Hey, Big Saver?

Exploring the Best Conditions to Facilitate Energy-Conservation Behaviour

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Abstract

Improving the efficiency with which people consume domestic energy has become a show-piece of how behavioural psychology can be applied to the field of environmental economics. This study builds upon the literature by providing subjects with energy performance information at group-level in a controlled field experiment setting. Its novelty is that it seeks to test the persistence of energy-saving habits, whether extrinsic incentives accentuate or crowd-out a motivation to save energy, and how heterogeneity in environmental attitudes impact upon action. Results suggest that providing relative information does stimulate energy-conserving behaviour, with this being most effective among those who held pre-trial preferences for sustainable living. However, the treatment variations indicate that subjects regularly fail to maintain 'good habits' once an intervention stops. Furthermore, we find evidence to imply that rewarding groups in this competitive environment may create perverse long-run effects. This has an important relevance for energy policy: whilst providing relative information could improve both consumer welfare and energy demand forecasting, the timescale, frequency and mechanism by which this is undertaken requires careful scrutiny and planning if these potential benefits are to be maximised and undesirable side effects prevented.

Key Words: Behavioural Nudging, Extrinsic Motivation, Energy Economics, Group Co-ordination, Sustainability, Environmental Economics

JEL Classifications: Q4, Q56, H31, L94

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1. Introduction

Improving the efficiency with which people consume domestic energy has become a show-piece of how behavioural psychology can be applied to the field of environmental economics. Research has shown UK consumers of domestic energy to switch energy tariffs with sub-optimal frequency despite the financial advantages this can provide them. In light of this disinclination, the use of non-pecuniary 'nudges' have constituted a leading alternative stimulus to improve consumption awareness and instil positive environmental habits.

Field trials that use student halls of residence have proven to be a popular setting for assessing the effectiveness of such nudging. One reason for this is that students are relatively unfamiliar with understanding their patterns of energy usage when compared against an average member of the population. This can make them more open to behavioural adaptation. Moreover, in these settings student rent is typically both pre-defined and inclusive of utility bills. This means that throughout the course of a study trial, no financial advantages are made (by the participant) if they become more energy efficient. Consequently, any behavioural change is assumed to stem from an intrinsically motivated response to the imposed treatment. This study builds upon the existing literature by conducting a controlled field experiment within student residences at a UK university. Students were issued with their absolute and relative energy consumption via a weekly email between January and May 2017. The three major research questions posed here ask whether (a) information creates a fall in consumption *per se*; (b) conservation behaviour persists once the information stimulus is removed and (c) the introduction of an extrinsic motivation heightens or offsets the desire to make energy savings.

In answering the first objective, these results imply that small (4-8 percentage point) yet significant reductions can arise by providing subjects with comparative energy consumption data, complementing the common view held within the field. In fact, students within the treatment switch from consuming at energy levels above to then below the baseline usage of those within their residences building. When exploring the second and third research questions, the study identifies some novel insights, each of which are potentially useful from both a social and policy-based standpoint. Regarding the question surrounding persistence, it seems most subjects quickly lose any 'good habits' (and return to pre-treatment levels of energy consumption) once the email intervention finished. However, interestingly, this pattern is not seen among students who indicated a persuasion for sustainable living before the trial began. Instead, they continue to exhibit lower levels of energy usage past the study treatment period. Regarding extrinsic motives, whilst through the study period itself the incentive to win a prize appears to accentuate energy conservation behaviour, once prize allocations are determined these habits vanish and subjects within this sub-treatment significantly raise their energy usage over subsequent time periods.

These findings therefore issue a mixed message for the field of energy policy. On the one hand, the results show that providing information in this format can constitute an effective environmental nudge and lead to efficiency gains. However, its timeframe and mechanism requires careful planning if one is seeking to optimise societal benefits, and indeed if unwanted (or inefficient) consumption patterns are to be avoided in the long-run.

Section 2 outlines the literature on environmental nudging in the energy sector. Section 3 describes the study, including its methodology, statistical testing and potential contributions it makes through its treatment design. Section 4 provides the results and associated data analyses. Section 5 proceeds with some further discussion before Section 6 concludes and recommends some next steps for research and policy in the field.

2. Background to The Study

Research has shown people on sub-optimal energy tariffs are not persuaded to act even when provided with information on the possible financial savings they could make by switching their package (Guilietti et al, 2005). Domestic energy constitutes around 27% of the UK's demand for fuel (DECC, 2015), meaning the associated savings that could be made by improving energy awareness could be substantial both for the individual and at aggregate levels. Research also shows many people use energy wastefully yet, once again, disseminating the advantages of consumption efficiency rarely achieves any significant behavioural adaptation. False perceptions play a major role here, and users frequently hold untrue or incorrectly weighted ideas on the relative energy requirements of domestic appliances (Atteri et al, 2010; Allcott, 2011a). The impact of this is that individuals often undertake 'energy-saving behaviour' that creates financial savings that fall short of their expectations (HM Government, 2006). Undoubtedly, the introduction of personal energy usage interfaces and the associated move to make these freely available (www.smartenergygb.org) could combat this effect, but uptake is voluntary and in a consumer area that already has widespread disengagement, the likely impact of self-stimulated action is not projected to be extensive.

This combination of facets has created an intense research field seeking to establish whether behavioural economics and psychology can successfully address people's unwillingness to act. (Abrahamse et al, 2005; Allcott & Mullainathan, 2010; Croson & Treich, 2014). Promoted methods seek to provide usage information in an easy and visible way, demonstrating to consumers as to how they can meet their energy requirements efficiently. Many also offer remedies when sub-optimal usage takes place (Hargreaves et al, 2013). Moreover, the studies are also assessing the relative success of using alternative channels to engage consumers, in light of the futility that signalling the possible pecuniary savings has.

"Nudge" (Sunstein & Thaler, 2008) is now synonymous with behavioural psychology and 'nudges' have shown some the best applied examples of how to adapt decision-making. A leading mechanism used by energy economists is to test the role of social comparisons (Bault et al, 2008; Griskevicius et al, 2008; Czajkowski et al, 2014; Sexton & Sexton, 2014; Dasgupta et al, 2016). The associated theory is that people tend to react over-sensitively to their performance or status relative to their peers. Thus, explicitly showing individuals where they sit regarding their energy-efficiency against those they deem akin to themselves could lead to reductions in consumption in order to improve their standing. The methods by which this has been implemented have taken many forms. Popular techniques have fused percentile statistics with a diagrammatic trigger, for example a happy or sad face (Allcott,

2011b) or 'green stars' (Costa & Kahn, 2013). The belief is that the latter element reinforces comparative performance. Other studies provide an explicit rankings breakdown, illustrating precisely where a subject lies in relation to their peers (Delmas & Lessem, 2014; Alberts et al, 2016). The results from these studies are encouraging, implying energy consumption can fall by a magnitude of between 0 – 10 percentage points (Allcott, 2011b; Delmas & Lessem, 2014). Gains from nudging have been even greater in other areas of environmental economics, including the promotion of recycling and reduction of food wastage (Convery et al, 2007; Kallbekken & Sælen, 2013).

Studies have typically believed that the greatest reductions arise from the initially poor performers, although counter-arguments have also been made in both directions. Indeed, under certain conditions, social comparisons may create a 'discouragement effect' which disincentives weaker participants (Hargreaves et al, 2013; Alberts et al, 2016). On the other hand, Delmas & Lessem (2014) conclude from their study that, alongside incentivising the worst performers, relative information also heightens the efficiency of already high performers. They attribute this to such respondents wanting to maintain a high status. This in turn defies the "Jevons Paradox" (Alcott, 2005), which would predict that one identified as a relatively strong performer, one should react by *raising* their energy consumption. This heterogeneity implies that 'targeted' dissemination (regarding both how the information is presented and to whom) could be crucial when seeking to ensure environmental gains can be made from such an intervention (Allcott & Rogers, 2014; Alberts et al, 2016).

A difficult aspect within this type of research is unravelling what motives are driving an individual to act (or not). This is particularly tasking here because energy efficiency provides a 'win-win', both reducing the harmful environmental externalities caused by excessive usage, yet also issuing (at times substantial) financial private gains to the agent (Kallbekken & Sælen, 2013). Consequently, energy conservation holds attributes akin to an impure public good (Cornes & Sandler, 1994; Kotchen, 2005; Kotchen, 2009) and disentangling these stimuli, and then deciding which is incentivising decision-making is a tall order.

Using student accommodation in a controlled field experiment does partially alleviate this problem (Delmas & Lessem, 2014; Alberts et al, 2016). This is because most university residences offer rental contracts that are inclusive of utility bills. Moreover, prices are set prior to residency and remain fixed throughout a tenancy, eliminating any financial advantages to students concerning how much energy they consume. Thus, if adjustments in energy usage are witnessed once subjects are provided with performance information, this gives a clearer indication that actions are driven by an intrinsic desire to improve their standing or to act pro-socially. In this respect, the study setting is 'cleaner'. Furthermore, there is evidence that in this context, people of student age are typically more open to behavioural adaptation (Guiliano & Spilimbergo, 2009). This is just one reason why some experimenters believe student cohorts do not always represent the wider population, although research does exist to the contrary for this specific setting (Druckman & Kam, 2011). Nonetheless, we apply an air of caution regarding the extent to which any findings could be

fully transferred to a wider population. This was one motive for offering a subset of students the opportunity to win a prize in this study. By doing so, their consumption is compared against others within the trial in order to further explore the motivational conundrum posed here and possibly provide findings with a greater degree of external transfer to the domestic residential market where both intrinsic and extrinsic incentives exist.

This project also builds upon the existing literature in another couple of domains. The first is that information is provided to *groups* of respondents who share a living space (hereon in referred to as "flats"). The reason for doing this comes from evidence from both laboratory and field settings that suggest groups can exhibit stronger tendencies for pro-social action than when people act as individuals (Olson, 1971; Isaac & Walker, 1988; Fehr & Schmidt, 1999; Frank, 2003). This pattern has arisen across public good games, voluntary action, waste reduction and environmental affiliation. The notion is also supported by the subjective well-being literature, stating that "inter-connectivity" and feeling part of something bigger than oneself instils a stronger societal construct and level of psychological happiness (Putnam, 1995; Diener & Biswas-Diener, 2008). This in turn can facilitate instances of altruism (Andreoni, 1990), reciprocity (Sugden, 1984) or positive social action (Czajkowski et al, 2014). An alternative argument is that groups could cause greater energy conservation through the competitive atmosphere it imposes. Indeed, when presented as a "team", respondents frequently react more fiercely in order to improve their standing relative to rival groups (Terry et al, 1999; Baik, 2008; Konrad, 2009; Nitzan & Ueda, 2009). Regardless of which disposition may motivate them, issuing information to a group seeks to understand if (and to what extent) this adjusts the scale of behavioural change.

This study also attempts to understand if and how those who have already committed to an environment of sustainable living react to comparative information. How and why individuals develop pro-social (Kahnemann & Knetsch, 1992; Weimann, 1994; Putnam, 1995) or pro-environmental (Costa & Kahn, 2013; Czajkowski et al, 2014; Steg et al, 2016) attitudes has been widely explored and so this study does not seek to decipher the reasons for their stance *per se.* However, it instead explores the extent to which their beliefs correspond to action given that attitude heterogeneity has been shown to impact upon efficiency in other areas of environmental action (for example Perez Urdiales et al, 2016). To test this, a subset of our treatment are taken from a long-standing movement at the university, known as 'The Green Flats Project'. These students, when completing their accommodation application form, indicated a preference to reside with people wishing to live sustainably. Including this treatment affords s the chance to ask questions such as whether 'Green Flat' residents (i) hold 'below-average' baseline usage *prior* to information dissemination, (ii) are more or less responsive to the comparison data and (iii) display a different consumption trajectory across the study period.

Another area within this project was to consider how extrinsic motivations could affect the behaviour of participants. To do this, around half of the treatment flats were entered into a competition for prizes, with the winners being those flats who used the least energy per student over the intervention period. The literature here suggests two possible

impacts from implementing this treatment. On the one hand, contests typically create incentives for an overprovision of effort relative to the socially-optimal level. Such 'over-dissipation' (Konrad, 2009, p.55) is accentuated in experimental settings, where the extent to which respondents engage in the contest consistently exceed the thresholds predicted by theory (Davis & Reilly, 1998). This is exacerbated in instances when prizes are distributed proportionally (Cason et al, 2010), prize quality is high (Doraszelski & Markovic, 2007), there is a heightened 'desire to win' (Lugovskyy et al, 2006) and when we see a greater degree of homogeneity among contestants (Clark & Riis, 1998; Baik, 2008). On the other hand, there is an opposing literature which shows empirical and experimental examples (Bergstrom et al, 1986; Pellerano et al, 2017) of where such extrinsic incentives offset (or "crowd out") the innate or intrinsic motive to act in a pro-social way. An overview of the evidence surrounding this area is provided by Cerasoli et al (2014), and it is certainly an aspect that is both interesting and highly policy-relevant to consider.

Finally, there is often disagreement in this research domain as to how persistent habits are once a 'nudge' is removed. For associated policy, understanding the long-term benefits of an intervention is crucial for both forecasting impact and estimating the financial outlay required in order to achieve a successful outcome. Existing evidence in this domain is varied, with some studies suggesting that behavioural habits can partially persist into the medium to long term (Abrahamse et al, 2005; Allcott & Rogers, 2014) whilst others indicate that pro-social actions quickly dissipates once the intervention disappears (Dolan & Metcalfe, 2015). To test this, we stop sending emails to a subset of our student groups half way through the trial period. By comparing their consumption against those who obtain the rankings email for the whole intervention timeframe, the question on habit persistence can be further explored.

By imposing these new elements onto an existing research framework, this study looks not only to confirm and reinforce some of the current beliefs on how non-financial stimuli can incentivise behavioural change, but also examine how such action might be influenced by facets of persistence, extrinsic motivation and prior attitudes towards sustainability.

3. The Study

The experiment ran between January and May 2017 at the University of East Anglia (UEA), Norwich, UK. Fourteen flats were selected for the study that involved 140 students. An overview of the flats and their attributes is given in Table 3.1. Before the trial began, participants were informed that the energy they used in residences would be logged and that this (anonymised) data would be sent to them through a weekly email. This would show their absolute usage and how this compared to the other residences partaking in the study. It was made explicitly clear that relative efficiency would not lead to a change in accommodation fees.

Including the 'Green Flats' afforded a unique opportunity to see if those who signalled a pre-existing preference for a pro-environmental lifestyle deviated from the main cohort. Possible differences could be anticipated in relation to general (base) usage or how the information influenced relative energy performance. Whilst the 'Green Flats Project' has

existed at UEA for a number of years, no direct obligation or onus is placed upon the students regarding sustainability when they live in the flat through the academic year. Nevertheless, the hypothesis here is that these participants would (a) consume lower levels of energy and (b) respond more strongly to comparable information given the self-imposed status they want to uphold (Dasgupta et al, 2016).

Flat Name	Number of Students	Email Stopped after 6 Weeks	Green	Prize
AA17	12			✓
BB17	8	✓	✓	
CC17	10			✓
DD17	10			✓
EE17	10	✓		
FF17	10	✓		
GG17	10		✓	✓
HH17	10			✓
II17	11		✓	✓
JJ17	11	✓	✓	
KK17	11			
LL17	9			✓
MM17	9			✓
NN17	9			

Table 3.1: The Monitored Flats and Their Characteristics

In order to test the role of persistence, four of the flats in the study would (without warning) stop receiving the emails, yet their usage continued to be logged and ranked. Monitoring also continued beyond the information dissemination period for all flats, in what is later described in the results and discussion sections as the 'post-intervention' timeframe. Figure 3.1 shows this, illustrating that, following ten weeks of emails, the Spring Semester was bisected with four weeks of an Easter break. Students returned and for a period of six weeks, where the monitoring continued. However, email communications stopped after four of these weeks, affording a chance to see if (short-run) habits persisted in the absence of a reminder for the remaining ten flats. For the four flats mentioned above, emails stopped in week 8 of the timeline given in Figure 3.1.

When exploring the role of the extrinsic motivation, the selection of the prize had to be chosen carefully. Instead of offering a direct monetary incentive, the prizes students were competing over were (i) a three course meal and drinks at one of the on-campus restaurants and (ii) lunch vouchers for the same establishment. It was felt that there were many positive aspects to this prize. Firstly, given that readings were being taken at group level, it reinforced

an idea of cohesion within flats and the notion of working as a team and being rewarded in the same way. Secondly, this prize was perceived as something that students would value with greater equity than monetary equivalents given the diversity in student financial backgrounds.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pre-Trial		Semester Part 1 (Email Sent)										Easter (Emails not Sent)				Semester Part 2 (Email Sent)				Post-Treatment (Emails not Sent)	

Figure 3.1: Timeline of Study

Each flat was fitted with a monitor that isolated, logged and stored energy usage data. Meter readings were taken at the same time of each week and students were emailed on the following day of each week. Figure 3.2 shows information was disseminated to students through three tables. One showed weekly usage and the associated rankings across all competing groups. A second gave the same information for overall usage and ranking since the intervention period began. The final table provided a 'rankings timeline' for the course of the trial period.

4. Results & Analysis

The Role of Information

One of the major aims of this research was to identify whether providing the energy information impacted upon subsequent behaviour. In order to assess this usage against that of those students not in the study, the university Estates Division were able to provide monthly energy usage for the associated residential buildings covering the study period. These buildings entirely comprise student accommodation, meaning the two data-sets are comparable across the experiment's timeframe. The results show a clear pattern of energy conservation develops for the treatment groups relative to this 'building-level' baseline.

Table 4.1 and Figure 4.1 confirm that, initially, students living in the treatment flats consumed more than the average level from within their respective buildings. However, over time this gap eroded and, after around two months of information emails, then swung to a point where monitored residences on average consumed at a level below that of others within their respective buildings. The magnitude of this effect is consistent with the previously cited field research and indicates the potential gains which can materialise by raising the visibility of energy usage via social comparisons. This in itself reinforces the positive contribution that behavioural psychology could play in facilitating tangible

adaptations in how people behave. Whilst this trend is aligned to previous work conducted at the university (Brock, 2016), this is still something that would be highly prioritised in future work in order to confirm the robustness of this result.

Energy Monitoring Research Project

Week **8**

Your Flat Code **DD17**

This Week

Rank	Team	Usage
1	BB17	10.56
2	NN17	11.16
3	HH17	15.49
4	KK17	15.55
5	GG17	16.97
6	MM17	18.00
7	CC17	18.44
8	EE17	18.78
9	LL17	19.93
10	FF17	21.94
11	**DD17**	**22.31**
12	II17	23.55
13	JJ17	25.55
14	AA17	26.81

Running Total

Rank	Team	Usage
1	BB17	917.63
2	HH17	1182.96
3	MM17	1236.00
4	NN17	1300.90
5	GG17	1306.33
6	KK17	1351.52
7	EE17	1472.60
8	CC17	1598.00
9	**DD17**	**1720.00**
10	LL17	1761.65
11	FF17	1764.80
12	AA17	2374.04
13	II17	2402.80
14	JJ17	2432.79

Weekly Performance

Week	Rank
1	7th
2	9th
3	11th
4	9th
5	11th
6	11th
7	7th
8	11th
9	
10	
11	
12	
13	
14	

To opt out at any time, email michael.brock@uea.ac.uk

Figure 3.2: A Sample Email

	Average Weekly Usage [Building (KwH)]	Average Weekly Usage [Study Flats (KwH)]	**Difference (%)**	t-statistic *(p)*
January	19.65	20.47	**+ 4.14****	2.43 *(0.01)*
February	20.38	20.93	**+ 2.69***	1.63 *(0.051)*
March	16.07	15.74	**- 2.03***	-1.3 *(0.09)*
April	12.75	12.55	**+1.64**	-.079 *(0.21)*
May	13.99	14.36	**+2.64***	1.47 *(0.07)*

*** p<0.1 ** p < 0.05**

Table 4.1: A Comparison of Flat Usage against the Building Baseline

Although only a crude measure of persistence, the fall in efficiency between April and May serves as an initial warning about how subjects respond to information over time and how this relates to their behaviour. Emails stopped in early May, and by the end of this month the average usage of treatment flats was back above that of their building (although not fully returning to the pre-intervention disparity). Two possible conjectures arise from this. The first is that good habits may erode quickly once a nudge is no longer explicitly imposed upon individuals – this is something that shall be considered further in the next sub-section. The other is that by the time students had been exposed to many weeks of emails, the novelty or interest in the project had disappeared. Both of these conjectures hold a strong policy relevance, and indicate that extreme care needs to be paid to the frequency, format and timeline of delivering such information in order to maximise and also retain user engagement.

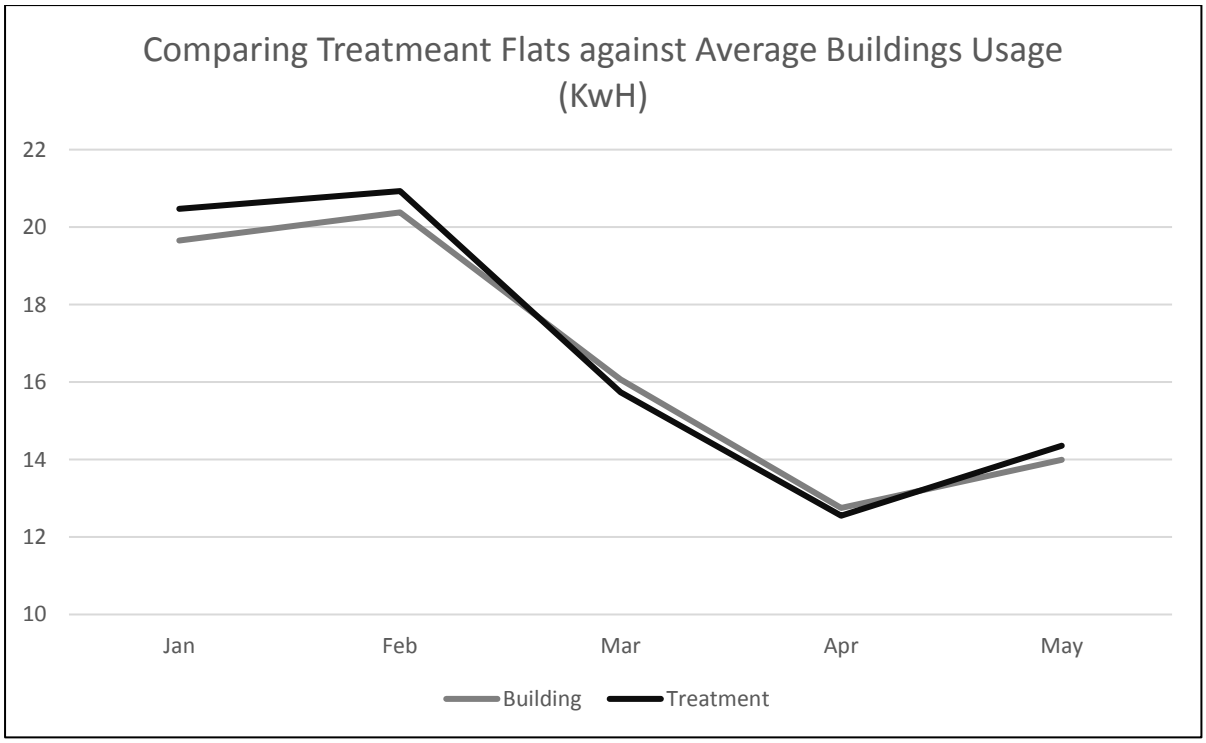

Figure 4.1: Comparing Treatment Flat and Building Usages

The Level of Persistence

Figure 4.1 already implies that there may be some questions regarding how long-lasting an information stimulant may be. As shown in Table 3.1, the in which the study sought to test this aspect was to include a sub-set of flats who stopped receiving emails after a period of just six weeks. Nonetheless, these flats' readings were still taken for the full 22 weeks of the study allowing their usage patterns to still be seen for a full three months after the email termination date.

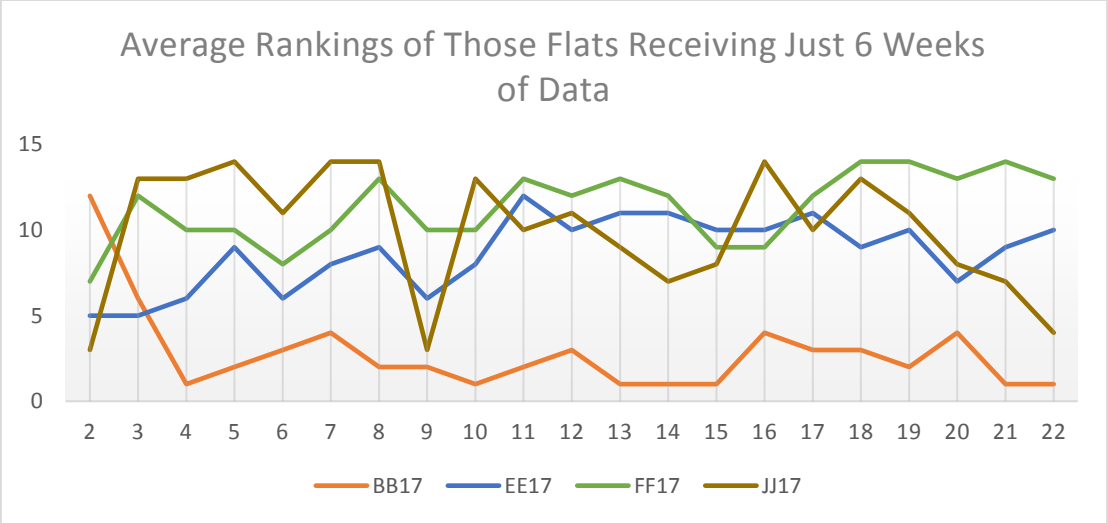

Figure 4.2: The Rankings Trends of the Four Flats where Emails Stopped after 6 Weeks

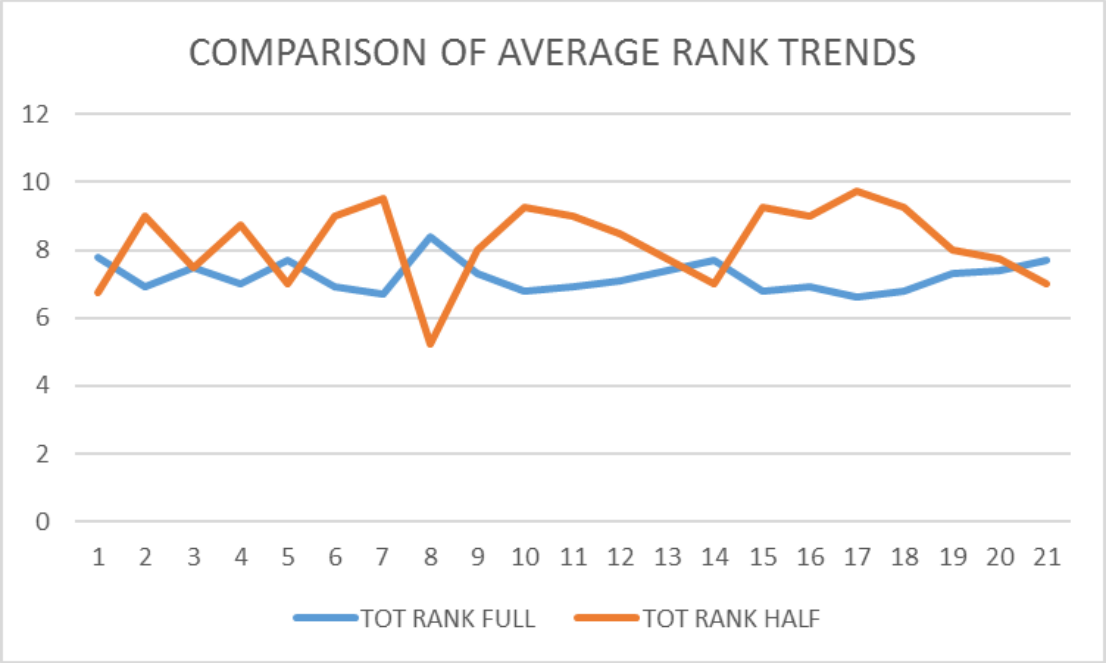

Figure 4.3: Comparing Ranking Trends between those Receiving Emails for only 6 Weeks against those Receiving Emails for the Full Study Period

Table 4.2 confirms that no significant differences occurred between the two treatment groups. However, upon closer inspection it appears that this may have been driven by the wide heterogeneity in the performances of the four "6-week" sub-treatment flats. Exemplified through the Figure 4.2, we see that Flat "BB17" was an extremely strong performer (hence low ranking) throughout the study period, perhaps because this group already held pre-existing habits that enabled energy efficiency. For both Figures 4.2 and 4.3, the crucial stage is Week 8, which was the time emails stopped for the "6-week" groups. With the exception of Flat "JJ17", Figure 4.2 shows an apparent upward trend (and thus worsening rank) following this period. When aggregated in Figure 4.3, this seems most pronounced in the initial weeks after the email stopped.

	(1)
VARIABLES	Log weekly usage per student
No email stop	*Ref*
Yes email stop	-0.00130
	(0.154)
Weeks	-0.0264***
	(0.00654)
Constant	2.970***
	(0.0859)
Observations	294
Number of number of teams	14

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.2: Linear regression model for the log weekly usage per student clustering by independent observations (teams).

Furthermore, when inspecting Figure 4.3 it is noteworthy to look at the slight increase in the rankings of those within the 'Full Information' treatment after Week 19. This is the time when the emails stopped being received by them for them. Whilst only collecting another two weeks is by no means a robust measure of persistence, the trends seen in Weeks 9-11 for our '6-week sub-sample' and in Weeks 19-21 for the remaining groups imply that it is the immediate time period after stopping an information interjection that create the most severe reactions in behaviour.

Unfortunately, university accommodation contracts ceased from 'Week 22', explaining why further monitoring did not occur. However, assessing these patterns in future work could easily be achieved by simply bringing forward the treatment start date, or by using a set of subjects (for example postgraduate students or domestic residents) who live in their accommodation for a full calendar cycle.

The Impact of Offering a Prize

Another key aim was to see what impact (if any) offering extrinsic incentives would have on the desire for subjects to improve their energy efficiency and lower their consumption. As previously stated, two strands of competing literature exist here. The first argues that the added competition should heighten the desire to improve one's standing, leading to an even greater reduction in energy consumed. However, an opposing (theoretical and experimental) literature shows evidence of where such extrinsic motivations can offset (or "crowd out") intrinsic desires.

The results of this study are mixed. Table 4.3 confirms that no significant differences in the energy consumption arise when formal econometric testing is used to compare those in the 'prize' versus 'non-prize' treatment groups. This would suggest that the opportunity to reap additional extrinsic benefits through a strong relative performance does not translate into greater instances of energy-saving behaviour.

	(1)
VARIABLES	Log weekly usage per student
Non prize	*Ref*
Prize	0.0888
	(0.111)
Weeks	-0.0264***
	(0.00654)
Constant	2.918***
	(0.103)
Observations	294
Number of number of teams	14

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.3: Linear regression model for the log weekly usage per student clustering by independent observations (teams).

However, by again delving a little deeper, a couple of interesting and policy-relevant patterns emerge from those flats who were given the chance to win a prize.

The first of these results arises if we segment the results into three stages: before, during and after the intervention. Table 4.4 provides the average consumption for the two groups across these periods. It shows us that 'pre-intervention', those in the 'prize' treatment consumed on average 23.9% more energy each week than those in the non-prize treatment.

This means the 'prize' sub-sample were relatively poor performers at the time that emailing began.

However, through the intervention period the gap not only shrunk but reversed so that, on average, 'prize treatment' groups consumed a marginally lower level of energy on average per week than the remaining set of participants. The difference (0.07KwH) is marginal and statistically insignificant, but given the pre-intervention consumption levels, this implies that the potential for additional reward could represent some form of stimulus to respondents. Regarding the post-intervention figures, we see the levels of energy usage from the 'prize' groups almost return to their pre-intervention threshold. Yet the magnitude of this return is by no means as substantial as for the 'non-prize' cohort, suggesting that perhaps there are some lasting effects from the extrinsic prize.

	Pre-Intervention Usage (KwH/Week)	Intervention Period Usage (KwH/Week)	Post Intervention Usage (KwH/Week)
Prize Cohort	14.99 (5.59)	16.85 (6.96)	14.22 (4.21)
Non-Prize Cohort	12.1 (3.76)	16.92 (6.89)	14.03 (5.68)

Table 4.4: A Comparison of Energy Usage differences between Prize and Non-Prize Groups.

Whilst this first effect seems promising, a second finding reveals that, in the period post-intervention, the average usage of the 'Prize' sub-sample rose by 22% compared with the final week when emails were sent. Combined with the statistics in Table 4.4, this implies that 'prize' flats exhibited a more pronounced downward trajectory in usage through the intervention period itself than 'non-prize' counterparts, but once prizes had been allocated, they display rapid rise in the energy consumption.

For individuals that are extremely competitive, this makes intuitive sense. Through the intervention period, they are likely to be very conscious of how much energy they were using, particularly in the weeks immediately prior to when the winning teams would be selected because of their strong desire to claim a prize. However, once the prizes were allocated, the strong impulse to be energy efficient disappears leading them to quickly return to a pattern of higher usage. It is note-worthy that this post-intervention pattern was not witnessed whatsoever for flats within the 'non-prize' treatment.

Informal evidence of this is given by Figure 4.4. This illustrates the ranking of the leading 'prize' flats over the duration of the study. Note that winners were determined by Week 17. The graph shows the four leading flats in the prize treatment had maintained a steady rank throughout the intervention period, but these quickly rose (meaning they were now performing relatively badly) once the announcement had occurred. When considering the design and nature of implementing some form of extrinsic motivation, this type of result is

undoubtedly poignant for policy-makers and energy providers alike, particularly if their objective is to improve the long-term consumption and stability of energy demand.

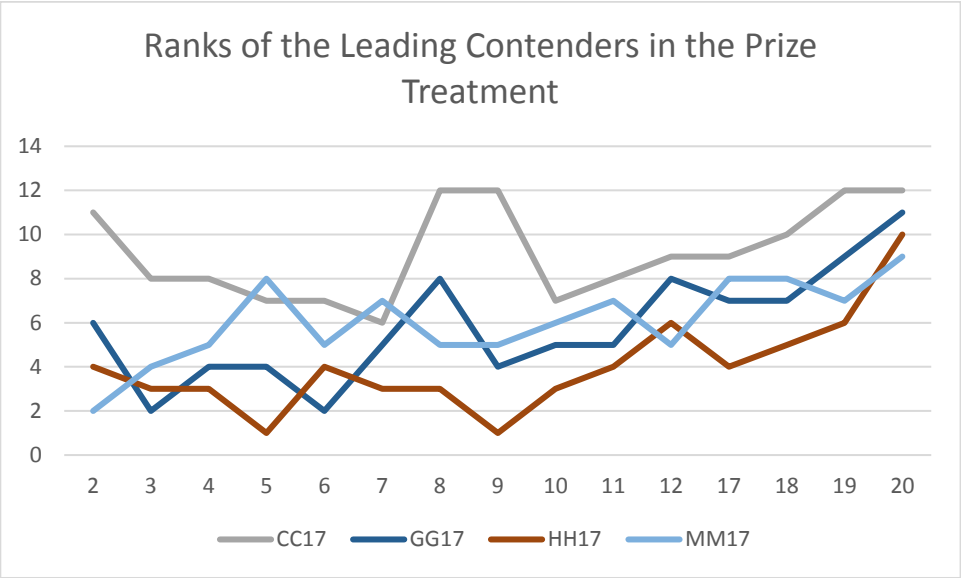

Figure 4.4: Ranks of the Leading Contenders in the Prize Treatment

The Impact of Residing in a Green Flat

One of the novel elements of this study was its ability to have a section of the subject pool from a 'Green Flat'. Recall that these participants had expressed a desire far before the study to live in an environmentally sustainable setting. It offered an opportunity to inspect whether they had a lower level of energy usage, and of equal interest, whether they responded differently when presented with this information.

A really surprising result here is that 'Green Flats' residents actually consumed more energy than those in standard residencies pre-intervention! Table 4.5 confirms this point, showing that Green Flat occupants on average consumed 29% more energy each week than their peers. This finding echoes work done previously in the study area (Brock, 2016) and seems to indicate that, regarding energy, there is a clear discourse between the intentions of a person and their behaviour in the absence of a mechanism for them to monitor or uphold their stated ambitions.

Nevertheless, this trend of over-consumption disappears over the intervention period and significantly reverses by the time the post-intervention period is reached. Unfortunately, we have no way of disentangling to what extent this occurs because of the information channels in themselves, or instead through a desire to defend a previously stated reputation. In any case, this finding is intriguing, especially for one who is looking to design techniques that will get consumers committing to longer-term pro-social activity.

	Pre-Intervention Usage (KwH/Week)	Intervention Period Usage (KwH/Week)	Post Intervention Usage (KwH/Week)
Green Flats	16.33 (7.71)	18.34 (8.41)	11.91 (5.73)
Non- Green Flats	12.73 (3.38)	16.42 (6.36)	15.65 (4.55)

Table 4.5: A Comparison of Energy Usage differences between Green and Non-Green Flats

The trends in Table 4.5 offer a second insight that is encountered from the Green Flat treatment groups. In just the same way as we saw with the post-intervention consumption patterns of Prize respondents, the average consumption of those living in Non-Green flats rose by 19.1% relative to the final weeks where the intervention took place. However, for the Green Flats over this same period, there was a continued fall in usage by an average magnitude of 23%. Linking this finding to the notions of behavioural habits and persistence, this offers the conjecture that long-term energy conservation habits may only materialise in if an individual has already expressed a pre-disposition to embrace environmental attitudes.

5. Discussion

Whilst these results are encouraging and complement the findings of previous studies in the field, we acknowledge that they would be significantly strengthened through repeat testing, in order to check their reliability and confirm their robustness. Furthermore, to do so with a larger cohort would be valuable. As such, this work serves not only as a pioneering study, assessing the roles of persistence, extrinsic motivation and attitudes to sustainability in examining resultant energy consumption, but also forms a platform from which to explore this area further in order to provide rigorous conclusions for both energy policy and for behavioural economics and environmental science.

If replication were to indeed verify them, these results could be fairly ground-breaking for relevant policy-makers in the field. For one, it appears that the degree to which 'good behaviour' persists is highly dependent upon a range of factors, including the prior attitudes of those receiving the information or the way in which an intervention interacts with other motives, be these extrinsic or intrinsic. With these intricacies put aside for one moment, it is clear that there are clearly potential advantages for gathering and disseminating information on energy usage, and the results here imply that the savings from imposing a competitive framework could offer a 5-10 percentage point reduction in energy consumption over a fairly short space of time. On aggregation, this could translate into significant savings and help domestic energy users both financially and psychologically. Moreover, this could also benefit

energy suppliers through the establishment of more consistent and predictable trends in energy demand.

Nevertheless, significant response heterogeneity arises through this study, and a recurrent feature from this is that, should identification be possible, policy-makers need to seize opportunities to target information to those with specific characteristics. This is something which the energy industry is already aware of through aforementioned studies in relation to performance (Abrahamse et al, 2005), political ideology (Costa & Kahn, 2013) and demographic status (Giulietti et al, 2005). However, this study explicitly demonstrates this, considering how both prizes and 'green' individuals reveal disparate patterns of behaviour.

Conclusion

This study builds upon a burgeoning literature that seeks to identity whether relatively cost-free behavioural nudging can influence people's energy demand. To test this, students living in halls of residence at a UK university were provided with (absolute and relative) energy usage data through a weekly email. The study introduced new insights, firstly by issuing energy information at a flat (apartment) level and secondly by splitting this cohort to explore aspects relating to extrinsic motivation, persistent behaviour and pre-existing environmental attitudes. This sought to assess (a) whether responses differ when data is provided through a group dynamic and (b) whether these imposed sub-treatments create a range of consumption trends as a consequence.

The results imply that issuing rankings information can incite behavioural change. The flats involved in the study reduced their usage by a magnitude which converted them from above to below-average consumers relative to their building-level cohort. Interestingly, students in the 'Green Flats' proved good performers through the trial, but further investigations show this was driven by a greater response to relative performance and persistence in good habits over time. Whilst no evidence arises to imply extrinsic motivations crowd out intrinsic ones, there are serious questions regarding the long-term impact of offering such additional reward, particularly from the point after a promised incentive is issued. Finally, 'good habits' typically seem to erode quickly, and, at multiple junctures in the study, an almost immediate upward trajectory in consumption is seen once emails cease.

These findings appear highly relevant for the field of energy economics and its policy and given the novel setting, we advocate extending and expanding upon theses experimental beginnings in order to strengthen the evidence for these early conjectures.

The main implication here is that policymakers, industries and consumers alike must consider the role that non-financial stimuli can have for inciting small and yet significant changes to behaviour. A motivation to change may exist, yet how long this desire remains present is highly debatable. Moreover, this project implies that the success of an intervention may crucially hinge on the *way* that it is imposed. This relates both to its frequency and its target demographic. It suggests that an ability to nurture (or indeed even establish) a desire for behavioural change in an environmental field such as energy usage will require a well-crafted and thoroughly planned scheme if the anticipated benefits are to fully materialise.

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