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Exploring Energy Use in Fashion Stores: A Field Experiment

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Abstract

Optimizing energy use is a growing concern in the commercial sector, particularly for fashion retailers due to its relevance within total expenses and the increasing scrutiny of environmental performance indicators in the textile industry. In this paper we conduct a field experiment (randomized control trial) in a major multinational company to test how information provided to store managers about the environmental impacts of energy use induces changes in selected temperatures within an automated technical platform. Based on a field experiment conducted in 155 stores located in three countries, our results show that managers receiving the information treatment are more likely to change the thermostat manually to reduce the gap between indoor and outdoor temperatures; this is consistent with a more sustainable pattern of heating and cooling.

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Reducing energy consumption facilitates environmental improvements while it may also have positive effects on the operating costs of companies. Energy efficiency and, therefore, also energy saving strategies have currently become major alternatives for large-scale mitigation of climate change (see e.g. IEA, 2018). It is thus unsurprising that many international corporations are paying growing attention to this area. These efforts are particularly relevant in activities, such as the textile industry, that are under increasing scrutiny by governments and NGOs due to their large environmental impacts. Indeed, a recent editorial of *Nature Climate Change* (2018) revealed that this sector, emitting more than some familiar carbon dioxide (CO_2) intensive sectors such as international aviation and maritime transport, is amongst the most polluting in absolute terms.

Reputational concerns and the search for cost minimization have both led to considerable progress in the energy domain by companies operating in the fashion business over the past few years. Actions in this field include the optimization of production and transport processes and, increasingly relevant in recent years, the construction and operation of "eco-efficient" stores that minimize energy consumption through the application of sophisticated technical systems (see Schönberger et al, 2013). In particular, Inditex, a major international player in the textile industry[1], has been a front-runner in the design and development of energy-efficient stores. The truly global relevance of this company and the rich data derived from the functioning of its automated "energy-optimizing" technologies make it a perfect setting to assess the effectiveness and potentials of energy conservation in the retail segment of the textile sector. This is particularly interesting from an economic point of view, since most energy interventions in the commercial sector have been designed and implemented from a purely technical perspective so far, without paying much attention to behavioral or other socio-economic issues.

The academic literature in this area is quite limited, in sharp contrast with the economic relevance of energy use[2] and the growing energy-efficiency investments within the commercial segment of the thriving textile industry (Elliot, 2016). Knowing whether the aforementioned measures are effective, at moderate costs, is essential to assess their usefulness for climate mitigation within this sector and on a larger scale. In this sense, exploring the scope of improvements of purely technological devices through behavioral approaches (in our case in the form of informational nudges) may provide valuable information on useful cost-effective alternatives. The setting of this application is, moreover, ideal for the implementation of a field experiment given the nature of the interventions and the existence of a common technological platform providing valuable data on energy consumption and outcomes. As far as we know, no other published study has conducted a field experiment on energy saving at a retail level within this crucial economic sector using nudges designed with direct input from their own managerial team.

Some specificities of the analyzed sector further contribute to the socio-economic interest of this paper. In contrast with earlier findings documenting very homogenous patterns of consumption for large retailers (Kahn and Kok, 2014), our data from Inditex show a large variability in heating and cooling

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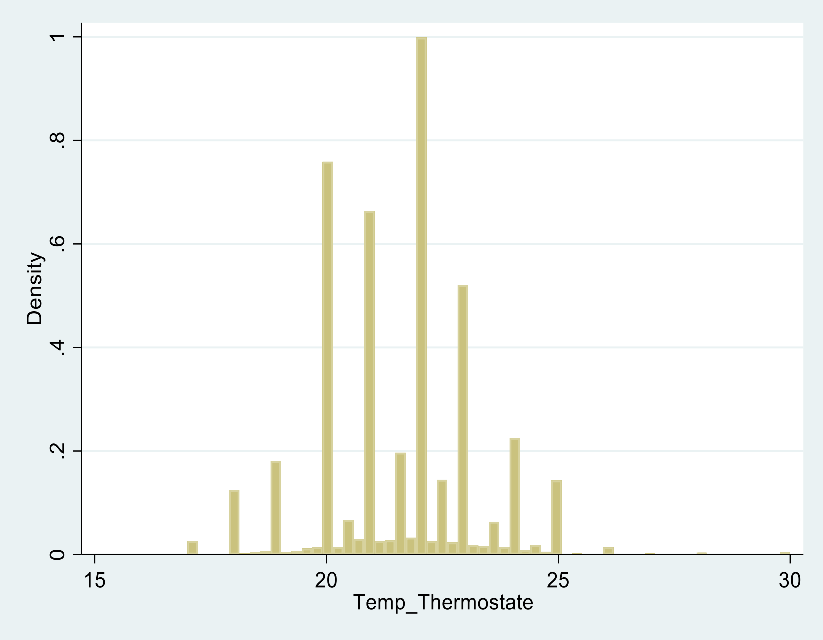
[1] This company, based in Spain, has 7,400 stores in nearly 100 countries. Popular brands of Inditex include Zara, Bershka and Massimo Dutti.

[2] Internal sources report that heating and cooling expenses of a typical Inditex store represent around one third of its total variable costs. Given the scope and extent of advanced technical devices to optimize energy use within this company, the figure may be even larger in other fashion retailers.

consumption patterns well beyond any adaptation to seasonal variations (Figure 1). That is, despite the automation of energy-related services (mostly heating and cooling) in the fashion retail sector through uniform technical approaches, patterns of energy consumption vary significantly across stores.

Figure 1. Average Target Indoor Temperature across Stores (in Thermostat)



Several reasons explain such a heterogeneous pattern of indoor temperatures in fashion stores. On the one hand, the relationship between indoor and outdoor temperature may have effect on the willingness of customers to try different clothes and hence on the amount of sales. This phenomenon may be exacerbated by the fact that store managers intend to maximize sales but usually do not deal with the payment of energy bills, thus creating a situation of asymmetric information between store managers and the top managers of the company. In addition, there may be agency problems in which the agent (store manager) may simply be interested in sales, independently of other costs, whereas top managers contemplate net profits. In this case, the selection of very comfortable temperatures may be seen as an “investment” to obtain higher sales, regardless of the wider economic and environmental objectives of top managers. In addition to these relevant aspects, different types of stores (“flagship” or insignia stores versus regular stores) might also require different patterns of heating and cooling, associated to a different stock of appliances (TV screens, intense lighting, etc.) Also, differences in indoor temperatures may be explained by varying competitive brand strategies that try to push customers in. Other factors may be related to human resources and differences in the training and knowledge of store managers and employees concerning energy saving strategies.

This paper is organized in five subsequent sections. We next provide an overview of the literature in this area, followed by a description of the design and implementation of the field experiment. Section 3 deals with the data and hypotheses, while section 4 describes the empirical approach and presents its results. Finally, section 5 concludes and discusses some implications.

1. Literature

As indicated, it is crucial to moderate energy consumption together with the decarbonization of the supply side to successfully fight against climate change. The importance of energy efficiency for climate mitigation has therefore led to growing public intervention across the world through various approaches. The recently reformed EU (2018) energy efficiency legislation illustrates this phenomenon with the enactment of more ambitious overall targets that should be attained through simultaneous action in different areas. In particular, EU policies in this field aim to create new and more effective ways of cooling and heating buildings (residential or commercial, public or private) through better design, improved appliances and adequate incentives. A more precise example of the relevance of cooling/heating-related energy use in the climate change debate is put forward by Reyna and Chester (2017). They show that the significant temperature increases associated to future climate scenarios in California would lead to a large expansion of electricity demand in the coming decades, although the upgrading of heating/cooling systems and appliances could result in much lower effects (roughly a 30% increase in demand between 2020 and 2060, but well below the 90% increase associated to current trends).

The socio-economic literature on energy efficiency has so far focused on the residential sector, particularly on measures and effects at a household level. This has also been the case in the design and analysis of behavioral interventions and their impacts on energy savings (see the extensive review by Hahn and Metcalfe, 2016 or Frederiks et al., 2015). Much effort has especially been placed on the role of social norms and peer pressure in the adoption of energy saving strategies (Schulz et al., 2007; Allcott, 2011a; Ayres et al., 2013; Costa and Kahn, 2013; Dolan and Metcalfe, 2015; List et al., 2017; Sudarshan, 2017; Gillingham and Tsvetanov, 2018). The literature has also documented several barriers for the adoption of energy efficiency and energy saving policies, including price misperceptions (Allcott, 2011b), or individual discount rates (Newell and Siikamäki, 2015). In addition to cost-benefit analyses and policy evaluations, other behavioral interventions have focused on aspects that could generate more effective results in this area. In this sense, some of the most studied behavioral phenomena include the rebound effect (Gillingham et al., 2016), and inertias to remain at the status quo or to stick to default settings (Fowlie et al., 2017).

Unfortunately, little is known on what is actually happening beyond households regarding these matters, and noticeably in the crucial business sector. Could similar behavioral phenomena explain the apparent inertias and slow progress in the adoption of energy efficiency there? Indeed, it seems that firms should be more proactive in this area as they should routinely invest in energy saving strategies that are usually expected to have a positive net present value under current regulations and co-benefits. Yet De Canio and Watkins (1998) have shown that individual specific characteristics of firms matter in engaging on energy investments and, as a consequence, general economic conditions and incentives may be insufficient to encourage adoption of energy saving technologies. In any case, the experimental evidence is limited, not only because few of the field experiments actually conducted in/by companies are eventually documented in the literature (Bandiera et al., 2011), but also because most interventions in the business world are outside the energy domain (see some examples ofenergy-related experiments in Staddon et al., 2016).

Still, a number of experimental papers deal with the role of incentives and provision of information to improve energy consumption patterns in firms. For instance, Schall and Mohnen (2017) explore the effects of monetary and non-monetary “eco-driving” (i.e. fuel-efficient) incentives to drivers of light commercial vehicles in different branches of a logistics company. Their results only show a 5% average reduction of fuel consumption due to a tangible non-monetary reward and also point out small reductions in consumption associated to the monetary reward treatment. Siero et al. (1996) report the results of two forms of feedback on energy consumption behavior in two units of a metallurgical company. In one unit employees received information about energy conservation, had to set energy objectives, and received feedback on their own conservation behavior. The same procedure was followed with employees in a second unit, but they also received information about the performance of the first unit. The results showed that employees subject to comparative feedback saved more energy than employees who only received information about their own performance and they were persistent six months after the intervention. Handgraaf et al. (2013) inquired on the role that different incentives could play in shaping employee behavior in terms of reducing energy consumption. Every week within a 13-month period, employees were rewarded (privately or in group) with monetary payments (up to €5) or they were given social rewards (grade points with a descriptive comment) for conserving energy. The authors found that in the short and long term, public rewards outperformed private rewards, and social rewards outperformed monetary rewards.

Additionally, other papers have dealt with the behavioral implications of actions taken outside the firm. Rosenkranz et al. (2017) analyze the impact of simplifying the annual email received by energy coordinators of firms participating in a voluntary agreement with the Dutch government to promote energy efficiency. They found that simpler emails led to a much more frequent downloading of the annual report providing detailed feedback on company performance in this area. They also reported a direct relationship between report downloading and the consideration of further measures for energy conservation. Ryan (2018) conducted a field experiment in the manufacturing segments of Indian chemical and textile sectors, with the provision of energy consulting (energy auditing and an energy manager to implement its recommendations). The results indicate that the treated companies, rather than reducing the use of energy, responded to productivity increases by using more energy to expand operation times or intensity of equipment use.

Such limited literature sets the context for this paper, which deals with an internal measure of provision of information that takes advantage of a pre-existing technological platform to optimize energy use at a store level, actually utilized to yield detailed information on treatment effects. This application can thus be interpreted as a way to complement automated approaches with behavioral devices, improve their performance (and thus increase the returns to a very sizeable investment), or as a way to detect constraints with univocal approaches.

2. Experimental approach

As indicated, the textile industry has attempted to reduce the use of energy along its production, logistics, and retail segments over the last few years due to economic and environmental concerns. This paper only focuses on the so-called fashion retailers that have generally experienced remarkable changes in their energy intensity and use of energy operation devices (smart meters, thermostats, etc.) over the last few years. In particular, Inditex has developed the "alive store" concept in which, thanks to various technical devices, the store "auto-regulates" its air quality, lighting, and temperature. In terms of temperature, the store manager may decide to change the predetermined target on the thermostat (see below) when the feeling is uncomfortable.

Target temperatures are expected to range between 19 and 24 degrees, depending on the applicable national legislation, but in practice they tend to vary mainly in response to external weather conditions and/or the affluence of customers. Figure 1 illustrates this phenomenon for the analyzed Inditex stores, whereas Table 1 shows that they register the highest indoor temperatures throughout winter and the lowest throughout summer, thereby highlighting the relevance of the seasonal variation of outdoor temperatures.

Table 1. Mean indoor temperatures per month

Month	Mean	Std. Dev.
1	21.984	12.394
2	22.229	14.834
3	21.778	11.232
4	21.720	10.720
5	21.380	12.431
6	21.304	13.036
7	20.859	14.477
8	21.016	17.114
9	21.412	15.655
10	21.563	13.232
11	21.600	13.060
12	21.835	11.534

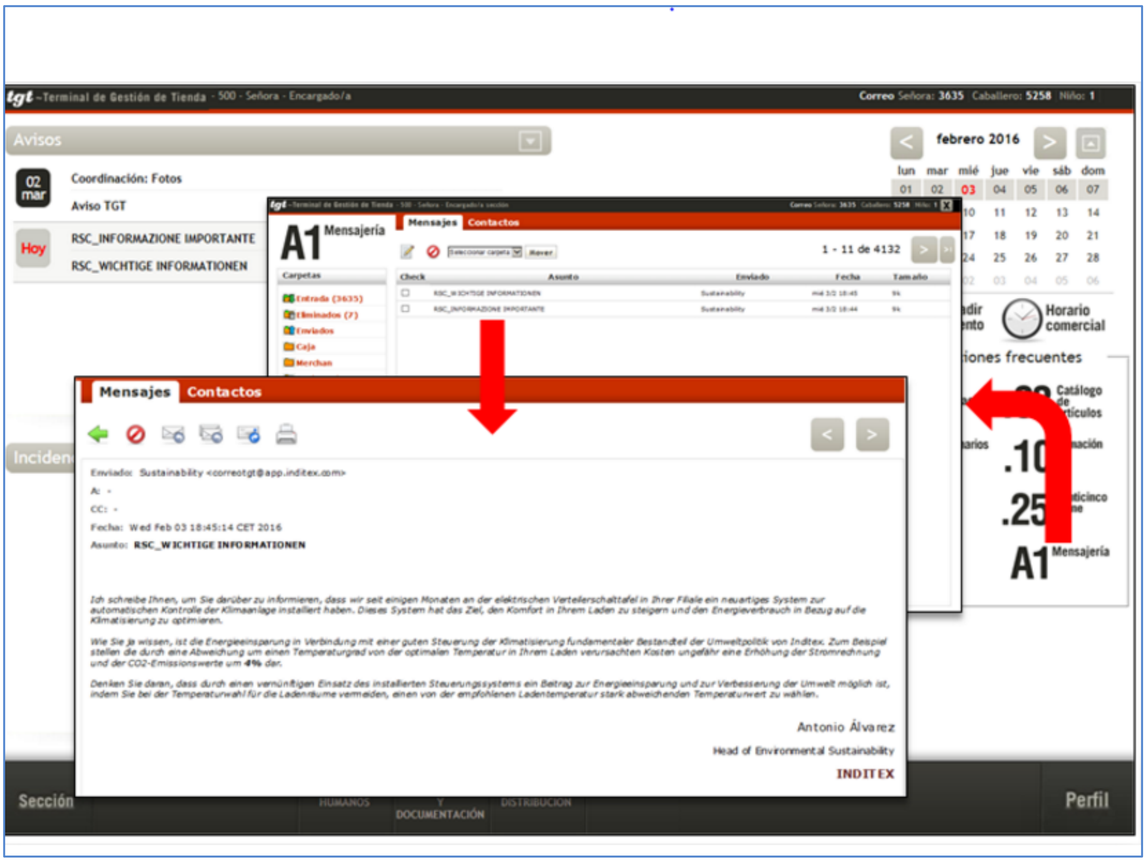
Such a pattern of temperature setting does not correspond with a sensible energy-saving strategy because managers aiming at reducing energy consumption would be expected to keep the stores cooler in winter and warmer in summer (among other things because customers wear warmer clothes in winter than they do in summer). In view of these behavioral failures, the field experiment evaluates the effect of an informational treatment that indicates the importance of energy savings and suggests avoiding large gaps between indoor and outdoor temperatures to achieve these savings.

Using the energy platform of Inditex, we could track indoor temperatures and the managers' behavior, without the subjects perceiving they were part of an experiment. Furthermore, the experimental setting was very real due to the collaboration of the Sustainability Department of the company, so no deception was practiced (Harrison and List, 2004). The provided information came in the form of an official email from the Head of the Sustainability Department. Moreover, the energy consumption of the stores selected for the experiment was monitored in real time over three years (before and after the treatment).

Selection criteria to participate in the experiment required that stores be included in their energy control platform since at least February 2105 and located at the street level. Consequently, stores located in shopping malls were excluded from our sample because most of these malls have centralized heating and cooling systems. Our interest was to assess the impact of store manager behavior on energy efficiency, so the selected stores were only those in which managers have the capacity to alter indoor temperatures. Zara, Oysho and Bershka were selected to participate in this experiment[3] to gain an understanding about the potential differential effects across Inditex brands that are commercialized in different stores and have significant managerial autonomy. The total 155 selected stores located in Spain, Italy, and Germany were randomly allocated to the control and treatment groups.

The informational treatment consisted, as advanced, in an email sent on 8 February 2016 by the Head of the Sustainability Department to the store managers, responsible for the daily operational activities at the store level. In this email, with "Important Information" as the subject line, the Head of the Department indicated the importance of saving energy to reduce emissions, and the relevance of keeping the inside temperature of the store in line with outside temperatures. The email was translated into three different languages (Spanish, German and Italian), depending on the location of the store. This email was sent from Inditex central headquarters at exactly the same time to all treated stores. Figure 2 illustrates the notification to store managers, which followed the routine channels of (intense) communication between headquarters and stores.

Figure 2. Message notification to store managers



[3] Zara is the oldest and most popular brand out of the total seven fashion brands of the company. It sells men's and women's wear. Oysho sells sport clothing and underwear; and Bershka specializes in clothing for youngsters.

The text displayed in the body of the email read as follows:

> Good morning!
>
> I am contacting you because I would like to know your opinion on the air conditioning system installed at your store, and to ask you to please answer the short survey attached.
>
> As you know, energy savings resulting from the effective running of the air conditioning system is a fundamental aspect of the Inditex Environmental Policy, as indicated in our Environmental Sustainability Strategic Plan 2016-2020.
>
> For several years now, a novel automatic air conditioning control system has been in place in the electric control panel of your store with the aim of improving the comfort of your store, whilst simultaneously saving energy and reducing electricity costs.
>
> As you know, the expense incurred by a difference of one degree in the optimum indoor temperature roughly implies an increase of 4% in the electricity bill and CO_2 emissions. Please remember that you can contribute to energy savings and environmental improvement through the correct use of the management system installed, ensuring that the store temperature setting is approximate to that recommended.
>
> Thank you very much for your cooperation
>
> Antonio Álvarez
> Head of the Sustainability Department

In addition to the text, a quick survey was enclosed in order to gather socio-economic characteristics of the managers, and their knowledge about energy saving practices. A reminder of this initial message was sent out again on November 2016 to evaluate persistence of the intervention.

3. Data and Hypotheses

Data on energy consumption were collected between February 2015 and February 2018 for all stores participating in this research. During this period, real time data of energy consumption, indoor temperature, thermostat changes by store manager, and outdoor temperature were recorded every fifteen minutes and later aggregated on an hourly basis. These high-frequency data were merged with additional characteristics of the stores, including variables describing their location, square meters and brand, among others. Such data were also merged with the aforementioned survey information obtained from store managers. Table 2 shows the summary statistics of the most relevant variables.

Table 2. Summary Statistics

Variable	Mean	Std. Dev.
Zara (=1, if store belongs to Zara chain)	0.718	0.449
Thermostat temperature (ºC)	21.596	9.342
Indoor temperature (ºC)	22.717	4.574
Ms2(Store square meters)	257.389	505.20
Thermostat changes (daily)	1.029	3.313
E-mail (treatment)	0.467	0.499
In-charge (years of experience)	7.619	6.755

Two main research hypotheses were tested employing these data:

(I) Average engagement of managers in temperature control is identical between treated and non-treated stores.

$$Ho: Thermostat\ Changes\ (Treatment)\ = Thermostat\ Changes\ (Control) \quad (1)$$

This implies that managers who receive the informational treatment (e-mail) are equally likely to manually change the thermostat as those who received no e-mail.

(II) Average differences between internal and external temperatures are identical between treated and non-treated stores.

$$Ho: Indoor\_Outdoor\ DifTemp\ (Treatment) = Indoor\_Outdoor\ DifTemp\ (Control) \quad (2)$$

In this case, the absolute deviation (or uncompensated difference between store indoor and external temperatures) is the variable of interest for our assessment. Such variable is presented in the informational treatment as the target variable that should be reduced to promote energy conservation.

4. Empirical Methods

4.1. Empirical Test Results

The Kruskal-Wallis (1952) equality-of-populations rank test provides statistical evidence on the difference between the number of times managers change the thermostat manually across samples (treated and non-treated). Table 3 shows that managers who received the informational treatment (email) changed the indoor thermostat temperature more frequently than did those who had received no such treatment. However, inertia to maintain the established thermostat temperature is also predominant in the sample, with nearly 80% of the stores never changing their thermostats.

Table 3. Hypotheses Test Results

Hypothesis	Kruskal-Wallis equality-of-populations rank test
(1) $Ho: Thermostat\ Changes\ (Treatment)\ = Thermostat\ Changes\ (Control)$	$\chi^2_{(1)}$ =41.945 (p-value=0.000)
(2) $Ho: Indoor - Outdoor\ DifTemp\ (Treatment) = Indoor - Outdoor\ DifTemp\ (Control)$	$\chi^2_{(1)}$ =1849 (p-value=0.000)

In terms of whether or not such thermostat changes were successful at decreasing the difference between indoor and external temperatures and, as a consequence, in reducing the heating and cooling costs, the results from the Kruskal-Wallis test again show statistical evidence in favor of this difference in the distribution of temperatures between samples. In particular, the small temperature gap between indoor and external temperature saw a statistically significant decrease of 0.3ºC.

In sum, our results show evidence in favor of the importance of human factors when achieving energy efficiency targets set in an automatized way. The following section aims to disentangle the impact of the treatment when controlling for additional factors.

4.2. Econometric Model

The econometric model aims to control for the impact of the potential differences in stores and managerial experience concerning the use of energy saving technologies. To estimate the impact of the information on energy consumption provided to store managers, we compare energy use before and after the treatment by estimating the differences between the treated and untreated stores. Given the dichotomous nature of our treatment, we have only two groups (T_0 non-treated or the control group, and T_1 treated). Energy use is recorded before the treatment (throughout 2015) and after the treatment (throughout 2016 and 2017). In essence, variation in energy consumption is explained across time and groups.

Difference-in difference (DID) regression models are estimated controlling for additional factors that may affect both groups of stores (treated and control) and between periods (prior and post treatment) by using time trend variables as control variables (Wooldridge, 2007). The inclusion of time trends allows for controls of a number of behavioral factors or socio-economic conditions that may vary over time and affect energy consumption.

DID estimation takes the following empirical form:

$$Y_{it} = \beta_0 + \beta_1 T_{it} + \beta_2 A_{it} + \beta_3 T_{it} A_{it} + \beta_4 Z_{it} + \varepsilon_{it} \qquad (3)$$

Where *Y* is the outcome variable of interest in each store (*i*) at a given day (*t*). Our objective is to assess the overall impact of our experiment on energy savings, so we first model the daily changes in the thermostat (Model 1, M1) and, in a second regression (Model 2, M2), we model the absolute difference between indoor and outdoor temperatures. In all specifications, β_1 captures the differences between the treated stores and those of the control group; β_2 (a dummy time trend variable) captures aggregated factors that would cause changes in energy use in the absence of treatment. The interaction term β_3 is the coefficient of interest (Product DID) for the first period of treatment (2016); it equals 1 for treated companies (and 0 otherwise). The coefficients represent the causal effects of treatment, i.e. the impact of receiving the email notification on updating thermostats in terms of the number of changes, and related effects in temperatures; β_4 represents other controls related to different type of managerial variables that may affect energy consumption related to different type of managerial techniques.

Table 4 reports the results of the DID regression for the changes in energy consumption. The full set of statistical controls for observable characteristics includes other managerial variables referring to the years of experience of the store manager. The table depicts robust results on the positive effects of the treatment over the changes in thermostat temperature. This means that store managers were very receptive to the informational treatment, the DID variable carrying a 1.52 coefficient. On average, store managers who received the treatment changed their thermostats 1.52 times more per day than their counterparts[4]. This is an encouraging finding, since prior to the experiment, most managers made no thermostat adjustment even in the case of significant seasonal variations in external temperatures. This inertia may happen because managers may have considered seasonal adjustments as being conducted by the system automatically when in fact they are not. In this sense, a better training of store managers concerning the energy efficiency system may significantly improve the outcomes of existing strategies.

M2 presents the causal relationship between receiving the treatment and reducing the temperature difference between indoor and external difference by 0.16ºC (DID coefficient). This represents a CO_2 emissions savings of around 0.64% in the calculated proportion of store emissions (reducing the energy needs associated to an additional cooling/heating degree is equivalent to a 4% reduction in CO_2, according to internal data). Managerial experience (reflected by the variable In_charge) again plays a positive role in energy saving, whereas store size is a factor that contributes negatively to undertaking effective energy saving measures. In particular, larger stores are less likely to adjust the thermostat, and each additional square meter contributes to increasing the gradient between external and internal temperatures by 0.003ºC.

In summary, although our treatment brings about a rather small (individual) impact during the period of analysis, the scaling up effect of these small behavioral changes by the total number of stores worldwide can render a rather significant result at a global level. However, larger reductions are presented just after the intervention.

Table 4. DID regression model results

	M1			M2		
	Coef.	**Std. Dev.**	**P**	**Coef.**	**Std. Dev.**	**P**
Email	1.969	0.087	0.000	2.073	0.073	0.000
Product(DID)	1.523	0.097	0.000	-.1622	0.075	0.032
year2016	-1.603	0.067	0.000	-1.316	0.049	0.000
year2017	-0.727	0.077	0.000	-1.355	0.055	0.000
In_charge	0.273	0.006	0.000	0.163	0.004	0.000
Ms2	-0.0005	0.000	0.000	0.003	0.0001	0.000
_cons	0.084	0.0733	0.000	2.561	0.0054	0.000
	$F(6, 55925) = 567.27$ $R^2 = 0.05$			$F(6,35903) = 241.36$ $R^2 = 0.38$		

Note: M1: Number of thermostat changes; M2: Temperature gradient between indoor and outdoor temperatures.

[4] The number of thermostats depends on the size of the store, with large stores having three or more.

5. Conclusions

The textile industry is under increasing scrutiny due to its large environmental impacts, some of them related to its growing energy use. In particular, the retail segment of this sector is going through an expanding demand of energy services (lighting, air conditioning, etc.) that takes a sizeable share of its operating costs. Thus, fashion retailers have been making substantial efforts in this area over the last few years, with significant investments in energy efficiency (building improvements, better appliances, etc.) and, in many cases, through the introduction of sophisticated and automated technological approaches. However, as Carrico and Riemer (2011) acknowledge, energy conservation strategies within firms face particular challenges, since employees may not have the right incentives due to asymmetric information issues and agency problems. In this context, univocal technological approximations may be insufficient to achieve the intended goals and also may be less cost-effective because the (usually large) investments may be unassociated with the expected energy and environmental gains.

In this context, the paper has explored the role of behavioral interventions to improve the performance of existing technological approaches. The experiment carried out in a major multinational of the fashion industry, Inditex, dealt with the role that informational nudges may play to encourage store managers to select target indoor temperatures that are more coherent with energy saving strategies. In this sense, a communication of the top managerial team to store managers (through the routine channels) informed them about the importance of energy savings and on the relevance of keeping aligned indoor and outdoor temperatures.

In spite of the potential lack of incentives to store managers, we found that those who received the information treatment were more likely to change manually the thermostat to reduce the gap between indoor and outdoor temperature than their counterparts. This phenomenon is coherent with a more energy-efficient pattern of heating and cooling costs in stores, and provides cost and emissions savings. Although the treatment has a small individual impact on energy savings at store level, we feel that the scaling-up effect across stores of a large multinational company or overall fashion retail sector may be considerable both in economic and environmental terms.

The use of a pre-existing automated “energy-optimizing" system facilitated the implementation of the experiment and also provided clues on the importance of behavior in the design of sensible energy-saving strategies in the commercial sector. This is particularly interesting from an economic point of view, as most energy interventions in this sector have been designed and implemented from a purely technical perspective so far.

In sum, our results show that there are potential venues to increase effectiveness of the current energy saving investments, well beyond those currently achieved. As shown in this paper, human factors and an understanding of the technology play a crucial role in complementing top of the line technologies, and they are crucial to making investments fully profitable. Therefore, proper training and the creation of incentives for energy efficiency may significantly help to improve energy savings.

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