Payments for environmental services supported social capital while increasing land management

Jennifer M. Alix-Garcia[a,1,2], Katharine R. E. Sims[b,1,2], Victor H. Orozco-Olvera[c], Laura E. Costica[c], Jorge David Fernández Medina[d], and Sofía Romo Monroy[d]

[a]Department of Applied Economics, Oregon State University, Corvallis, OR 97331; [b]Economics Department, Environmental Studies Affiliate, Amherst College, Amherst, MA 01002; [c]Development Research Group, The World Bank, Washington, DC 20433; and [d]Evaluation Department, National Forestry Commission of Mexico, San Juan de Ocotán, CP 45019 Jalisco, Mexico

Edited by Catherine L. Kling, Iowa State University, Ames, IA, and approved May 16, 2018 (received for review November 30, 2017)

Payments for environmental services (PES) programs incentivize landowners to protect or improve natural resources. Many conservationists fear that introducing compensation for actions previously offered voluntarily will reduce social capital (the institutions, relationships, attitudes, and values that govern human interactions), yet little rigorous research has investigated this concern. We examined the land cover management and communal social capital impacts of Mexico's federal conservation payments program, which is a key example for other countries committed to reducing deforestation, protecting watersheds, and conserving biodiversity. We used a regression discontinuity (RD) methodology to identify causal program effects, comparing outcomes for PES participants and similar rejected applicants close to scoring cutoffs. We found that payments increased land cover management activities, such as patrolling for illegal activity, building fire breaks, controlling pests, or promoting soil conservation, by ∼50%. Importantly, increases in paid activities as a result of PES did not crowd out unpaid contributions to land management or other prosocial work. Community social capital increased by ∼8–9%, and household-level measures of trust were not affected by the program. These findings demonstrate that major environmental conditional cash transfer programs can support both land management and the attitudes and institutions underpinning prosocial behavior. Rigorous empirical research on this question can proceed only country by country because of methodological limitations, but will be an important line of inquiry as PES continues to expand worldwide.

social capital | payments for environmental services | payments for ecosystem services | land conservation | conservation incentives

Payments for environmental services (PES) are a leading policy tool for global efforts to protect biodiversity and reduce land cover change. PES programs change landowner incentives by offering compensation for conservation activities, and have successfully reduced rates of deforestation in several documented cases (1–3). Multiple countries have adopted national payments programs as part of their efforts to reduce global emissions from land cover change or to protect biodiversity (those in operation for at least 5 years include programs in Mexico, Costa Rica, China, Ecuador, Peru, Brazil, Vietnam, and the United States). However, financial stewardship incentives remain controversial within the global conservation community (4–6). A central concern is that paying for actions previously offered freely may reduce community-level social capital or crowd out general prosocial behaviors (5, 7–9). Social capital and cooperation are crucial for the effective functioning of collective environmental incentives (7, 10–12), and are important drivers of economic development more generally (13, 14). Although theory and behavioral experiments have demonstrated the possibility for external incentives to either undermine or complement intrinsic motivation, there is little research investigating the impacts of actual PES programs on social capital. Prior work uses laboratory and field-based experiments to simulate PES (e.g., refs. 11, 12, and 15–18), relies on a small set of cases (19), or uses variation in payments that may be endogenous (20). This study provides a national-scale empirical test of how externally provided stewardship incentives affect communal social capital, defined as the institutions, relationships, attitudes, and values that govern interactions among people (21).

We studied the impacts of conservation payments in the context of communal applicants to Mexico's federal payments for ecosystem services program, which started in 2003 (22). We tested for program impacts on land cover management activities and social capital after 1–4 years in the PES program. To do so, we used data collected in 2016 from 862 communities that applied for PES between 2011 and 2014, and from more than 8,000 households within these communities. Although Mexico's program is one of the oldest and largest PES in the world, it shares fundamental design elements common to PES in many other countries. The program's primary goal is to conserve forest or other vegetative cover in areas threatened by conversion or degradation. It offers annual payments of between ∼20–80 United States dollars per hectare over 5-year periods to private and communal landowners. In exchange for the funds, landowners must maintain existing forest or natural land cover and engage in land management activities such as building fences, controlling pests, or patrolling for illegal activity. These activities are pledged voluntarily in a land management plan submitted with the application. After complying with maintenance pledges, participants may devote the remaining funds to uses such as wages for other types of work, community projects, emergency household aid, or individual lump sum cash payments.

Significance

Financial incentives for conservation are popular worldwide, but are also highly controversial. A core concern is that paying for environmental stewardship that community members have historically provided for free will undermine intrinsic conservation motivations or other prosocial attitudes, institutions, and values. We provide rigorous evaluation of the social capital impacts of a large payments for environmental services program. We find that conservation payments in Mexico increased land management activities, did not decrease prosocial work, and improved communal social capital. Although similar studies need to be conducted in multiple contexts, we provide evidence that conservation incentives can support social institutions, attitudes, and values while rewarding environmental stewardship.

Author contributions: J.M.A.-G., K.R.E.S., V.H.O.-O., L.E.C., J.D.F.M., and S.R.M. designed research; J.M.A.-G., K.R.E.S., V.H.O.-O., L.E.C., J.D.F.M., and S.R.M. performed research; J.M.A.-G., K.R.E.S., and L.E.C. analyzed data; and J.M.A.-G., K.R.E.S., V.H.O.-O., L.E.C., J.D.F.M., and S.R.M. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

[1]J.M.A.-G. and K.R.E.S. contributed equally to this work.

[2]To whom correspondence may be addressed. Email: jennifer.alix-garcia@oregonstate.edu or ksims@amherst.edu.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1720873115/-/DCSupplemental.

Published online June 14, 2018.

Here we studied common property applicants, either *ejidos* or *comunidades*, as they received the majority of PES funding during this period. These communities are formally recognized units of local governance and make decisions about common property land by assembly of members and an elected council, and control at least 45% of land with forest or vegetative cover in Mexico (23). Understanding community impacts of PES is important, because many current and planned PES initiatives pay communal landholders, rather than individual property owners. A recent global assessment found that at least 18% of the world's land area is held communally or by indigenous groups (24), and the true number is likely much higher when accounting for informal rights. In addition, stronger collective institutions may contribute to the increased environmental effectiveness of future PES (11, 12).

Methods

Rigorous evaluation of program impacts requires a suitable comparison group (e.g., refs. 25 and 26). Here, we estimated impacts by comparing survey responses from accepted and rejected applicant communities (Fig. 1 and *SI Appendix*, Table S1) that were close to an arbitrary scoring cutoff determined by program assignment rules and otherwise similar with respect to potentially confounding characteristics. We use rejected program applicants as a control because they are likely to share important unobservable characteristics affecting the decision to apply for PES, such as land quality, landowner skill, or underlying desire to conserve. We used regression discontinuity (RD) design, which identifies causal impacts using a comparison of outcomes for applicants just above and below program enrollment cutoffs (refs. 27 and 28; for environmental applications, see, e.g., refs. 29 and 30). RD validity requires that potential outcomes are continuous around the threshold. This will hold if applicants are not able to precisely manipulate their position relative to the cutoff, and other characteristics that could determine outcomes do not jump discontinuously at the cutoff. RD design does not require that treated applicants have the same distributions of covariates as control applicants, and indeed, this should not be the case if the program is intentionally targeted. For instance, if the program is targeted toward properties with a higher risk for land cover loss, then successful applicants might, on average, be closer to cities or have more agriculturally suitable land. Accepted and rejected applicants very close to the enrollment cutoff values, however, should be very similar with respect to both observable and unobservable characteristics.

We believe the continuity of potential outcomes condition is satisfied because of the process of annual application and assignment conducted by the Mexican National Forestry Commission (CONAFOR). Program contracts were awarded on the basis of point scores that follow publicly announced, preset guidelines. Point scores were assigned by the central CONAFOR office (*SI Appendix*). Applicants were ranked by point score, and those with the highest scores within each state, year, and subprogram received funding until available predetermined budgets were exhausted. This process thus created multiple arbitrary enrollment cutoffs across years and states at different point scores. We recentered these around zero, so communities with original scores above the cutoff had positive scores ("accepted" units) and communities below the cutoff had negative scores ("rejected" units; Figs. 1 and 2 and *SI Appendix*, Fig. S1). Our estimates were then based on regression models that controlled for the recentered score to capture targeting factors correlated with ranking, and for each Mexican state to account for state-level fixed factors such as dominant ecosystem type or conservation management history.

Given high compliance with the assignment rules (Fig. 2*A* and *SI Appendix*, Fig. S1), we used a strict or intent-to-treat RD design (but see *SI Appendix* for robustness checks using fuzzy RD and additional covariate controls). We tested the validity of the RD design by verifying that preexisting geographic and demographic characteristics did not jump discontinuously at the cutoff score (*SI Appendix*, Fig. S2 and Table S2). RD design also requires the standard causal inference assumptions of excludability (PES affects outcome measures only through the program itself) and no interference (potential outcomes are not affected by whether other communities participate). Robustness checks indicate that multiple rejected applications do not affect social capital (*SI Appendix*, Table S14). Spillover effects between communities are likely to be limited (*SI Appendix*). To explore impacts in the medium and short term, we analyzed samples from the 2011–2012 and 2013–2014 cohorts separately. The characteristics of our samples indicate they are very similar to the universe of eligible applicants to Mexico's PES between 2011 and 2014 (*SI Appendix*, Table S9).

The institutional review board protocol number is 2016/04/17. Deidentified data used in this study can be found in Datasets S1–S3.

Results

Coincident with the primary goal of the program, we found that Mexico's PES program increased land cover management, as measured by a combined index of activities (Fig. 2 and see *SI Appendix*, Fig. S3 for detailed indicators). Fig. 2*A* shows a visual representation of the RD estimate of PES on the land cover management index. The distance between the average, state demeaned land cover management index just to the left and right of zero can be interpreted as the causal impact of the PES program on communal land management activities: an increase of ∼0.18 for the earlier cohorts ($P = 0.004$) and 0.12 ($P < 0.001$) for the later cohorts. Compared with the means among controls, these represent 72% and 40% increases. The combined effect across all cohorts is an increase of 0.13 ($P < 0.001$), or 48%.

We similarly calculated RD impacts for the time spent by households in land management work (see Fig. 2*B* and *SI Appendix*, Tables S3 and S4 for regression estimates). We found

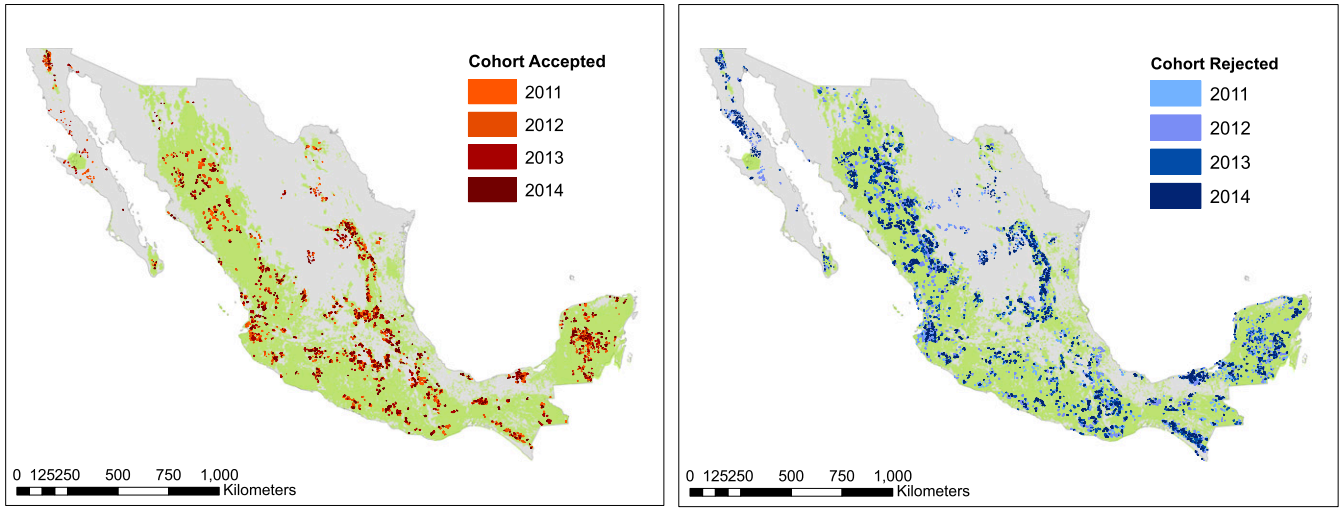

Fig. 1. Accepted and rejected Mexico PES program applicants are located in similar areas. Parcel boundaries of accepted and rejected applicants to the hydrological services and biodiversity conservation programs, 2011–2014.

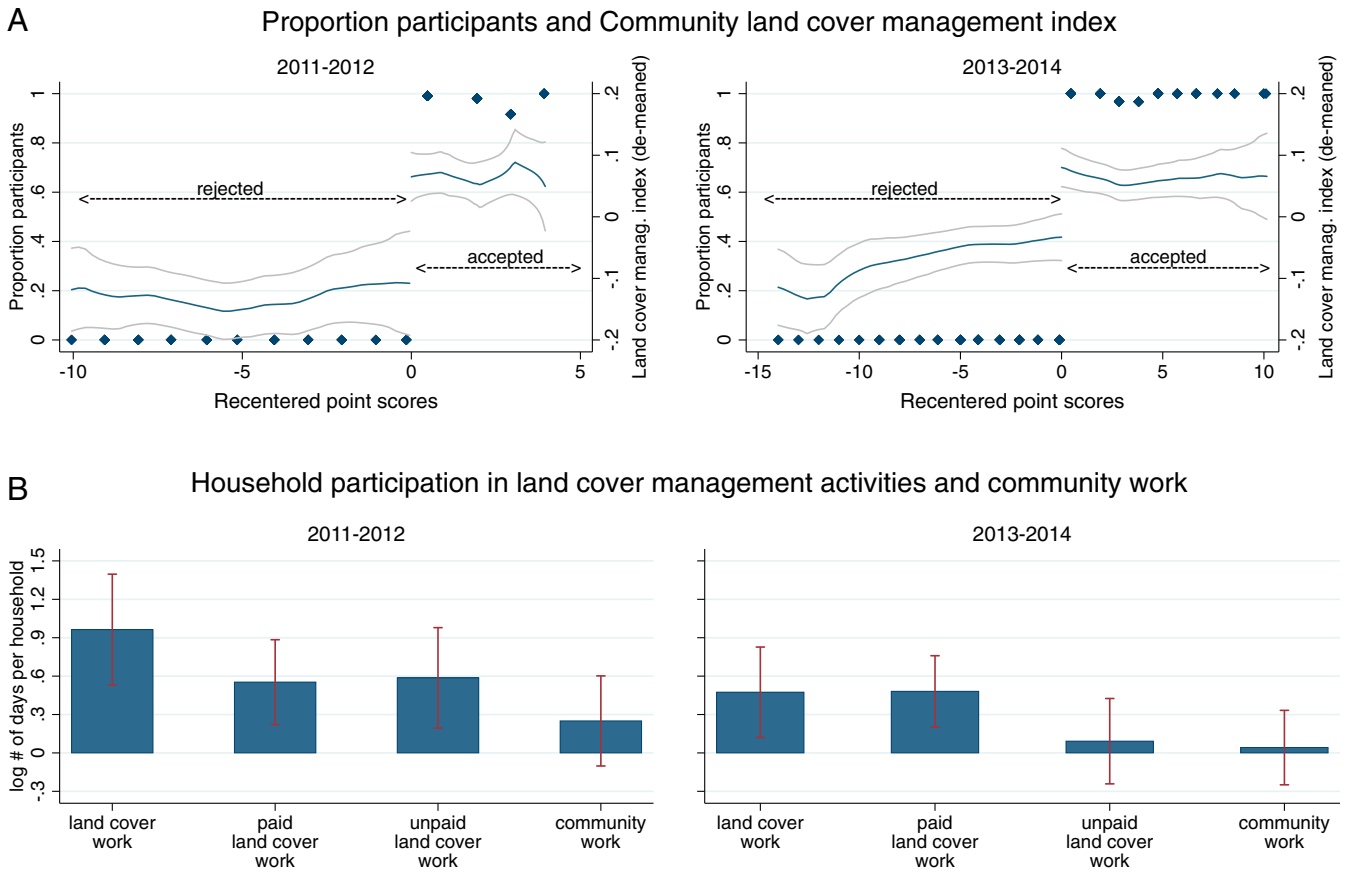

Fig. 2. Conservation incentives increased land management without reducing prosocial work. (*A*) Diamonds indicate the proportion of communities within each normalized point score group that are participants. Dark lines indicate a kernel regression of the state de-meaned land management index on the point score for communities below the cutoff and above the cutoff (difference is the program impact). Light lines are 95% confidence intervals. 2011–2012 total number of data points used for each cohort (N) = 357 (n above cutoff = 206; n below cutoff = 151); 2013–2014 N = 505 (n above = 287; n below = 218). (*B*) Wide bars indicate the estimated impacts of the PES program on log transformed household work days, using regression discontinuity. Thin bars indicate 95% CIs. 2011–2012 N = 3,466 (n above = 2,038; n below = 1,428); 2013–2014 N = 4,947 (n above = 2,828; n below = 2,119).

that PES increased the number of days per year that each household devotes to land cover work, including both work that is paid for through wages and work that is not financially compensated. Transforming the estimated impact into days, land cover work increased by ∼4.2 days per household for the earlier cohort ($P < 0.001$) and 2.3 days for the later cohort ($P = 0.008$). These effects are large relative to the baseline work days reported among controls (2.4 and 3.8 days per household) and translate to an average increase across both cohorts of ∼460 days of labor per community per year (2.7 days × 170 households). For the combined cohorts, we reject the hypothesis that households contributed fewer days to unpaid land management work ($P < 0.001$). This provides evidence that paying communities for conservation activities did not reduce unpaid, proenvironmental activities by crowding out intrinsic motivation or through other mechanisms (e.g., refs. 9 and 16).

Even when funds are used for social projects, they may still decrease social capital if there is elite capture or if distribution of new funds disrupts existing fairness norms. To test the notion that increases in paid conservation activities might crowd out other prosocial activities, or social capital more broadly, we measured days spent in other community work at the household level, as well as multiple social capital outcomes at the household and community levels (Figs. 2 and 3). Our social capital measures (Fig. 3) were designed to be broadly inclusive of elements believed to be part of social capital both globally (21, 31) and within the Mexican context (32, 33). We included actions that indicate cooperation (participation), investments that benefit the whole community (infrastructure), and attitudes providing the foundations of social capital (trust). We also measured institutional structures that support social capital, including the range of decisions made by the community assembly (governance), and whether a wide variety of community members participated in decisions (inclusion). Indices were constructed with simple item aggregation (but see *SI Appendix* for further discussion).

We found (Fig. 2*B*) that conservation payments did not reduce days spent in other community work, as might be expected if PES were undermining prosocial behavior (across both cohorts we reject the null that days spent in community work decreased; $P = 0.004$). We also found that point estimates of the effect of PES on social capital were positive, as measured by the total social capital index (Fig. 4). For cohorts with longer exposure to PES, we found a 15% increase compared with the mean value for the controls ($P = 0.005$), and for cohorts with short-term exposure, we found a positive but not statistically significant increase of 6.7% compared with the control mean ($P = 0.053$). The combined impact across all cohorts on the total social capital index was an 8.6% increase relative to the control mean ($P = 0.003$). At the household level, impacts on the total index were positive in magnitude, and we reject ($P = 0.003$) a greater than 1% decrease in the household total index. To explore specific responses underlying results, we estimated impacts on all index components (*SI Appendix*, Tables S6 and S7). In addition, we investigated possible heterogeneity by region (*SI Appendix*, Table S8). Although some

regions have higher average social capital (see means among controls *SI Appendix*, Table S8), program effects were generally not substantially or statistically significantly different across regions. Results are also similar for states with high and low real values of the point scores (*SI Appendix*, Table S12) and do not depend on the window of analysis around the threshold (*SI Appendix*, Table S13).

Our main community-level results suggest that conservation payments may increase social capital more in the medium than the short term. However, comparison of effects across time was confounded by a rule change about land management pledges starting in 2013. The 2011–2012 cohorts had to pledge specific land cover management goals, but could use all funds flexibly. For instance, communities in which management activities were already part of communal work duties could increase those activities without pay and use the funds for other community investments. The 2013–2014 cohorts had to pledge to spend 30–40% of funds specifically on land management, including for uses such as equipment and individual wages. Thus, an alternate explanation for the larger impact on social capital for the 2011–2012 cohorts is that flexible use of payments better complements intrinsic motivations for land management, possibly by facilitating other investments that strengthen communal social capital. Consistent with that hypothesis, the 2011–2012 cohort had a greater estimated magnitude increase in unpaid land management activities, more investment in community vehicles (*SI Appendix*, Table S6), and more lending of objects or money to friends (*SI Appendix*, Table S7). Differences between cohorts are not statistically significant, but suggest that future research should explore whether flexible lump sum compensation or payments targeted at specific activities best reinforce prosocial behavior.

Conclusion

In summary, we found that a key national program that uses financial incentives to promote conservation on communal lands led, as intended, to policy-relevant increases in land cover management activities. Despite this incentivized increase in management activities, we did not find declines in household contributions to unpaid land cover work or other prosocial work. In fact, we found increased levels of community social capital as a result of Mexico's PES program and no changes in household trust or participation. These results are important for global conservation efforts, as they demonstrate that it is possible to compensate communities for their stewardship efforts without harming social cooperation or undermining existing institutions.

Future research should examine whether PES also complements social capital in a variety of other types of local institutional contexts, including those in which local institutions have less

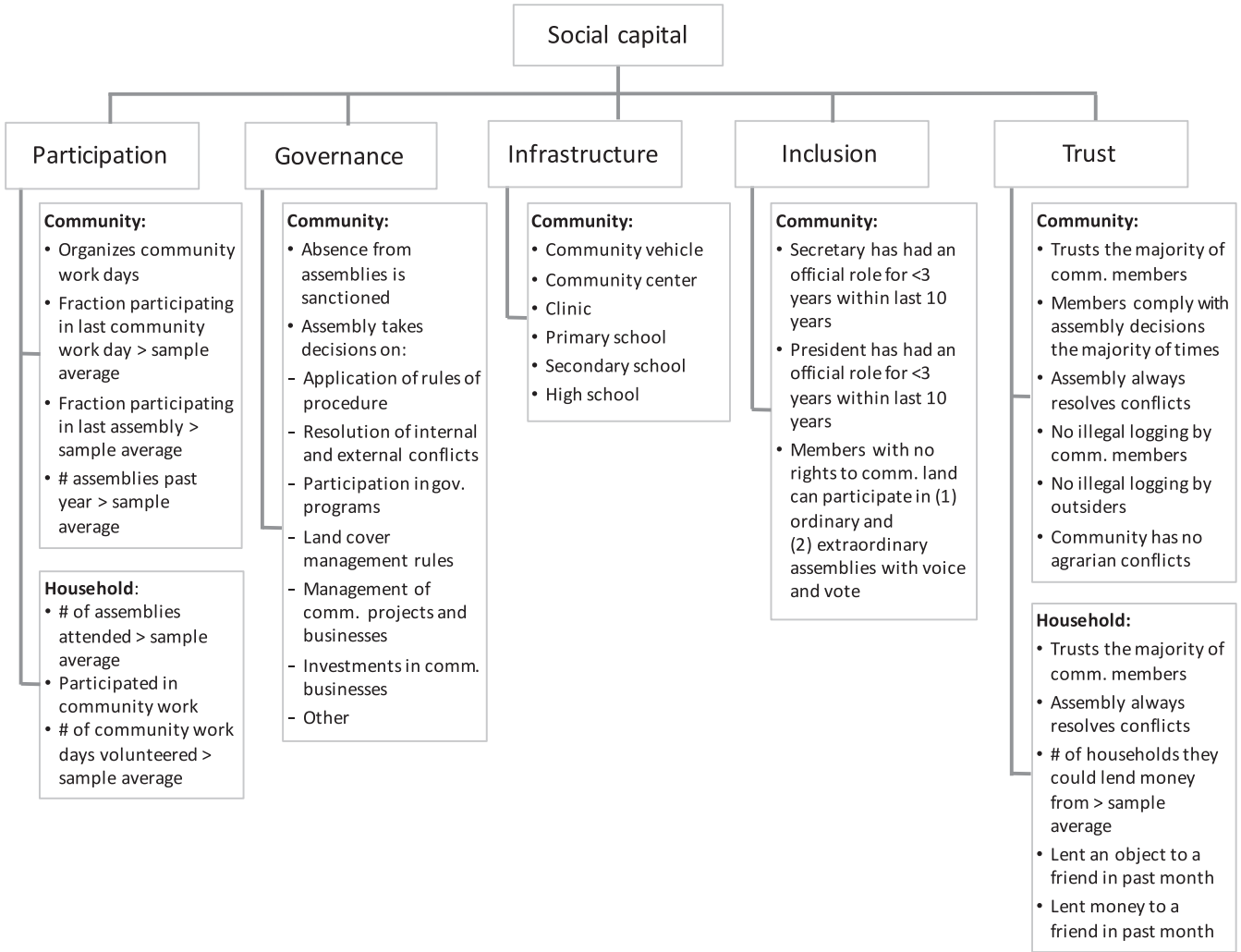

Fig. 3. Measures of community and household-level social capital. Measures of social capital at the community and household level were constructed from answers to survey questions, as summarized in this schematic.

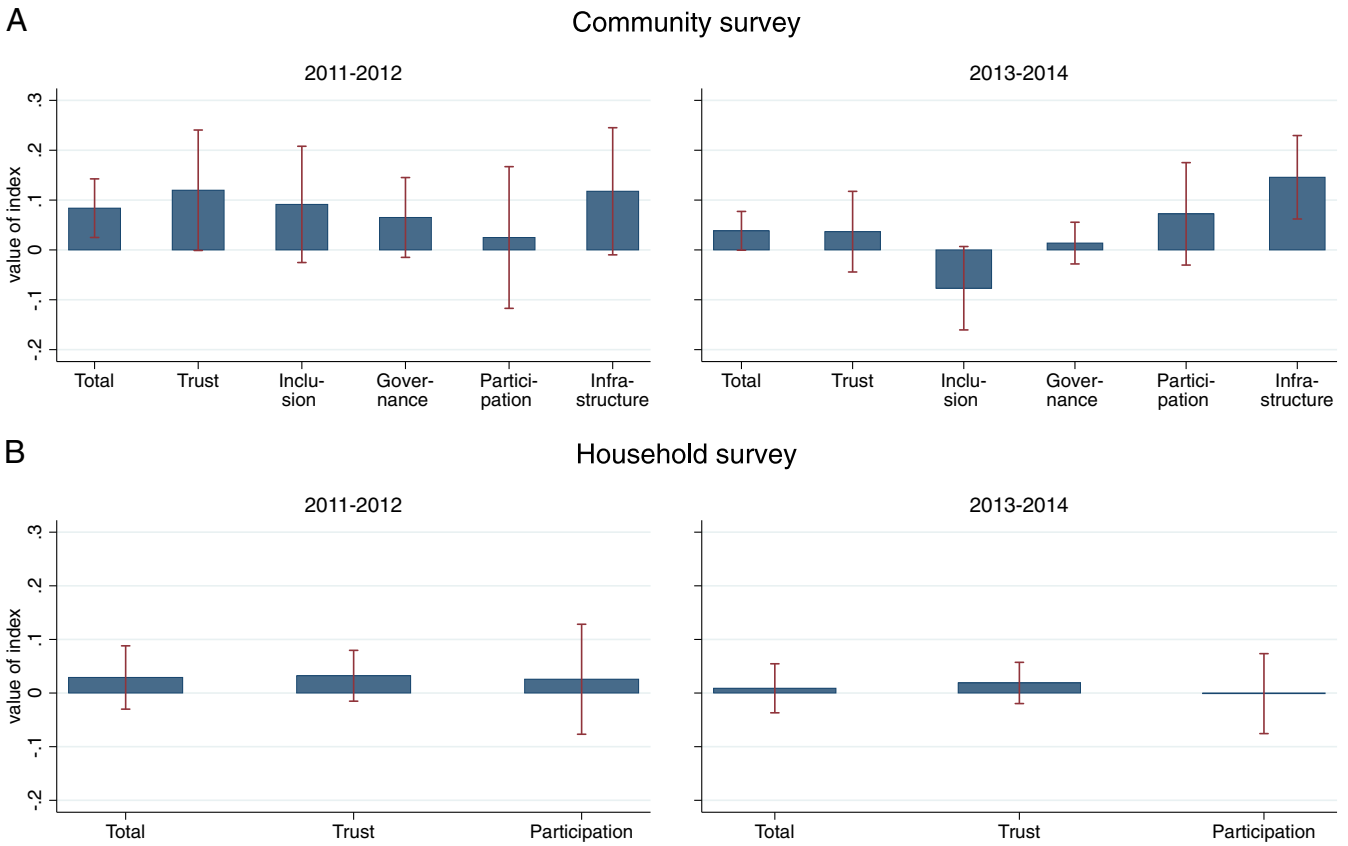

Fig. 4. PES supported community and household level social capital. Wide bars indicate estimated impacts of the PES program on social capital measures using regression discontinuity design. Thin bars indicate 95% CIs. "Total" is a composite index of the other measures. (*A*) Based on surveys of community leaders (n = 357 for 2011–2012 cohorts; n = 505 for 2013–2014 cohorts). (*B*) Based on surveys of individual households (n = 3,466 for 2011–2012 cohorts; n = 4,947 for 2013–2014 cohorts).

structure or formal support. PES inherently supports landowners; future studies should further explore impacts on households without land rights. As PES programs mature, future investigations should also focus on longer-term impacts, including the possible implications for behavior after contracts are completed.

Our research answers recent calls both for more rigorous evaluations of PES (34, 35) and for a better understanding of the social impacts of all types of participatory development programs (14). We have demonstrated a national-scale, empirical approach to answering this question, but there is an important need to also study the social impacts of incentive programs in other contexts. Although some conservation questions may be answered using cross-country research, causal estimates of social capital impacts can only be studied country by country because they must include both in-person surveys in remote areas and detailed understanding of and information on program selection criteria. Furthermore, constructing a comparison group that does not confound country differences in attitudes and behavior with impacts on social capital is a major empirical hurdle. Truly global studies may be possible in the future, but will require that national statistical agencies supplement existing surveys with new questions to achieve meaningful and sustainable long-term measures of trust and social capital that are comparable across countries.

ACKNOWLEDGMENTS. We acknowledge provision of data and time from CONAFOR and support from the field offices in implementing the survey. We acknowledge survey implementation by Chapingo University and thank all survey team members and participants for their time. We acknowledge financial support from the World Bank's programs of i2i, PROFOR, and Environment and Natural Resources; Mexico's National Evaluation Agency; CONAFOR; the Carnegie Corporation of New York (Grant G-F-16-53728); and our academic institutions.

1. Alix-Garcia JM, Sims KR, Yañez-Pagans P (2015) Only one tree from each seed? Environmental effectiveness and poverty alleviation in Mexico's payments for Ecosystem Services Program. *Am Econ J Econ Policy* 7:1–40.
2. Börner J, et al. (2017) The effectiveness of payments for environmental services. *World Dev* 96:359–374.
3. Jayachandran S, et al. (2017) Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation. *Science* 357:267–273.
4. Redford KH, Adams WM (2009) Payment for ecosystem services and the challenge of saving nature. *Conserv Biol* 23:785–787.
5. Muradian R, et al. (2013) Payments for ecosystem services and the fatal attraction of win-win solutions. *Conserv Lett* 6:274–279.
6. Schröter M, et al. (2014) Ecosystem services as a contested concept: A synthesis of critique and counter-arguments. *Conserv Lett* 7:514–523.
7. Bowles S (2008) Policies designed for self-interested citizens may undermine "the moral sentiments": Evidence from economic experiments. *Science* 320: 1605–1609.
8. Bruner A, Reid J (2015) Behavioral economics and payments for ecosystem services: Finally some free lunches (Conservation Strategy Fund, Washington, DC), Discussion Paper 13.
9. Agrawal A, Chhatre A, Gerber ER (2015) Motivational crowding in sustainable development interventions. *Am Polit Sci Rev* 109:470–487.
10. Segerson K (2013) Voluntary approaches to environmental protection and resource management. *Annu Rev Resour Econ* 5:161–180.
11. Kaczan D, Pfaff A, Rodriguez L, Shapiro-Garza E (2017) Increasing the impact of collective incentives in payments for ecosystem services. *J Environ Econ Manage* 86: 48–67.
12. Andersson KP, et al. (2018) Experimental evidence on payments for forest commons conservation. *Nature Sustainability* 1:128–135.
13. Keefer P, Knack S (2008) Social capital, social norms and the new institutional economics. *Handbook of New Institutional Economics* (Springer, Berlin), pp 701–725.
14. Mansuri G, Rao V (2012) *Localizing Development: Does Participation Work?* (World Bank Publications, Washington, DC).

15. Narloch U, Pascual U, Drucker AG (2012) Collective action dynamics under external rewards: Experimental insights from Andean farming communities. *World Dev* 40: 2096–2107.
16. Alpízar F, Nordén A, Pfaff A, Robalino J (2017) Unintended effects of targeting an environmental rebate. *Environ Resour Econ* 67:181–202.
17. Kaczan DJ, Swallow BM, Adamowicz WL (July 20, 2016) Forest conservation policy and motivational crowding: Experimental evidence from Tanzania. *Ecol Econ*, 10.1016/j.ecolecon.2016.07.002.
18. Alpízar F, Nordén A, Pfaff A, Robalino J (2017) Spillovers from targeting of incentives: Exploring responses to being excluded. *J Econ Psychol* 59:87–98.
19. Nieratka LR, Bray DB, Mozumder P (2015) Can payments for environmental services strengthen social capital, encourage distributional equity, and reduce poverty? *Conserv Soc* 13:345–355.
20. Yañez-Pagans P (2015) Cash for cooperation? Payments for Ecosystem Services and common property management in Mexico. Available at https://lacer.lacea.org/bitstream/handle/123456789/52978/lacea2015_cash_cooperation_mexico.pdf?sequence=1. Accessed May 31, 2018.
21. Grootaert C, Van Bastelaer T (2001) Understanding and measuring social capital: A synthesis of findings and recommendations from the Social Capital Initiative (World Bank Publications, Washington, DC), Social Capital Initiative working paper No. 24.
22. FONAFIFO, CONAFOR, Ministerio de Medio Ambiente del Ecuador (2012) Lecciones aprendidas para REDD+ desde los programas de pago por servicios ambientales e incentivos para la conservación: Ejemplos de Costa Rica, México y Ecuador (World Bank Publication, Washington, DC). Spanish.
23. Reyes JA, et al. (2012) *Atlas de Propiedad Social y Servicios Ambientales en México* (Instituto Interamericano de Cooperación para la Agricultura, Benito Juárez, Mexico). Spanish.
24. Rights and Resources Initiative (2015) Who owns the World's land: A global baseline of formally recognized indigenous & community lands (Right and Resources Initiative, Washington, DC).
25. Andam KS, Ferraro PJ, Sims KR, Healy A, Holland MB (2010) Protected areas reduced poverty in Costa Rica and Thailand. *Proc Natl Acad Sci USA* 107:9996–10001.
26. Baylis K, et al. (2015) Mainstreaming impact evaluation in nature conservation. *Conserv Lett* 9:58–64.
27. Imbens GW, Lemieux T (2008) Regression discontinuity designs: A guide to practice. *J Econom* 142:615–635.
28. Lee DS, Lemieux T (2010) Regression discontinuity designs in economics. *J Econ Lit* 48: 281–355.
29. Chen Y, Ebenstein A, Greenstone M, Li H (2013) Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy. *Proc Natl Acad Sci USA* 110:12936–12941.
30. Alix-Garcia J, McIntosh C, Sims KR, Welch JR (2013) The ecological footprint of poverty alleviation: Evidence from Mexico's Oportunidades Program. *Rev Econ Stat* 95: 417–435.
31. Grootaert C (2004) *Measuring Social Capital: An Integrated Questionnaire* (World Bank Publications, Washington, DC).
32. Merino L, Martínez AE (2014) A vuelo de pájaro: Las condiciones de las comunidades con bosques templados en México (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Tlalpan, Mexico).
33. Perevochtchikova M (2017) *Estudio de los efectos del programa de pago por servicios ambientales: Experiencia en Ajusco* (El Colegio de Mexico AC, México).
34. Naeem S, et al. (2015) Environment and development. Get the science right when paying for nature's services. *Science* 347:1206–1207.
35. Samii C, Lisiecki M, Kulkarni P, Paler L, Chavis L (2014) Effects of payment for environmental services (PES) on deforestation and poverty in low and middle income countries: A systematic review. *Campbell Syst Rev*, 10.4073/csr.2014.11.