto & Ucayali
Yaguas	Indirect	2011	2018	Loreto
Santiago Comaina	Reserved	1999	–	Loreto
Sierra del Divisor	Reserved	2006	–	Loreto