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The Use of Green Nudges as an Environmental Policy Instrument

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Abstract

This article discusses the use of green nudges – behavioral interventions aimed at reducing negative externalities – as an environmental policy instrument. We present a new framework for classifying nudges according to how they affect behavior. Pure nudges change the choice environment to guide behavior unobtrusively. Moral nudges trigger a psychological reaction to encourage behavior change. Our review of empirical studies reveals that green nudges, pure or moral, can have a significant impact on behavior and the environment but that the effects are highly context dependent. Based on both our review and basic welfare economics models, we discuss key factors for policymakers to consider when choosing between implementing a green nudge and implementing conventional policy instruments.

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INTRODUCTION

Behavioral interventions, most notably in the form of nudges, are rapidly becoming part of the policymaker's toolkit. A nudge is defined in economics as a change in the decision environment that influences people's behavior without prohibiting any choices or significantly changing the economic incentives (Thaler and Sunstein, 2009). Nudges are intended to counteract poor choices made by individuals in areas such as personal savings and health (e.g., encouraging individuals to save more or to eat healthier). Thus, nudges aim to improve an individual's welfare rather than address externalities, even though poor individual choices can also create negative externalities, such as rising health care costs. If well designed, a nudge "[…] creates large benefits for those who make errors, while imposing little or no harm on those who are fully rational" (Camerer et al., 2003). By this definition, nudges are a behavioral solution to a behavioral problem.

The concept of nudging has also found its way into environmental policy, with nudges influencing people's behavior to reduce negative externalities such as waste and resource use. In this context, nudging is a behavioral solution to a conventional economic problem (i.e., negative externalities). To distinguish between a nudge that improves the welfare of the individual herself and a nudge that reduces a negative environmental externality, we will refer to the latter as a green nudge.

In this article, we present a new, simple framework for classifying nudges, review empirical field studies that test green nudges, and, based on the findings of these studies, discuss the potential for green nudges to serve as an environmental policy instrument. In particular, we consider when green nudges can and should be used as substitutes or complements to standard policy instruments such as a tax on emissions. Thus, the discussions and findings we will present here are intended to provide a basis for policymakers to determine when and whether a green nudge is a suitable policy instrument.
FRAMEWORK FOR CLASSIFYING PUBLIC POLICY INTERVENTIONS

In this section, we present a novel framework for classifying public policy interventions according to the problem they target (the “why”) and the type of intervention (the “how”).\(^1\) As shown in Table 1, the first part of the framework (“Why?”) distinguishes between possible reasons for interventions: conventional economic problems, such as market failures and externalities, and behavioral economic problems, such as predictable mistakes in decision-making created by internalities and bounded rationality. The second part of the framework (“How?”) distinguishes between types of interventions, such as conventional economic taxes and behavioral economic nudges. The interventions in box A -- conventional policy instruments to address conventional economic problems (i.e., Pigovian taxes, tradeable permits, command-and-control measures, information programs) -- and box D -- classic, self-focused nudges to correct for behavioral mistakes -- are well-known elements of the policy maker’s toolkit.\(^2\) Box B includes conventional policy instruments that account for the fact that people may not be fully rational and attentive when making choices, such as a tax that accounts for limited attention to prices (Farhi and Gabaix, 2019) or biased, incorrect perceptions of the consequences of a behavior (Madrian, 2014).

In this article, we focus on Box C in Table 1 -- green nudges. Green nudges are behavioral interventions aimed at reducing negative externalities. This means that the reason for such interventions is conventional, but the type of intervention is behavioral. It is important to note that a green nudge does not aim to correct a mistake in the individual’s decision-making (which is the case for the self-focused nudges in box D). Instead, it relies on people’s cognitive biases and moral concerns about their impact on the environment to "nudge" them away from making

\(^1\) Our classification is inspired by the classification of policy instruments in Loewenstein and Chater (2017).
\(^2\) For details on conventional policy instruments see Sterner and Coria (2012) and for an introduction to behavioral economics Camerer et al. (2003).
choices that create negative externalities. Thus, it is the reason for the nudging that distinguishes self-focused nudges from green nudges. In other words, does the nudge help individuals overcome their decision-making errors or does it aim to reduce externalities?3

We extend our framework by classifying self-focused and green nudges into two categories: pure nudges and moral nudges. These categories are essential for estimating the welfare effects of nudging policies.

Table 1. Overview of interventions by reason and type

<table>
<thead>
<tr>
<th>Why?</th>
<th>Type of Intervention</th>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conventional Economics</td>
<td>Behavioral Economics</td>
</tr>
<tr>
<td></td>
<td>A. Externality-correcting taxes, tradeable permits, command and control, information</td>
<td>C. Green nudge: pure and moral</td>
</tr>
<tr>
<td>Conventional Economic Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(externalities, public goods, common-pool resources, asymmetric information)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral Economic Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(internalities, bounded rationality)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Internality-correcting taxes, regulation, Information</td>
<td>D. Self-focused nudge: pure and moral</td>
<td></td>
</tr>
</tbody>
</table>

**Pure Nudges**

A pure nudge is a behavioral intervention that aims to makes it easier for the individual to "do the right thing." Examples are putting healthy foods at the top of a menu to make them more noticeable or automatically enrolling employees in an employer-matched savings plan. While

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3 This also means that green nudges are not motivated by paternalism, thus avoiding the criticism that self-focused nudges are often subject to (e.g. Sugden 2018; Sunstein and Thaler, 2003). However, there may still be ethical objections regarding the government’s exploitation of people’s behavioral biases, regardless of the overall objective.
both self-focused and green pure nudges make subtle adjustments to the pre-existing choice environment to affect behavior, they differ in their desired outcome. A *self-focused* pure nudge is designed to counteract decision-making errors such as inattention or self-control problems/laziness that lead to undesirable outcomes for individuals. In contrast, a *green* pure nudge does not assume that people make errors in their decisions; instead it uses limitations in their decision-making to nudge their behavior towards a socially desirable behavior that may or may not be in the individual's self-interest. For example, an individual might decide not to sign-up for a green electricity tariff, but when defaulted into a green tariff by their provider, their inattention or laziness might prevent them from switching back, even though this was their original choice.

Because pure nudges usually work through rearranging the existing choice environment, it is often impossible *not* to nudge behavior. The nudge may simply be unintentional. To illustrate, consider a menu that first presents the healthy food and then the unhealthy food. This order will nudge customers towards the healthy food by making it more salient. The reverse order will nudge individuals towards unhealthy food by making that choice more salient.

**Moral Nudges**

While pure nudges simply make it easier to "do the right thing," moral nudges actually reward people for "doing the right thing" through psychological utility. More specifically, moral nudges intentionally trigger psychological reactions such as fun, fear, shame, or pride. The most prominent moral nudge is the use of social proof—"9 out of 10 people in your city pay their taxes on time—you are currently not one of them" (Hallsworth et al., 2017) or "Compared to your neighbors with similar sized houses, you consume far more energy" (Allcott, 2011). Both of these examples are green nudges, primarily targeting an externality, which is also their most common use. However, if a moral nudge is used to encourage a behavior that mainly benefits
the one being nudged, such as exercise (Butera et al., 2019) or increased savings (Beshears et al., 2015), we classify it as a *self-focused* moral nudge.

Because moral nudges trigger a conscious psychological response from the individual being nudged, they are more prone to backlash or a boomerang effect than pure nudges, either because the intended behavior is not in line with the preferences of the individual or because the individual objects to being nudged at all. For the same reason, moral nudges risk wearing off more quickly than pure nudges, which usually remain unnoticed.

**EMPIRICAL FIELD STUDIES OF GREEN NUDGES**

In this section, we discuss the empirical evidence concerning green nudges and their potential impacts on behavior, focusing on field experiments that measure behavioral outcomes. First, we summarize all studies on pure green nudges. Then we summarize the studies on moral green nudges. We conclude by summarizing the main lessons from the literature.

**Pure Green Nudges**

We discuss pure green nudges by their type: defaults, provision and simplification of information, changes to the physical environment, and reminders.

*Defaults*

The *default effect* refers to the tendency of people to remain with an alternative already chosen by someone else, even when the cost of making their own active choice is very small (Johnson and Goldstein, 2003). The most well-known example of such prosocial default effects is that the percentage of people who are willing to donate their organs is substantially higher in countries where people are organ donors by default (Johnson and Goldstein, 2003). Sunstein and Reisch (2013) identify three principal ways in which defaults may influence behavior. First,

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4 See Appendix Table 1 for a list of the studies of green nudges published in peer-reviewed journals that we discuss here.
people may interpret the default as a recommendation from someone – an expert or a policymaker – who has additional information that justifies the default option. Thus, setting a default can lower the decision costs for some individuals. Second, people may avoid deciding altogether, which means that providing a default choice may cause them to move from no decision to the pre-set (i.e., default) decision. Finally, loss aversion or status quo bias may contribute to a default effect because many individuals will evaluate available options relative to the default.

A few studies have examined default effects and environmentally-friendly behavior. For example, Egebark and Ekström (2016) found a default effect for computer printing behavior: when the default printer setting was changed from single-sided to double-sided, the consumption of printer paper dropped by about 15 percent, and there was no evidence of a decline in this effect 28 weeks after the change. Pichert and Katsikopoulos (2008) found that many German electricity consumers choose an environmentally-friendly electricity option if it is the default option. Ebeling and Lotz (2015) compared the green energy choices of "opt-in" and "opt-out" customer groups. They found that only 0.6 percent of the opt-in group purchased a green contract, compared to 5.6 percent for the opt-out group. In Brown et al. (2013), the default temperature on thermostats was changed from the standard 20 °C setting to a lower default setting. They found that a 1-degree decrease resulted in a lower average temperature initially, but the effect disappeared and actually moved in the opposite direction after a few weeks. This suggests that a default may have the greatest impact if it is set close enough to people's actual preferences such that it is not worth moving away from it (Löfgren and Nordblom, 2020), while individuals with strong preferences for an option other than the default may be more likely to override it (Johnson and Goldstein, 2003). However, to date, there is little empirical evidence supporting this hypothesis, partly because it is difficult to measure underlying attitudes and preferences. Finally, Löfgren et al. (2012) conducted a field
experiment with experienced users of carbon offsetting and found no difference in the choice to offset flight emissions between a default to compensate, a default not to compensate, and an active choice setting; the authors concluded that experience reduces default effects, which suggests that the effect of the default is highly contextual and thus should be tested in a pilot study before being implemented.

Provision and simplification of information

If decision-makers are inattentive to some aspects of a decision problem, they will make a decision that is different from what is predicted by conventional economic theory. Chetty, Friedman, and Kroft (2009) found that shoppers pay only limited attention to a sales tax compared to the price before tax. Similarly, Allcott (2011), Allcott and Taubinsky (2015), and Allcott and Knittel (2019) found that consumers pay little attention to fuel and electricity costs when buying cars or lightbulbs, focusing more on the sales prices they face. Paying limited attention to a complex problem is not necessarily irrational, as it takes time and energy that might be better spent on other decisions (Caplin and Dean, 2015). However, provision and simplification of information could nudge decision-making.

Consumer product labels are a primary example of the provision and simplification of information. In a study of electrical retail stores that provided labels containing information on lifetime energy costs of appliances and staff training, Kallbekken, Saelen, and Hermansen (2013) found mixed evidence, with a strong initial effect for only one type of appliance. Other studies have also found mixed results. Stadelmann and Schubert (2018) found that providing both a label and a visually augmented label that contained monetary and lifetime-oriented information on energy efficiency increased the sales proportion of energy-efficient appliances. Allcott and Knittel (2019) found that providing individually tailored information about lifetime fuels cost had no effect on the average fuel economy of vehicles purchased, and Allcott and
Sweeny (2017) found that information provision had no effect on the demand for energy-efficient durable goods. However, the primary purpose of a label is to provide better information to improve choices, which is not a nudge per se. While a label could still address the problem of inattention, it is difficult to determine the size of this effect.\(^5\)

There is also evidence suggesting that the order in which information is presented can affect the salience of the information. For example, Kurz (2018) found that the share of vegetarian dishes sold increased by six percentage points when the menu order was changed so that the vegetarian option was more visible to customers. Gravert and Kurz (2019) found an even larger effect by rearranging a menu in favor of a vegetarian option. Indeed, placing the vegetarian dish at the top of the menu reduced the share of meat dishes ordered from 46 percent to about 21 percent. In Tiefenbeck et al. (2016), real-time feedback on energy use was provided through an animation of a polar bear standing on melting ice. This visual feedback reduced the average shower time by 22 percent. However, they found no lasting effects on shower time once the visual feedback device was turned off.

*Changes to the physical environment*

The physical environment can also be used as a nudge to provide clues about appropriate behavior. For example, Kallbekken and Saelen (2013) examined a green nudge to reduce food waste in buffet restaurants that was provided through the physical environment. They found that providing plates that were almost 50 percent smaller than standard plates had a significant effect, reducing food waste by approximately 20 percent.

Designs of the physical environment are often used to encourage pro-social waste and recycling behavior. Examples of such nudges include the design of waste bins and the footsteps

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\(^5\) For this reason, we do not include studies on the effects of labels in Appendix Table 1.
needed to reach the waste bin. However, there have been few rigorous evaluations of such nudges.

**Reminders**

Reminders, which increase attention to a decision and thus reduce forgetfulness, fall somewhere between pure and moral nudges. Reminders can also impose moral costs if they draw attention to a decision that the decision-maker would rather avoid (Damgaard and Gravert, 2018).

Wallander, Ferraro, and Higgins (2017) examined the effect of reminders on participation in voluntary land conservations programs and found that a reminder sent to participants whose conservation contracts were expiring increased their participation rates. However, subsequent letters that provided peer comparisons and social norms messages did not increase participation. Gilbert and Zivin (2014) found a 0.6–1 percent reduction in hourly electricity consumption following receipt of an electricity bill, which is a type of reminder, but the effect varied considerably across households and seasons. To encourage airline pilots to fly more fuel efficiently, Gosnell, Metcalfe and List (2020) sent reminders that included personalized targets. In the subsequent eight months, the individual target treatments resulted in fuel savings for the airline of 1–10 percent.

**Moral Green Nudges**

We discuss moral green nudges by their type: inter-personal motivations and social comparisons, moral suasion, and goal setting and commitment.

**Inter-personal motivations and social comparisons**

One important driver of human behavior is the desire for success relative to other people. There is extensive empirical evidence that people care about their status and relative consumption (Frank, 1985; Johansson-Stenman, Carlsson, and Daruvala, 2002). Further, Sexton and Sexton
(2014) use the term "conspicuous conservation" to describe consumption that signals pro-environmental action and generates observable green status.

Several studies examine how social information – i.e., information about other people's behavior – affects people's decisions, by nudging them to conform. Cialdini (2003) suggests that the extent to which social information affects behavior depends not only on the information regarding what others actually do (descriptive messages) but also on whether such information conveys approval of certain behavior (injunctive messages).

A series of field experiments on water and energy conservation suggests that the provision of both descriptive and injunctive norm messages often has a statistically significant effect on individuals' behavior to reduce water and electricity use, although the size of the effect varies considerably (e.g., Allcott, 2011; Ferraro, Miranda, and Price, 2011; Ferraro and Price, 2013; Costa and Kahn, 2013; Ayres, Raseman, and Shih, 2013; Bernedo, Ferraro, and Price, 2014; Allcott and Rogers, 2014; Brent et al., 2015; Jaime and Carlsson, 2018). For example, Allcott (2011) found a 2 percent reduction in electricity use, while Ferraro and Price (2013) found a 3–5 percent decrease in water use.

Other studies investigate how social information is communicated. For example, Delmas and Lessem (2014) compared the effects of providing household electricity use information individually in private and providing the information in public to everyone and found that only a combination of private and public information reduced energy use (by 20 percent). Sparkman and Walton (2017) investigated the role of dynamic social norms -- i.e., information on how other people's behavior changes over time -- and found that dynamic norms had stronger effects than static norms.

Empirical evidence on the long-term effects of these types of moral green nudges is still limited. Brandon et al. (2017) showed that 35-55% of the treatment effect of home energy reports continues, even when the treated individuals move out of the house. It makes sense that
a nudge to buy an energy-efficient water heater will continue to affect energy consumption for the next residents. On the intensive margin (i.e., daily energy saving behavior), individuals will need to be "re-nudged," through reminders, for example. Indeed, moral nudges such as social comparisons, reminders, or feedback face the risk of wearing off once an individual has been exposed to them repeatedly, although Allcott and Kessler (2019) found that social norm comparisons have long-term effects on behavior and that households can be re-nudged to continue to save energy.

A related challenge concerning the effect of nudges is whether the behavior in question is actually "nudgeable." If the difference in utility between two options is large, nudges will not work. For example, Holladay et al. (2019) found that while providing social comparisons increases free initial audits for home installations of energy-efficient products, there was no effect on actual purchases. Similarly, Hahn et al. (2016) found that providing social comparisons affects water consumption but does not result in consumers switching to less water-intensive landscaping arrangements. Finally, in a large study in Germany, Andor et al. (2020) found that norm messages had almost no effect on household energy consumption. The authors argue that in places like Germany, there is simply less room for a reduction because the initial energy use level is already low, which means that additional energy consumption reduction would be very costly. This finding is consistent with Ferraro and Price (2013), who found that social comparisons concerning energy consumption had almost double the effect on high-consumption households relative to low-consumption households.

Moral suasion

Moral suasion nudges inform people of the right, moral behavior without explicitly providing social comparisons (e.g., Schultz, 1999; Goldstein, Cialdini, and Griskevicius, 2008). Ito, Ida, and Tanaka (2018) used moral suasion to reduce energy use during peak hours in Japan by
providing some households with the following message: "Substantial energy conservation will be required for the society during critical peak-demand hours in summer and winter." Electricity use was reduced by eight percentage points, compared to a fifteen percentage point reduction when an economic incentive was used. Further, the effect of moral suasion diminished quickly when the message was repeated, while the effect of the economic incentives did not. Egebark and Ekström (2016) found no effects of a moral message aimed at reducing the use of printer paper.

*Goal setting and commitment*

The final category of moral nudges are nudges that prompt individuals to set a goal or make a commitment to undertake a pro-environmental behavior in the future. These nudges work because most individuals gain utility from following through with their plans and promises (Festinger, 1957).

Harding and Hsiaw (2014) examined how voluntary goal-setting concerning electricity savings affected actual electricity use and found that those who set a realistic goal saved more than those who set either a very low or a very high goal. Loock, Staake, and Thiesse (2013) found that both individual and default goals lead to significant energy savings, but that default goals that deviate too much from self-set goals could have a negative impact on energy savings. Kormos, Gifford, and Brown (2015) combined goal-setting with descriptive social norms to influence private vehicle use. They found that goal-setting alone had a small effect on private vehicle use, but the effect increased considerably when goal setting was combined with information on others’ vehicle use.

Nudging people to commit to a behavior is a stronger nudge than prompting them to set goals. For example, in a study by Giné, Karlan and Zinman (2010), smokers who were trying to quit were offered the option of depositing money into an account. If they had successfully quit smoking after six months, they got their money back and a reward. Otherwise, the money
was given to charity. The rate of smoking cessation was approximately 3–6 percentage points higher for those enrolled in the program than for a control group. In Baca-Motes et al. (2013), hotel guests who were asked to commit to behaving more sustainably were more likely to reuse their towels than those who were not asked to make such a commitment. The effect was stronger if guests received a wearable pin, and when the commitment was more specific (e.g., reuse towels) than general (e.g., act in an environmentally friendly way).

**General Lessons from the Literature**

This review of the empirical literature suggests three general lessons. First, the observed effects vary greatly across studies. This could be because the effects are highly context specific, but it could also be that there was no room for behavior change. Second, nudges targeted to whether or not an action is taken (the extensive margin), such as setting green energy tariffs as the default electricity contract, tend to have larger and more permanent effects than those targeted to the extent of the action (the intensive margin), such as social norms for electricity consumption. Third, there has been little study of the long-run effects of green nudges. However, the evidence in the literature reviewed here suggests that effects, especially for moral nudges, decrease over time.

**THE USE OF GREEN NUDGES VERSUS CONVENTIONAL POLICY INSTRUMENTS**

There have been very few empirical studies on the relative effectiveness of conventional policy instruments versus green nudges.⁶ Thus, in this section, we discuss how, in theory, to decide

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⁶ Benartzi et al. (2017) compared a social norm message with discounts of the electricity bill and found that for the nudge, 27.3 kWh was saved per dollar spent on the intervention, while for the discount, the figure was only 3.41 kWh. Nauges and Whittington (2019) compared price instruments and social norm messages and found that the net benefits for society tend to be higher for a price instrument than for a social-information nudge, but that price increases also imply that households would bear most of the costs.
between using a green nudge or a conventional policy. In particular, we discuss criteria based on the models in Carlsson and Johansson-Stenman (2019) and Farhi and Gabaxi (2019). We begin by discussing the use of nudges and their effect on utility in a simplified case of identical individuals with perfect and imperfect taxation. We then expand the discussion to the more realistic case of heterogeneous individuals, including discussing distributional and political economy considerations and crowding out. In particular, we extend the discussion in the literature on the design of conventional instruments (such as taxes and standards) when consumers are characterized by bounded rationality to the case of environmental policy (e.g., Tsvetanov and Segerson, 2013; Allcott, Mullainathan, and Taubinsky, 2014; Heutel, 2015; Farhi and Gabaix, 2019). We conclude with a summary of key factors that policy makers should consider in the design and implementation of green nudges.

**Optimal Nudging Versus Conventional Policy Instruments with Identical Individuals**

To identify when it is optimal to use a nudge, we first consider a simple model with identical individuals and two goods -- one clean and one dirty-- where the dirty good generates a negative environmental externality. The objective of the government is to maximize the sum of utilities; because individuals are identical, this is equivalent to obtaining a Pareto-efficient allocation of the goods. We consider decision utility, as inferred from the individuals' observed choices, as well as experienced utility, which is a measure of the "happiness" derived from a choice.

*Optimal pure nudge with perfect taxes*

In our simple model with identical individuals, when there are no administrative costs or limitations regarding the implementation of a tax, it would never improve welfare to complement the tax with a pure green nudge (Farhi and Gabaix, 2019, Carlsson and Johansson-Stenman-
Stenman, 2019). The pure nudge will only affect decision utility; thus, a perfect Pigovian tax is sufficient to achieve optimal allocation.

*Optimal moral nudge with perfect taxes*

On the other hand, a moral nudge could affect an individual’s moral self-image and, consequently, experienced utility (Allcott and Kessler, 2019; Carlsson and Johansson-Stenman, 2019). Moral utility decreases with consumption of the dirty good. Thus, strengthening the social norm through a moral nudge will have a positive effect on experienced utility if it reinforces the individual’s self-image as a good and responsible person, but its effect on utility is negative if it makes people feel guilty. Moral nudges with positive utility effects are called “moral subsidies” by Allcott and Kessler (2019) and “encouraging nudges” by Carlsson and Johansson-Stenman (2019); moral nudges with negative utility effects are called “moral taxes” and “discouraging nudges,” respectively. The welfare effects of introducing moral green nudges on top of Pigovian taxes are similar to introducing pure green nudges, with the addition of the encouragement or discouragement effect of the moral nudge. This means it may be optimal to introduce encouraging moral green nudges to complement an optimal Pigovian tax, for example, in order to generate a feeling of pride from not consuming much of the dirty good.

How much moral utility would a nudge provide? While there are methods for estimating the effects of a policy intervention on the externality and for calculating administrative costs, methods for estimating an intervention's effect on moral utility are still in their infancy. The literature on this issue includes Allcott and Kessler (2019), who measured the willingness to pay to opt out of social comparisons for energy consumption; Damgaard and Gravert (2018), who identified the annoyance costs of receiving reminders from a mailing list from which individuals have unsubscribed; and Butera et al. (2019), who showed the deadweight loss of a social recognition program by measuring the willingness to pay to opt out. All three studies
found evidence that the moral nudge used to influence behavior imposed disutility on at least some decision-makers in the form of guilt, shame, or annoyance.

*Optimal nudge with imperfect taxes*

Naturally, if the existing tax is too low, or non-existent, a nudge could play a bigger role as a policy tool. If there were no administrative costs related to the level of the nudge, a pure green nudge could be used to complement the tax so that the combination mimics the outcome that would result from an optimal tax. To illustrate, suppose that without any regulation, the prices of both the clean good and the dirty good are 10 USD and that the dirty good generates constant marginal damage of 3 USD per unit consumed. A first-best Pigovian tax would be 3 USD per unit consumed. In the absence of a tax, an optimal nudge should affect decision utility such that the consumption pattern would be the same as if there were a 3 USD tax. The optimal level of the nudge depends on how effective the nudge is in affecting the decision utility, i.e., the *nudgeability* of decision-makers (Gabaix and Farhi, 2019). The larger the nudgeability, the lower the level the nudge needed. If, on the other hand, there were a cost related to the size of the nudge, the level of the optimal nudge would reflect the tradeoff between getting the incentives right and the cost of the nudge.

It is straightforward to generalize the example discussed above to a situation that is characterized by some type of internality, in addition to the externality. For example, suppose that people perceive the initial price of the dirty good to be 8 USD instead of 10 USD (e.g., because they misperceive the associated subsequent energy costs). In this case, the optimal tax is 5 USD -- i.e., the sum of the external cost ($3) and the misperception ($2). Thus, with an optimal tax, there is still no additional role for a nudge. However, if the tax is not set at the optimal level, a pure nudge should be used. In this case, the pure nudge should be set so that the combination of the nudge and the tax mimics the outcome of an optimal tax. With a non-
optimal tax, there is also more room for moral nudges, including discouraging moral nudges. This is because, with a discouraging moral nudge, there is a trade-off between the reduction of the negative external effect and the direct negative effect on moral utility versus the marginal cost of providing the nudge. With an encouraging nudge, there is a trade-off between the reduction of the negative external effect and the direct positive effect on utility vs. the marginal cost of providing the nudge.\(^7\)

**Optimal Nudging Versus Conventional Policy Instruments with Heterogeneous Individuals**

Next we extend the discussion to examine the case where individuals are heterogeneous, in particular when there are differences in the level of externalities generated by individuals or the extent to which individuals suffer from internalities. Another important source of heterogeneity is that individuals can be more or less affected by a nudge. As we will see, this is an additional motivation for using nudges when environmental taxes can target neither externalities nor internalities perfectly. We will also briefly discuss distributional and political economy considerations related to nudges with heterogeneous individuals.

*Using nudges when taxes cannot target externalities perfectly*

Suppose that when consuming the same goods, some individuals generate much larger externalities than others do, but that a tax can only be differentiated at the goods level. Such imperfect externality targeting of a tax is very common. For example, consider gasoline taxation, where the optimal level of a (second-best)\(^8\) tax would be a weighted average of the

\(^7\) Although we have focused on the choice to implement a nudge together with a pre-existing tax, the same type of reasoning applies in the case of a pre-existing tradeable permit system.

\(^8\) Clearly, a gasoline tax cannot result in a first-best allocation because many of the externalities depend on where, when, and how a car is used.
marginal damage caused by car transport (cf. Diamond 1973; Knittel and Sandler 2018). In this case, the gasoline tax will be too high for those individuals causing low externalities and too low for those causing high externalities. However, if it is possible to implement a nudge that reduces driving and targets those who cause large externalities, then it may be optimal to complement an optimal gasoline tax with such a nudge. For example, targeting the nudge to urban areas would reduce traffic where the externalities are large, without affecting traffic in the countryside. An extreme case of imperfect externality targeting is when a tax does not target the end-users. For example, airline pilots often do not have a direct incentive to avoid carbon taxes and hotel guests have no direct incentive to reduce food waste. In such situations, a nudge that targets the end-users could be highly desirable.

Using nudges when taxes cannot target internalities perfectly

Next, we consider a situation in which there is heterogeneity in the misperception of the price of the dirty good. Suppose, for example, that some people underestimate future electricity costs when buying a new refrigerator. This is an internality because these individuals would be making a choice that is not in their best interest. An optimal second-best tax on the refrigerator will be based on the externality plus the weighted average of the misperception of the future cost. This means that the second-best optimal tax will be too high for those without cost misperceptions and too low for those with high cost misperceptions. Thus, there is the potential to have a nudge on top of an optimal tax, if those with a cost misperception would be affected more by the nudge than those without cost misperceptions. For example, the nudge could be targeted towards those age or socio-economic groups where the cost misperceptions are largest.

9 The weights are determined by the derivative of the gasoline demand for the dirty good with respect to the tax.
10 This is presumably small, given that often the electricity price internalizes the electricity externalities through, for example, a tax.
11 The weights are given by the derivative of the demand for the refrigerator with respect to the tax.
One could also design a nudge that reduces inattention and induces all people to more carefully consider future costs.

**Distributional effects of nudges and taxes**

In general, taxes have much larger direct monetary effects than nudges. This can lead to concerns about distributional effects and inequality in society, especially if a tax disproportionally affects low-income individuals. However, while a nudge would have much smaller direct monetary effects, it is not obvious ex-ante that it would be superior to a tax overall. Indeed, a number of studies argue that the efficiency of taxes that target externalities makes up for any societal inequalities they might produce and hence, redistribution should be left to income taxation (see e.g., Boadway and Keen, 1993 and Pirtillä and Tuomala, 1997). While these results do not mean that it is always optimal to delegate equity concerns to an income tax, the welfare effects of the distributional effects of environmental policies tend to be smaller when there are other policy instruments that can address equity issues (see e.g., Johansson-Stenman, 2005) However, even when equity-efficiency separation is possible, political-economy considerations may make it impossible, or at least very difficult, to internalize externalities through taxes, suggesting a potential for nudges as well as other policy instruments. Opposition to raising fuel taxes in many countries is a prime example of such a situation.

**Crowding out and crowding in of intrinsic motivation**

An additional issue that needs to be addressed when choosing optimal nudges in the case of heterogeneous agents is the extent to which economic policy instruments may crowd out intrinsic motivations for environmentally-friendly behavior. However, as argued by Carlsson and Johansson-Stenman (2012), conventional economic policy instruments may crowd in or
crowd out other motivations. Nevertheless, when there is a risk that conventional policy instruments could crowd out intrinsic motivations for pro-social actions, and the expected crowding-out effect of a nudge is expected to be smaller, there could be a role for nudges, in particular nudges that provide moral subsidies and thus strengthen the intrinsic motivation. For example, a subsidy for electric vehicles might crowd out intrinsic motivation to purchase them, while a social norms nudge could strengthen it.

There is little empirical evidence of spillover effects and crowding out by nudges. However, in a study of the effects of a subsidy versus a default enrollment in a pension plan, Chetty et al. (2014) find that the latter is more effective for a majority of inattentive savers, but the subsidy crowds out savings for the minority of savers who are attentive to the subsidy. Jaime and Carlsson (2018) find substantial spillover effects between households targeted by a social information campaign concerning water savings and untargeted households.

**Considerations for the Practical Implementation of Green Nudges**

When it comes to the practical implementation of nudges as policy instruments, and based on the results of the scientific studies we have reviewed here, we recommend that policy makers consider the following additional factors.

*Implementation costs*

An important factor to consider is the cost of implementing a nudge. Nudges are often presumed to be quick and cheap interventions compared to conventional policy instruments. While this is true for a small group of nudges, such as changing the default option, most nudges are context dependent and thus require a significant amount of research and iterative testing to be effective. Nudges often also have higher variable costs. For example, providing detailed feedback on energy consumption relative to neighboring households requires far more time, effort, and data.
availability than increasing the existing energy tax. In the literature we have reviewed here, these costs have usually been covered by academic researchers working in collaboration with organizations or the public sector. We are not aware of any studies quantifying these costs, but intuitively, we would expect that relying on academics to design and test policies is an expensive approach to policy making.

There are also potential differences between nudges and taxes in terms of enforcement costs. Given that nudges, by definition, should allow individuals to make any choice in a given choice set and should not change the monetary costs of any of the choices, behavior change under a nudge is not enforceable. However, for green nudges to be an effective tool and their development costs justified, governments need to either mandate nudges or implement them themselves. Mandating firms to use nudges, such as placing vegetarian food on top of the menu or setting double-sided printing as the default, requires enforcement. This places nudges at the same level as other policy instruments in terms of enforcement. Government mandate of nudges also raises the issue of the ethics of using nudges, which is beyond the scope of this article.

In practice, several governments have created dedicated units to design and test nudges and help with their implementation across governmental agencies. The UK’s Behavioral Insights Team is a prime example of this type of approach. The US and Australian governments, as well as the World Bank and the OECD, have established similar types of "nudge units" that fulfill this role (OECD, 2017).

**External validity**

Our review of empirical studies that have evaluated green nudges suggests that on average, nudges have had moderate effects. However, recent meta-studies have found that published studies might overestimate the effect of the nudge and thus the external validity of these studies may be limited (DellaVigna and Linos, 2020). There are several reasons for this. First, there is
publication bias. More impressive results are more easily published than small or non-existent results (Al-Ubaydi et al. 2017), which could bias our perception of the effectiveness of nudges. Second, researchers may (unintentionally) select contexts in which the green nudges have the highest possibility of being successful because, for example, baseline behavior is particularly low, the problem is very salient, or the sample was easily accessible. For example, Allcott (2015) finds that the identical social comparison home energy report nudge has had much smaller impacts in studies that were conducted after the first studies on these green nudges were published, indicating that the initial evidence may have been too optimistic. Third, research studies are conducted by academics who are able to exercise tight control over the implementation and quality of the study. Once a nudge is scaled up to a larger share of the population, however, the researchers have less control over the implementation, and this could affect the impact of the nudge (Al-Ubaydi et al. 2017). Nevertheless, one advantage of nudges over conventional policy instruments is that they can often be tested on a smaller scale. For example, the Danish fat tax was abolished after just 15 months because of unintended side effects and its failure to affect saturated fat consumption (Bødker et al., 2016). In this case, a smaller-scale pre-study would likely have saved a lot of money and time.

SUMMARY AND CONCLUSIONS

Green nudges are a new addition to the environmental policy maker's toolkit. Using a new policy classification framework, we have shown that green nudges differ from self-focused nudges not in the type of intervention (i.e., how they change behavior), but in the reason for nudging. Specifically, self-focused nudges seek to improve the welfare of the individual by correcting for a behavioral problem (such as internalities or bounded rationality), while green nudges seek to reduce a negative environmental externality, which is a conventional economic problem. The fact that green nudges seek to address a conventional economic problem means
that a direct comparison of green nudges with conventional policy tools is highly relevant, because policy makers may need to decide between them when faced with a specific environmental policy problem. Based on an extensive review of the literature on green nudges, we have presented a theoretical comparison of green nudges and a Pigovian tax. We show that moral nudges (which affect both decision and experienced utility) can be welfare improving when implemented as a complement to optimal taxes. When taxes are not set optimally, both moral nudges and pure nudges (which affect only decision utility) can be efficiency-improving complements to taxes. Finally, we have discussed additional issues that policy makers need to consider when comparing green nudges with other polices, including distributional effects, the potential to crowd out intrinsic motivation, implementation costs, enforcement, and the external validity of experimental findings.

Research that compares green nudges with conventional policy instruments is still in its very early stages. Thus, the discussions and findings we have presented here should be viewed as an effort aimed at asking the right questions rather than seeking to provide all the right answers.

**Acknowledgments**

Financial support from the Swedish EPA, the Center for Collective Action Research (CeCAR), and the Swedish Research Council (ref. 2016-02371) is gratefully acknowledged. We have received valuable comments from two anonymous reviewers, Martin Dufwenberg, Suzanne Leonard, Åsa Löfgren, Andreas Nilsson, Katarina Nordblom, Eva Ranehill, and seminar participants at the Swedish EPA, University of Copenhagen, University of Gothenburg, University of Exeter, University of Sterling, and University of Toulouse, as well as participants at the World Conference of Environmental and Resource Economists held in Gothenburg, Sweden in June 2018.


Sunstein, C., Thaler, R. 2003. Libertarian paternalism is not an oxymoron. The University of Chicago Law Review. 1159-12


Appendix

Table 1. Field studies of green nudges published in peer-reviewed journals

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of nudge</th>
<th>Environmental problem targeted</th>
<th>Effect of nudge on behavior</th>
<th>Statistically significant effect?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure Nudge – Defaults</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arafia, León (2013)</td>
<td>Opt-in vs. opt-out</td>
<td>Carbon offsetting of air travel</td>
<td>+27%</td>
<td>Yes</td>
</tr>
<tr>
<td>Brown et al. (2013)</td>
<td>Default</td>
<td>Default temperature on the thermostat</td>
<td>-1.8%</td>
<td>Yes</td>
</tr>
<tr>
<td>Ebeling, Lotz (2015)</td>
<td>Opt-in vs. with opt-out</td>
<td>Green energy contract</td>
<td>+860%</td>
<td>Yes</td>
</tr>
<tr>
<td>Egbar, Ekström (2016)</td>
<td>Default</td>
<td>Paper use</td>
<td>-14%</td>
<td>Yes</td>
</tr>
<tr>
<td>Löfgren et al. (2012)</td>
<td>Opt in/opt out/active choice</td>
<td>Carbon offsetting of air travel</td>
<td>-16% (opt in) -7.7% (opt out)</td>
<td>No</td>
</tr>
<tr>
<td>Tolte et al. (2014)</td>
<td>Opt-in vs. opt-out</td>
<td>Purchase of steering unit with heat pump</td>
<td>-10% (opt-in) -23% (opt-out)</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pure Nudge – Provision and simplification of information</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gravert, Kurz (2019)</td>
<td>Order on menu</td>
<td>Meat consumption</td>
<td>-55%</td>
<td>Yes</td>
</tr>
<tr>
<td>Kurz (2018)</td>
<td>Order on menu and presentation</td>
<td>Vegetarian food</td>
<td>+45%</td>
<td>Yes</td>
</tr>
<tr>
<td>Tiefenbeck et al. (2016)</td>
<td>Feedback in a salient way</td>
<td>Electricity consumption</td>
<td>-22%</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pure Nudge - Changes to the physical environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kallbekken, Saelen (2013)</td>
<td>Change plate size</td>
<td>Food waste</td>
<td>-21%</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Pure/Moral Nudge – Reminders</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilbert, Zivin (2014)</td>
<td>Reminder</td>
<td>Electricity consumption</td>
<td>-0.89%</td>
<td>Yes</td>
</tr>
<tr>
<td>Wallander et al. (2017)</td>
<td>Reminder</td>
<td>Sign-up conservation program</td>
<td>+2.9%</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Moral Nudge – Inter-personal motivations and social comparisons</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcott (2011)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>-2.72%</td>
<td>Yes</td>
</tr>
<tr>
<td>Andor et al. (2020)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>+3.8% (private framing)</td>
<td>Yes</td>
</tr>
<tr>
<td>Asensio, Delmas (2015)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>-0.7%</td>
<td>Yes</td>
</tr>
<tr>
<td>Ayres et al. (2013)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>-8.2% (social framing)</td>
<td>Mixed</td>
</tr>
<tr>
<td>Bernedo et al. (2014)</td>
<td>Comparison, long run</td>
<td>Water use</td>
<td>-2%</td>
<td>Yes</td>
</tr>
<tr>
<td>Brent et al. (2015)</td>
<td>Comparison</td>
<td>Water use</td>
<td>-0.89%</td>
<td>No</td>
</tr>
<tr>
<td>Costa, Kahn (2013)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>-1% – 5%</td>
<td>Mixed</td>
</tr>
<tr>
<td>Delmas, Lessem (2014)</td>
<td>Comparison; private and public</td>
<td>Electricity consumption</td>
<td>-5.6% (private) -19.2% (public)</td>
<td>Yes</td>
</tr>
<tr>
<td>Ferraro, Price (2013)</td>
<td>Comparison; strong and weak</td>
<td>Water use</td>
<td>-2.8% (weak) -4.6% (strong)</td>
<td>Yes</td>
</tr>
<tr>
<td>Ferraro et al. (2011)</td>
<td>Comparison, long run</td>
<td>Water use</td>
<td>-0.16% (weak) -0.96% (strong)</td>
<td>Yes if strong</td>
</tr>
<tr>
<td>Holladay et. al. (2019)</td>
<td>Comparison</td>
<td>Purchase of efficient durables</td>
<td>0%</td>
<td>No</td>
</tr>
<tr>
<td>Jaime, Carlsson (2018)</td>
<td>Comparison</td>
<td>Water use</td>
<td>-5.4%</td>
<td>Yes</td>
</tr>
<tr>
<td>Mizobuchi Takeuchi (2013)</td>
<td>Comparison; financial reward</td>
<td>Electricity consumption</td>
<td>-6.8%</td>
<td>Yes</td>
</tr>
<tr>
<td>Pellerano et al. (2017)</td>
<td>Comparison, financial reward</td>
<td>Electricity consumption</td>
<td>-0.6% – 1.1%</td>
<td>Yes if no reward</td>
</tr>
<tr>
<td>Richter et al. (2018)</td>
<td>Comparison; varying reference group</td>
<td>Share of sustainability-labeled seafood</td>
<td>+6% – +21% (small) +8% – +18% (large)</td>
<td>Mixed</td>
</tr>
<tr>
<td>Sparkman, Walton (2017)</td>
<td>Dynamic and static norms</td>
<td>Meatless lunch</td>
<td>+42% (dynamic) +36% (static)</td>
<td>Mixed</td>
</tr>
<tr>
<td>Sadarshan (2017)</td>
<td>Comparison</td>
<td>Electricity consumption</td>
<td>-5.6%</td>
<td>Yes</td>
</tr>
<tr>
<td>Schultz et al. (1999)</td>
<td>Social comparison</td>
<td>Electricity consumption</td>
<td>+ 8% (descriptive, short run), -5.7% (injunctive, long run), +2.3% (descriptive, long run), -8.3% (injunctive, long run)</td>
<td>Mixed</td>
</tr>
<tr>
<td><strong>Moral Nudge – Moral suasion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ito et al. (2018)</td>
<td>Normative appeal</td>
<td>Electricity consumption</td>
<td>-0.03% (short run)</td>
<td>Only short run</td>
</tr>
<tr>
<td>Study (Year)</td>
<td>Type/Motivation</td>
<td>Environment/Action</td>
<td>Outcome</td>
<td>Compliance</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
<td>--------------------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>Goldstein et al. (2008)</td>
<td>Normative appeal</td>
<td>Towel reuse rate</td>
<td>+26%</td>
<td>Yes</td>
</tr>
<tr>
<td>Kallbekken, Saelen (2011)</td>
<td>Normative appeal</td>
<td>Food waste</td>
<td>-28%</td>
<td>Yes</td>
</tr>
<tr>
<td>Egbark, Ekström (2016)</td>
<td>Normative appeal</td>
<td>Paper use</td>
<td>-2.6%</td>
<td>No</td>
</tr>
<tr>
<td>Schultz et al. (2007)</td>
<td>Plea</td>
<td>Recycled waste</td>
<td>0%</td>
<td>No</td>
</tr>
<tr>
<td>Yoeli et al. (2013)</td>
<td>Observability</td>
<td>Sign-up energy conservation program</td>
<td>80% – 200%</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Moral Nudge – Goal setting and commitment**

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Type/Motivation</th>
<th>Environment/Action</th>
<th>Outcome</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baca-Motes et al. (2012)</td>
<td>Commitment</td>
<td>Using towel additional days</td>
<td>+3.5% (general), +28% (specific)</td>
<td>Mixed</td>
</tr>
<tr>
<td>Bryce et al. (1997)</td>
<td>Commitment</td>
<td>Number of weeks household recycled waste</td>
<td>+13%</td>
<td>Yes</td>
</tr>
<tr>
<td>Harding, Hsiaw (2014)</td>
<td>Goal</td>
<td>Electricity consumption</td>
<td>-0.04%</td>
<td>Yes</td>
</tr>
<tr>
<td>Jaeger, Schultz (2017)</td>
<td>Commitment + social norms</td>
<td>Water use</td>
<td>-3.5% (social norm, short run), -5.6% (warning, short run), -8% (social norm, long run), -3% (warning, long run)</td>
<td>Mixed</td>
</tr>
<tr>
<td>Loock et al. (2013)</td>
<td>Goal</td>
<td>Electricity consumption</td>
<td>-2.3%</td>
<td>Yes</td>
</tr>
<tr>
<td>Terrier, Marfaing (2015)</td>
<td>Commitment + appeal</td>
<td>Towels replaced in hotel room</td>
<td>-19.5% (commitment), -20.5% (commitment + appeal)</td>
<td>Yes</td>
</tr>
</tbody>
</table>