Field experimental evidence shows that self-interest attracts more sunlight

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Edited by Thomas Dietz, Michigan State University, East Lansing, MI, and accepted by Editorial Board Member William C. Clark July 9, 2020 (received for review March 9, 2020)

This study examines how messaging approaches in a prosocial intervention can influence not only the effectiveness of the intervention but also, contagion afterward. Our investigation focuses on leveraging two motivations for solar adoption: self-interest and prosocial. Using data from a natural field experiment in 29 municipalities containing 684,000 people, we find that self-interest messaging is twice as effective in inducing solar adoption both during and after the intervention. Adoptions under self-interest messaging have 10% higher net present value, but prosocial messaging increases the likelihood that adopters recommend solar to their friends and neighbors. Income moderates the effectiveness of self-interest messaging, performing much better in high-income communities than low- and moderate-income communities. There was no significant difference across income groups for prosocial messaging. These results provide guidance to policy makers aiming to encourage prosocial behavior across all income groups.

nudge | solar photovoltaics | low and moderate income | energy | field experiment

As policy makers around the world continue to grapple with the challenge of mitigating climate change, the cost of many renewable energy technologies has plummeted. The cost declines have been especially rapid for residential rooftop solar photovoltaic (PV) systems, which have become cost effective for many households in the United States and many other countries. Yet, they are still relatively rare, with only about 1 in 50 households in the United States hosting a rooftop solar system by the end of 2019 (*SI Appendix* has calculation details). Additionally, it is generally even less common for low- and moderate-income households to adopt solar PV systems (1), leading to much policy interest in accelerating adoption by this customer segment for energy equity reasons.*

There is a growing literature demonstrating that interventions designed around insights from social psychology and behavioral economics, often called social nudges, can be cost-effective means to encourage conservation and prosocial environmental decisions (5–9). At the core of nearly all such behavioral interventions is some intended message the experimenter is trying to get across, whether it be a social norms message stating that peers or neighbors are performing the behavior (10) or simply a message intending to inform consumers of a real cost (11). However, less is known about how the core message of a prosocial campaign can influence its effectiveness. Furthermore, there is building evidence of peer effects or neighbor effects in prosocial activities (12–16), but there is limited evidence on how different messaging approaches can influence contagion of product adoption. Thus, messaging strategies can be of great interest to policy makers aiming to foster the adoption of prosocial behavior.

In this study, we run a preregistered natural field experiment to explore the effectiveness of messages aimed at prosocial motivations vs. messages targeted toward individual self-interest as part of a large-scale municipality-based campaign to encourage solar PV adoption. These two messaging approaches are motivated by previous empirical findings and generate hypotheses that vary by income group. Given the evidence of social interactions and peer effects playing a central role in the adoption of prosocial behaviors and technologies, we are also especially interested in how messaging can influence the strength of contagion after the campaigns are completed. By focusing on solar energy, our study is directly relevant for policy makers aiming to increase the adoption of renewable energy to mitigate climate change. However, it also contributes to our broader understanding of human behavior by exploring the effect of different informational approaches to influence a large-scale decision.

The interventions used in this study are variants of a large-scale grassroots campaign known as the Solarize program (17). This program is run at the municipality level and typically includes several key tenets: a limited time frame, volunteer solar ambassadors who spread the word about solar, a single municipality-chosen solar installer, and group pricing. Our study is specifically interested in how the messaging approach being

Significance

There is substantial policy-maker interest in assuring that the benefits from rooftop solar photovoltaic systems are shared by communities of all income groups. This study performs a field experiment leveraging a limited-time grassroots campaign to promote household adoption of solar to test the effectiveness of two messaging approaches motivated by previous empirical work. We find that self-interest messaging outperforms prosocial community-oriented messaging. The self-interest approach leads to higher-net present value systems, while the prosocial approach leads to greater peer recommendations and satisfaction with the installations, consistent with prosocial messaging leading to adoption by more community-oriented households. Income moderates the effectiveness of self-interest messaging, with high-income communities responding more than low- and moderate-income communities.

Author contributions: B.B. and K.T.G. designed research; B.B. and K.T.G. performed research; B.B., K.T.G., and M.O. contributed new reagents/analytic tools; K.T.G. and M.O. analyzed data; and K.T.G. and M.O. wrote the paper.

The authors declare no competing interest.

This article is a PNAS Direct Submission. T.D. is a guest editor invited by the Editorial Board.

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This article contains supporting information online at https://www.pnas.org/lookup/suppl/doi:10.1073/pnas.2004428117/-/DCSupplemental.

First published August 10, 2020.

*For example, consider this quote from California Governor Jerry Brown in 2016: "Oftentimes we've gotten criticism that solar energy. . .is about more affluent people. We have to make it available for. . .lower income Americans" (2). Ameli and Brandt (3) also show that low-income groups are more reluctant to invest in energy efficiency, even if they would financially profit from it. However, solar adopters may be ideologically diverse (4).

used in the campaign outreach can influence the campaign's effectiveness and how the effect of these messages differs based on the average income of the community, which is motivated by the policy makers' concerns about solar being primarily adopted by wealthy households. In assessing the campaign effectiveness, we examine the effect of prosocial- vs. self-interest–oriented messaging on the number of installations using administrative data, as well as the expected electricity generation and net present value of the investment using data from Google Sunroof. This provides insight into not only the uptake of the prosocial behavior but also, the value of such behavior for the environment.

We use self-interest messaging that focuses on the financial benefits of adopting solar (e.g., "save thousands by installing solar") and prosocial messaging that draws attention to the community benefits (e.g., "Our community is doing something together to have more clean energy"). We find that self-interest messaging is far stronger in inducing rooftop solar adoptions both during and after the campaigns. We further find that the self-interest messaging leads to different types of systems being installed: the systems installed in communities receiving self-interest messaging are more productive and more financially attractive, with a 10% higher net present value. The panels installed are also less likely to be made in the United States and more likely to be purchased up front rather than through a power purchase agreement, lease, or loan. These results indicate that if the goal is simply to increase solar generation, then self-interest messaging may be preferred, but if there is a policy-maker preference for domestically made panels, then prosocial messaging may be preferred.

These results further suggest that the households that choose to adopt solar in each treatment may be different in their characteristics. With different adopters, it is possible that the messaging also influences the process of the diffusion of the new technology by changing the proclivity of households to have social interactions relating to solar. Classic models of diffusion (e.g., refs. 18–20) and work in social psychology (21–23) have emphasized the importance of word of mouth and social interactions in the process of diffusion of new technologies and behaviors. We thus follow the two treatment groups after the campaigns and survey both solar adopters and interested nonadopters from the campaigns to better understand their motivations and social interactions relating to solar. This study examines the effect of messaging on subsequent contagion after the messaging intervention.

We find that solar adopters in the prosocial campaigns are more likely to recommend solar to friends and show greater satisfaction with their installations (despite their installations being less productive and less financially lucrative), consistent with greater "warm glow" from the installations. This might seem to suggest greater contagion after the prosocial messaging campaigns than the self-interest campaigns. However, the evidence on peer effects in solar adoption suggests that the number of neighbors adopting can speed adoption, so the greater uptake from the self-interest messaging could dominate. The self-interest messaging leads to a higher rate of adoption after the campaigns than the prosocial messaging, suggesting that "seeding" the communities with solar is the stronger influence on the subsequent number of solar adoptions.

A key question for policy is whether income moderates the effectiveness of the messaging. We find that high-income communities are much more responsive to self-interest messaging than low- and moderate-income communities, demonstrating a moderating effect of income under self-interest messaging. Although we cannot discern a significant difference in the effectiveness of prosocial messaging across income groups, we find suggestive evidence that prosocial messaging may be more effective in low- and moderate-income communities—a finding that deserves future work. These results suggest that for high-income communities, the greater adoption and contagion may commend the self-interest messaging approach, while for the low- and moderate-income communities, we cannot make a clear recommendation.

While we do not claim that these findings generalize across all locations and domains, they provide experimental evidence on the effectiveness of different messaging approaches for encouraging adoption of rooftop solar across communities of all income groups. The remainder of the study is as follows. We first discuss the experimental design in greater detail. Then, we present our results, and finally, we conclude.

Experimental Design

Our data come from a natural field experiment encompassing 29 municipalities with 684,000 people in the state of Connecticut, a state with high electricity prices and thus, generally financially attractive solar installations. The experiment was designed by the authors, and the treatments were implemented by the nonprofit SmartPower. This study was reviewed and deemed exempt by the Yale Institutional Review Board on September 23, 2016. The design of the treatments was motivated by the existing literature. There is substantial economic evidence that personal financial factors influence decisions, including prosocial decisions (e.g., ref. 24). Furthermore, Gillingham and Bollinger (17) present survey evidence from solar adopters during Solarize campaigns indicating that the number 1 single most important reason for the decision to install solar was "discount pricing offered through a Solarize program." The third most commonly listed single most important reason was "lower my monthly utility bill." These findings suggest a hypothesis that messaging focused on self-interest and personal financial savings would be effective.

However, there is also the large literature demonstrating that social identity plays a strong role in influencing decisions (25–27) and that prosocial interventions that draw upon social norms can be effective (10, 16). Solar energy can be thought of as an impure public good (28), in that it provides broader social (environmental) benefits, and many prospective solar adopters may see their proenvironmental actions as a crucial part of their social identity. Indeed, the second most commonly listed "most important reason" for the decision to install solar in the survey in ref. 17 was "concern for the environment." Furthermore, work in social psychology has suggested that self-interest motives can be dominated by "self-transcendent" motives (11), so highlighting self-interest rather than prosocial aspects might even reduce the interest in a green product like solar energy. This is also suggested by the findings of Asensio and Delmas (29), who find that monetary messages about energy conservation increased consumption of electricity in university housing, and Steinhorst et al. (30) show negative side effects from a monetary framing of proenvironmental behavior. Steg (23) also points out that focusing on financial incentives may cause people to activate their "egoist" values, which may crowd out intrinsic motives and reduce proenvironmental actions. Thus, a competing hypothesis is that prosocial messaging will dominate self-interest messaging.

Our experiment runs a horse race between these two hypotheses. However, we are also especially interested in how the different messages resonate with communities across the income spectrum. Appeals to public goods may have different impacts on different groups (31). Furthermore, diverse segments of the United States underestimate the environmental concerns of nonwhite and low-income populations (32), and this environmental belief paradox may push people who are underestimating the concern in their community away from proenvironmental actions (33), again leading to heterogeneous impacts across groups. Indeed, community identification can moderate the impact of

Fig. 1. Example photos from Solarize campaigns.

financial incentives in water conservation (34). In addition, there is evidence that low-income households respond more to prosocial messages in charitable donations (35). In contrast, high-income individuals react more to self-interest in the financial education setting (36). There is also evidence that lower-income individuals tend to prioritize "community" relative to higher-income individuals, who tend to prioritize material wealth (37, 38). These findings suggest a hypothesis that households in lower-income communities respond more to prosocial messages, while those in higher-income communities will respond more to self-interest messages.

With these hypotheses in mind, we designed our treatments to be identical Solarize campaigns except for the key messages being used in all of the outreach. Specifically, the self-interest messages focused on personal financial benefits and included messages, such as "Good long-term, personal investment" and "Gives you more control of your energy." In contrast, the prosocial messages focused on community benefits and social norms, with messages such as "The community is doing something together to have more clean energy" and "All of my friends and neighbors are doing it too." *SI Appendix* has the full set of messages used. These messages were displayed prominently in all of the marketing materials and were emphasized by SmartPower staff at the campaign kickoff meetings and other events.

We use a stratified randomization approach in this study. Based on discussions with SmartPower, we selected 30 municipalities that have not recently received a Solarize campaign but have expressed some interest in Solarize at some point. From this pool, we prematched the municipalities into groups of three based on their socioeconomic characteristics and prior solar adoptions in order to improve the balance of observables. For this prematching, we used a propensity score matching approach along with checks for similar income and population. Among each group of three municipalities, we randomized each municipality into the self-interest messaging, prosocial messaging, or control group (*SI Appendix* has more details on our randomization approach). Our budget did not permit running the 20th campaign, so we completed 10 prosocial messaging campaigns and 9 self-interest campaigns. For logistical reasons, campaigns were run over three rounds, with roughly the same number of prosocial and self-interest messaging campaigns run in each round. The campaigns began in April 2017, and the last campaign was completed in May 2018.

All campaigns lasted roughly 20 wk and included kickoff events, a single municipality-chosen solar installer, tabling at other events, signs at town halls, solar home tours, local media mentions, social media outreach, direct mailings, and additional informal social interactions between neighbors and volunteers (39, 40). Fig. 1 shows photos from several of the campaigns, and *SI Appendix* contains further details about how the campaigns work. SmartPower staff helped facilitate the outreach and focused the messaging toward either the self-interest messages or the prosocial messages. In *SI Appendix*, Fig. S1, we provide two examples of leaflets that were distributed in a self-interest messaging municipality and a prosocial municipality, showing how the order and content of the bullet points describing the benefits of solar are altered.

The messaging treatments in this study are run at the municipality level for multiple reasons. The Solarize campaigns have been shown to work well at the municipality level (17), which is also the level at which permitting and many other regulatory activities occur in Connecticut, reducing modifiable areal unit problems. In contrast, household-level messaging could be confounded by spillovers due to peer effects across households (41, 42).[†] We aimed to avoid running campaigns or having controls

[†]In concurrent work, we find some evidence of such spillovers within a 1-mile buffer in adjacent municipalities but none beyond this limited buffer.

Table 1. **Pooled sample balance of demographics and voter registration variables across 1) the 9 towns that received self-interest messaging, 2) the 10 towns that received prosocial messaging, and 3) the 10 control towns**

	1) Self-interest		2) Prosocial		3) Control		*P* values		
Variable	Mean	SD	Mean	SD	Mean	SD	1)2)	1)3)	2)3)
Population density	1,564	(2,003)	1,724	(1,888)	1,086	(1,064)	0.86	0.54	0.38
Median household income	78,935	(22,004)	90,045	(27,289)	82,544	(22,072)	0.35	0.73	0.52
Median age	41.8	(6.6)	41.8	(4.8)	42.4	(5.1)	0.98	0.82	0.77
Fraction population over 65	0.162	(0.038)	0.159	(0.023)	0.171	(0.038)	0.88	0.62	0.44
Fraction white	0.829	(0.160)	0.799	(0.176)	0.840	(0.124)	0.71	0.87	0.57
Fraction black	0.060	(0.097)	0.084	(0.118)	0.068	(0.067)	0.64	0.83	0.72
Fraction Asian	0.040	(0.021)	0.049	(0.023)	0.043	(0.029)	0.42	0.81	0.64
Fraction families	0.795	(0.073)	0.817	(0.066)	0.822	(0.061)	0.53	0.41	0.85
Fraction commute 60+ miles	0.078	(0.040)	0.084	(0.059)	0.066	(0.046)	0.80	0.56	0.46
Fraction college graduates	0.385	(0.075)	0.456	(0.131)	0.377	(0.140)	0.18	0.87	0.22
Fraction below poverty	0.092	(0.089)	0.072	(0.080)	0.082	(0.061)	0.63	0.78	0.77
Fraction detached dwelling	0.656	(0.217)	0.642	(0.202)	0.683	(0.195)	0.89	0.78	0.65
Fraction registered Republican	0.213	(0.072)	0.234	(0.086)	0.221	(0.051)	0.58	0.79	0.69
Fraction registered Democrat	0.358	(0.140)	0.355	(0.134)	0.345	(0.080)	0.96	0.82	0.86

Demographic variables are from the 2013 to 2017 American Community Survey. The *P* values are for a pairwise two-sided *t* test of differences in means by group.

in adjacent municipalities at the same time to prevent issues of spillovers to adjacent municipalities and for the most part, achieved this with only a few exceptions for logistical reasons (*SI Appendix*, Fig. S2 shows a map of Connecticut with the campaigns marked). Because we ran campaigns at the municipality level, each treatment campaign cost on the order of \$20,000 to \$30,000, which explains the relatively small sample size in the study.

Our data include all residential rooftop solar PV installations in Connecticut from 2010 to 2019, US Census Bureau data from the 2013 to 2017 American Community Survey, data from Google Sunroof on the solar potential of rooftops and potential net present value of a solar installation in 24 of our 29 municipalities, and a survey of adopters ($n = 223$; 41% response rate) and nonadopters ($n = 218$; 19% response rate) who expressed interest in solar (43). Table 1 shows the balance of observables, demonstrating that the randomization was successful in creating three reasonably matched groups. For simplicity, we also divide up our communities based on the US Department of Housing and Urban Development area median income (AMI) in each region of Connecticut. Those below AMI we call "low and moderate income," and those above we call "high income." More details on the data, AMI designations, and a variety of summary statistics are provided in *SI Appendix*.[‡]

Results

Effects of Messaging Strategy on Adoption and Contagion. We first examine solar adoptions over time relative to the start of the campaigns. Fig. 2*A* shows the number of solar installations per month per 1,000 owner-occupied households.[§] Just prior to the campaigns, the average number of installations is similar across the three groups [difference across the three groups in year prior $F(2, 26) = 0.96$, $P = 0.40$], although with the relatively small sample, there are some slight differences in earlier years. During the campaign period, self-interest messaging led to substantially more installations than prosocial messaging [$M = 1.08$ for self-interest and $M = 0.70$ for prosocial; $t(28) = 2.53$, $P = 0.02$]. Both led to more installations than the control [$M = 0.47$ in control; for self-interest $t(28) = 4.70$, $P < 0.001$; for prosocial $t(28) = 2.03$, $P = 0.05$]. This evidence indicates that the Solarize campaigns were effective in increasing adoptions and that the self-interest messaging was the superior approach on average. For context on the strength of our result, 58% (88) of our 152 town-months would have to be replaced by data with no effect to invalidate the inference that self-interest messaging campaigns significantly increase adoption of solar. To invalidate the inference that self-interest messaging campaigns are significantly more effective than prosocial campaigns, 21% (22) would have to be replaced by data with no effect (44, 45). *SI Appendix*, Table S4 presents a regression analysis, including specifications with municipality and month × year fixed effects for robustness to any concerns about slight differences in adoptions or any other covariates across the treatments and control.

We next explore contagion after the campaigns. As can also be seen in Fig. 2, self-interest messaging continues to perform better than prosocial messaging after the campaigns [$M = 1.12$ for self-interest and $M = 0.69$ for prosocial; $F(28) = 1.83$, $P = 0.07$]. Self-interest messaging also led to more adoptions than the control [$M = 0.52$; $t(28) = 2.81$, $P = 0.01$], but there is no significant difference between the prosocial messaging and the control group [$t(28) = 0.55$, $P = 0.58$]. These findings so far are consistent with the first hypothesis (that self-interest messaging can dominate prosocial messaging in our context) but is at odds with what might have been expected from some of the existing literature.

Characteristics of Systems Installed across Messaging Approaches. To explore what might be leading to the differences in adoption across the messaging strategies, we examine the characteristics of the adoptions, including prices, system productivity, and financial benefits. Fig. 2*B* shows the price of a solar installation over time relative to the start of the campaigns. Prior to the campaigns, the price of a solar installation is roughly similar across the three groups, and we fail to reject the null of equality [difference across the three groups in year prior $F(2, 26) = 2.17$, $P = 0.13$]. During the campaigns, there are no significant differences between the control and two treatment groups [mean difference self-interest to control = +\$57/kW; $t(28) = 0.80$, $P = 0.43$; mean difference prosocial to control = +\$72/kW; $t(28) = 0.95$, $P = 0.51$]. This result indicates that the treatments did not reduce the price per

[‡]Note there is a high correlation between income and the fraction of college graduates (at the municipality level), with a Pearson correlation coefficient of 0.86. The municipality-level correlation coefficient between income and minority status in Connecticut is surprisingly quite a bit closer to 0 at −0.31.

[§]*SI Appendix*, Fig. S4 presents a similar graph by the month in the sample.

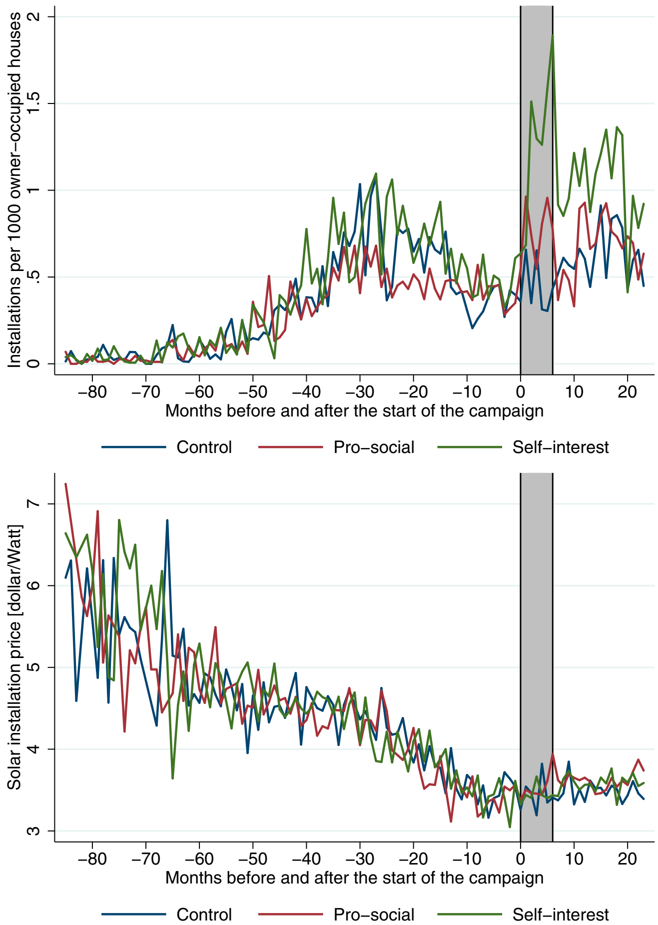

Fig. 2. (*A*) Installation rate and (*B*) solar installation price by treatment over time relative to the start of the campaign. The gray area shows the timing of the campaign

watt of solar but still substantially increased the rate of adoption, suggesting that the increased adoption is the result of the social interactions and information transmission rather than the effect of discounted pricing.

Next, we compare the productivity of the installed systems across treatments to shed light on whether the systems installed are equally beneficial for the environment. We use Google Sunroof data to examine the hours of sunlight per year. Since we did not prematch to balance observables with the Google Sunroof data, we perform all of our hypothesis tests using these data based on the fixed effects regressions in *SI Appendix*. Self-interest messaging led to solar systems with substantially more hours of sunlight [difference between self-interest and prosocial = 28; $t(23) = 2.02$, $P = 0.05$], amounting to 28 kWh/kW installed, which leads to an extra 4.4 MWh generated over the lifetime of an average 7.8-kW system. This suggests that the installations have more favorable orientations and face less shading. We confirm these results in a regression that also includes the control in *SI Appendix*, Table S8.

When comparing the financial benefits from the systems installed in the two treatments, we find that self-interest messaging led adopters to receive a higher net present value of electricity savings over the lifetime of the solar system [mean difference self-interest to control = $1,515; $t(23) = 5.17$, $P < 0.001$; mean difference self-interest to prosocial = $1,784; $t(23) = 3.10$, $P = 0.005$]. These findings indicate that self-interest messaging brings in adopters who install more productive (and thus, generally more environmentally beneficial) and financially lucrative solar systems. This may suggest that consumers with a more financially oriented self-identity are drawn in to adopt under self-interest messaging (33). It is also possible that these financially oriented consumers make sure to optimize their systems, in line with cognitive consistency theory (46, 47).

Considerations in the Adoption Decision. Our survey data on solar adopters provide insights into the key factors influencing adoption. Table 2 compares adopter responses under self-interest messaging with those under prosocial messaging. Adopters under self-interest messaging are more likely to report "money" as the number 1 reason to install solar [mean difference between self-interest and prosocial = 0.12; $t(186) = 1.66$, $P = 0.049$]. They are also more likely to put money as both the number 1 and number 2 reasons [mean difference between self-interest and prosocial = 0.23; $t(122) = 2.80$, $P = 0.003$]. These findings show that self-interest messaging indeed drew a set of adopters more focused on financial considerations, again suggesting that this may be part of their self-identity (33).

Given the differences in solar adopter financial orientation, one might expect differences in other characteristics of adopters. Yet, in most cases, there are no significant differences in adopters (Table 2, household characteristics). Characteristics, such as income, share that owns a hybrid vehicle, share that expects solar or electricity prices to go up, share that is a Democrat, and share with a graduate degree, are all similar across adopters in the two treatments.[¶] Two characteristics differ. Under prosocial messaging, there is a higher share of households with more than three people [mean difference = −0.14; $t(195) = -1.95$, $P = 0.026$] and that own an electric vehicle [mean difference = −0.06; $t(195) = -1.66$, $P = 0.049$]. The latter finding is consistent with prosocial messaging drawing in households with a more proenvironmental self-identity (23).

We next examine differences across the messaging approaches in satisfaction with the adoption (Table 2, installation satisfaction). Adopters in prosocial campaigns are more satisfied with their installations [mean difference = −0.45; $t(140) = -2.24$, $P = 0.013$], are more likely to state that they would recommend solar to friends or neighbors [mean difference = −0.43; $t(141) = -2.79$, $P = 0.003$], and are more likely to state that they already have recommended solar to friends or neighbors [mean difference = −0.44; $t(140) = -2.00$, $P = 0.023$]. These findings are again consistent with the prosocial campaign bringing in a set of adopters with stronger proenvironmental self-identities than the self-interest campaigns.[#]

It may seem surprising at first that the adopters under prosocial messaging are more satisfied with their installations despite the systems having lower financial benefits on average. However, if adopters receive a greater warm glow boost (48) under prosocial messaging than self-interest messaging, this could increase their willingness to install solar even if it is not as lucrative to. We also find that adopters under prosocial messaging are more likely to buy United States-made solar panels than adopters under self-interest messaging [mean difference = −0.07; $t(661) = -2.26$, $P = 0.012$]. Conversely, adopters under self-interest messaging are more likely to pay cash for their installation, which provides greater financial benefits than a solar lease or loan [mean difference = −0.08; $t(661) = 1.96$, $P = 0.025$].[‖] This is again consistent with self-interest messaging drawing consumers with

[¶]In contrast, *SI Appendix*, Table S10 shows that adopters and nonadopters of solar differ significantly in household characteristics and beliefs.

[#]The response rate to the survey is also slightly higher for the prosocial messaging, which reinforces this result because filling out a survey is a prosocial activity.

[‖]*SI Appendix*, Table S11 shows full results.

Table 2. **Main reason to install ("What was the single/second most important reason for the decision to install solar?"), household characteristics, and installation satisfaction (Likert scale: 1 = not at all important, 7 = extremely important)**

	Self-interest	Prosocial	*P* value of difference
Share of households for whom money is†			
First reason to install solar	0.60	0.47	0.049*
First and second reasons to install solar	0.45	0.22	0.003**
Household characteristics			
Share of families with 3+ people	0.42	0.56	0.026*
Share with income above $100,000/y	0.77	0.76	0.405
Share that owns a hybrid vehicle	0.19	0.19	0.491
Share that owns an electric vehicle	0.04	0.11	0.049*
Share that expects solar prices to go up	0.32	0.38	0.222
Share that expects electricity prices to go up	0.94	0.90	0.207
Share registered as Democrat	0.54	0.53	0.451
Share registered as Republican	0.06	0.08	0.378
Share with undergraduate degree	0.87	0.93	0.075
Number of local organizations involved	2.28	2.37	0.393
Measure of community feeling (Likert 1–7)‡	5.46	5.39	0.276
Installation satisfaction			
Satisfied with installation (Likert 1–7)	5.93	6.38	0.013*
Would recommend solar to friends (Likert 1–7)	6.18	6.61	0.003**
Have recommended solar to friends (Likert 1–7)	5.77	6.21	0.023*
Observations	93	104	

The *P* values are for a pairwise one-sided *t* test of differences in means by group. *$P < 0.05$; **$P < 0.01$.
†The options were "lower my monthly utility bill," "concern for the environment," "stabilize energy costs over time," and "a short payback period."
‡Community feeling is measured as the average procommunity answer to the following questions (Likert 1–7): "I perceive myself as a citizen of my community," "I feel strong ties with other citizens in my community," "Being a citizen of my community does not mean a lot to me," "I identify with other citizens in my community," "It is important for me to be a citizen of my community," and "Being a citizen of my community is not part of my identity."

a financially oriented self-identity, while prosocial messaging draws consumers with a proenvironmental self-identity.

Comparing Spatial Clustering across Messaging Approaches. It is possible that because prosocial messaging leads to greater recommendations to friends and neighbors, it might lead to greater spatial clustering of installations. Of course, this may be countered by the greater peer effects created by the self-interest campaigns due to more total adoptions. We first explored spatial clustering using a Getis Ord Gi* approach at the census block group level. There is evidence of hot spots in only three municipalities (two prosocial and one self-interest), so we cannot distinguish a difference between prosocial and self-interest messaging. We then used the ArcMap nearest neighbor tool to calculate the average distance between every pair of solar installations in a municipality or census tract. Regardless of the geographic unit used, there are no significant differences in spatial clustering between the prosocial and self-interest messaging (*SI Appendix*). This finding suggests that enhanced peer effects from greater adoption in the self-interest campaigns may entirely countervail the greater recommendations in the prosocial campaigns over the time period we observe.

Income as a Moderator of the Effect of Messaging. Given the literature suggesting that low- and moderate-income communities might respond differently than high-income communities, we examine whether income moderates the effect of messaging. Fig. 3 illustrates that both during and after the campaigns, self-interest messaging performs much better in the high-income municipalities [mean difference between high income and low and moderate income for self-interest during = 0.54; $t(28) = 4.79$, $P < 0.001$]. In fact, 62% (23) of our 36 mo of high-income campaign data would have to be replaced by data with no effect to invalidate the inference that self-interest messaging campaigns are significantly more effective than prosocial campaigns in high-income municipalities (44, 45). We observe some evidence that prosocial messaging performs better in low- and moderate-income communities than high-income communities, but the result is not significant, and we interpret it as a suggestive finding that warrants further research. In *SI Appendix*, including *SI Appendix*, Tables S6 and S7, we show that these findings of a significant difference for self-interest and not for prosocial are robust to a variety of specifications.

An explanation for the finding that income moderates the effectiveness of self-interest messaging is that high-income households are more likely to have strong egoist values (23) and self-identify with being financially competent, as well as be surrounded by a similar social network of friends and neighbors who care about financial considerations (33). An alternative explanation is that the underlying solar potential differs by the income of the community. The Google Sunroof data on the full distribution of solar potential for all buildings in each community indicate that the potential financial gains are actually $1,500 lower in the higher-income communities than low- and moderate-income communities, although this result is not significant. Thus, while we cannot rule out this alternative explanation, it appears that values and norms are the more likely explanation.

Conclusions

In this study, we run a natural field experiment exploring the effect of two different messaging strategies, each motivated by theory, on the adoption and contagion of residential rooftop solar in the context of a grassroots campaign. Our investigation examines the effect both on average and across communities

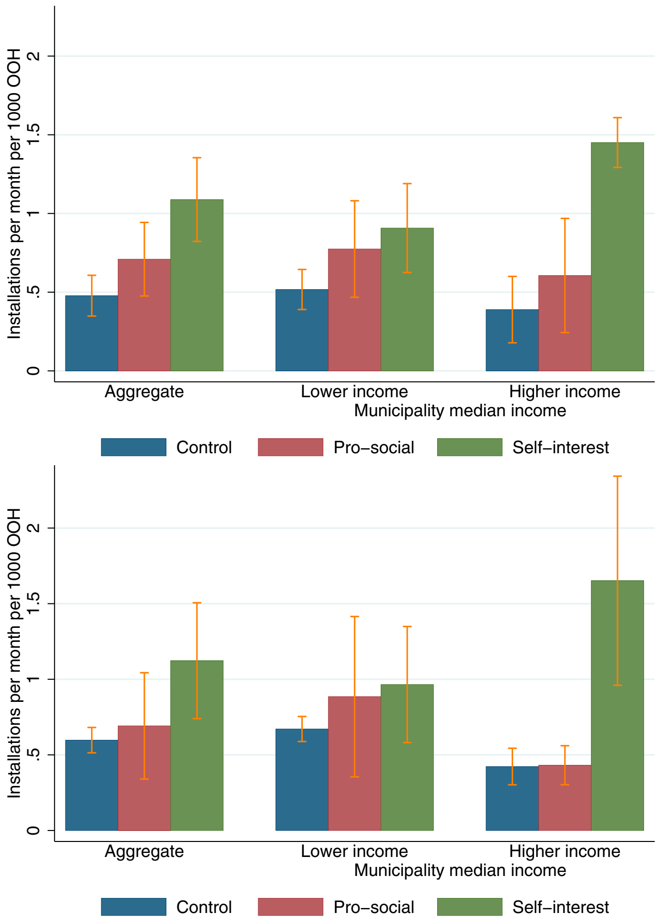

Fig. 3. Solar adoption by treatment (left bars) and by treatment and income groups (center and right bars) during (*A*) and after (*B*) the campaign. Unit of observation is town-month. Error bars indicate 95% CIs, with SEs clustered by municipality. The sample consists of all treatment and control installations during (*A*) and after (*B*) the campaigns. OOH, owner-occupied households.

belonging to different income groups, for there has been a great deal of policy-maker attention focused on low- and moderate-income solar adoption. We find that self-interest messaging dominates prosocial messaging in our setting, in contrast to the findings in ref. 29. The difference likely is due to a different context (e.g., solar vs. energy efficiency), highlighting the usefulness of further studies in this area, as suggested by ref. 31.

The adopters under self-interest messaging tend to install more productive and higher-net present value systems, consistent with self-interest messaging drawing more financially oriented consumers than prosocial messaging. Similarly, adopters under prosocial messaging tend to be more likely to recommend solar to friends and neighbors and more satisfied with their installations, suggesting that prosocial messaging draws consumers with more proenvironmental self-identities. We further show that income moderates the success of the self-interest messaging, a result that is consistent with work in social psychology and behavioral economics on identity, values, and norms. We cannot distinguish a moderating effect of income in prosocial messaging, although we find suggestive evidence that prosocial messaging works better in low- and moderate-income communities than high-income communities. We view this as an area ripe for future research. However, our findings do suggest that the designers of future programs could consider ways to assure that lower-income households, which may be less self-interested, also share in the full benefits of solar with higher-net present value systems.

Because our findings are in the context of a well-known but specific type of grassroots campaign for solar, we cannot opine on whether the two messaging approaches would work more broadly. Similarly, while we designed our messaging approaches based on evidence suggesting that they would be effective, other messaging approaches are possible that may work just as well or better than the two we examined. Further research will be needed to uncover the other contexts in which these findings apply, as well as other messaging approaches. We see our work as building a foundation for improved understanding of strategies to bring solar to communities of all groups.

Data Availability. All data and replication code are available at GitHub, https://github.com/MartenOvaere/Self_Interest_Attracts_More_Sunlight.

ACKNOWLEDGMENTS. This field experiment was preregistered at the American Economic Association (AEA) Randomized Controlled Trial (RCT) registry with RCT identification AEARCTR-0002218. We are grateful to many colleagues for their comments and suggestions. We also appreciate the helpful comments from participants at the 2019 Advances with Field Experiments conference; participants at the Behavior, Energy, and Climate Change conference; and seminar participants at Yale, KU Leuven, and the University of Alabama. This material is based upon work supported by the US Department of Energy's Office of Energy Efficiency and Renewable Energy under Solar Energy Technologies Office Award DE-EE0007657. This report was prepared as an account of work sponsored by an agency of the US Government. Neither the US Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the US Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the US Government or any agency thereof.

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