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Social comparison and energy conservation in a collective action context: A field experiment

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Social comparison and energy conservation in a collective action context: A field experiment*

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Abstract

This field experiment quantifies the impact of social norm information on the demand for indoor temperature. Based on high-frequency data from indoor temperature monitors, we provide participating households with a comparison of average temperature in their apartments relative to that measured in a control group. For more than 90 percent of participants, financial benefits of energy savings are only indirect, as building-level heating costs are shared across apartments in proportion to their volume. Despite the associated collective action problem, we estimate that the intervention induces a -0.28°C reduction in average indoor temperature. This suggests that direct monetary incentives is not a pre-requisite for social comparison feedback to induce energy savings.

Keywords: Informational intervention; Monetary incentives; Energy saving; Social comparison feedback; Social norms.

JEL Codes: C91, D12, D62, D91, H41, Q41.

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1 Introduction

Social comparison feedback, which informs people about their behavior relative to the typical behavior of others, has been established as a cost-effective tool to promote energy conservation (e.g. Allcott, 2011; Costa and Kahn, 2013; Allcott and Rogers, 2014). Our field experiment quantifies the effect of a social comparison feedback intervention on demand for indoor temperature in apartment buildings.[1] Arguably, lowering indoor temperature during the heating season is associated with significant disutility, and the extent to which social comparison feedback can also incentivize behavior in a high-effort setting is an open question (see Myers and Souza, 2019).

Our study differs from related interventions on two important aspects. First, instead of relying on repeated information provision, we send out a single letter informing subjects about how indoor average temperature measured over one month during the heating season compares to that measured in a group of control apartments. In the apartments we consider, managing indoor temperature involves adjusting valves installed on each individual radiator, which requires more effort than adjusting a single thermostat (as in Myers and Souza, 2019), but less effort than managing a plug load (as in Allcott and Rogers, 2014).

Second, while all subjects are tenants and pay for their use of heating energy, a large majority of subjects rent their apartment in buildings that have no individual meters for heating energy use. For these tenants, building-level energy cost are shared across apartments in proportion to the volume of each property. One implication is that financial benefits of individual energy savings are only indirect, being conditioned on the behavior of other tenants in the same building. The implied collective action problem contrasts with previous studies in which energy savings imply either direct financial benefits (Allcott and Rogers, 2014) or no financial benefits at all (Myers and Souza, 2019). In line with this, our intervention does not provide information on individual monetary savings, but rather considers the use of normative appeals referring to specific benefits of reduced energy demand.

[1] According to IPCC (2014), in 2010 buildings accounted for 32% of total global energy use and 19% of energy-related GHG emissions. Further, the IEA (2011) reports that around a quarter of buildings' potential energy savings in 2050 come from space heating by the residential sector.

We find that our intervention induces a -0.28$°C$ reduction in average indoor temperature (-1.2%) relative to control, and is virtually unaffected by the presence of normative appeals. This corresponds to a reduction of energy use by at least 2 percent (see Palmer et al., 2012), which is not trivial given the relatively low cost of the informational intervention. Our results also indicate that the presence of indirect monetary incentives is sufficient for social comparison feedback interventions to induce energy conservation behavior.

2 Experimental design

Our sample includes 45 apartment buildings, all located in a single Swiss canton and managed by a common real estate agency. All 855 apartments in these buildings are equipped with indoor temperature monitors, small devices without a display which record temperature every 15 minutes. Our intervention includes four experimental treatments and a control. First, we allocate 15 buildings to the control group and 30 in the treatment group.[2] Importantly, apartment-level heating energy meters are only present in two control buildings (34 apartments) and three treated buildings (62 apartments). Second, apartments in treated buildings are allocated to one of four experimental conditions (opt-out design).

For all four treatments, the general layout of the informational intervention closely follows Allcott and Rogers (2014).[3] In particular, each household is informed about average indoor temperature in their apartment measured during December 2018 in comparison to the corresponding average for "more than 200 comparable households" (i.e. the control group). This design also includes a set of normative signals, including recommended temperature levels and smileys (injunctive norms, see Schultz et al., 2007), as well as households' percentile information : "the indoor temperature in your apartment is higher than X% of comparable apartments" (see Ferraro et al., 2011). One implication of this design is that all the participants, including those performing better than the average, have a benchmark to improve. In addition, we include a collective action statement emphasizing common benefits afforded by individual efforts.

The four treatments vary with respect to the presence of an appeal to reduce indoor temper-

[2] The main sample characteristics are provided in Appendix A.

[3] The letter template is reproduced in Appendix B.

Table 1: Overview of experimental conditions and treatment assignment

Condition	Information	Apartments
Control	None	232
Social Comparison	Social comparison only	147
Corporate Social Responsibility	Social comparison + an appeal to cooperate for corporate responsibility goals	154
Financial Appeal	Social comparison + an appeal to cooperate for financial savings	143
Environmental Appeal	Social comparison + an appeal to cooperate for a better environment	145

ature, which can potentially enhance the effectiveness of social comparison feedback (Bicchieri and Dimant, 2019). The benchmark "Social Comparison" treatment includes no specific appeal to tenants. In the remaining three treatments, we include an appeal for an efficient use of energy. This is framed as a request for cooperation with the real estate agency to achieve corporate social responsibility objectives (treatment "Corporate Social Responsibility"), financial savings for the households (treatment "Financial Appeal"), or environmental benefits (treatment "Environmental Appeal"). See Table 1 for a summary of treatment assignment.

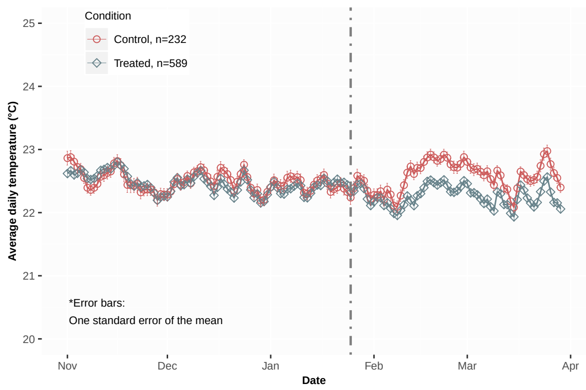
3 Results

Information letters were sent on January 25, 2019. Out of the 855 apartments, 10 tenants could not be reached by mail and 24 opted-out from the study. The final sample includes 821 apartments.

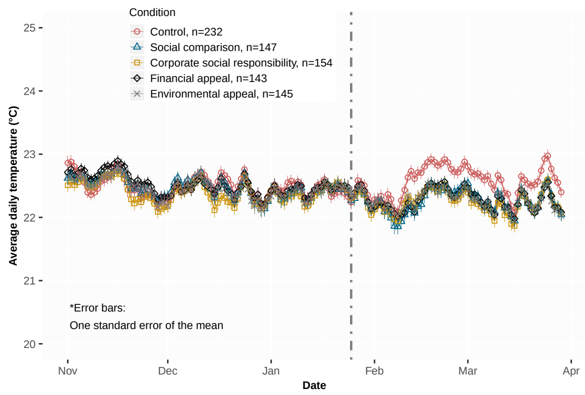
Figure 1 depicts daily average temperature levels, with the intervention date indicated by the black vertical line.

Average daily temperature before the intervention is 22.49$°C$ in control apartments, and 22.48$°C$ in treated apartments, suggesting no discernible difference. After the intervention, average temperature slightly increases to 22.57$°C$ in the control group, while it drops to 22.27$°C$ in the treatment group (pooling all conditions together, Panel a). Moreover, Panel (b) suggests little difference in how individual treatments affect average indoor temperature. Panel (c) and (d) document possible heterogeneous effects for tenants with pre-treatment temperature below-average and above-average respectively. In line with studies that include injunctive norms (see

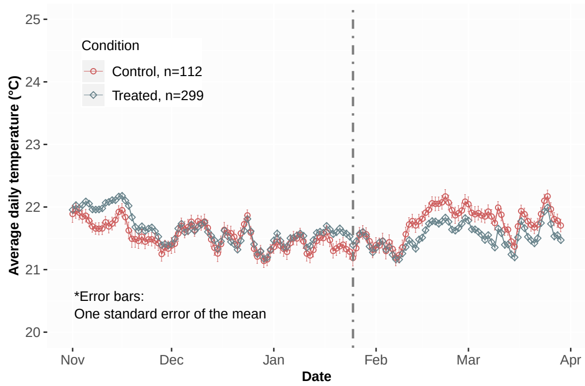
Figure 1: Average daily temperature levels, $^{\circ}C$



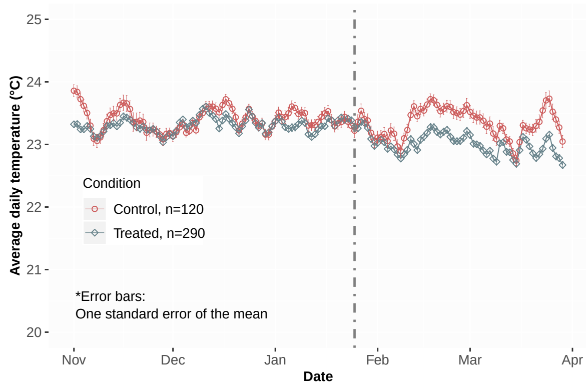
(a) Treatments pooled



(b) Individual treatments



(c) Apartments with below-average pre-treatment temperature



(d) Apartments with above-average pre-treatment temperature

Schultz et al., 2007; Allcott, 2011), we observe no undesired reaction to social norm information among low energy consumers.

To quantify these differences, we run a set of difference-in-differences regressions on mean daily indoor temperature, with results reported in Table 2. In column (1), we report a fixed-effect regression with average treatment effect estimated separately for each condition relative to control. Columns (2) to (6) report fixed effect quantile regression results to document heterogeneous effects highlighted above.

Treatment effect estimates vary between -0.25 and -0.31$^{\circ}C$ (-1.1% and -1.3% respectively), with pairwise chi-square tests confirming no statistically significant difference between indi-

Table 2: Regression estimates for mean daily indoor temperature ($°C$)

	Model 1: Fixed-effect regression	Model 2: Fixed-effect quantile regressions				
		q=0.1	q=0.25	q=0.5	q=0.75	q=0.9
	(1)	(2)	(3)	(4)	(5)	(6)
Social comparison x post	-0.30***	-0.33***	-0.29***	-0.27***	-0.27***	-0.29***
	(0.07)	(0.07)	(0.05)	(0.05)	(0.06)	(0.09)
Corporate social responsibility x post	-0.25***	-0.27***	-0.24***	-0.23***	-0.25***	-0.23***
	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.09)
Financial appeal x post	-0.31***	-0.36***	-0.33***	-0.30***	-0.28***	-0.27***
	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.08)
Environmental appeal x post	-0.27***	-0.28***	-0.26***	-0.26***	-0.24***	-0.25***
	(0.07)	(0.06)	(0.05)	(0.05)	(0.06)	(0.09)
Apartments	821	821	821	821	821	821
Observations	120,441	120,441	120,441	120,441	120,441	120,441
(Pseudo)R^2	0.01	0.12	0.13	0.13	0.13	0.13

Notes: Column (1) reports linear fixed-effect regressions with robust standard-errors clustered at the apartment level reported in parentheses. Columns (2) to (6) report fixed-effect quantile panel regressions (bootstrapped standard-errors). All regressions include apartment and day fixed effects. *, ** and *** denote statistical significance at 5% and 1% and 0.1% levels respectively.

vidual treatments. Furthermore, the regression estimates suggest that treatment effects are homogeneous across temperature quantiles. Appendix C provides corresponding random effect regressions and estimates for a sample restricted to apartments without individual meters for heating energy. The results are consistent throughout.

4 Conclusions

In this paper, we have studied the impact of an informational intervention centered around social comparison feedback on indoor temperature, and reported an estimated average treatment effect of -0.28$°C$ (-1.2%). We therefore find that tenants in our sample are willing to sacrifice part of their comfort to reduce energy use, even in the absence of direct financial benefits. Evidence also suggests that the impact of the intervention is persistent with time. Whether the intervention induces energy savings in the subsequent heating season is left for future research.

Appendix A Sample information

Table A1: Sample statistics and balance in control vs. treated groups

	Control	Treated	p-value
Construction year	1,976.20	1,977.97	0.43
Building size (number of units)	33.43	37.15	0.47
Total heating surface (m^2)	2,995.47	3,367.84	0.49
Total energy consumption (kwh in 2016)	383,905.90	401,160.10	0.91
Energy consumption per m^2 (kwh in 2016)	119.90	124.46	0.25
Heating degree days	2,520.79	2,537.92	0.79
Average daily temperature (Dec. 2018, in $°C$)	22.49	22.44	0.53
Share of buildings with individual meters (%)	0.10	0.13	0.76
Number of tenants	1.83	2.23	0.0004
Flat size (m^2)	78.34	74.65	0.07
Number of floors	4.47	4.98	0.15
Monthly rent (CHF)	1,344.53	1,314.73	0.32
Female (%)	56.51	53.07	0.37
Number of apartments:	232	623	

Notes: This table compares control and treated group in terms of variable means. P-values for the building level variables are from Wilcoxon tests, p-values for apartment-level variables are from two-sided t-tests.

Appendix B Letter template (translated from French)

Company logo
Institute logo

University name

Institute name
Address

Tenant's name
Tenant's address

Contact person:
Prof.
Tel:
Email:

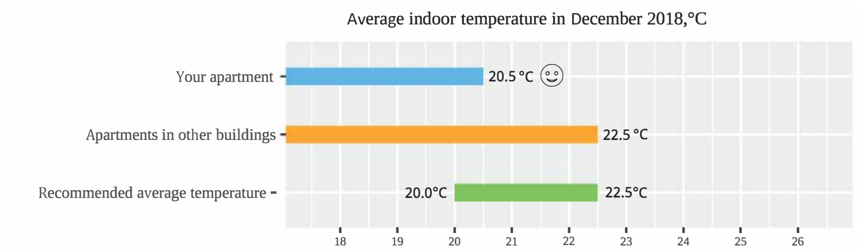
Dear Sir/Madame,

[*TEXT ONLY IN CONDITIONS WITH APPEALS:* Some time ago, COMPANY NAME had a system installed to optimize heating supply in your building, which saves on average 10% of heating energy per year. [*TEXT ONLY IN FINANCIAL APPEAL CONDITION:* **This investment helps to reduce heating costs for tenants.**] [*TEXT ONLY IN ENVIRONMENTAL APPEAL CONDITION:* **This investment helps to preserve our climate for future generations.**] Tapping the full potential of this investment and thus contributing to the social responsibility objectives of COMPANY NAME require your cooperation.]

COMMON TEXT IN ALL THE CONDITIONS: As part of a study in collaboration with COMPANY NAME, we are pleased to offer you information on your heating use during the past month as well as recommendations on the management of the temperature in your apartment. In December 2018, the average indoor temperature measured in your apartment was XX °C. Your indoor temperature was higher than that of X% of apartments in other comparable buildings.

1°C less means 6% in energy savings!

Managing the indoor temperature in your apartment helps to reduce energy consumption for your entire building. All individual energy savings together will therefore have a greater impact.



<u>Your apartment</u> : average temperature measured in your apartment in December 2018.

<u>Apartments in other buildings</u> : average temperature measured in more than 200 comparable apartments during the same period.

<u>Recommended average temperature</u> : 20.0°C recommended by the Swiss Federal Office of Energy (22.5°C maximum for elderly and disabled persons).

Would you like to take steps to **optimize your energy use**? Find a few tips on the reverse side.

1

Managing indoor temperature.

23 degrees Celsius in the bathroom (**position** 4 or upper third of the valve).

20-23 degrees Celsius in the living room (position 3 or middle third).

17-20 degrees Celsius in the bedrooms (position 2 or lower third).

Position 1 (or lower third) is recommended in rarely occupied rooms or when you are on vacation (never close the valve entirely).

Ventilate well and efficiently.

Avoid leaving your titling windows constantly ajar. This allows the heat to escape and does not allow fresh air to get inside.

Ventilate at most 1-2 times a day for 5 minutes by opening as many windows as possible (3 times a day if your windows have a high performance thermal insulation).

It is human activity that creates humidity (bathing, cooking, exercising)! **Ventilate according to the rate of human activity in the apartment**

Fully exploit indoor heat.

Avoid placing furniture near your radiators or covering them with clothes.

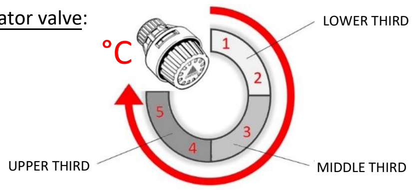
During the day, open your curtains and shutters to get the most of the sunrays.

During the night, close your curtains and shutters to keep the heat inside.

If you sleep with an open window, set your valve to position 1 (or lower third) and close the door.

✂ --

Setting of the radiator valve:



You may well have strategies that are not mentioned above. Find more advice on heating management and opportunities to save energy at **https://www.suisseenergie.ch/chauffer**.

Make use of reminders and change your habits! Keep a reminder near your windows or radiators and discuss it with the other members of the household.

Thank you for your responsible use of energy!

Kind Regards,

Prof.
University address
Annex: Reply coupon and envelope

Appendix C Additional regression results

Table C1: Random-effects regression estimates for mean daily indoor temperature, C°

	Basic specification (Model 1)	With control variables	Log-transformed outcome	Non-metered apartments
	(1)	(2)	(3)	(4)
Social comparison x post	-0.30***	-0.29***	-0.014***	-0.37***
	(0.07)	(0.06)	(0.003)	(0.02)
Corporate social	-0.25***	-0.24***	-0.011***	-0.33***
responsibility x post	(0.07)	(0.06)	(0.003)	(0.02)
Financial appeal x post	-0.31***	-0.29***	-0.013***	-0.41***
	(0.06)	(0.06)	(0.003)	(0.02)
Environmental appeal x post	-0.27***	-0.23***	-0.012***	-0.34***
	(0.07)	(0.06)	(0.003)	(0.02)
Dummy_post	0.08 .	0.06	0.004 .	0.16***
	(0.05)	(0.05)	(0.002)	(0.04)
Social comparison	-0.02	-0.06	0.001	-0.02
	(0.12)	(0.12)	(0.005)	(0.18)
Corporate social	-0.09	-0.13	-0.004	-0.10
responsibility	(0.12)	(0.11)	(0.006)	(0.18)
Financial appeal	0.001	0.02	0.001	0.04
	(0.12)	(0.11)	(0.005)	(0.18)
Environmental appeal	-0.04	-0.06	-0.001	-0.10
	(0.12)	(0.12)	(0.006)	(0.18)
Intercept	22.50***	22.43***	3.11***	22.55***
	(0.08)	(0.16)	(0.004)	(0.12)
Apartments	821	821	821	725
Observations	120,441	119,662	120,441	106,383
R^2	0.01	0.02	0.01	0.01

Notes: Linear random-effect panel regressions reported. Column 1 reports our baseline regression corresponding to Column 1, Table 2. Column 2 adds the following control variables: apartment size, number of tenants, and gender of the letter recipient. In column 3 the dependent variable is log-transformed. In column 4 we consider only apartments that do not have an individual meter. Robust standard errors clustered at the apartment level are reported in parentheses. $^{\cdot}$, *, ** and *** denote statistical significance at 10%, 5% and 1% and 0.1% levels respectively.

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