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An experimental test of the effect of negative social norms on energy-efficient investments

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ABSTRACT

Energy efficiency is an important economic and environmental concern, and likewise the correction of current wasteful energy practices. We document widespread "tire pressure neglect" – three-quarters of drivers waste gas driving on underinflated tires. Negative descriptive social norms are one potential cause, but have not been tested in high-neglect environments, where those norms are widespread. This confounds the mechanism: are these norms signals of private value to consumers, or do they imply standards for social judgment from others? We conducted a field experiment at gas stations in Chicago – our intervention included treatments with information about tire pressure neglect, promotions in the form of price reductions from $0.50 to free, a descriptive norm of behavior, and "help" in the form of air pump assistance. The treatments are designed to provide the ability to consider four potential underlying drivers: information, monetary cost, social norms and social pressure. Treatments that only included information were ineffective, despite average fuel savings of $10.51, but small promotions had substantial impacts. When the air pump price was free, the social norm discouraged inflation. However, when the research assistant offered help, inflation rates were buoyed by the social norm. These results highlight the importance of incentives over mere information treatments, and offer a new perspective on how information and monetary levers can influence decision-making in the presence of negative social norms.

1. Introduction

> "Motorists must be alerted to the fact that even small losses in inflation pressure can greatly reduce tire life, fuel economy, safety, and operating performance."
>
> National Research Council (2006).

Energy efficiency is a critical element of policy to address increasing energy prices and the compounding externalities of pollution. Even as the cutting edge of "green" technology advances, many currently available investments in energy efficiency are routinely neglected. This is particularly perplexing to researchers because often the direct personal benefits alone appear to outweigh the costs of conservation, even holding aside social gains (Jaffe and Stavins, 1994; Hausman and Joskow, 1982). For example, government estimates suggest tire pressure under-inflation is common, at roughly 75% of the

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domestic personal vehicle fleet (USDOT, 2001). This despite the fact that properly inflated tires can substantially improve fuel efficiency (between 2% and 3%) and also reduce accidents by improving stopping speed and preventing tire blowouts (NHTSA, 2005).

We document widespread "tire pressure neglect" by surveying drivers at gas stations in Chicago. An intervention was designed to address three possible causes of neglect: awareness, cost and social norms. We offered information about tire pressure and gauged subjects' tires, in case they were simply unaware of the concern (Simon, 1955; Gabaix, 2011). We also offered token incentives, and measured their cost against our estimated future savings for drivers. Finally, we were concerned about the perception of widespread neglect as a self-perpetuating social norm (Cialdini and Trost, 1998). Previous field studies have shown that negative descriptive norms discourage good behavior (Cialdini et al., 1990; 2006; Reno et al., 1993), but examine contexts where the negative descriptive norm is artificially induced by experimenters.[1] This confounds the effects of social norms as information (Becker, 1991; Hertwig and Herzog, 2009) and social norms as standards of approval (Benabou and Tirole, 2005; Cialdini, 2003).

We instead test the effects of naturally occurring negative social norms in a randomized between-subjects field experiment. In six of our seven conditions, posters were hung on gas pumps and research assistants offered to gauge tire pressure for free to drivers pumping gas. In three of those six conditions, a negative descriptive social norm was included on the poster. As well, two different incentives were offered – either the pump fee was waived, or the research assistant offered help (or a no-incentive control). While we expected both incentives would increase tire inflation on their own, offering help would emphasize being observed and carry implicit social pressure, compared to waving the fee for the pump. This contrast provides an indirect test of these competing accounts of the effects of social norms – if social approval is being conveyed, then social norms should temper the effect of social pressure.

Analyzing our results, we found that the information intervention alone had almost no effect on tire inflation rates, even though the average driver with one or more low tires (78% of our sample) would have saved more than $10 in gas expenses over the next four months. Two small incentives – waiving the $0.50 air pump fee, or helping with the inflation itself – averaged roughly $30/h in gas savings at the intervention level, and $48/h in the single most effective treatment. In treatments where the descriptive norm was included on the poster, the effects were mixed – when the pump was free, the social norm reduced tire inflation (23.9% vs. 11.6%), but when subjects were offered help by the research assistant, the social norm increased tire inflation (17.3% vs. 32.9%). If the negative descriptive norm primarily worked through the social expectation channel, a decrease in the help treatments would have been observed because the norm would alleviate the social pressure to inflate. However, because we observed the opposite, the norm may primarily be operating through information channel.

This paper is divided into sections as follows: The next section reviews the benefits and costs that are relevant to tire pressure neglect, and applies existing theory to our intervention strategies. Section 3 covers the details of our experimental methods and data sets. Section 4 summarizes the methods and results of our field study. Section 5 discusses the theoretical implications and practical applications.

2. Motivation

There have been economic approaches to the slow adoption of efficient behavior that focus either on market failures, or on atypical or unobserved preferences (see Jaffe and Stavins, 1994). However, we believe that psychological factors also play an important role in obscuring the value of investments in efficiency. A number of recent papers have begun to look at the social impacts on energy conservations (Ferraro and Price, 2013; Herberich et al., 2011; Allcott, 2011). We extend the literature by looking into the potentially confounded impacts of information and pressure.

An initial concern about tire inflation is that most people are simply unaware of the importance of tire inflation, or even the level to which their tires are and should be inflated. That is, it can be difficult to monitor every last detail of car maintenance, and drivers might only focus on a few of the most important things (Simon, 1955; Gabaix, 2011). The effects of inattention are twofold – for one, drivers might not be aware that tire inflation improves fuel efficiency. As well, drivers may not know their own tire pressure level.[2] The inertia of inattention can be powerful (Madrian and Shea, 2001). Our intervention addressed both of these concerns – first, we put posters up on gas pumps alerting drivers to the costs of under inflation (see Appendix A), and we also offered to gauge the tires of any car that pulled up, for free, while gas was being pumped. This is of interest from a policy perspective because recent regulation is focused on impacting behavior through information: recent regulations require automatic tire pressure monitoring systems installed in most new cars in the USA (2007), European Union (2010) and South Korea (2012), with more jurisdictions on the way. Part of our intervention could be thought of as a particularly attention-grabbing, one off, tire pressure monitoring system.

A second channel that may be influencing tire inflation neglect are the upfront costs – money, time and effort – which are small relative to the long-run benefits. However, the immediacy of the upfront costs may discourage inflation

[1] A negative descriptive norm, defined here, is information given to a subject that the desired behavior is uncommon.

[2] Automatic Tire Pressure Monitoring Systems have been mandatory for new cars starting in 2007 but even these only alert drivers once a tire is severely underinflated, and at a risk of blowout (roughly ¼ of all tires, Thiriez and Bondy, 2001).

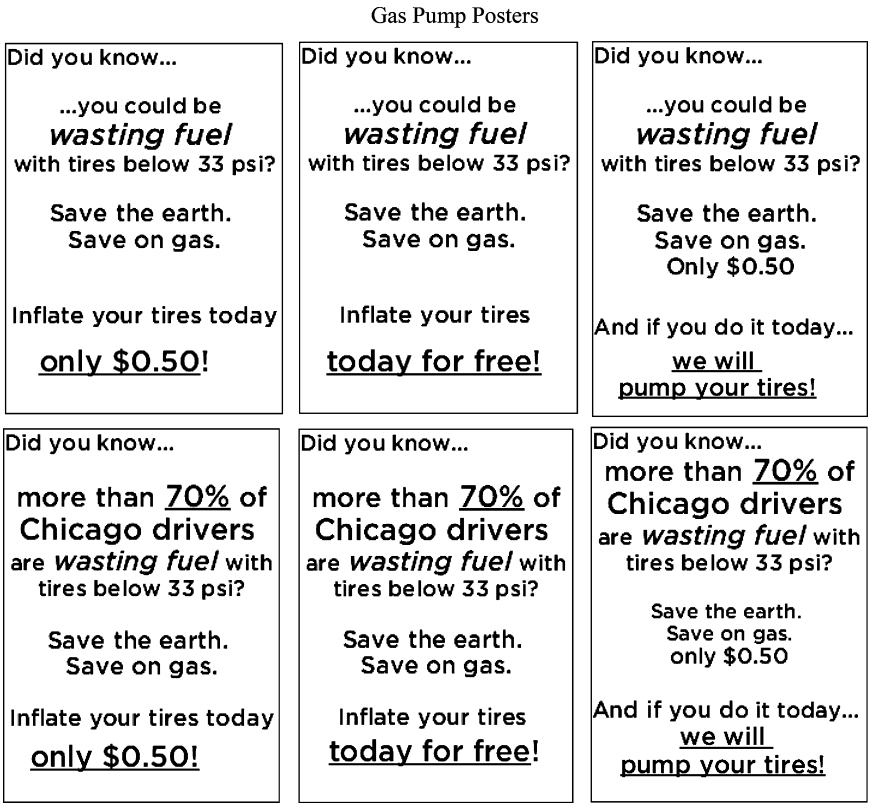

Fig. 1. Gas pump posters. The six posters placed on gas pumps. They are arranged from left to right by the incentive offered (no offer, free, and help, respectively) and top to bottom by the framing (personal and social, respectively).

disproportionately compared to the benefits. For one, present-biased drivers will focus too much on the immediate costs (Laibson, 1997), and if they are naïve about their present bias, they might still be convinced that inflation is a good idea for them but always "plan" to do it next time, and procrastinate indefinitely (O'Donoghue and Rabin, 2001). This intervention alleviated some of the upfront costs either by waiving the $0.50 price of the pump, or by offering help with the pumping (see Fig. 1). We calibrate the effects of these incentives against the expected long-run benefits, and control for individual differences in wealth with both FOIA and observed datasets.

A final channel that might perpetuate tire pressure neglect is the current social norm: the knowledge that tire pressure neglect is common may undermine any effort to encourage inflation though the desire to perpetuate the social norm. Many studies have shown the relationship between believing in positive social norms and positive behavior, both in randomized experiments and survey data (Schultz, 1999; Schultz et al., 2007; Goldstein et al., 2008; Beshears et al., 2011; Stern, 2000). The research on negative social norms – knowledge that a positive behavior is uncommon – is less clear. Several field experiments contain evidence of the discouraging effect of negative social norms, but all of these were conducted in domains where the negative behavior described in the social norm was uncommon – littering in a campus dorm; littering in a hospital parking lot; stealing from a national park – thus, the negative descriptive norm was artificially created by the experimenters (Cialdini et al., 1990; Reno et al., 1993; Cialdini et al., 2006).

The artificiality of the negative social norm experiments creates two problems in interpreting the results: understanding the application, because the effect is unclear when the descriptive norm actually describes the truth, and understanding the theoretical implications, because these domains confound two potential mechanisms for the effect. On one hand, the awareness that a majority of people do not perform a positive act could undermine perceptions of social desirability, diluting the potential for guilt or praise that motivate action (e.g. Benabou and Tirole, 2005; Cialdini, 2003). On the other hand, knowing that people do not perform an act may be information about the utility of the act itself similar to crowds revealing private signals about the value of a good (Becker, 1991; Hertwig and Herzog, 2009). In terms of tire pressure neglect, the norm may imply either that tire inflation is not held in high esteem, or that it does not save much gas.

The discouraging impact of negative social norms has also been demonstrated in descriptive social norm studies that simply provide a population mean to subjects (e.g. Ferraro and Price, 2013; Herberich et al., 2011; Allcott, 2011; Frey and Meier, 2004; Schultz et al., 2008; Gerber and Rogers, 2009; Chen et al., 2010). A common finding in this literature is that giving information about the average can reduce the desired behavior among those who are already outperforming the

average.[3] Fr one, this still confounds information and esteem effects. But in addition, these results are problematic to generalize – the subject pool is biased from ex ante selection, and could shift toward the population average for many other reasons that do not involve the psychology of social norms (e.g. regression to the mean). In our case, any result from an experiment that only generalizes to the most diligent individuals has little practical value for cases like tire pressure neglect, where diligence is exceptionally rare.

To address the impact of social norms and incentives, our intervention varied the presence of negative social norms with different incentive schemes. Key to the evaluating the intervention's treatments is a distinction in how subjects perceive a price reduction and a help offer – both reduce the upfront costs of tire inflation, but the help offer also carries with it a stronger element of social expectation. That is, people often find it difficult to say "no" to a personal request, succumbing to social pressure (Flynn and Lake, 2008; Andreoni et al., 2011; DellaVigna et al., 2012). As well, this offer may emphasize the degree to which the subject feels like their behavior is being observed (Ariely et al., 2009; Griskevicius et al., 2010). If negative descriptive norms affected the perceived social desirability of an action, then the social norm would be more discouraging when paired with a help offer than a price reduction.

However, if their primary effect is through the information channel, then the effect of social norms should not be any different with the help offer than with the price cut. In fact, there are reasons to predict the opposite direction entirely. For one, some research suggests that if an action is less personally desirable, it sends an even stronger signal about prosocial motivation (Benabou and Tirole, 2005; Gneezy et al., 2012). In that case, you would expect the help offer to draw attention to the injunctive norm (Schultz et al., 2008). Another possibility is that the social norm might lead drivers to infer that the inflation itself is more difficult, more of a hassle than they had believed. In that case, too, we would expect the social norm to highlight the benefits of the help offer. Across these competing theories, we make a strong prediction about interpreting an interaction effect between negative social norms and the help offer – that is, a negative interaction would be evidence for a norms-as-approval account, while a positive interaction would be evidence for a norms-as-information account.

In summary, our intervention compared the effects of six different treatments, randomized in the field. Three treatment branches varied the incentive offered: either waiving the pump fee, or offering help, or nothing. Each of these three were offered with a message that either included or did not include a negative descriptive social norm, for a total of six between-subject conditions (Fig. 1). In addition to these six interventions, a no-gauge, no-intervention control group was included as a baseline measure of tire inflation rates, for a total of seven conditions, which were randomized in half-hour time blocks across eight sunny afternoons in two gas stations in Chicago during July 2010. In the next section, we report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

3. Methods

3.1. Selection of subject pool

Data were collected at gas stations in Chicago, IL. Researches approached an initial pool of 91 stations. Eleven of the 91 stations consented to our treatments. Two of the eleven were selected based on the number of customers, air pump location, and some logistical concerns.[4] Our subject pool came from gas station patrons who used the gas pumps. We only included drivers who were pumping gas to ensure that every subject had a financial stake in the car and may be interested in fuel efficiency. For the same reason, we excluded taxis, rentals, and other company-owned cars, leaving a total of 700 customer visits to the gas pump included our data set.[5]

3.2. Experimental design

The treatments in the intervention followed a 2×3-way between-subjects design, crossing the presence of a social norm (2: Social Norm versus Control) with type of incentive offered (3: Help versus Free versus No Offer). In addition to these six treatment conditions, a passive control condition was included each day to measure baseline air pump use. Cell sizes are shown in Table 1. Subjects in the passive condition had no knowledge of our research assistants and were not offered gauges or shown posters. Those in the treatment conditions knew we were surveying their tire pressure levels but not about any other data we were recording, including the main DV, tire inflation, so the design should be considered a natural field experiment (Harrison and List, 2004).

[3] For example in Schultz et al. (2008), subjects using less power than average regressed toward the average power use that was reported to them in treatment, which happened to be higher than their baseline level.

[4] This selection was not intended to be a thoroughly representative sample, and could affect the external validity of our overall cost-benefit analysis for other gas stations, though this should not affect of our comparisons between treatments.

[5] 40 repeat visitors were also removed *post hoc*.

Table 1
Raw counts of cell sizes and consumer behavior by condition. Although we collected data on 700 unique eligible cars (personally owned vehicles using a gas pump) only 490 were offered a free gauge during our intervention (intent to treat; ITT), 285 accepted the free gauge and selected into treatment, and 221 had at least one underinflated tire (treatment on the treated; TOT).

Condition	Eligible cars	Gauge offered (ITT)	Gauge taken	1+ low tires (TOT)	Air pump used during visit		
					Count	% of ITT	% of TOT
Control							
No offer	112	97	48	32	1	1.0	3.1
Free	87	71	37	31	18	25.4	58.1
Help	104	81	46	43	14	17.3	32.6
Social norm							
No offer	103	85	61	45	5	5.9	11.1
Free	102	86	48	36	10	11.6	27.8
Help	86	70	45	34	23	32.9	67.6
Passive control	106				0		
TOTAL	700	490	285	221	71		

3.3. Procedure

Data were collected during eight 3.5 h afternoon sessions on weekdays by two teams of two research assistants.[6] There were seven conditions, and each was randomly assigned to one half-hour block in each session. During all seven conditions, the following data was recorded about every subject: times of arrival and exit; which pump they used; license plate number; estimated age, race, and gender; number of passengers; any car maintenance (vacuum, oil check, car wash, etc.); and our main dependent variable, whether or not they inflated their tires. In the no-intervention control condition, these data were all that we observed.

At the start of the six information conditions, posters were placed on every gas pump in the station (see Appendix A). The six different posters used in the treatments can be found in Fig. 1. The top of each poster varied the inclusion or omission of a negative descriptive social norm (either "you could be wasting gas. . ." or "Over 70% of Chicago drivers are wasting gas. . ."). The bottom line of each poster described the price and offer of help for the treatment ("only $.50"; "free"; or "we will pump your tires"). Once the posters were placed, each subject was approached while pumping gas with an offer of free tire gauging, and if they accepted, the subject's attention was directed toward the poster and asked when their tires were most recently inflated.

After the tires were gauged, the subject was informed of the tire pressure. The number of "low" tires was always reported, and emphasis was made if tires were dramatically lower than recommended levels (<10 psi, roughly) though there were no explicit guidelines were given to research assistants about when or how to convey these extremely low tires.[7] Once the results were reported, subjects were shown where the air pump was, and in the help conditions, the offer to help was reiterated verbally. If the driver pulled up to the air pump, the research assistant would then pay for or assist with the air pump, as per the condition.[8]

3.4. License plate data

We recorded license plate information in order to control for income, value of the car, car ownership and distance from home as much as possible through census information related to the driver's address and information specific to the car. The list of license plates was submitted to the State of Illinois Secretary of State under the Freedom of Information Act, and the Driver's Privacy Protection Act. From the driver and vehicle registration database, we were able to determine each car's make model and year number, the owner's home address, and how long ago the car was bought. We compiled several covariates of interest – using their addresses, we estimated their income using US census tract median income data, and also used Google maps to estimate the driving distance to the gas station for each subject. From the car information, we were able to estimate the current resale value of the car (using values listed online in the Kelly Blue Book). We also used this data set as a second check to make sure no corporate-owned cars were included in the analysis.

[6] One day was cut short by severe weather, though the data collected before the storm is included. Removing this data has no substantive impact on the conclusions, so in our analysis we leave it in for completeness.

[7] Our procedure demanded a clear cut-off rule, so we considered any tire gauged below 33 psi as "low", even though each car's ideal pressure depends on many factors. This was chosen because it is the correct cold psi for most passenger car tires. Given that these cars were all coming straight off the road after driving around on hot (~90°F) days, this cut-off was conservative.

[8] We were not able to modify the pump itself to waive the fee in the "free" conditions, so placing quarters into the machine directly was a pragmatic second-best alternative. Subjects, however, were only told that the pump was free, without explaining precisely how that was to be accomplished. In all conditions, subjects who explicitly asked to borrow a tire gauge to accurately fill up were allowed to do so. Tires were always filled to (or recommended to be) 38–40 psi, which corresponds to a cold level of 32–34 psi, the standard range recommended by manufacturers for most cars.

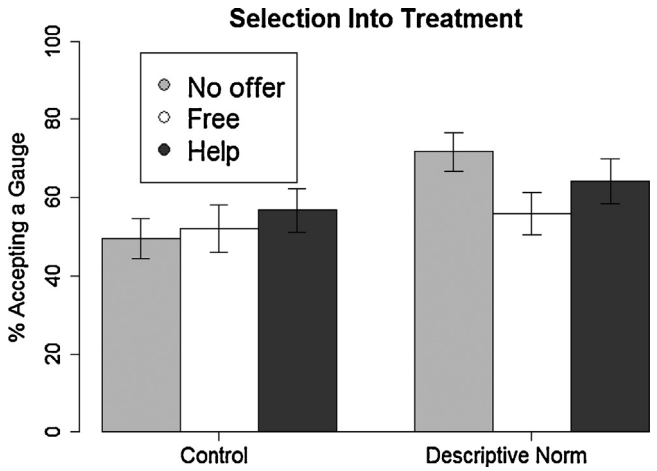

Fig. 2. Percentage of drivers who accepted an offer of a free gauge by the experimenter during the intervention. Because posters were hung before drivers arrived at the pump, it is conceivable that they may have affected selection into treatment. However, we observe no meaningful differences between conditions that cast doubt on our inflation results.

4. Results

4.1. Baseline tire inflation

Somewhat surprisingly, none of the 106 drivers that pumped gas during the no-intervention control inflated their tires at the air pump. However, during the entire intervention, 49 drivers used the air pump but not the gas pumps (avoiding all contact with our intervention). As a comparison, 700 people used the gas pump in total across the intervention. This leaves us with two ways to calculate the baseline rate of inflation, before our treatments commence. We think it is fair to consider the fraction of drivers who use the air pump alone, 6.5%, as a generous upper bound on baseline tire inflation rates, while the 0% who used the gas pump and the air pump in the same visit is an obvious lower bound. For comparison, the inflation rates in the six intervention treatments in Table 1.

4.2. Intervention effectiveness

The reduced form results for the intervention are reported as both Treatment on the Treated (TOT) and Intent to Treat (ITT). In total, there were 490 eligible drivers (driver pumping gas. . .) who were offered a gauge by the experimenter. Theses 490 make up the subject pool for the ITT results, while TOT includes only those who both accepted the offer and had at least one low tire ($n = 221$). Both analyses are important: ITT accounts for the possibility of selection into treatments (based on the posters), and also allows us to compute an aggregate cost-benefit analysis of the intervention as a whole. However, TOT is a fairer test between conditions because we can be sure those drivers actually needed air. Selection into treatment among those offered a gauge (ITT), is plotted in Fig. 2 – overall, we do not see any meaningful differences.

The raw inflation rates are reported in Table 1 while the group means are graphed in Fig. 3 (TOT) and Fig. 4 (ITT). The first comparison of interest is whether the No Offer interventions were able to alert drivers to the importance of tire pressure neglect and motivate inflation without extra incentives. The data suggests that the "No Offer" conditions that included information did not statistically impact inflation rates both in TOT and ITT (TOT: Control-No Offer: $m = 3.1\%$, SE = 3.0%; Social Norm-No Offer: $m = 11.1\%$, SE = 4.7%; ITT: Control-No Offer: $m = 1.0\%$; SE = 1.0%; Social Norm-No Offer: 5.9%; SE = 2.6%). The next comparison is whether the two incentives were effective looking across the main effects of the two incentives. Our results show that both incentives were significantly larger than either of the no-incentive controls – we encouraged inflation both by waiving the pump fee (TOT: $m = 41.8\%$, SE = 6.0%; ITT: $m = 17.2\%$, SE = 3.0%) and by offering help (TOT: $m = 48.1\%$, SE = 5.7%; ITT: $m = 24.5\%$, SE = 3.5%). However, there was no significant difference between the main effects of the two incentive treatments (TOT: $t(218) = 1.28$, $p = 0.201$; ITT: $t(487) = 1.89$, $p = 0.06$).

4.3. Social norm effects

This experiment was designed both to test for a main effect of negative descriptive social norms, and to see whether that effect varied across incentive treatments. The results show that there was no main effect of the social norm treatments (TOT: $m = 33.0\%$, SE = 4.4%; ITT: $m = 15.8\%$, SE = 2.4%) compared to the control treatments (TOT: $m = 31.1\%$; SE = 4.5%; $z(221) = 0.52$, $p = 0.599$; ITT: $m = 12.9\%$, SE = 2.1%). However, planned contrasts showed that the effect of the social norm varied, depending on the incentive offered. Specifically, the negative social norm reduced inflation when the pump was free (Control-Free: $m = 58.1\%$; 8.9%; Social Norm-Free: 27.8%; SE = 7.5%; $z(67) = 2.57$, $p = 0.010$) but it increased inflation rates when the assistant

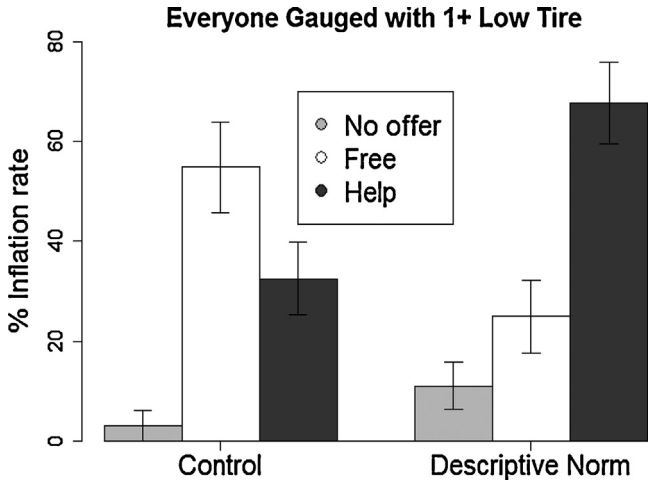

Fig. 3. Raw percentage of tire inflation among Treatment on the Treated (TOT), by condition. Error bars represent ± one standard error of the group mean.

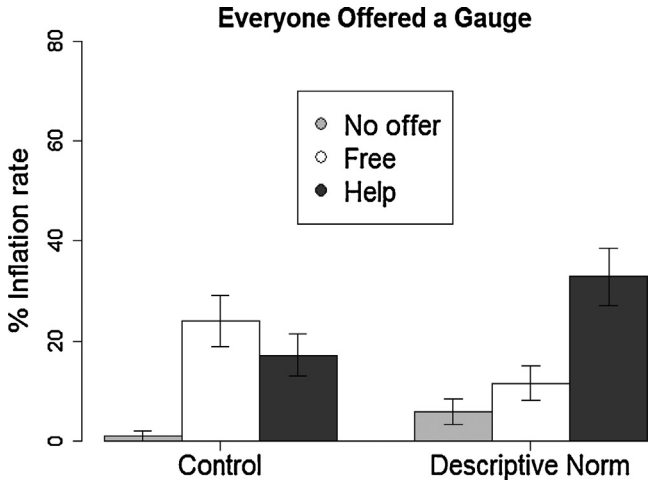

Fig. 4. Raw percentage of tire inflation among Intent to Treat (ITT), by condition. Error bars represent ± one standard error from the group mean.

offered help (Control-Help: $m = 32.6\%$; SE = 7.1%; Social Norm-Help: $m = 67.6\%$; SE = 8.0%; $z(77) = 3.21$, $p = 0.001$). These results are confirmed in ITT: the social norm discouraged inflation when the pump fee was waived (Social Norm-Free: 11.6%; SE = 3.5%; Control-Free: $m = 25.4\%$; 5.2%; $z(156) = 2.00$, $p = 0.046$), but had the opposite effect when paired with the help offer (Social Norm-Help: $m = 32.9\%$; SE = 5.6%; Control-Help: $m = 17.3\%$; SE = 4.2%; $z(150) = 2.19$, $p = 0.029$),

4.4. Logistic regression models

These comparisons were also confirmed in a series of logistic regressions, presented in Table 2. We performed sets of pairwise analyses between conditions, both in a simple model (specifications 1 and 3), and in a mixed model analysis (specifications 2 and 4), where we first entered covariates and then compared treatment effects within the residuals. Each model was tested at both the level of Intent to Treat (1 and 2) and Treatment on the Treated (3 and 4). These results again confirm that offering incentives led to a significant increase in pumping rates, and the effectiveness of each incentive significantly varied, depending on the framing with which it was paired.

4.5. Cost-benefit analysis

Our data allow for a back-of-the-envelope estimate of the expected effect of our interventions on our subjects' future gasoline consumption. In Table 3, we apply these figures to national estimates of the average city car's monthly gas consumption (Davis et al., 2011), and the observed average price of gas during our intervention ($3.14/gal). We assume average

Table 2
Results from a series of binary logistic regressions showing the pairwise differences in log-odds between incentivized conditions. These results buttress our above analysis of raw percentages which indicate an interaction between incentive and framing, whereby free air was most effective in a personal framing, and help was most effective in a social framing.

	1	2	3	4
CH-SH	−0.851**	−0.743*	−1.466***	−1.647***
	(0.389)	(0.440)	(0.490)	(0.582)
SH-SF	1.313***	1.301***	1.836***	2.055***
	(0.422)	(0.465)	(0.532)	(0.632)
SH-CF	0.441	0.405	0.543	0.523
	(0.377)	(0.428)	(0.514)	(0.630)
CF-CH	0.410	0.338	0.922**	1.124**
	(0.377)	(0.451)	(0.486)	(0.565)
CF-SF	0.872**	0.896**	1.293**	1.532**
	(0.436)	(0.479)	(0.528)	(0.634)
CH-SF	0.463	0.557	0.370	0.408
	(0.447)	(0.490)	(0.504)	(0.565)
Population	ITT	ITT	TOT	TOT
n	490	490	221	221
Adjusted R^2	0.172	0.304	0.304	0.443
Covariates?	No	Yes	No	Yes

Abbreviations: CH, Control-Help; CF, Control-Free; SH, Social Norm-Help; SF, Social Norm-Free.
* Significance of likelihood-ratio test: $p < 0.10$.
** Significance of likelihood-ratio test: $p < 0.05$.
*** Significance of likelihood-ratio test: $p < 0.01$.

Table 3
Data collected during the present study are compared to results from other field studies to estimate the effect of our intervention on future fuel savings, in 2010 prices, across a four-month window.

Source	Number
(a) Average miles driven per city car [a]	11,300 mi/y
(b) Average car mileage (in mpg) [a]	22.5 mi/gal
(c) Recommended tire inflations per year [b,c]	3
Average 4-month gas consumption per city car	**167.4 gal**
(d) Fuel savings from tire inflation [c,d]	2.0%
(e) Cost of gas, per gallon [e]	$3.14/gal
Gas saved, per inflation	**$10.51**
Personal vehicles eligible for treatment [e]	700
Hours of data collection [e]	50.25
ITT take-up of incentivized conditions [e]	21.1%
ITT take-up of Norm + Help intervention [e]	32.9%
Hourly gas savings – incentivized conditions	**$30.90**

[a] Davis et al. (2011).
[b] Pearce and Hanlon (2007).
[c] National Research Council (2006).
[d] National Highway Transportation and Safety Agency (2005).
[e] Data collected from the present study.

potential savings at 2% across all cars with at least one low tire (National Research Council, 2006).[9] We also limit the window for fuel savings to four months, under the assumption that the tires will remain under appropriate pressure for that length of time. Over that four-month window, tire inflation would save $10.51 worth of gas for the average driver with at least low tire.

The cost-benefit analysis presented in Table 3 only reflects fuel savings, it does not include the safety benefits of improving stopping speed (see NHTSA, 2005) or any psychic benefit such as warm glow and social esteem. As for costs, we assume that it takes a driver 3–5 min to inflate their tires at a cost of $0.50 (in a non-"free" condition).[10] It is important to note that one interpretation of the results from our cost-benefit analysis is that our sample had an average marginal wage of over $130 an hour. In order to calculate a monetary benefit of the intervention, the benefit-cost estimate was combined with the intent-to-treat success rates within the two information-only treatments (3.3%), the four incentivized treatments (21.1%), and the

[9] Pearce and Hanlon (2007) estimated a lower level of fuel savings (1–1.5%), but admitted their estimate was extremely conservative. They studied a population self-selected for higher car maintenance (regular oil change customers at a mechanic's), and modeled only the one best inflated tire on each car, even though inflation savings are convex and thus driven by the least inflated tire (NRC, 2006). These government reports are supported by estimates from tire manufacturers.
[10] There is also the cost of monitoring and gauging the tires. We offered to gauge while drivers idly pumped gas, costing little extra time. This offer of help had essentially no impact in our most effective treatment, implying that the cost is trivial.

most effective treatment (social norm + help; 32.9%). By this measure, the information-only treatments saved $4.83/h; the incentive treatments, $30.90/h; and the most effective treatment, $48.18/h. To consider a similar intervention at a broader level, these should be compared to the marginal cost for one attendant and a tire gauge, plus $0.50 per inflation in the "free" conditions. As long as take-up is higher than in our no-incentive treatments, there is plenty of room for interventions that pay for themselves even before considering the larger social impact. That being said, our data cannot claim how gas stations would profit from such an intervention in the long run due to the positive or negative impact on customer loyalty and future gas sales.

5. Discussion

The results of our field experiment confirmed that tire pressure neglect is widespread, and found mixed support for at-the-pump interventions. We saw essentially no increase in tire inflation during our baseline information treatments, even though drivers were presented with information on the importance of tire inflation and their current tire pressure level. Our cost-benefit calculations suggest that tire inflation is a valuable investment for most drivers, the value of the potential gas savings alone would vastly outweigh the $0.50 price of the pump. This seems especially puzzling when compared to the large effect of small cost reductions: subjects were more responsive to small changes in the upfront costs of inflation ($0.50 in change) than to much larger differences in the future benefits of inflation (news about potential long-term savings).[11] We interpret this as evidence of present bias (Laibson, 1997). Consider also that these conditions also included strong positive injunctive norms (as in Schultz et al., 2008), and the implied social sanction had no effect.

More practically, our results are evidence that while information may be necessary to induce behavior change, it was not sufficient in our case. We made a good faith attempt to harness attention and knowledge to induce behavior change, but drivers may still have not been convinced of the benefits. However, these results do not exclude the possibility that another awareness effort might work. There is one notable comparison in the policy world – since 2007, US automakers have been required to install Tire Pressure Monitoring Systems ("TPMS") in all new passenger vehicles, and other jurisdictions have since followed suit – the EU in 2010, and South Korea in 2012, with Japan, Russia and others on the way. It is fair to say that our two information-only treatments were more attention grabbing than dashboard lights, and yet they had almost no impact. That at least suggests that policy makers should temper their expectations about how much TPMS alone can reduce tire pressure neglect. It remains to be seen empirically whether the long-term nagging of a dashboard light can eventually overtake our one-time attention shock in effecting change.

In contrast to the predictions of social norm theory, we found limited support for the suppressing effect of negative descriptive social norms in our treatments (Cialdini, 2003). In fact, we found wide variation in the effect of social norms across conditions: the social norm discouraged inflation when the pump fee was waived but encouraged inflation when help was offered and social pressure was potentially increased on the subjects. We take this as evidence that the negative social norm did not undermine the social esteem of the behavior, which would have neutralized the effect of social pressure. Instead, this suggests that negative social norms are discouraging because they question the value of inflation. This mechanism is particularly relevant in domains where neglect is common and well-known such as tire pressure. If a negative social norm is pervasive, then social sanction may still be effective, while cost reductions may pale in comparison to the signal that is implied by widespread neglect. We remain agnostic between what exactly information is being learned. That is, subjects could be using the negative social norm to make an inference about either the benefits of inflation (how much gas it saves), or the costs of inflation (how hard it is to do), or both. Since the benefits are more ambiguous than the costs, they may be more swayed by this indirect mechanism, but this is ultimately an empirical question.

From a policy perspective, this study has a limited scope since we only observe tire pressure decisions made that day. Thus, we treat inflation as a one-time investment in energy efficiency over the medium-term, rather than as a long-term maintenance strategy to curtail energy-intensive behavior (Stern and Gardner, 1981). We do believe our results could generalize to other efficiency investments, which tend to be both more effective at reducing energy consumption, and yet are under-appreciated as a conservation strategy compared to curtailment (Attari et al., 2010). However, a comprehensive account of tire pressure neglect would also consider the dynamic effects of our treatments, where issues like procrastination and habit formation become more important and tire inflation might more closely resemble a curtailment behavior.

The results of this study can inform many real-world efforts to encourage pro-social behavior in other domains. For one, efforts to raise awareness and monitoring may not be sufficient to change behavior. These strategies are far more effective when they are paired with reductions in the immediate costs. Furthermore, the role of social norms may not be as simple as previous literature have suggested, and it is critical to understand what it is that lay perceptions are conveying about the behavior itself. As a general rule, where neglect is the dominant state of affairs, we reject the common dichotomy between psychological approaches that focus on persuasive appeals, and economic approaches that focus on incentive structures. Rather, we argue that getting the most out of either approach requires a careful understanding of both.

[11] A lab survey pilot of a community population presented our intervention message and asked their beliefs about the fuel savings of tire pressure over a three-month window. Savings estimates were quite high (mean = $59.88; SD = $62.17).

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Appendix A.

Gas Pump Poster Placement

Posters were placed in the same location on every pump – in the upper right corner, between the electronic display and the pump handle, in as obvious a place as we were allowed.

Appendix B.

Research Assistant Script

1. *Once they have put the gas pump in the car, ask* "Hello, I'm doing a survey, can I gauge your tires quickly?" [*if asked for a reason why, say* "a school project"]
2. *If they agree. . .*"Thanks. We're also trying to get people to pump their tires today, if you'll take a look at our poster". [*gesture toward the poster*]
3. *Gauge tires and record pressure. While doing so, ask* "when was the last time these tires were inflated?" *If they don't give a specific answer, ask again for a guess.*
4. *Report results – any tire 33 or below is* "low", *otherwise it's* "fine". *If the subject asks for specific numbers, give them. Tires below 25 are* "very low".
5. (a) *In the help conditions*:
   "So if you want me to help with the air pump, just pull up over there and I'll be right over." [*gesture toward air pump*]
   (b) *In other conditions*:
   "So if you want to fill up the air pump is right over there." [*gesture toward air pump*]

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