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Using Behavioral Economics in the design of Energy Policies

Energy Division
Infrastructure and Energy Sector

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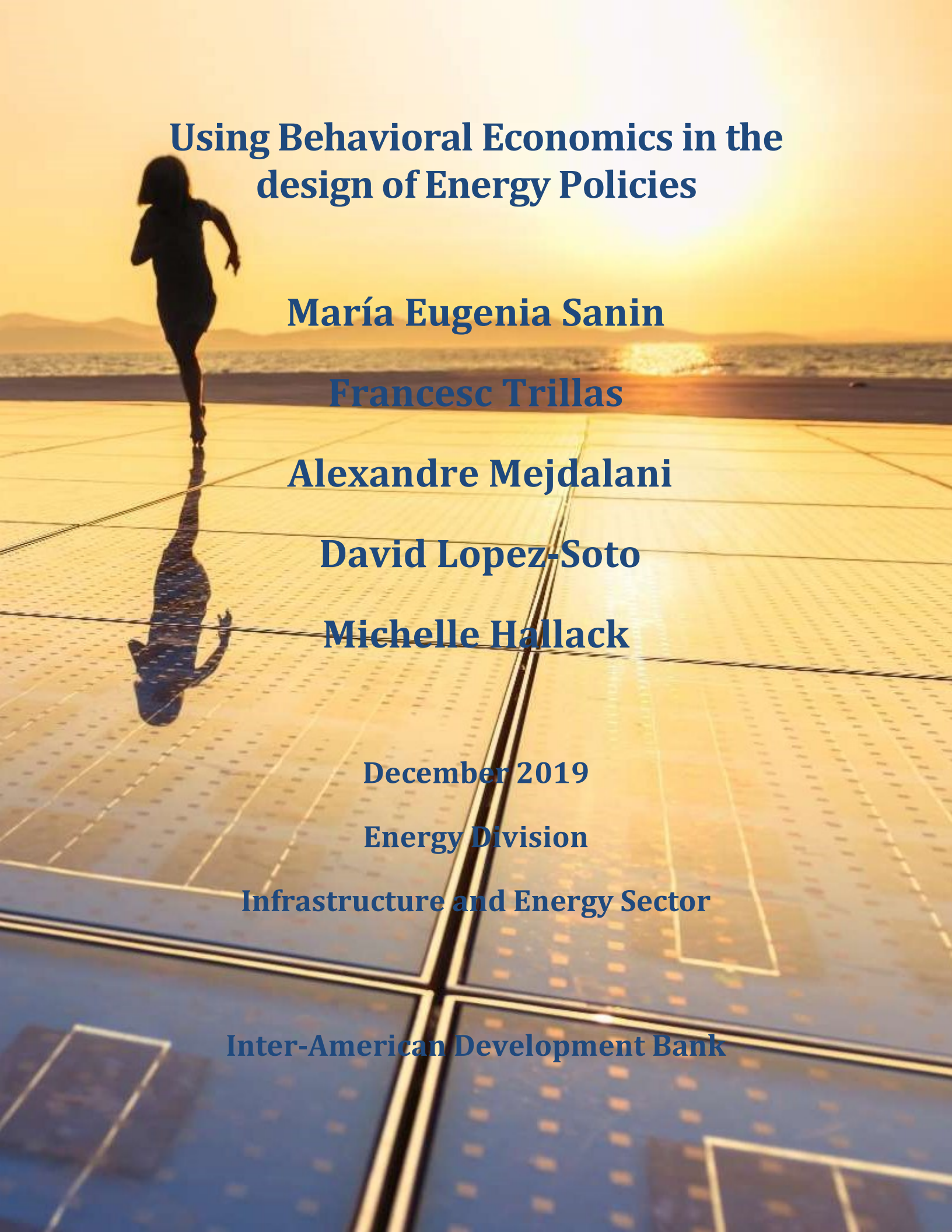

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Contents

Executive Summary

Historically, the demand-side of the energy market has been a passive player, particularly in the short term. Long term trends were analyzed but small or no attention was payed to consumers' behavior. Policy design and implementation followed very strict textbook economical rules of rationality and maximization. It was assumed that energy consumers would increase energy efficiency or change their consumption profile, every time it was economically efficient to do so. The reaction of consumers, especially at the household level, is quite inconclusive and there is little consensus on the magnitude of the price elasticity of electricity demand either in the short- or the long-run. In this context, it is frequently assumed that short-term demand is inelastic to prices. Besides, the energy policy was mostly oriented towards shaping supply to meet given demand.

In a context of growing energy demand and environmental constraints, promoting a better use of existing infrastructure appears as a key for energy security and sustainability. Additionally, trends introduced by new technologies and the design of new services – such as decentralized generation, energy storage, electric vehicles, demand response programs, etc. – are empowering consumers. Their new role requires a better understand of their choices. What kind of information should be provided to consumers? How can we change consumer's behavior to increase industry efficiency?

A better use of energy and its infrastructure can be promoted in three alternative ways: (i) by directly imposing efficiency standards; (ii) by giving economic incentives (prices or subsidies), or; (iii) by nudging energy users to freely change their behavior, for example, by changing the way the information is displayed/ received or by tapping on social norms.

Standards are generally imposed to captive consumers and have been more frequently used to foster Energy Efficiency. Incentive schemes have had limited impact due to the inelasticity of energy demand as well as to the lack of saliency of energy prices. Herein we will focus on the third type of policy that intends to modify the behavior of energy users. Concretely, behavioral interventions will tackle two complementary instruments to foster better usage of infrastructure by end consumers: (i) energy efficiency or energy "conservation", i.e. lowering the level of consumption; and (ii) demand management, i.e. changing the demand profile, by decreasing the peak of infrastructure use at certain times of the day/season.

In this line, we will describe and discuss why we observe that household´s energy consumption is in general different from what we would expect from a utility maximizing consumer. These differences are generally called behavioral biases. We will then proceed to describe different energy policies that have tackled those differences and the key to their success or failure. We will also discuss how do these biases operate in the case of policy makers and experts in the sector, by describing an experiment we performed with Latin American Energy Regulators. Finally, we will discuss some lessons learnt that could be used in the LAC region.

1 Introduction

Economists have known for a while that the "homo economics", who optimizes the utility function, is a strong simplification. But how strong and misleading is this simplification? Is there a different/better approach to the problem? These questions have been the focus of several research papers and have reached mainstream journals in the past few years.

Under the name of "Behavioral Economics" (BE), a body of research focused on how to improve the understanding and the representation of human behavior in economic theory, has reached the status of an established discipline in the past few years. It introduced new research instruments and inter-disciplinary viewpoints to the traditional blackboard of economics. BE research develops around experimental findings and empirical observations of agents' behavior and decisions, which suggest that Traditional Economics (TE) sometimes is not a good representation of the real world (Wolfgang, 2006). In TE theory agents maximize expected utility using exponential discounting of the future, and they have free access to all available information[1]. Experimental settings and empirical observations indicate that human behavior in the real world systematically deviates from what this type of optimization models predict. It indicates that human decision making is based on a set of rules that simplify information processing and decision making, what we called behavioral biases. In this regard, BE challenges more than one of the assumptions[2] of TE. It provides a new perspective that can inform policy makers on how economic agents evaluate options, take decisions, and adapt their behavior system based on a change of the economic environment or error of judgement.

If for TE, a policy correcting a market failure by establishing the right price incentive is enough to deliver the optimum result, for BE results will also depend on the way players process the information into decision making.

[1] The difference between perfect and complete information comes from the general equilibrium models of game theory. An information is said to be perfect if it is available, without costs, to all players of the game. A game has complete information if all players are aware of the actions of all other players and their payoffs.

[2] As an example, experimental findings suggest the following deviations from rational behavior: (*i)* failures of expected utility theory; (*ii)* the endowment effect; (*iii)* hyperbolic discounting and (*iv)* social preferences (Wolfgang, 2006).

Box 1: BEHAVIORAL ECONOMICS AS A VIBRANT RESEARCH FIELD

As a field of research, BE is well incorporated within the mainstream discussion. Up to 2019, four BE scholars were Economics Nobel Prize Laureates:

- ✓ Hebert Simon[3] laureate 1978. He proposed the concept of bounded rationality and provided the foundation for a microeconomics approach to behavior, such as evolutionary economics, institutional economics and organizational economics (Simon, 1979). Simon focused on defining bounded rationality and its application to understand how institutions and organizations decide. Bounded rationality can be defined as a rational behavior compatible with the cost of information access and the computational capacity to process the information. The decision, in this context, is a process searching a satisfactory point instead of the optimal point. In a context of bounded rationality, the optimization is not possible (or too costly). Organizations and intuitions create rules (formal and informal) to allow different players to decide under bounded rationality.

- ✓ Daniel Kahneman and Vernon L. Smith laureates 2002. The first one received the price, "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty". Smith´s contribution was on the development of experimental economics to test agent's rationality and decision making under alternative market mechanisms.

- ✓ Richard Thaler laureate 2017. He incorporated the main findings on human decision bias in policy design. He focused on loss aversion and endowment effect, mental accounting, limited control, and social preferences[4]. This means that, from the understanding of people decision heuristics, we can evaluate the economic inefficiencies associated with human biases and we can create tools to nudge people to decide more efficiently, without forcing them into the optimal solution.

This started as a marginal field in economics, but the interest in BE studies keep rising. In 2017, 5,938 peer-reviewed articles were published in Economics and Decision Theory journals concerning BE, of which 15.8% contained the word "Policy" in their abstract, 3.6% the word "Energy", and around 1% contained both the words "Energy" and "Policy" (see Figure 1). Since Kahneman's Nobel laureation, the publications in BE more than doubled, and the application of Behavioral experiments to energy policy emerged as a research field.

[3] Simon's contributions to modern energy policy research goes far beyond its contribution to organizational economics, behavior and decision making. On his seminal paper "The Architecture of Complexity" (Simon, 1962), he also develops the concept of *hierarchical complexity*, exploring the dynamics of hierarchically organized systems and its decomposition. In the energy sector, the reformulation of the roles of agents (and the dependency among them) redefine the hierarchical decision process, which may increase the complexity and change incentives created by traditional policy design.

[4] The fact that the book Nudge: Improving Decision about Health, Wealth and Happiness from Thaler and Sunstein (2008) has already been cited more than 10323 times (Google scholar, checked 04/23/2018) also shows the growing academic interest in behavioral interventions.

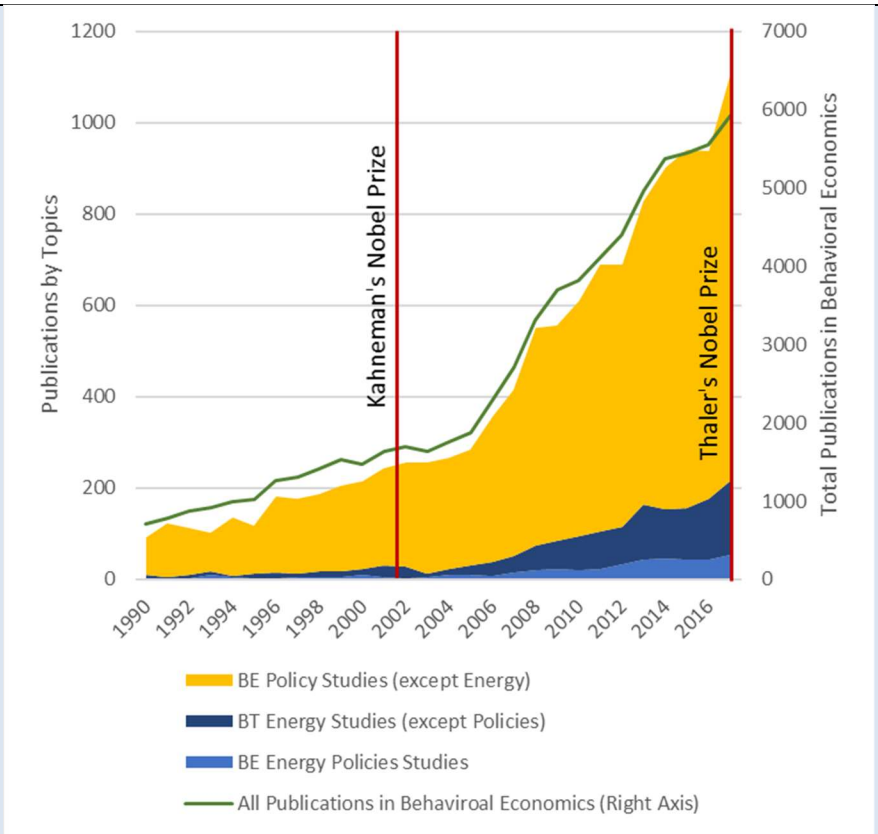

Figure 1. Evolution of Behavioral Economics Publications by area of interest[5], 1990 - 2017

Source: Own elaboration using Elsevier's Scopus data

The design of public policy must consider behavioral bias both in the case of final consumers and for the case of stakeholders and organizations (in firms and regulatory agencies).

2 The use of Behavioral Economics in the design of Policy Solutions

The use of BE tools is appealing for policy makers because (i) it respects consumer's free choice (which is central in a liberal society) by (often) inducing a change in behavior simply by changing the way information is conveyed; (ii) it is associated with low cost interventions usually associated with sending a letter or changing a sign; and (iii) it can be a key element to overcome the barriers

[5] Filtered by Economics and Decision Theory publications in peer-reviewed journals. Only articles that explicitly use "Behavior" or "Behavioral" (in U.S. or British spelling) are accounted. Scopus curates from over 5,000 publishers worldwide.

that traditional pricing policies usually encounter. There is huge potential to systematically incorporate BE in the design of public policy.

Madrian (2014) suggests at least three substantive insights that come from reviewing the BE literature for public policy applied to consumers: (i) the psychological biases of consumer can generate market inefficiencies beyond the traditional taxonomy of market failures; (ii) the effectiveness of traditional policy tools may be impacted by psychological considerations, and; (iii) an understanding of psychology can expand the scope of policy tools.

2.1 Examples of consumer's behavioral biases and solutions available

Thaler and Sunstein (2008) identify the behavioral biases that explain why quotidian decisions are not derived from utility maximization. In Box 2 we grouped them in a set of the most studied in the context of energy policy.

BOX 2: BEHAVIORAL BIASES APPLIED TO ENERGY USAGE	
Behavioral bias	**Possible interventions**
I.Framing [6] : drawing different conclusions depending on how information is presented	Use positive framing when referring to self-other: refer to benefits to oneself and others (Loroz, 2007).
II.Cognitive overload/Satisficing and Bounded rationality [7]: exert efforts to reach a satisfactory outcome instead of the optimal one	Making desired actions easier and quicker using new technologies. Reduce perceived uncertainty by making people try the desired action in a risk-less environment. Information and incentives are more motivating if they come from a trustworthy source (Craig and McCann, 1978).
III.Status quo,[8] inertia[9] and anchoring: resisting change or deferring making a decision, even if an alternative behavior yields better outcomes. Also using anchored knowledge when deciding on a new mater by only slightly adjusting behavior	Thaler and Sunstein show that anchor designing can be a way to push (or nudge) decision towards the optimal direction. Set defaults like washing machines in short cycle or house heaters in off during the night. Encourage behavioral change when a life change happens like moving houses. Anchoring energy conservation during midday, for example.

[6] See also Kahneman and Tversky (1979).
[7] See also Thaler and Shefrin (1981)
[8] See also Tversky and Kahneman (1974)
[9] See Hartman and Doane (1991), Madrian (2001) and Brown (2001).

IV.Sunk cost effect: irrationally fixated on recovering losses already incurred	Frame messages to reduce saliency of costs already incurred in non-efficient equipment. Provide information on future returns on investment in efficient equipment. Cash-back bonuses for upgrading appliances may be more efficient than month to month incentives after appliances have been upgraded.
V.Present bias[10], Temporal discounting and spacial discounting: perceive things as less valuable if further away in time or space	Different techniques to both increase the saliency of future payoffs and making people visualize more vividly their future self can be applied. Consider immediate intrinsic rewards like praise or extrinsic like gifts.
VI.Loss aversion: • weighing losses more heavily than equal sized gains • more willing to take engage in risk behavior if to avoid certain loss than to get an equally size gain	Frame energy-conservation messages in terms of cost and loss avoidance when referring to one-self.
VII.Social norms, comparison and reciprocity: people are influenced by the behavior of others	Compare a household consumption with that of their neighbors focusing on positive norms (Allcott, 2011). Frame energy savings as socially desirable, more so with immediate social groups (Goldstein et al. 2008) and including reinforcement mechanisms (like a smiley) to avoid rebound effects. Make collective achievements more salient, showing that no neighbors are free riding, for example. This effect is stronger when individual motivation is low (Schultz, 2013). Respond to other people's actions with the same action (Fehr and Gachter, 2000). Andor and Fels (2018) show that social comparison produces between 1.2% and 30% reduction in energy consumption as compared with a control group. A caveat is that larger samples find smaller effects.
VIII.Availability heuristics and saliency: likelihood of events is assessed	Messages should include examples of actions that are easily available in consumer's memories because they are recent, frequent or because they are emotionally salient like testimonials in the media.

[10] According to Allcott (2016) six main internalities are responsible for individual mistakes: present bias, biased beliefs, bias toward concentration, costly information acquisition, exogenous inattention, and endogenous inattention.

considering the most readily available events in memory	Gilbert and Zivin (2014) find a reduction in consumption between 0.6 and 1% of the average daily consumption in the first week after receiving the bill.
IX.Intrinsic motivation: people may respond negatively to extrinsic motivations (like monetary incentives) if the intrinsic motivation is high	In-kind gifts and praise can prove more powerful than sole financial incentives to induce sustained change in behavior.

Source: Sanin (2019)

2.2 Steps to include BE tools in policies

The first question that need to be answered before thinking about using BE as a policy tool is: is consumers behavior aligned with economic incentives? If they are, behavior is perfectly rational, and policy should focus on designing economic incentives properly. Myers and Souza (2018) show that behavior interventions without price incentives alignment have small or no effects.

Instead, if consumer behavior is not aligned with economic incentives, there is room for using BE to design policy interventions. Similarly, BE can be used in organizations and among policymakers to improve performance. Similarly, BE can be used in organizations and among policy makers (see Section 4). Figure 2 shows the three sequential steps that need to be followed to apply BE to policymaking.

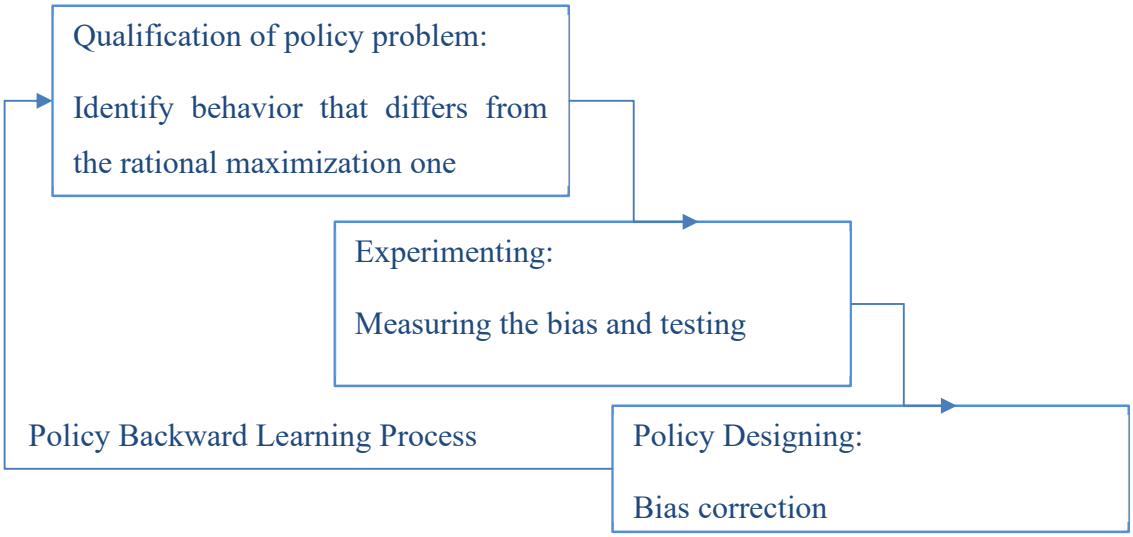

Figure 2. A 3-step framework for desinging BE intervetions

Source: Own elaboration

The first step consists in qualifying the policy problem. Beyond assessing the effectiveness of policies in terms of achieving the expected goals, policy makers should aim at identifying and analyzing the elements leading to the observed outcomes (Gunn, Mullen and Ryle, 2012). Consequently, the first step consists in understanding whether a behavioral bias exists or if the unexpected outcome is due to an economic instrument that is not well designed. Once the behavioral bias is identified it is important to understand which of the biases in Box 2 is explaining the behavior.

The second step is to measure the bias of agents and to test which intervention could correct the bias. This step consists of behavioral experiments (in real life or in a lab) to identify how agents take decisions in different scenarios. Such experiments allow to measure the bias and to test how changes in the way information is disclosed as well as other nudges and behavioral tools may impact agent decisions.

Third step is the policy design. In this final step, policymakers – now aware of the biases – can re-design policies so that they can have the expected result. New biases can emerge from policy adaptation. Policymakers should continuously learn and review policies in order to adjust them to the new environment.

BOX 3: DESIGNING A BEHAVIORAL EXPERIMENT IN A NUTSHELL

RANDOMIZED CONTROL TRIALS (RCT) – in real life

The measurement of the impact that a policy intervention has in correcting a behavioral bias builds on the difference-in-difference methodology typically used for policy impact evaluation. The methodology measures the change that can be attributed to an intervention, which involves counterfactual analysis, i.e. measuring what happened as compared to what would have happened in the absence of an intervention. To this end the intervention is organized as a controlled trial where a group of households that share socioeconomic characteristics are randomly[11] divided in two groups: treatment, who receive the policy intervention and control, serving as the counterfactual group for the treatment and receiving intervention. This is generally made possible in the energy context by the fact that building infrastructure takes time and therefore the first people served by the new infrastructure (like the installation of smart meters) will be treated before. The people that wait for the infrastructure can therefore serve as a control.

Since both groups share socioeconomic characteristics, we expect them to react in the same way. This ensures that the different outcomes in several chosen indicators can be attributed to the policy.

In a few equations this type of study is organized as follows:

$$\text{Intervention} = a_1 + b_1 * \text{Treatment} + X' * c_1 + e_1 \quad \text{(A)}$$

$$\text{Consumption} = a_2 + b_2 * \text{Estimated Intervention} + X' * c_2 + e_2 \quad \text{(B)}$$

$$\text{Consumption} = a_3 + b_3 * \text{Treatment} + X' * c_3 + e_3 \cdot \quad \text{(C)}$$

where X is a matrix of controls that may influence consumers. The parameter b_3 shows the importance of the intervention, usually called in the literature Intention to Treat *(ITT*). The parameter b_2 shows the impact in households who change behavior due to the policy implemented, usually called Treatment on the Treated *(TOT*).

The difference in terms of the chosen indicators are usually considered the benefits of the policy and are compared with the costs of the intervention in a rigorous cost-benefit analysis (see Sunstein, 2018 for a general account of the interest in performing cost-benefit analysis).

BEHAVIORAL GAMES – in the lab

The methodology just mentioned is used but, in a classroom. People with similar socioeconomic characteristics are randomly selected in a treatment group and in a control group. Several instructions are given to each group to explain the rules of the game where some receive treatment instructions while others don't. Outcomes depending on alternative behavior are measure and the outcomes due to alternative behavior are measured after a few trials or iterations.

[11] If the treatment cannot be chosen randomly, we call the experiment a pseudo-experiment

3 Behavioral Economics as a design tool for energy policy: key findings

Overall, Behavioral Economics has been applied to three areas of energy policy: (i) reducing energy consumption and creating conservation habits; (ii) promoting the investment in energy efficient equipment, and (iii) supporting pro-environmental behavior by increasing the provision of public goods (Pollitt and Shaorshadze, 2011). Interventions can be applied to tackle these areas separately or together.

Regarding the type of instrument used to correct for the behavioral bias as detailed in Box 2, BE interventions can be grouped in:

Strategies that provide information (or lower the cost of acquiring it) as:

a. Making it easier for the consumer to understand their consumption[12] (bias II), underlying peak consumption over the day or over the month (bias III and VIII)
b. Audits to make more salient appliance consumption of energy
c. Explaining future benefits of buying more efficient appliances (bias IV and VI)

Motivational strategies (usually referred to as "nudges and framing") as:

d. Promoting social comparison or appealing to social norms (Nolan et al., 2008) by increasing the moral cost of those who consume more than average energy or for those who save less that others do (bias VII). This is usually also accompanied by making salient the health impact of pollution or the climate change impact.
e. Promoting a positive formulation (or positive framing) when talking about the self or the future self (bias I)
f. Promoting the intrinsic motivation like using in-kind gifts (bias IX).[13]

Numerous interventions could be cited to illustrate the use of the previous, mostly combining more than one. Herein we will select only a few of them to present the frontier of knowledge on the

[12] This applies for example to a change in the tariff structure that has no pecuniary impact but makes consumption per period more salient (Brutscher, 2011).
[13] Refunds or other premium method may replace pro-social reasons or intrinsic motivation as shown in Bowles, 2016.

matter with a focus on policy design. Additionally, the previous strategies to tackle behavioral biases are usually used together with incentive reforms to ensure that such incentive reforms have the expected result (see for example Delmas et al. 2013 for a review on the impact that BE interventions may have when use together with incentive reform).

3.1 Strategies that provide information

The objective of this type of interventions is to make consumption more salient to attract the consumer's attention to it, promoting rational utility maximization. This can be done mainly by providing more information using different strategies in terms of reach (apps, mailing lists, letters or information in the electricity bill), possibly in short intervals to break inertia and creating new energy consumption habits. It will most surely also be design accounting for motivational strategies like framing (e.g. using positive wording to be more appealing) or comparison with other consumers if tackling social norms. Herein we summarize some of the most used.

3.1.1 Devices to disclose/underline consumption information

Within this first group of strategies that provide information on own consumption, there are several studies on the effect of incorporating devices in the home with a screen where own consumption is provided in real time. According to Gilbert and Zivin (2014), these devices promote more efficient consumption by making prices and quantities more salient, because they lower the cost of understanding consumption (Jessoe and Rapson, 2014) and are vehicles for "nudges".

Gilbert and Zivin (2014) show that the arrival of the invoice produces the same pattern of behavior as a message: households reduce consumption between 0.6% and 1% of the average daily consumption in the first week after they receive the bill. They even observe a small decrease at 20 days after the invoice arrived (when it expires). This effect is like the one produced by sending energy consumption reports to households, something that has been well studied by the association of the OPOWER consultancy with several electricity companies in the USA (Asensio and Dalmas, 2016, Allcott, 2011, Allcott and Rogers, 2014 and List et al., 2017). Ito et al. (2018) found that messages with moral persuasion also exhibit "habituation" (decrease in consumption over time) but also "cessation" (treatment effect fade out after some repetitions). They suggest to restart the behavioral intervention after a period of pause to overcome such cessation.

With respect to strategies that provide advice for energy savings[14], this information can be provided through the screen within the home, internet pages, letters to the home or on the invoice itself. Alcott and Rogers (2014) argue that this type of intervention can be effective because it is a signal that puts the focus on energy consumption, reminding households to turn off the lights, regulate the thermostat and even invest in efficient appliances. The evidence shows that, in those cases where information is provided through physical mail, when the letter arrives, the decrease in consumption is greater than a few days later. There is also "action and regression": after some time households go back to previous consumption. This study also shows evidence that this cycle of "action and regression" decreases in amplitude if regular mail is sent fostering "habituation". In this same vein, Abrahamse et al. (2005) conclude that providing information to households has an effect on energy conservation, but they are rather short-lived.

3.1.2 Tools to disclose scarcity information: rate structure

The price elasticity of energy consumption *per se* is low but, as previously shown, it increases with information / saliency of price and consumption (Allcott, 2016, Jessoe and Rapson, 2014). Additionally, households seem to use heuristic rules to consume energy: they respond to price increases of one hour, but do not respond very differently to different increases (Gillan, 2017). This means that automatic shutdown of appliances during peak price hours produces reductions in consumption but is not very sensitive to the size of the price differential. Automatization reduces household's optimization efforts but does not eliminate lack of attention that households give to relative prices.

Allcott (2011) evaluated the first real time pricing (RTP) experience in the United States: the Energy-Smart Pricing Plan in Chicago implemented since 2003. A number of 693 households self-selected into the intervention (which defines this as a pseudo experiment with selection bias). They were divided between treatment and control group randomly. The paper finds that households who enroll in RTP are significantly elastic to price but with a low elasticity in absolute value. Moreover, the intervened households reduced consumption during peak hours but without smoothing demand

[14] This also applies to information on own consumption compared to neighbors.

towards off-peak periods. Finally, the paper found that households that received more information (in their case by using a price light that changed color according to real time price) were more elastic. In other words, is not the price variation that makes the difference but the way in which the information regarding the price is transmitted.

Delmas et al (2013) metanalysis finds that the greater effect of energy saving is observed in studies of audits to households (13.5%), followed by social comparisons (11.5%). On the other hand, the latter (as well as interventions that include advice on energy savings and feedback on own consumption) is not significant in the meta regression. Indeed, this paper finds that audits are the second most statistically significant and largest effect in general.

3.2 Motivational Strategies

3.2.1 Social Norms

Andor and Fels (2018), review the literature on social comparison. They conclude that in general social comparison produces energy savings of between 1.2% and 30% with respect to the control group. However, there is a boomerang effect: social comparison increases consumption in homes that consume little as well as in those households that overestimate their consumption. The great gap between 12% and 30% is attributed to the mechanism by which the social comparison is transmitted. Comparisons through emails, online or in-home-displays (IHD) are more effective than letters, even if there is still little literature on the influence of IHD on consumption. Another point is that studies with larger samples (more than 80,000 households) find smaller effects (2%). Finally, studies find that social comparison increases the effect of other treatments when added to them.

With respect to mechanisms for recruiting households in energy saving programs, randomized controlled trials teach us that voluntary participation through remote control (of air conditioning) increases with the observability of the decision to participate by the neighbors (Yoeli et al., 2013). This is explained by the effect of reputation and indirect reciprocity. The effect is stronger in neighborhoods where interaction between neighbors is strong and in those neighbors that receive a letter of invitation to adhere to the program underlining the contribution to a public good. Delmas

and Lessem (2014) find a similar result. Some time back, Moskovitz (1992) argued that customers would voluntarily sign up and pay higher electricity rates if the additional money collected were earmarked to support renewable energy projects and environmental activities.

Households also accept participation in energy audit programs of energy companies (audits that identify opportunities to lower consumption) the lower the cost of the audit and when households receive energy consumption reports that compare them with neighbors (LaRiviere, et al., 2014). With respect to compensation for remote control of electric power or of certain appliances within the home, Broberg and Persson (2016) conduct a choice experiment and find that households should be compensated with a higher amount when control is higher (all electric power *versus* only heating), in peak hours *versus* valley hours, but less if it is only in the cases of extreme events.

An interesting result is that of Tiefenbeck et al (2013), who find evidence of "moral licensing" with a social comparison treatment. This means that the effect of social comparison is clear in the short run but its implications for the long run are still to be better assessed.

3.2.2 Framing and intrinsic motivation

Delmas et al. (2013) find that monetary incentives can "backfire", that is, increases consumption, if not designed properly and with careful behavior considerations. This is because they may decrease intrinsic motivation. All the interventions reviewed in this Section 3 use principles of framing in their design, in general using positive wording to promote behavior or negative wording to underline a loss (in this case the policy wishes to appeal to the loss aversion bias).

In the next section we show a specific application of an intervention where the way the message is conceived (framing) impact the outcome.

4 Using BE to improve institutional and organizational design: an experiment with Energy Regulators in Latin America and the Caribbean

Institutions are constituted by human beings, who are biased. Nonetheless, there is little evidence on how to deal with this challenge. From Institutional and Organizational Economics, we know that the routines associated with the decision process generate institutional path dependence.

Understating the dynamic of institutions and the challenges to include innovation in their decision process is crucial for policy makers[15].

The OECD's Behavioral Insights and Public Policy Report (2017) suggests that behavioral practitioners in public policy should: (i) consider applications of behavioral insights to the formal rules and practices that govern the work of public organizations to strengthen their effectiveness; (ii) promote consistency in the organization, methodologies, quality controls and capacity support functions of the different behavioral initiatives; (iii) encourage the development of knowledge and capacity among public officials; (iv) take into consideration behavioral insights when designing and evaluating policy implementation; and (v) develop processes to determine when there is a behavioral issue that can be successfully addressed through the application of behavioral science.

Although behavioral economics has analyzed the realistic behavior of market participants in experiments and randomized field trials, it has done less so about the realistic behavior of regulators and how this impacts policy and institutional design. The analysis of departures from full rationality of other public decision makers (judges, medical doctors, sports referees, development professionals –see for example Franck et al., 2017, and World Bank, 2015) provides plenty of methodological inspiration.

Chetty (2015) lays the foundations of a pragmatic approach to use behavioral insights to develop new policy tools that consider framing effects and other departures from the rationality assumptions traditionally used in economics. Results from experiments can help to design such tools.

The general objectives that can be potentially addressed with experiments with regulators include:

(i) to analyze to what extent the behavior of regulators departs from the assumption of full rationality, both in a "positive" way (social norms, intrinsic preferences), and in a "negative" way (expert biases);

(ii) to compare the departures from full rationality of regulators with the departures from full rationality of other subjects, such as market participants, students or other professional experts;

[15] Vazquez and Hallack (2018a) and Vazquez, Hallack, Perez (2018) built dynamic models to simulate changes in policymaker's decisions based on observed result of the industry.

(iii) to use these insights to develop proposals towards second generation commitment devices that help develop regulatory institutions in a variety of sectors, especially those subject to technological change and environmental pressure.

Well-designed experiments can test hypotheses like the following:

(a) regulators are as affected in general by departures from full rationality as any other subject (as shown in previous research summarized by Frechette, 2015), and these departures have a significant impact in their decisions;

(b) regulatory reforms can help mitigate those departures from full rationality that are negative for welfare and build on those departures (such as social norms or intrinsic preferences) that have a positive impact.

A framing experiment seems a good place to start with regulators, because it is now a standard practice in the literature. It also offers a desirable "neutrality" characteristic: the possibility of labelling choices both as good and bad behavior, so that subjects are not under the impression that the people running the experiment are trying to catch them behaving inappropriately.

Trillas (2016) summarizes the research that studies the behavioral biases for regulators. He suggests lines of future work that include the, until now unexplored venue of conducting laboratory experiments with real regulators.

Andreoni (1995) presents a framing experiment that can be easily replicated in this case. It builds on the insight that subjects seem to cooperate more when a social dilemma problem is framed as the possibility of creating a positive externality, than when it is framed as the possibility of avoiding a negative externality, even when the two problems have the same material payoffs.

Framing effects are a general form of departure from full rationality, as many other departures can be interpreted as a form of framing. Since framing experiments have been conducted with a variety of populations and more can be conducted in the future, energy regulators will be compared with other professionals (development professionals, arbitrators, judges, sports referees, medical doctors) and with student subjects.

In this line, during the ARIAE meeting organized by the Interamerican Development Bank in Washington DC on September 27th and 28th, 2018 we conducted this type of experiment with Energy Regulators from the Latin America and the Caribbean Region.

The number of participants in the experiment was 24 and the experiments had a duration of approximately one hour at the end of the first day of the meeting. The morning after preliminary results were discussed with the participants.

The objective of the experiment was to verify if the people who participate in a professional event in the energy sector respond to the traditional assumptions of rationality used in economic theory. We wanted to verify if they show cooperative behavior, if they are affected by context effects ("framing") and if the way they are affected is different from a non-expert group.

Participants where given 60 monetary units or tokens per round during 6 rounds. Each round each participant has to choose whether to contribute to a public good or not, simultaneously with an unknown partner that changes each round (no signaling possible). At the end of each round each player knows his earnings. Half of the participants had to make the decision under a positive framing while the other half has a negative framing, under the same payoffs.

The difference in framing was formulated as follows.

$$\text{Pay-off}_{\text{Positive}} = X + 0.8\,(G1 + G2) \qquad (1)$$

$$\text{Pay-off}_{\text{Negative}} = Y + 0.8G2 + 0.8\,(60-X) = Y + 0.8G2 + 48-0.8X \qquad (2)$$

where X, Y and the investments in the individual fund and G1 and G2 are the investments in the public fund. A player under positive framing decides X and G1 and a player under negative framing decides Y and G2, and by his partner.
The objective function in (1) has the same payoffs as the objective function in (2) given that G2 = 60-Y if an endowment of 60 monetary units is available. Equation (1) shows a positive "framing" (investing in the public fund exerts a positive externality on others) and is equivalent in terms of the payoff to the negative "framing" in (2) (investing in the individual fund exerts a negative externality on others).

According to the traditional rationality assumptions in economics,

i) the dominant strategy is not to invest anything in the public fund, and
ii) different "framing" should not affect the behavior of subjects.

The total gain on average after 6 periods of a person subjected to a positive framing was 461.4, whereas the total gain on average after 6 periods of a person subjected to a negative framing was 439.

If each player had used his dominant strategy by investing everything in the individual fund, her earnings would have been 360 (60 times 6). All players achieved superior gains. If each player had used the strategy that maximizes the joint profits (of the couple) by investing only in the common fund, their earnings would have been 576 (0.8 times 120 times 6). Nobody reached those high earnings.

Additionally, in a questionnaire, the subjects under the positive framing had to judge the degree of justice of raising prices by 3% with an inflation of 5%, and those of the negative framing the same with respect to lowering prices by 2% with inflation of 0%. No differences were observed in relation with this framing experiment.

Although we conclude that on average subjects under a positive framing contribute more, the more cooperative subjects were concentrated in a sub-group.[16] An obvious limitation of this experiment is that the number of participants was restricted to 24.

Another limitation is the absence of extrinsic incentives (there was no form of remuneration). Lessons for future work include the difficulties in controlling the conditions of the experiment in a professional event as compared to an experiment with students at University (6 people who in some cases know each other by sharing a table at the end of a day of work in a noisy room). Enhanced conditions for experiments with regulators, besides the possibility of remunerating subjects, can include the use of technology (computers or smart phones) and the adaptation of experiment instructions to a specific regulatory context.

Knowing the factors that affect the decision-making of professionals in the energy sector regarding their capacity for cooperation, can help to design new public policy tools and institutions.

[16] The difference was mostly due to the high profits of one of the two tables of 6 people in which the people subjected to a positive framing sat during the experiment. The other table had gains even slightly below the people subjected to the negative framing.

5 Conclusions

Behavioral Economics (BE) helps policymakers to identify (i) **why** the economic incentives are failing to have the expected impact in behavior, (ii) **what** is the behavioral reason explaining the gap between the expected outcome and the realized one, and (iii) **how** to adapt policy to take this into account and to nudge people in the right direction. Additionally, BE interventions are usually based on information and motivational interventions that have a very low cost (like the cost of sending a letter or a message in an app) and, when they go together with other incentives reform, results can be quite important (Delmas et al. 2013).

The energy sector is facing several new challenges like the use of new technologies, the changing roles of agents and the creation of new services. The design of policies that properly identify the **why**, the **what**, and the **how** is probably the only way to proceed in such a changing environment.

The studies that we have reviewed concerning BE interventions in the Energy Sector can be summarized in the following key messages:

1. Increasing saliency of prices and of efficiency in appliances has a significant impact even if the impact's amount is small and are worth exploring given their low cost of implementation.
2. For BE interventions to have long term impacts the interventions need to progressively incorporate new information and be repeated through time to generate habituation.
3. The largest energy efficiency impacts have been found in auditing interventions where households receive information regarding appliance consumption as well as a plan to reduce consumption of electricity.

More research is needed in this direction to explore the full potential of BE in a context of behavioral change in the Energy Sector given the rise of prosumers and behind-the-meter activity in general.

Regarding behavioral biases among energy experts and regulators, we find that biases are also present in this group since their behavior is not predicted by maximizing their payoffs as traditional economics would do. Additionally, we find that, as consumers, they are influenced by positive framing. Future experiments may address the professional biases of regulators or energy professionals (engineers, economists, lawyers…) and how different professional biases

interact with heterogeneous biases (see Salganik, 2018) of market participants, both to influence their consumption decisions and to influence their perception about the seriousness of climate change and other problems as voters and citizens demanding policies in regulated industries.

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