Econometric modeling of the impact of forest conservation policies on the provision of ecosystem services

Juan Robalino,

Universidad de Costa Rica and CATIE

Liberia, 2016

Joint work with a lot of people

- Alexander Pfaff, Duke University
- Arturo Sanchez, University of Alberta
- Catalina Sandoval, UCR
- Laura Villalobos, Gothenburg University
- Diego Herrera, University of Vermont
- Paul Ferraro, Georgia State University
- Francisco Alpizar, CATIE and EfD
- and many others…

Research question background

So, what can we do to protect forest?

1) Create protected areas

2) Pay landowners to protect their forest

How is forest related to the provision of ecosystem services?

1) Reduces the amounts of CO2 in the atmosphere

2) Might reduce vulnerability to changes in climate and to extreme weather events

And other services like Water and air purification, and scenic beauty…

Why is evaluation important?

- When evidence is missing…
  - decisions are not based on what works..
  - despite good intentions, decisions are not optimal
- Advantages of evaluating
  - Cost effective measures can be identified
  - Generates credibility and increases support and willingness to contribute

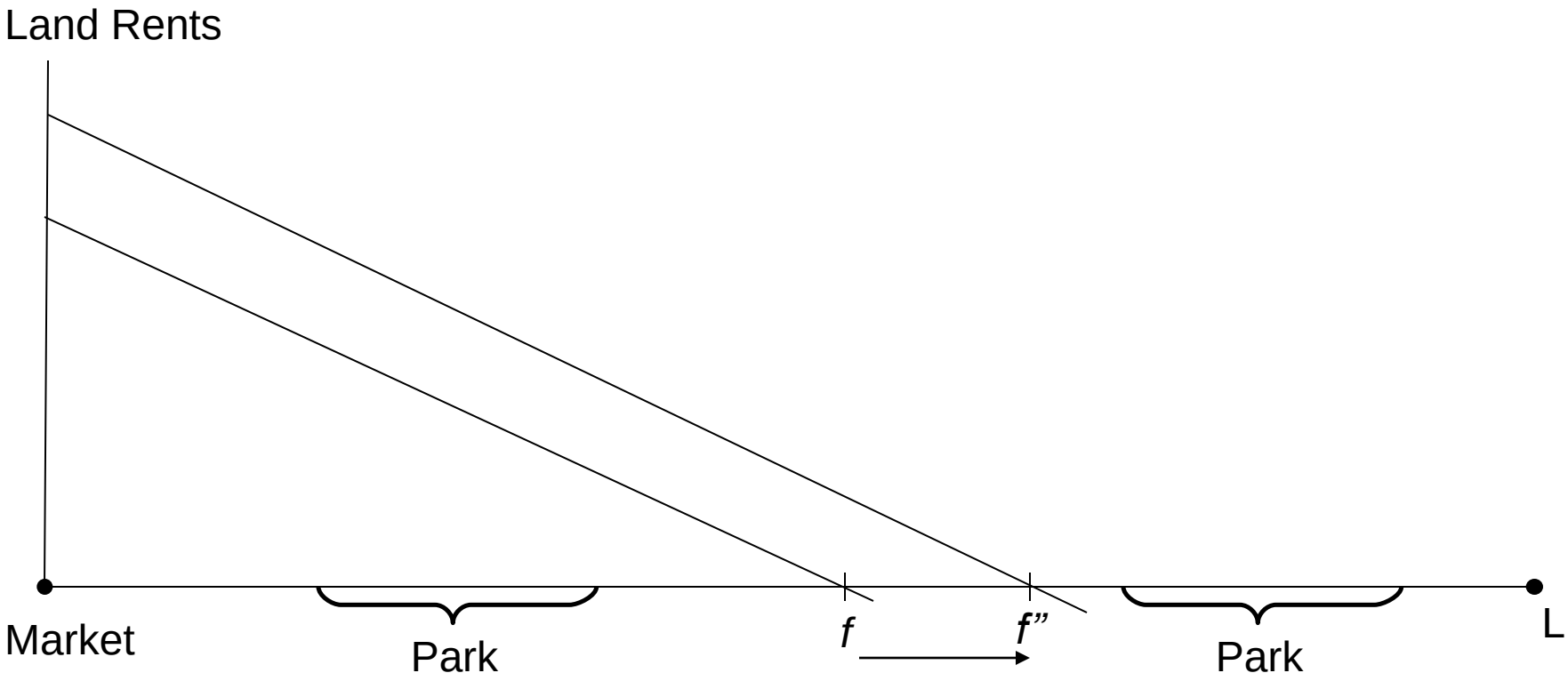
Expected impacts of conservation policies on deforestation

- Protected areas forbid deforestation
- Payments are incentives to conserve forest

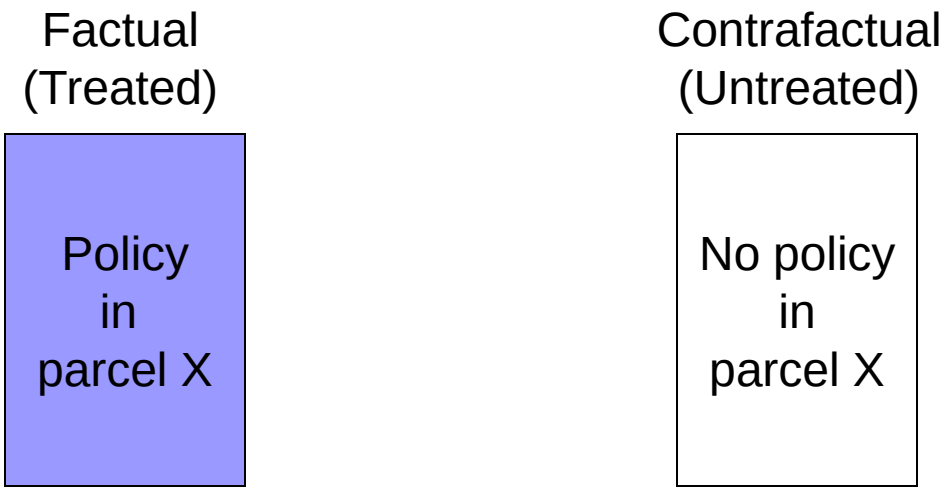
Change in the expected impact

- The impact of the policy could be reduced due to:
  - Illegal behavior:
    - Illegal deforestation
    - Break the contract
  - Missing the target
    - Parks and payments might be located in areas where no deforestation is going to take place (illustration)
  - Leakage effect
    - People might increase deforestation else where
- The impact of the policy could also be increased:
  - Propagation and contagion of conservation due to interactions

Simple graphical representation



Treatment Effect



Treatment effect in Parcel X =

The Factual Deforestation Rate -

The Counterfactual Deforestation Rate

Estimating counterfactuals

- Two very common ways of estimating counterfactual deforestation rate:
  - Use areas where no conservations policies have been implemented
  - Use the same area before the policies was implemented

Differences in means

- Wittemeyer et al. 2008

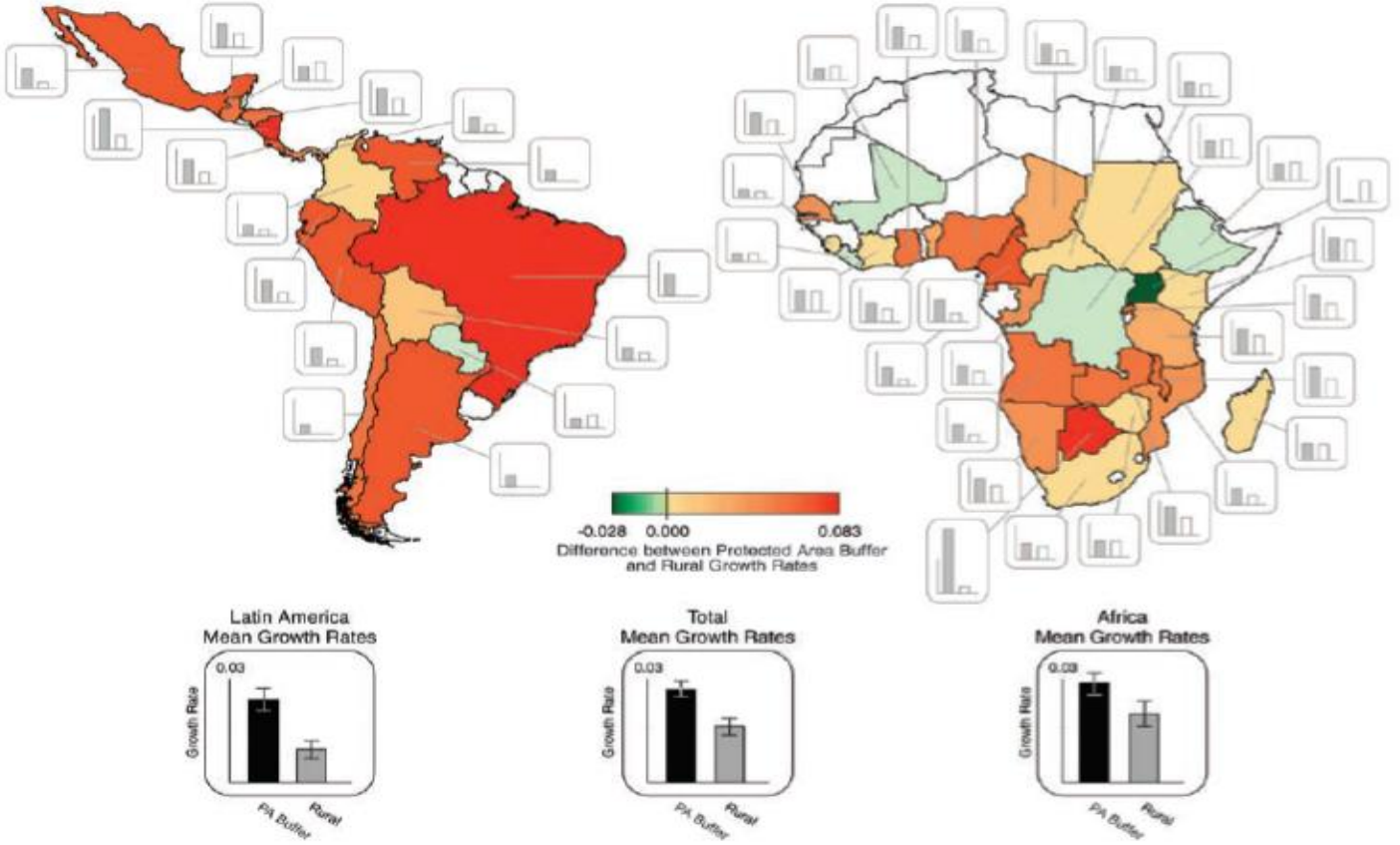


Fig. 1. Across Africa and Latin America, human population growth rates in 10-km buffers surrounding PAs (black bars) nearly doubled those of national rural growth rates (gray bars), exceeding them by an average of ~1% per annum. Error bars show standard errors of the means. Buffer growth rates topped the national rural growth rate in approximately 85% of the 45 countries for which PAs were assessed (colors are scaled by the difference between buffer and rural growth rates). The smaller histograms compare average buffer (gray) and rural (white) population growth rates for each country. Growth rates in PA buffers were unrelated to PA (*29*) size (Spearman's rank correlation: $r_s = -0.05$, $n = 284$, $P = 0.40$); country size ($r_s = -0.21$, $n = 45$, $P = 0.16$); or the proportion of area under protection in a country ($r_s = 0.23$, $n = 45$, $P = 0.12$).

Before and after comparisons

- Bruner et al. Science 2001

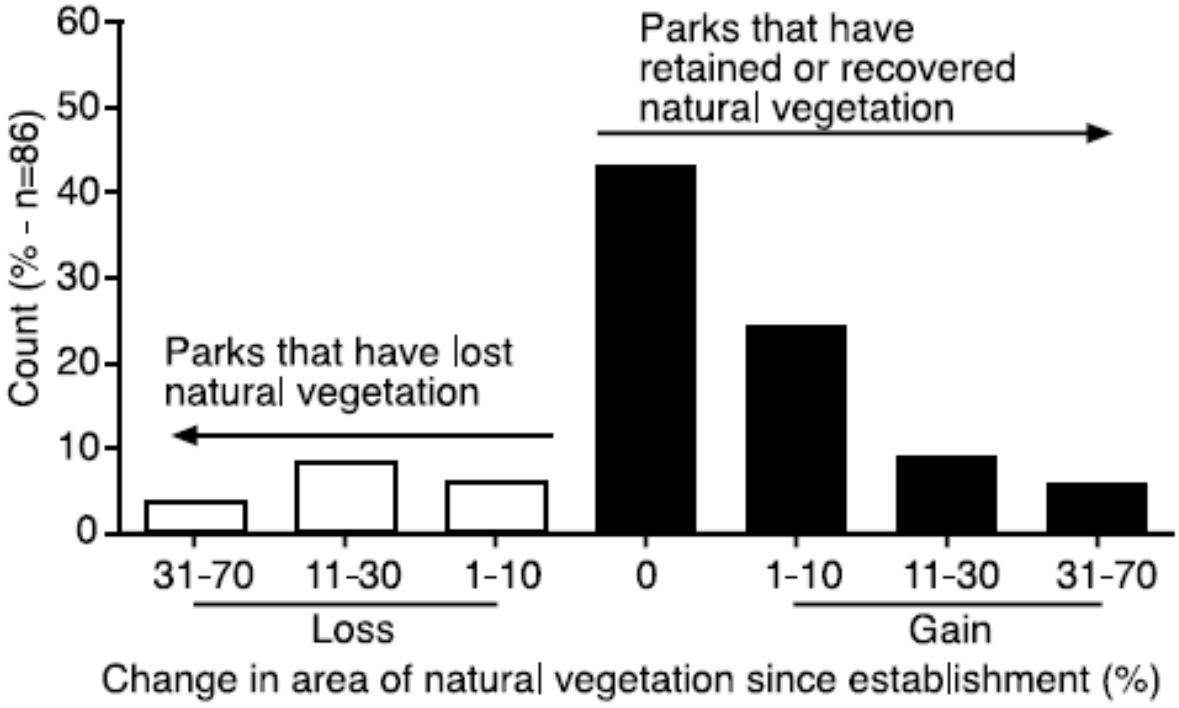


Fig. 1. Change in the area of natural vegetation since establishment for 86 tropical parks. The majority of parks have either experienced no net clearing or have actually increased natural vegetative cover. Median park age is 23 years.

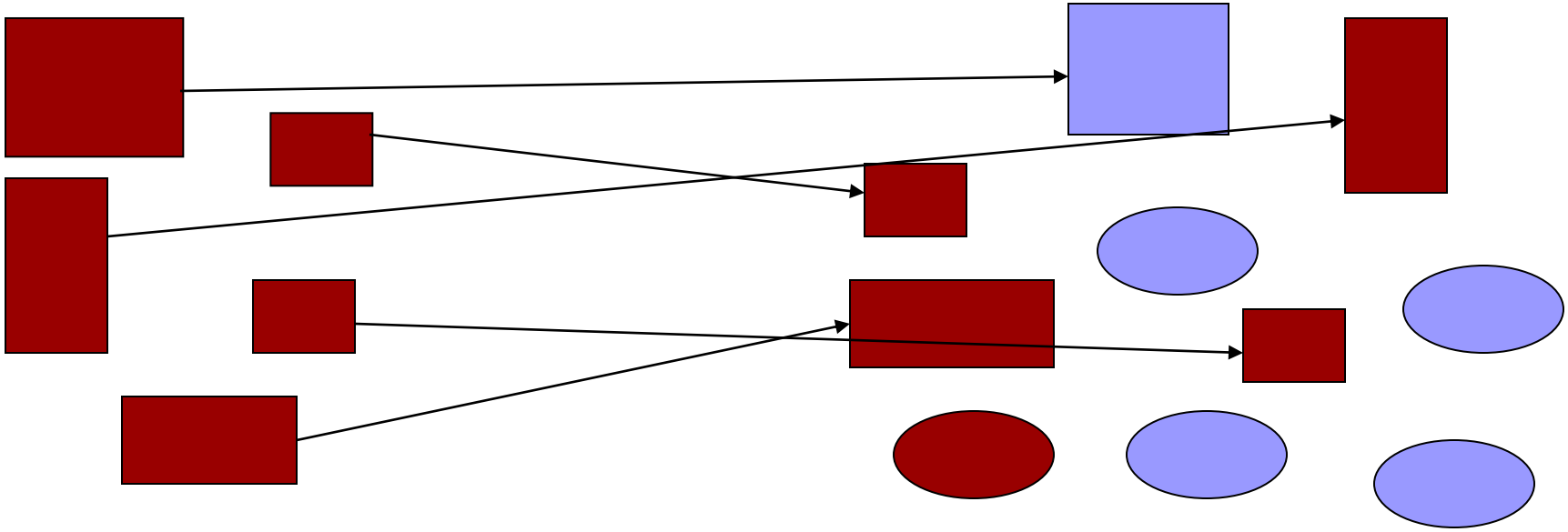
How do we identify the impact?

- Ideally, like in the natural science, experiment with random assignment
  - Then, other deforestation drivers are canceled out in expectation
  - Controls for observable as well as unobservable factors
  - However, policies are rarely applied randomly
- Controlling for observable factors:
  - Regression analysis
  - Matching Strategies

Matching Strategies

Treated observations:
Plots inside National Parks

Untreated Observations:
Plots away from National Parks

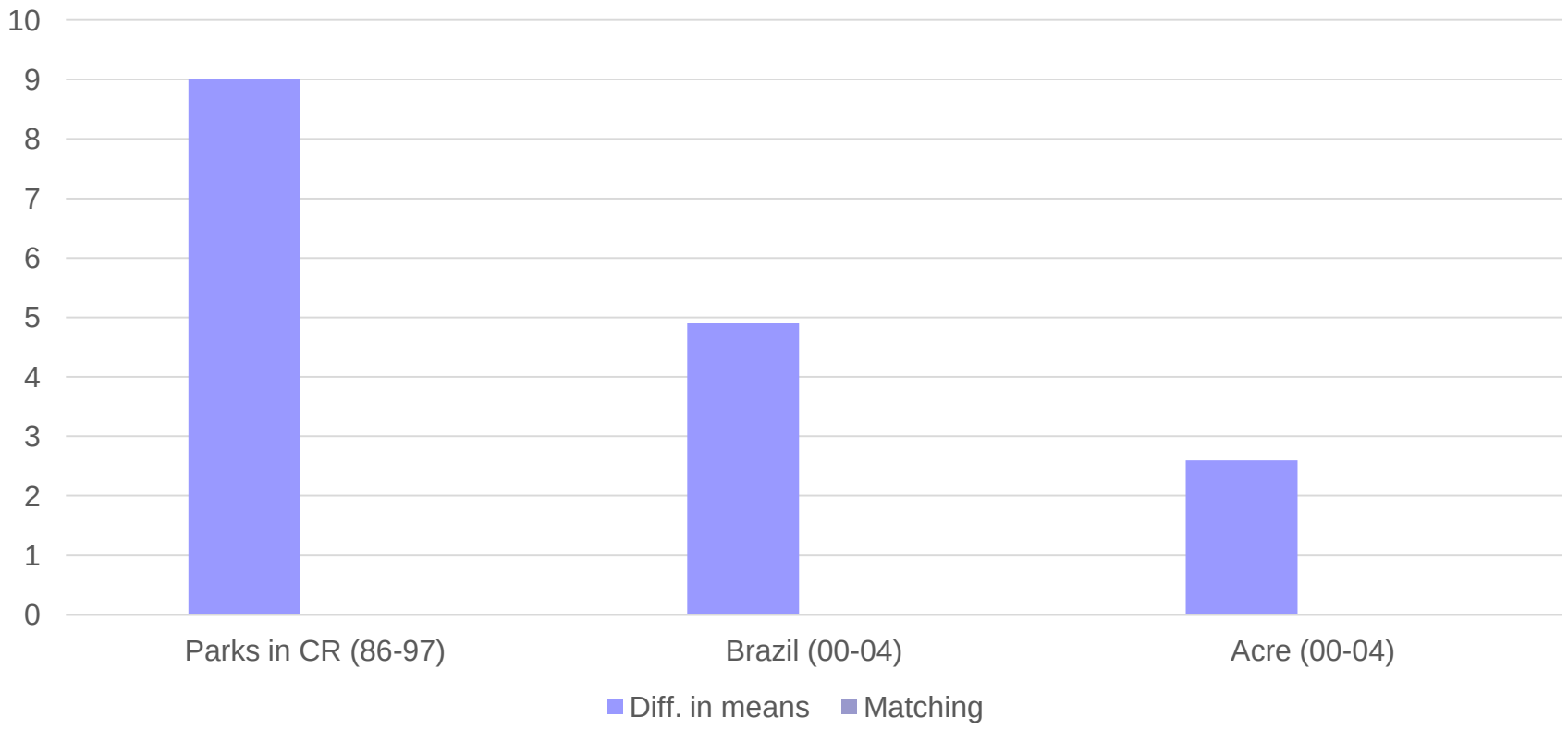


Advantages and Disadvantages

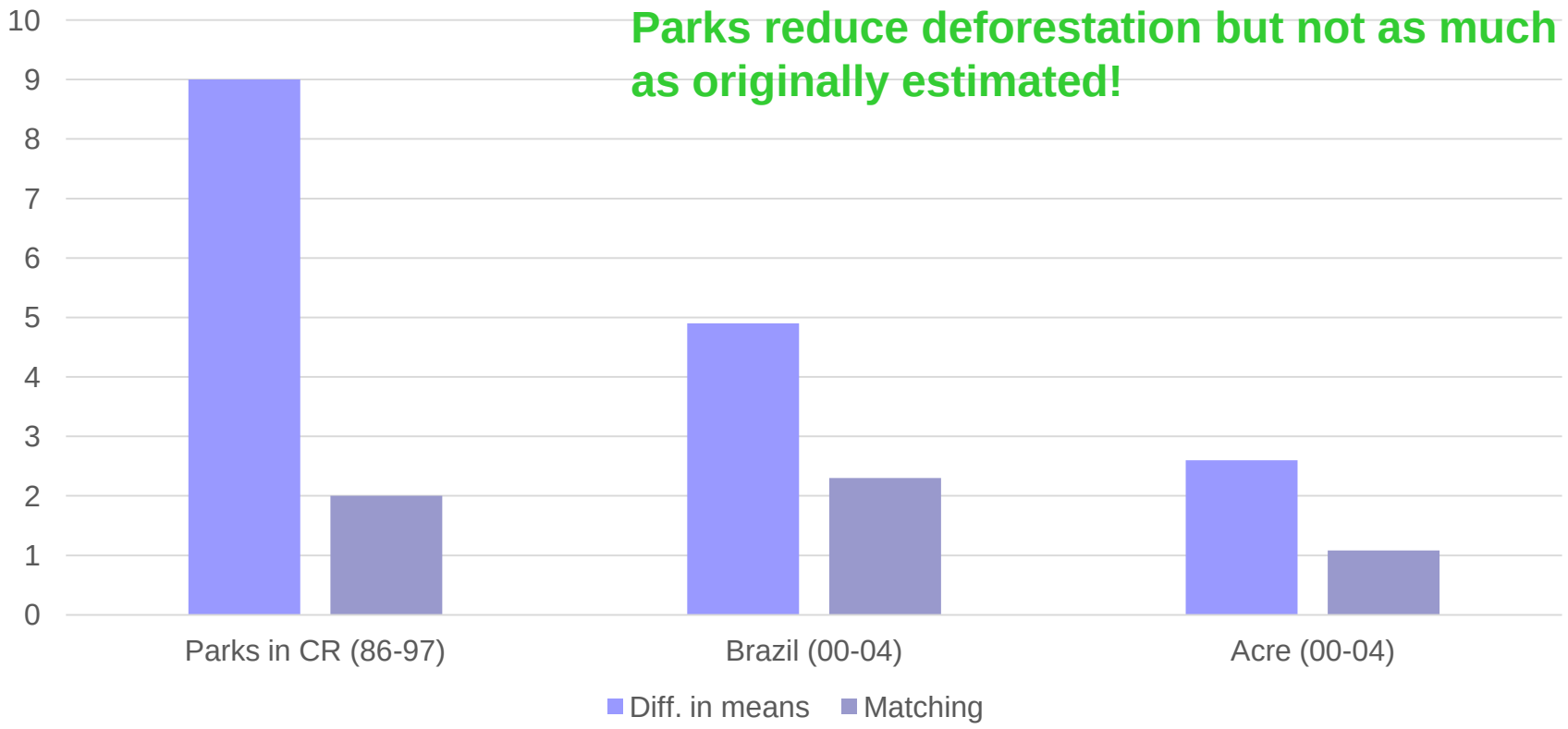
- Advantages
  - Reduce the bias due to the lack of random assignment
  - Less dependent on the functional form assumed

- Disadvantages
  - Unobservables might bias the estimation of the effect
  - Loss of observations (degrees of freedom)
  - Standard Errors

Impacts after bias correction



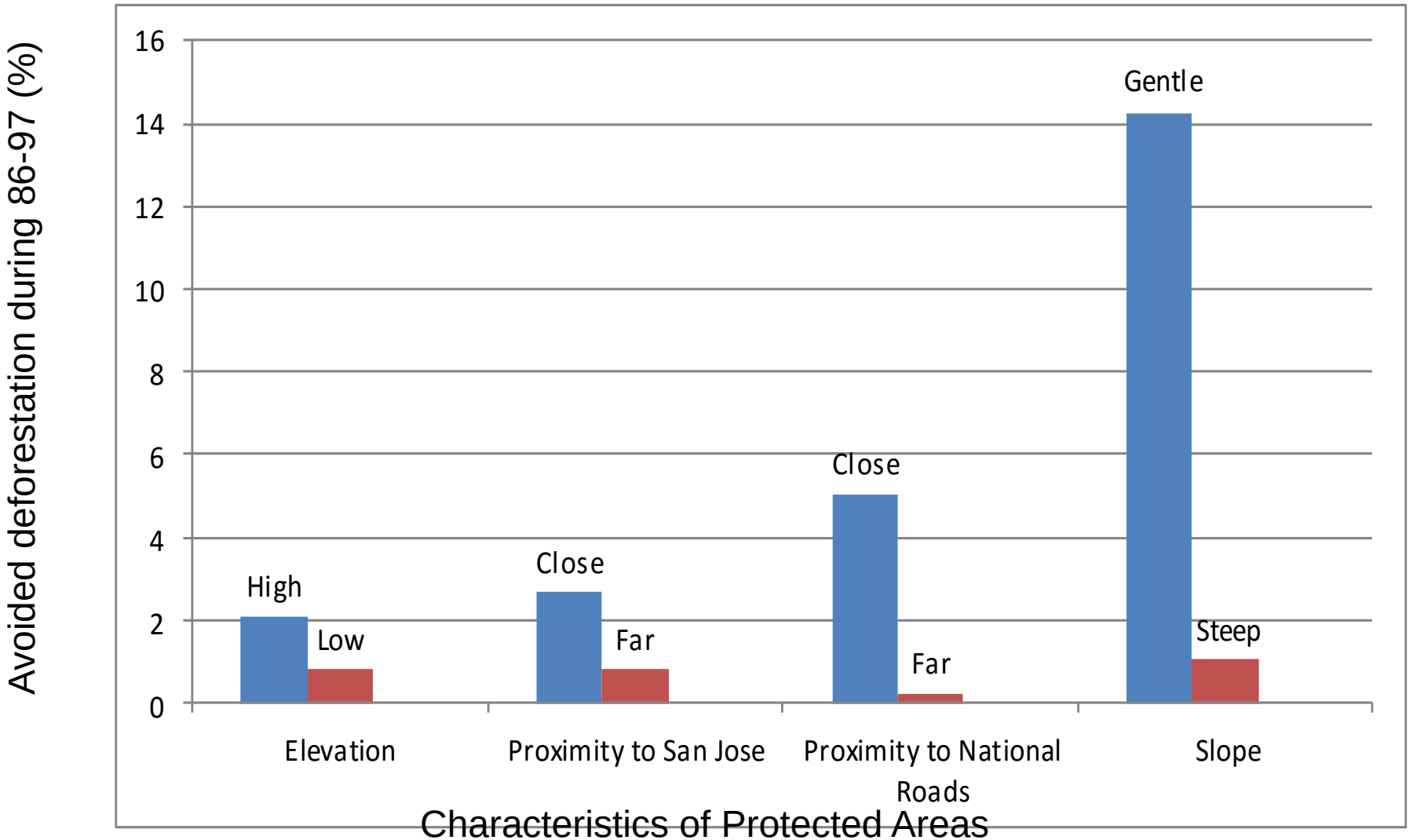
Impacts after bias correction



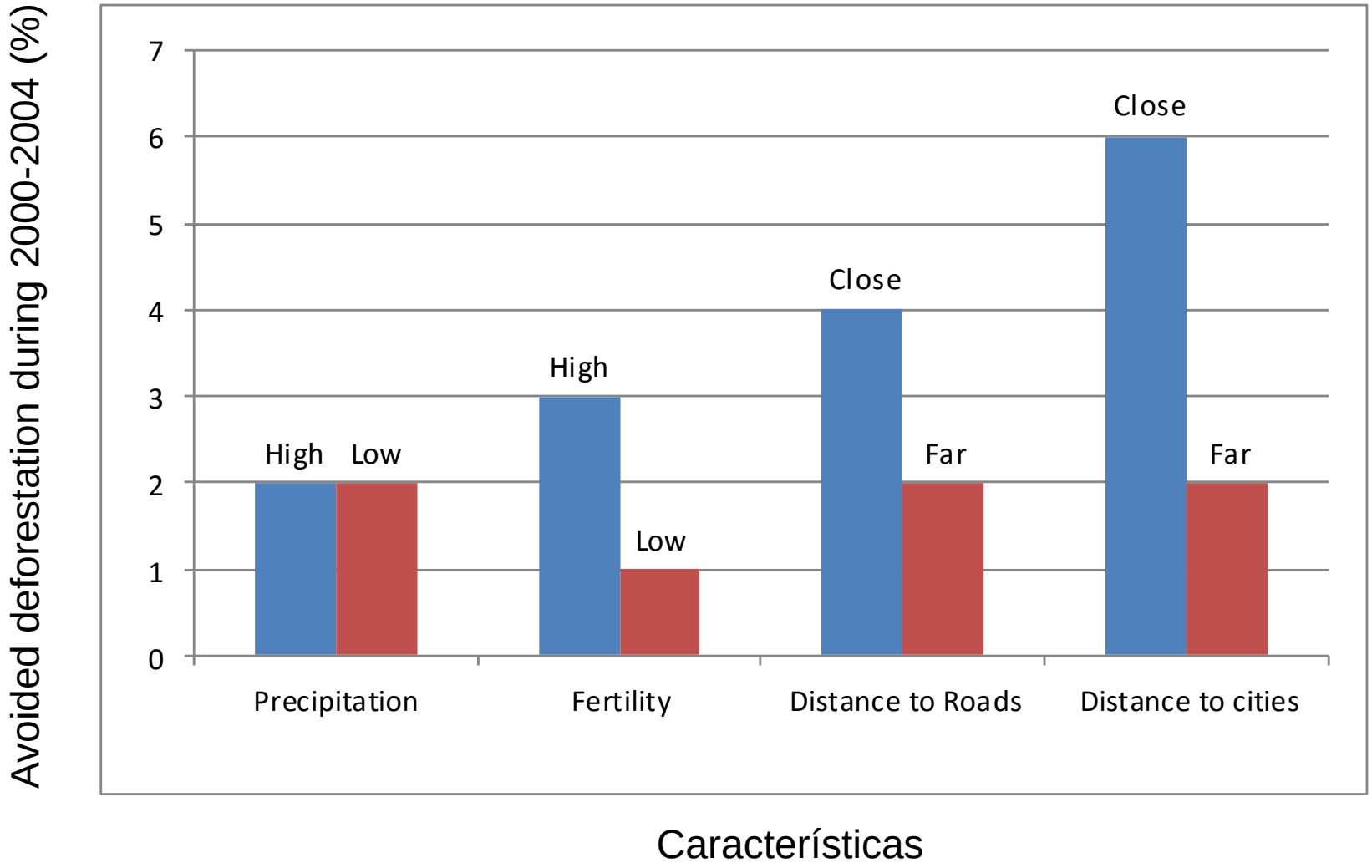
Difference in the impacts

- We estimated average treatment effects of parks
- However, treatment effects might vary between parks and within parks
- We will test if different land characteristics and governance have different effects

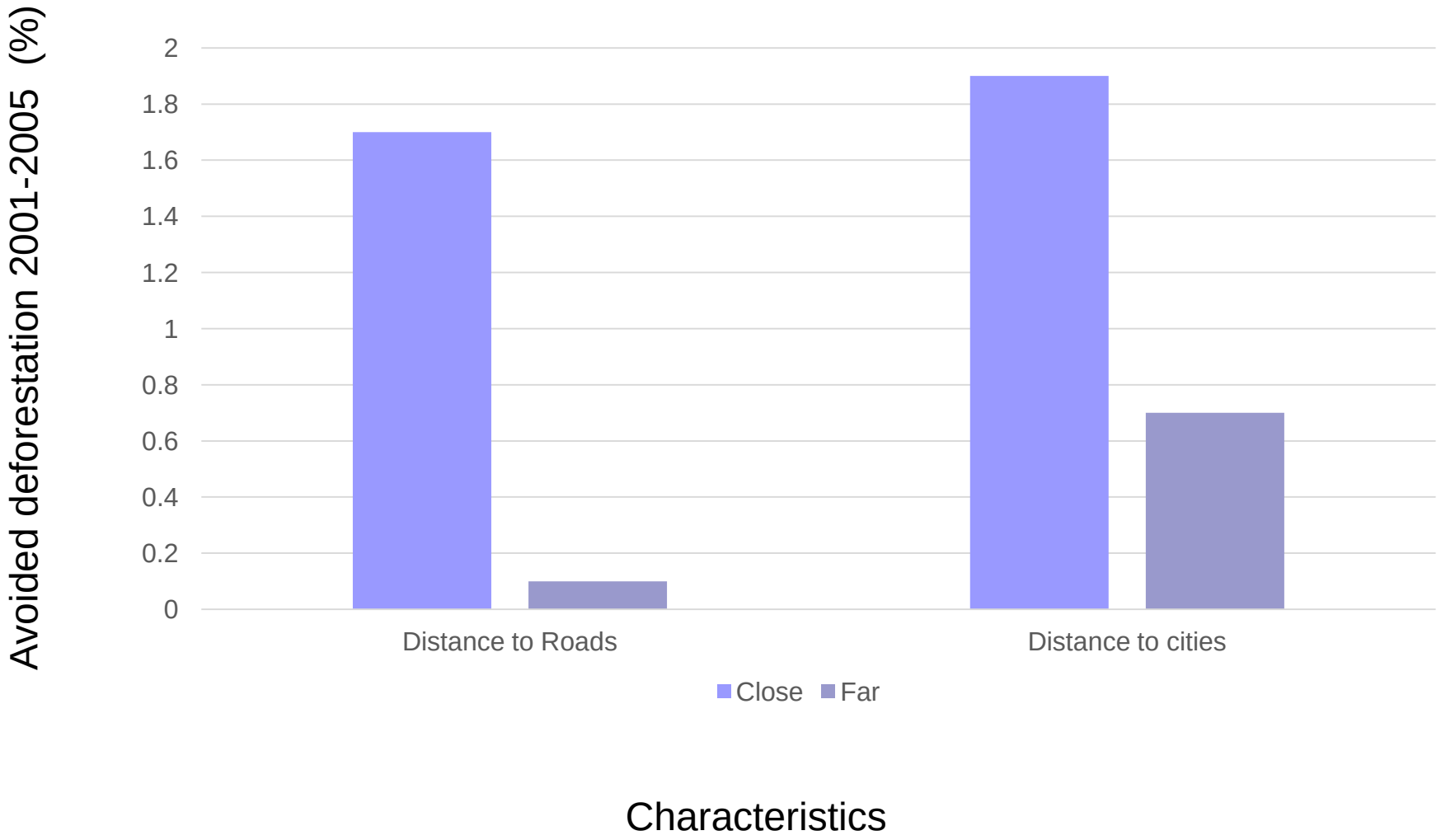
Impact according to land characteristics in Costa Rica



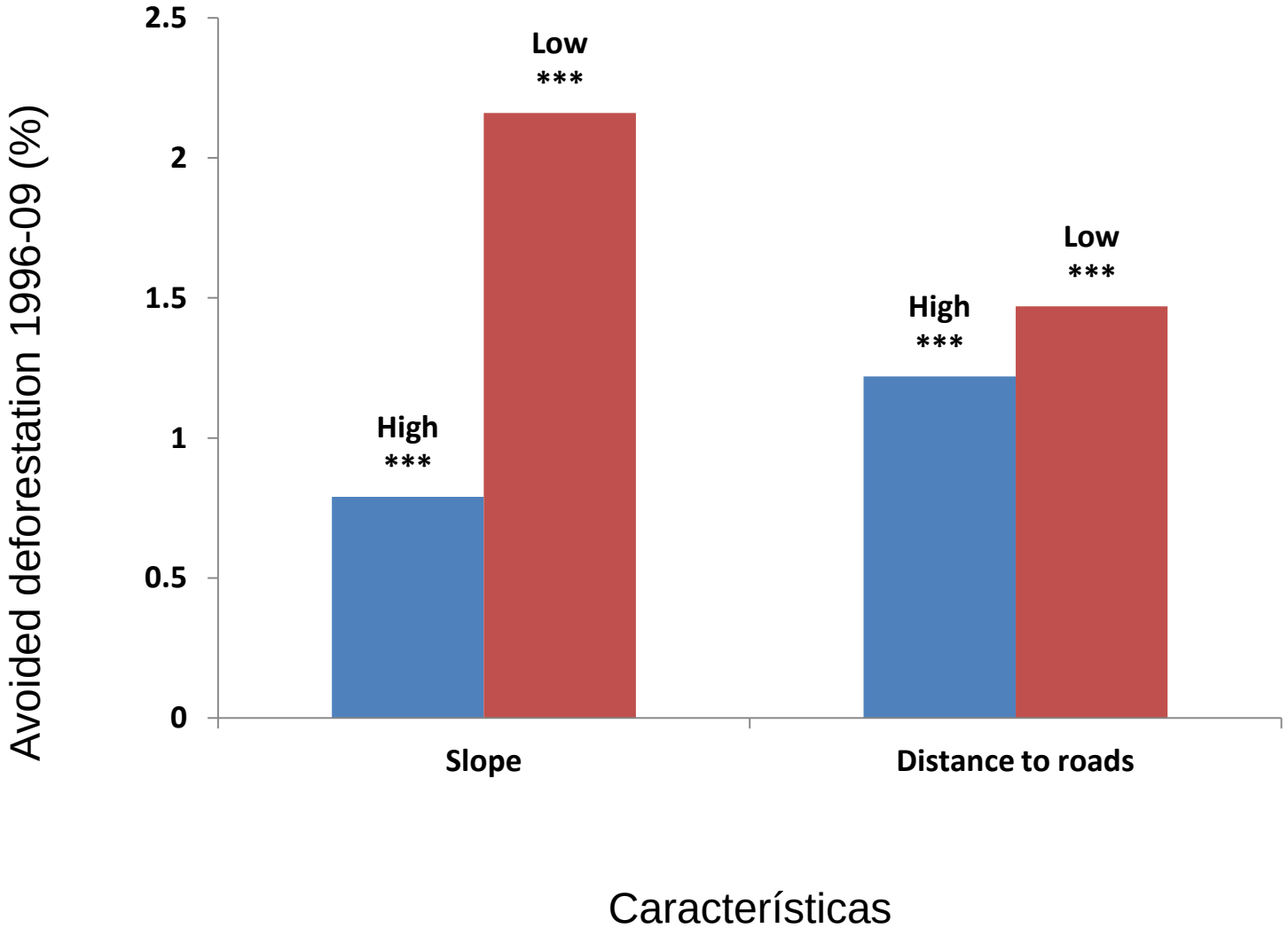
Impacts by land characteristics in the Brazilian Amazon



Impacts by land characteristics in the low lands in Bolivia



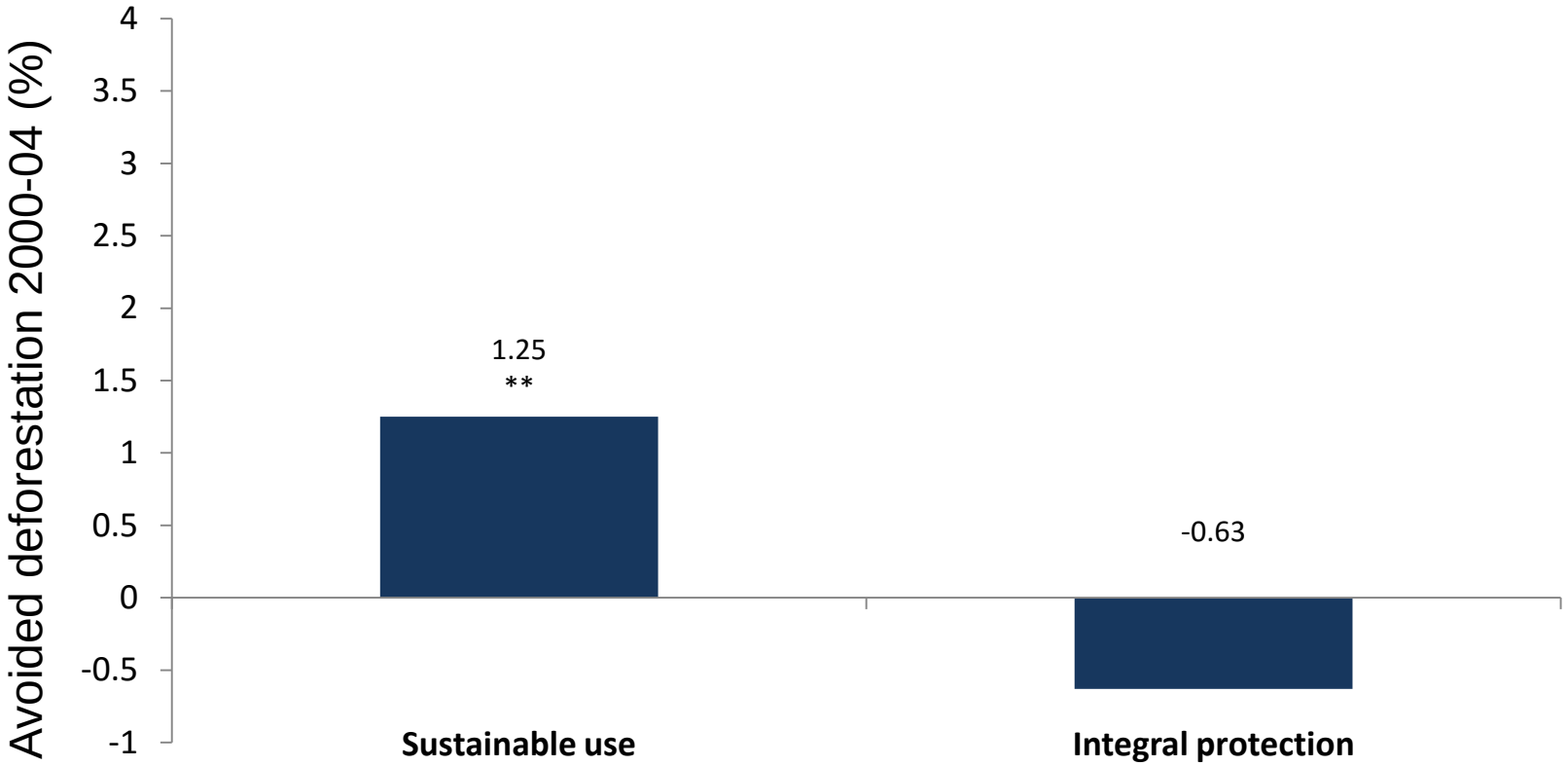
Minas Gerais



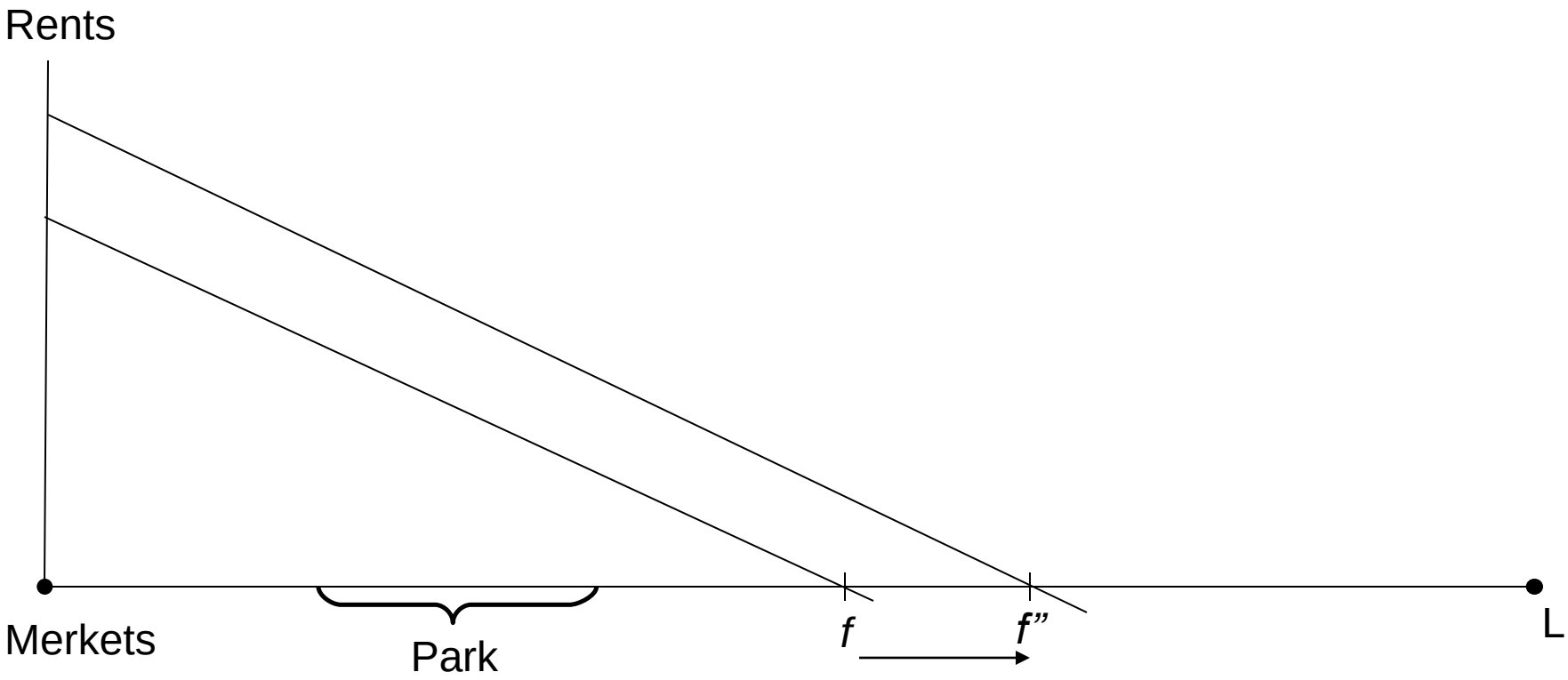
So, what did we learn?

- Protect high deforestation threat areas
  - Forest in plains
  - Forest close to roads
  - Forest close to cities
  - Forest in soils with high fertility
- But what about levels of restrictions of resource use inside protected areas?

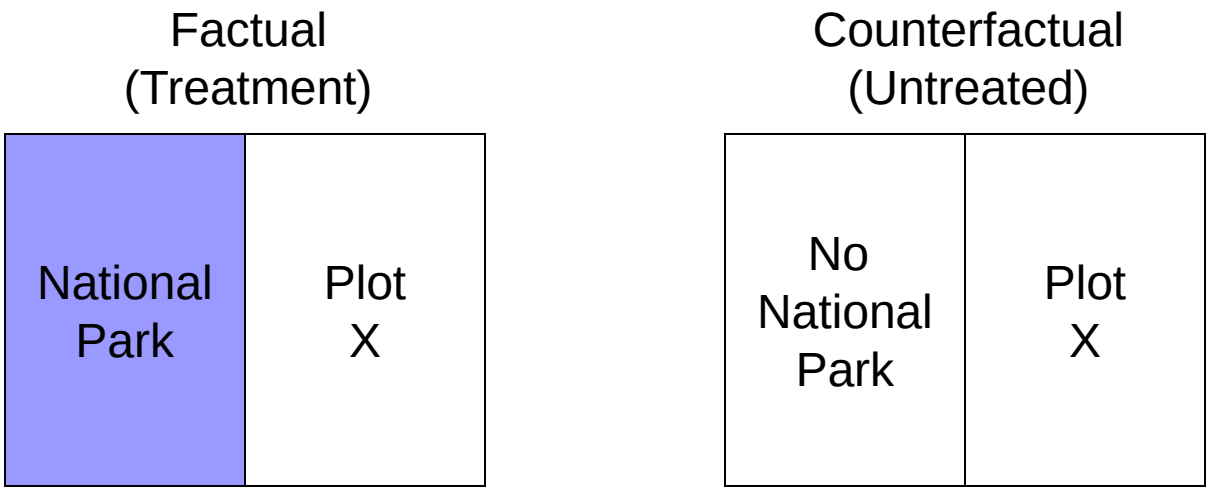
Acre State in the Brazilian Amazon impacts according to level of restriction



What about leakage effects?



Empirics

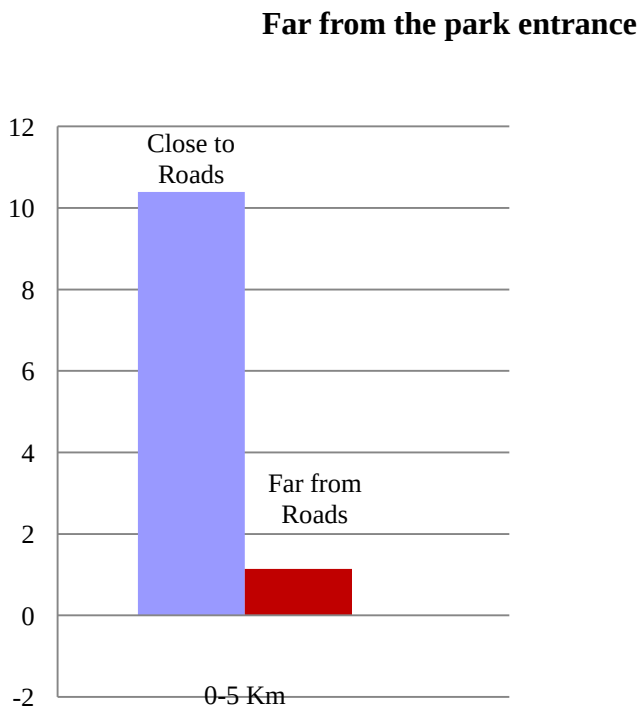


Treatment effect in plot X =

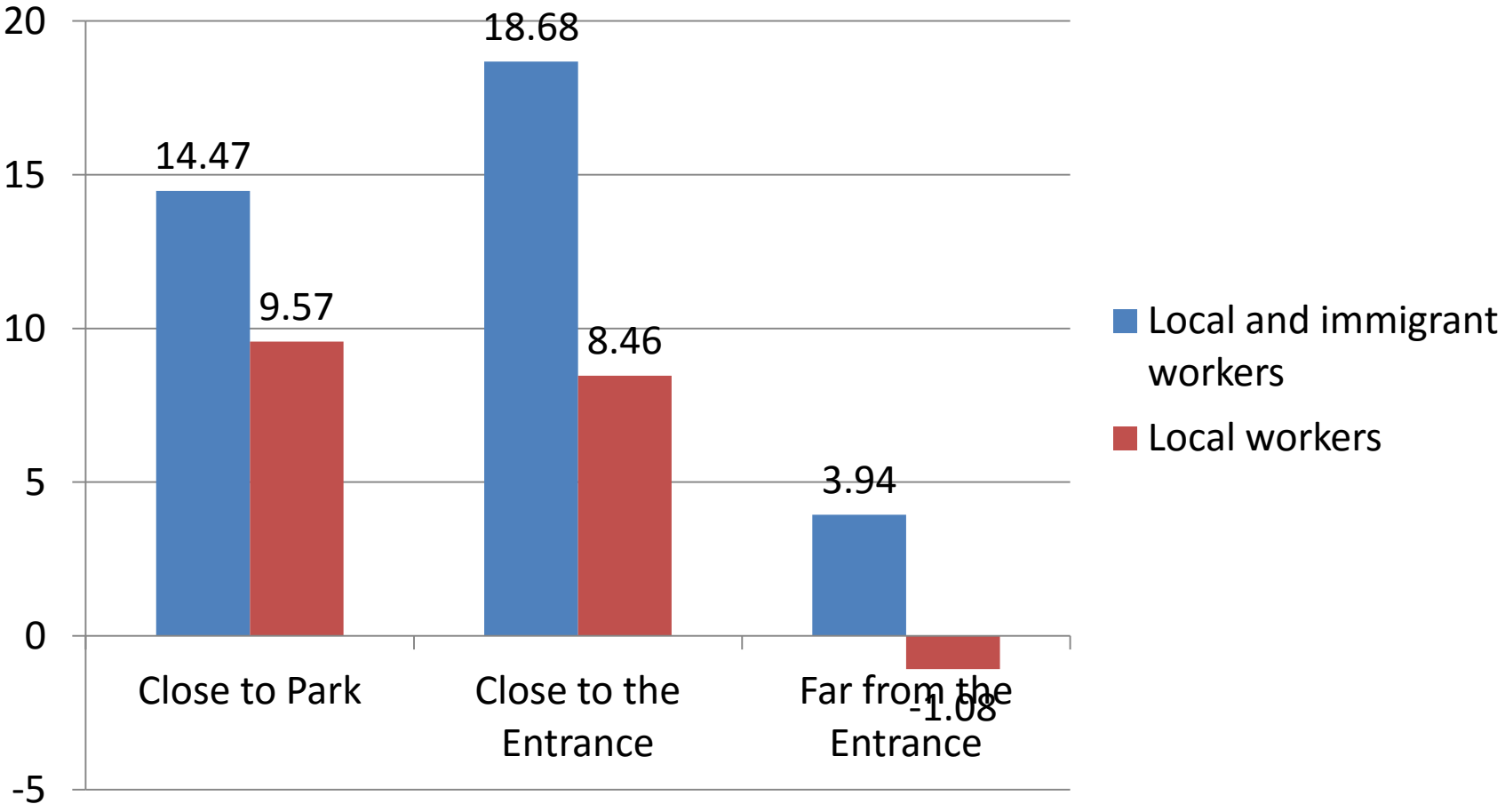
Factual Deforestation Rate -

Counterfactual Deforestation Rate

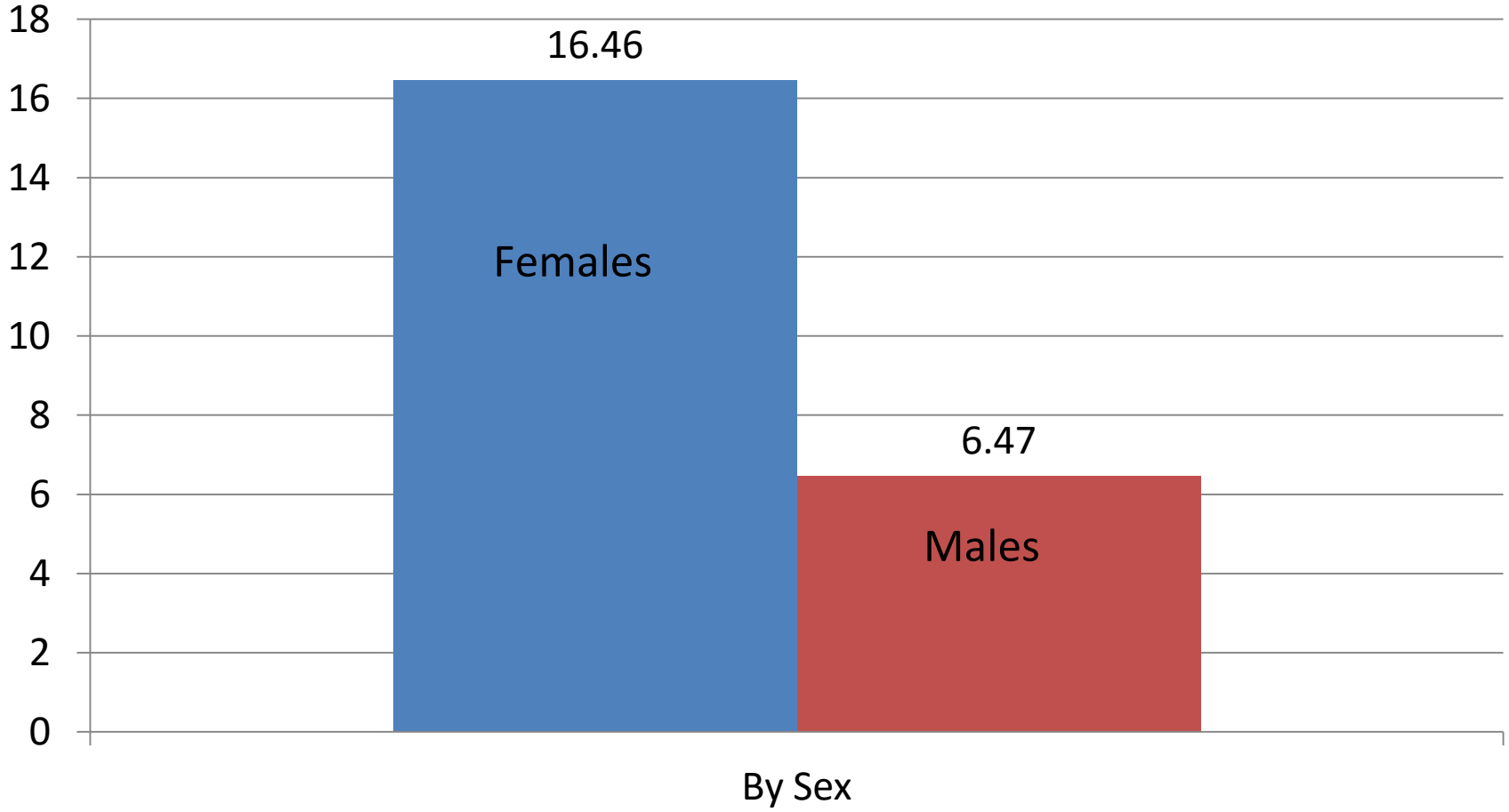
Leakage effects on 86-97 deforestation



Previous evidence from CR shows that parks' impacts on wages are positive close to the entrances of the parks



… and that close to entrances, females benefit the most…



Park and forest effects on vulnerability to climate

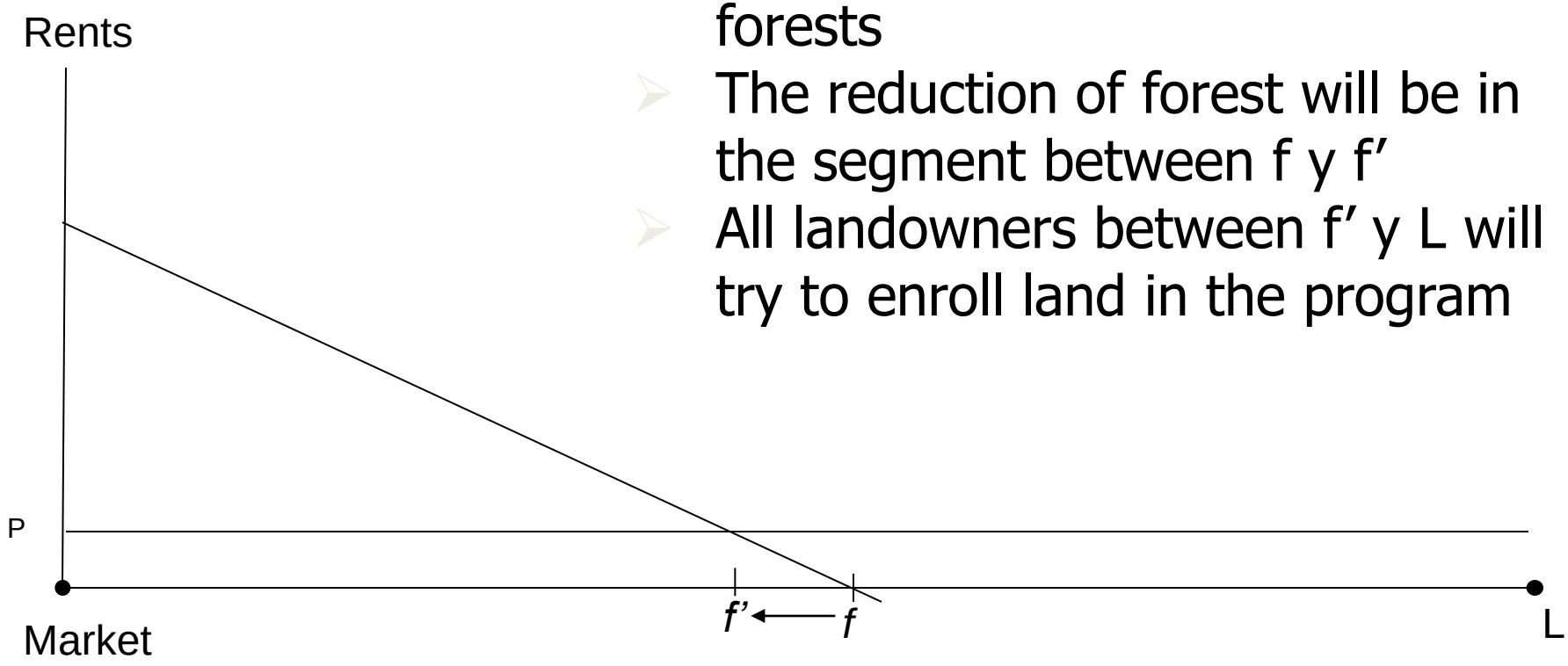
- Evidence of the effects of forest on floods
  - Tan-So et al. 2016 in Malaysia (in the wet season)
  - Pacay et al. 2015 in Honduras (in the dry season)

- Effects of protected areas on diseases
  - PA are negatively correlated with malaria, acute respiratory infections and diarrhea (Bauch et al. 2015)

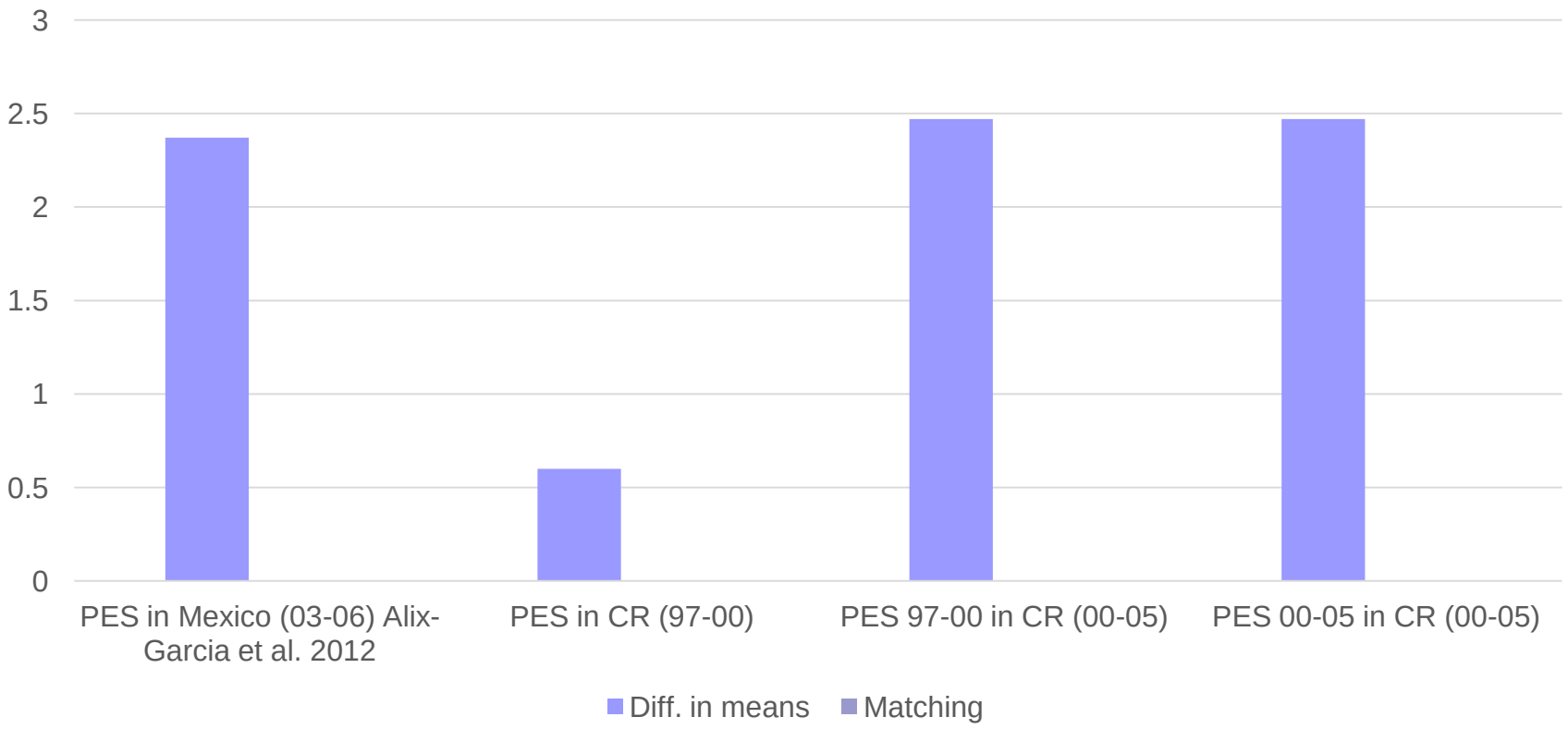
- Effects of protected areas on natural shocks
  - In Mexico, they reduce exposure but if exposure occurs, they do not reduce the adverse effects (Roman et al. 2016)

Simple Model of PES

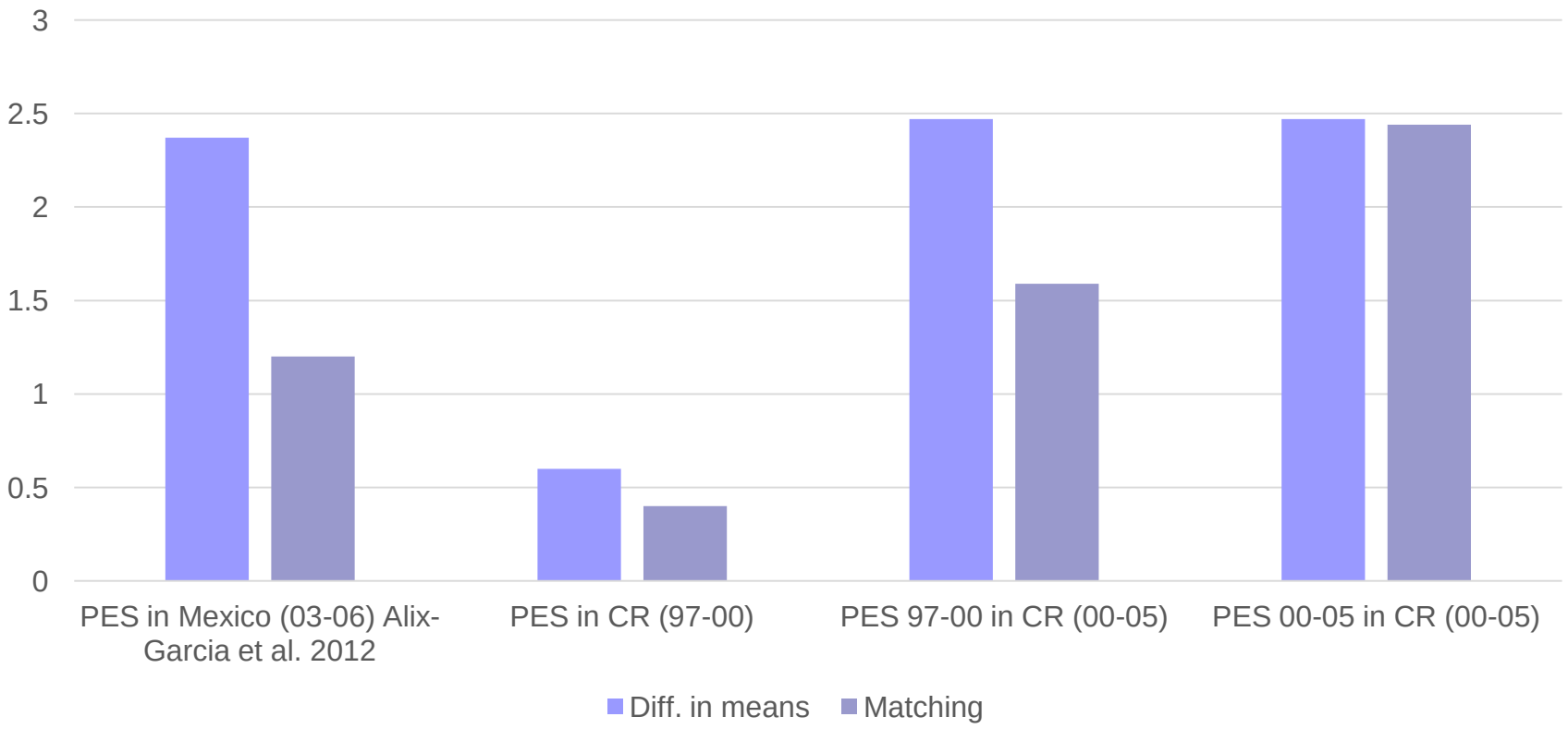
- Payments increase the returns of forests
- The reduction of forest will be in the segment between f y f’
- All landowners between f’ y L will try to enroll land in the program



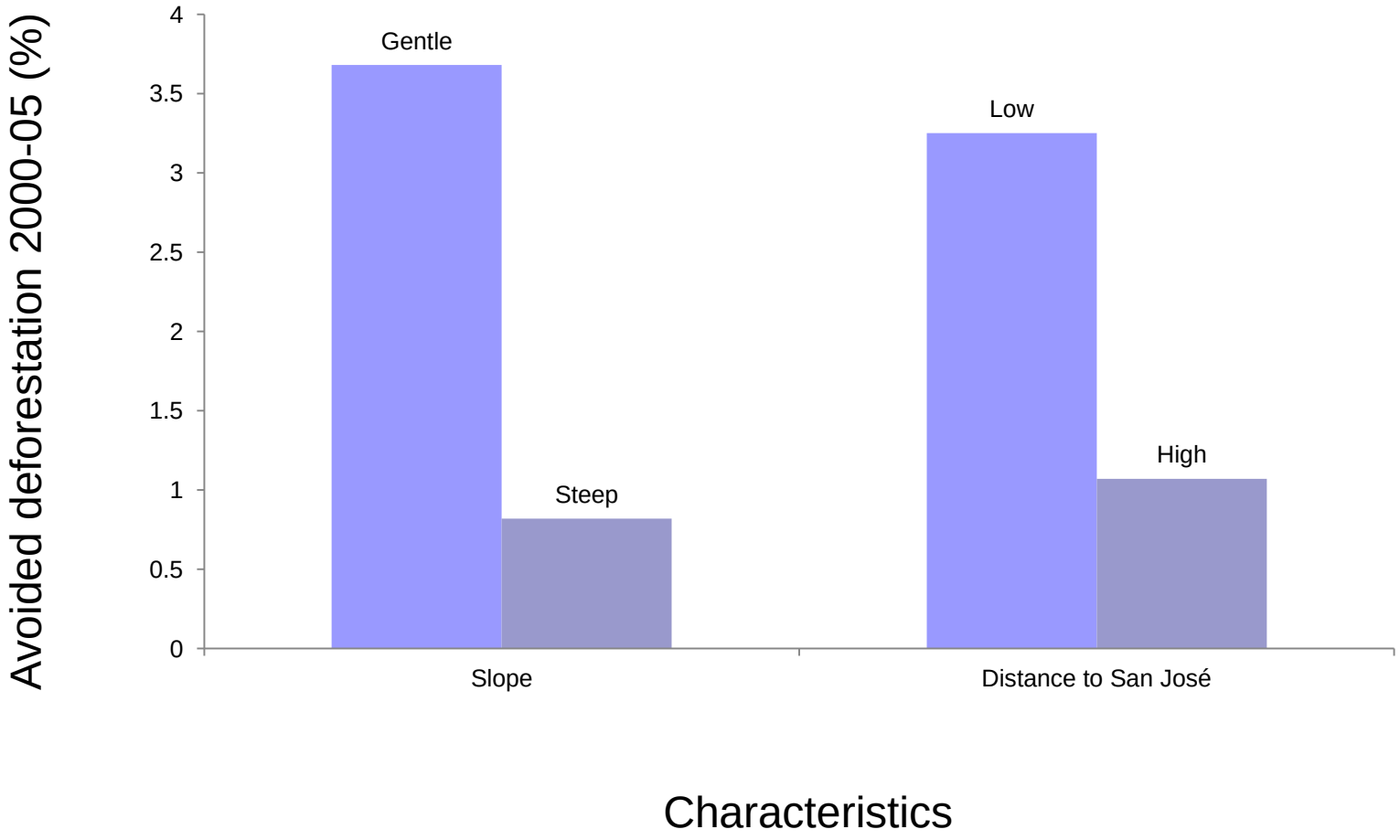
Impacts after bias correction



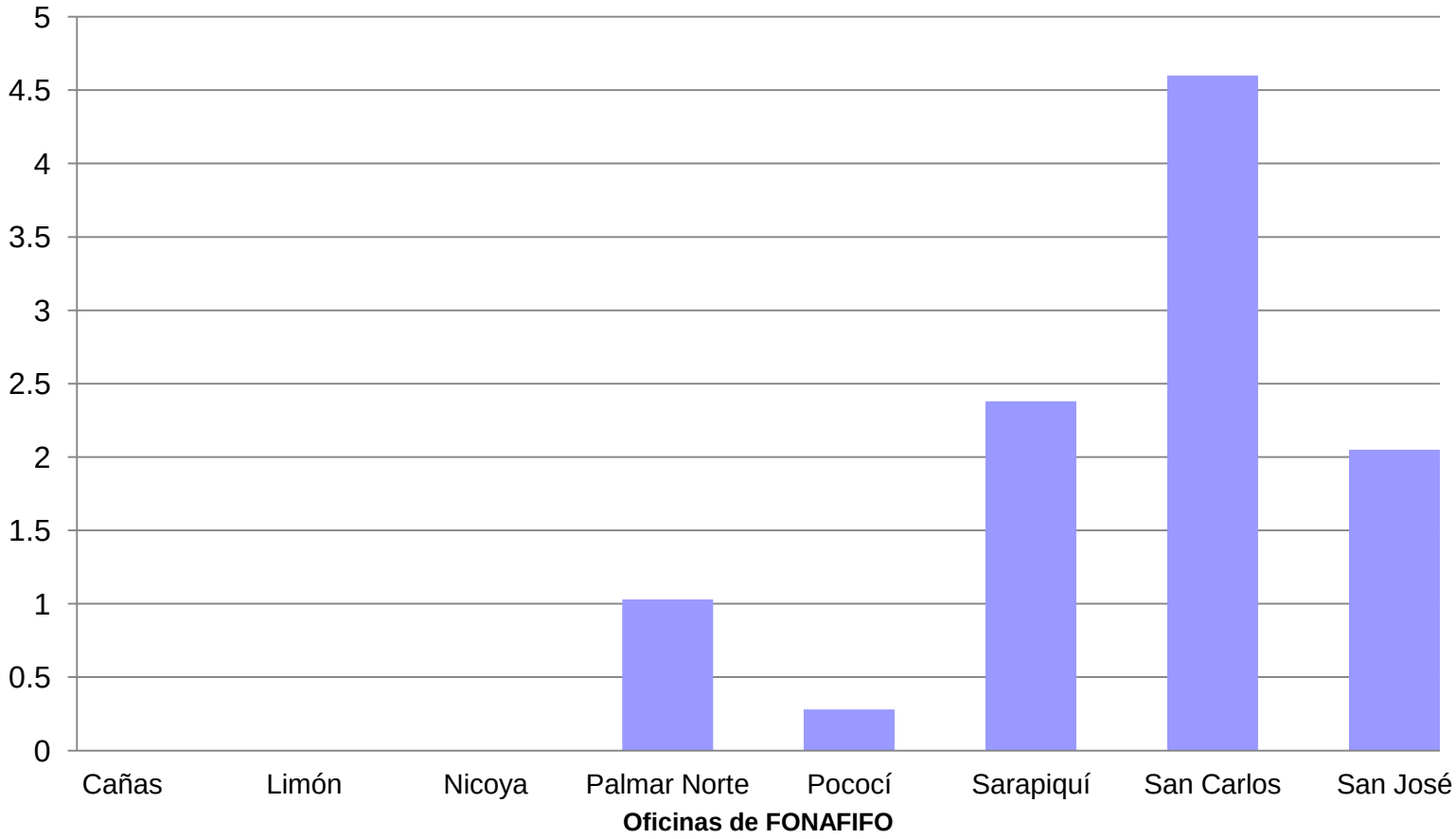
Impacts after bias correction



Payments' effects by land characteristics



Payment effects by offices



Spillover effects

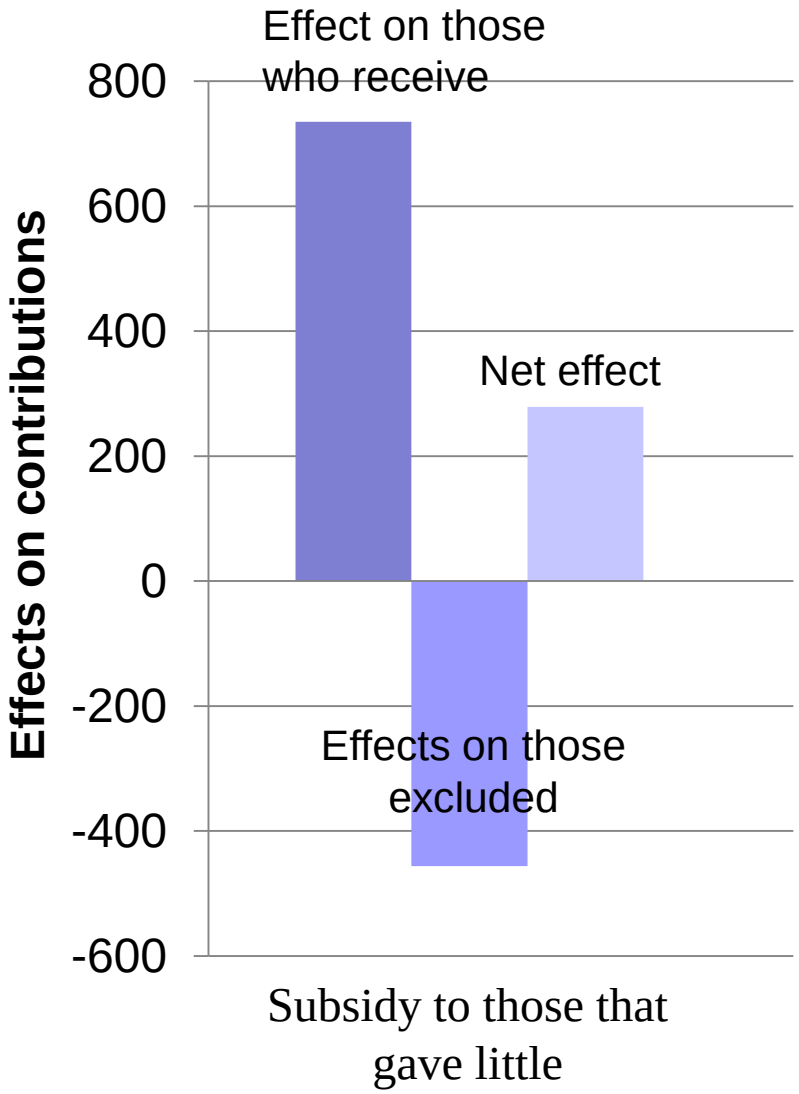
- Leakage effects
  - Evidence for Mexico (Alix-Garcia et al. 2012)
    - In poor municipalities, deforestation increases next to enrolled parcels
    - In less poor municipalities, deforestation decreases next to enrolled parcels
- There might be behavioral reasons too
  - What if payments are only given to landowners that are going to deforest?
  - Experiment in Costa Rica where people are excluded from payments

Behavioral spillover effects (Alpizar et al. 2015)

- Experiment: one hour survey to landowners
  - After 30 minutes, we gave them 10 dollars and ask for a donation for an environmental NGO
  - At the end, we gave them 10 dollars more and ask for a donation again, but we provide incentives or exclude from those incentives

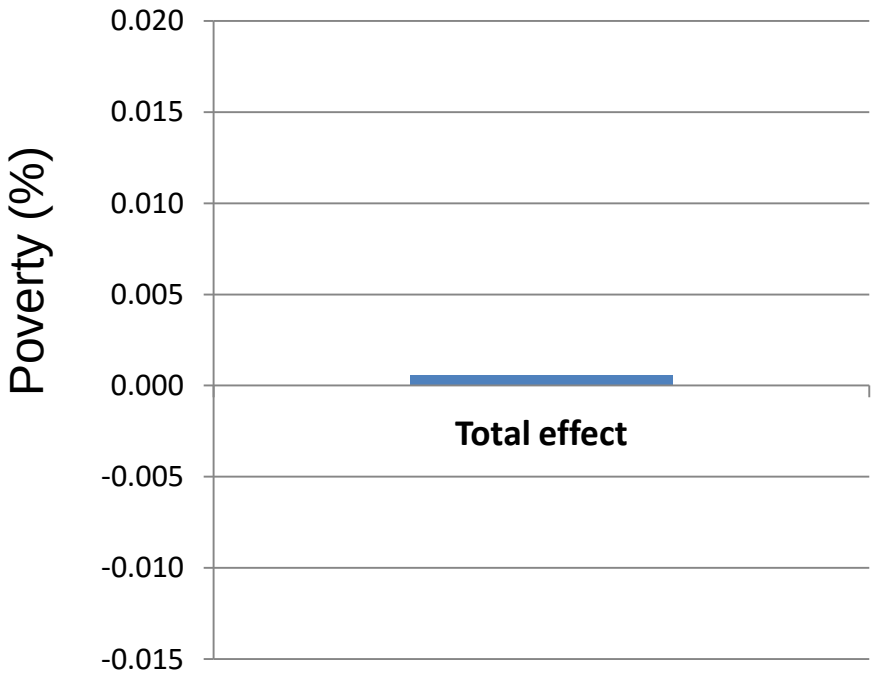
- We test three rules
  - Exclude those that gave a lot and include those that gave little
  - Exclude those that gave little and include those that gave a lot
  - Randomly choose who gets the subsidy

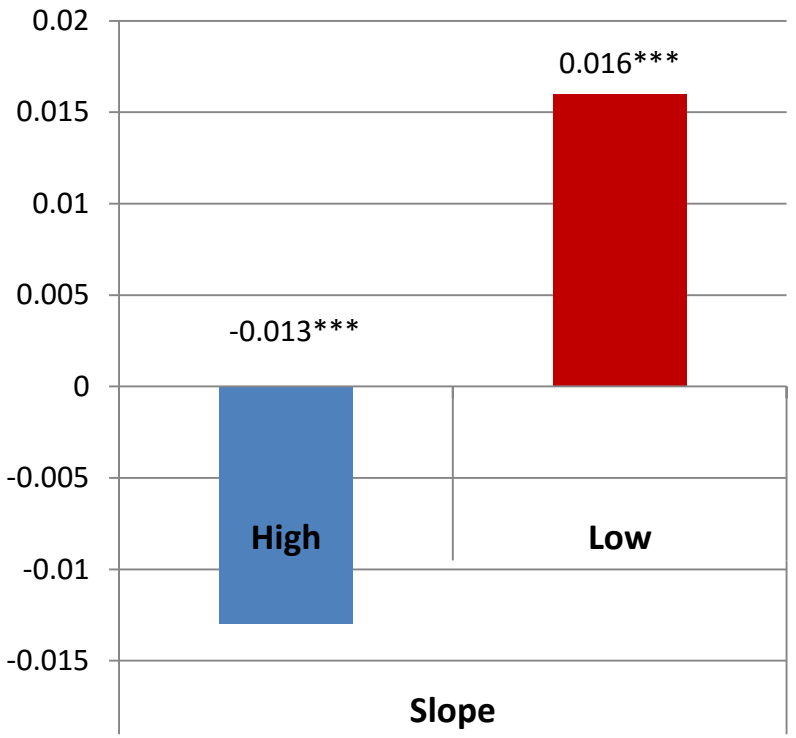
Behavioral spillover effects



Poverty impacts of PES

What happens when PES coverage increases by 10%?
Impact of PES on poverty





*** indicates significance at 1%

Conclusions

- Like with parks, payments located in high deforestation threat areas have significantly larger impact on deforestation

- Leakage effects might also be large
  - Due to economic conditions like in Mexico…
  - Behavioral effects based on who is selected in Costa Rica

Conclusions

- Parks can have positive impacts on wages but these benefits are not evenly distributed
  - Local people versus non-local
  - Proximity to park entrance
  - Gender
- Net impacts of payments on poverty are very low
  - Increase poverty in places with high opportunity costs of conservation (low slopes)
  - Decrease poverty in places with low opportunity costs of conservation (high slopes)

Thanks!