A decade of nudging: What have we learned?[*]

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Abstract

In the past decade, nudging as a method to influence behavior has received increased attention both among academics and more generally. Nudges are often low-cost interventions but may, nevertheless, be surprisingly effective. However, as the research field has matured, it has also become clear that nudges are not always as effective as originally thought. In this paper, I give a selected overview of recent nudging interventions and discuss what we have learned from the past decade of using nudging to affect behavior.

1. Introduction

The aim of this paper is to give an overview of recent developments in the research on nudging, and to take stock on what roughly one decade of research in nudging has taught us about their effects.

Nudging as a tool to influence behavior was first conceptualized in 2008 by Cass Sunstein and Richard Thaler. By that time, behavioral and experimental economists had, for some time, been demonstrating that in many circumstances human behavior deviates from the predictions of traditional rational-agent models, and that the choices people make often are not only in their own self-interest (see DellaVigna (2009) for an overview). There are several reasons why these observations had ramifications for policy. First, to the extent that people fail to act in their own self-interest, it provided an argument for paternalistic policies that enforce or encourage better choices and therefore improve welfare (Thaler & Sunstein 2003, Camerer et al. 2003). Second, more traditional policy tools such as taxes or subsidies might not function as well as the standard rational-agent model had predicted (Duflo et al. 2006, Chetty et al. 2009, Saez 2010). Third, seemingly irrelevant factors, such as the framing of information, provided new possibilities to influence behavior (Kahneman & Tversky 1979, Tversky & Kahneman 1986, Thaler 2015).

On this background, Thaler and Sunstein introduced the terms *choice architecture* and *Nudging*. The choice architecture is the (organized) setting in which choices are made and a nudge is defined as »any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives« (Thaler & Sunstein 2008). This definition emphasizes three key aspects of nudges. First, the focus on *predictability* requires nudges to be based on a *theoretical foundation*, which can generate predictions. That theoretical foundation is behavioral economics, which combines rigorous economic modeling with insights from psychology. Second, the definition emphasizes that nudges *preserve choice* and do not force people to act in any particular way. Therefore, while Thaler and Sunstein acknowledge that nudges are paternalistic in their aim, they also argue that nudges are libertarian precisely because they preserve all available choices. Some therefore called nudges *soft* interventions as opposed to e.g. *hard* regulation, which restricts choice. The third key component is that economic incentives are largely unchanged. This essentially means that nudges exploit factors that would seem to be irrelevant for the rational decision-maker be-

cause it does not influence economic incentives and therefore the trade-off between different choices. Examples include simplification of information, reminders, implementation intentions and soft deadlines, framing interventions, social norm comparisons, and changing default options

Indirectly, the definition implies that nudging interventions often have low implementation costs. One reason is that economic incentives are unchanged. Hence, there are no impacts on public revenue of providing subsidies (and no revenues from taxes). In addition, the administrative burden of nudges is often low compared to that required for hard regulation and tax collection. Because of the low implementation costs, nudging interventions often compare favorably to other interventions in terms of apparent cost-effectiveness (Benartzi et al. 2017). This, in combination with the »softness« of the approach and early evidence of effective nudges, made nudging policies appealing both to academics and practitioners. This increasing popularity is illustrated by the increase in Google searches on the term »Nudging« in Denmark and worldwide shown in Figure 1. The apparent appeal of nudging and behavioral design is also seen by the large number of institutions applying nudges and behavioral insights to public policy around the world (see OECD Research, 2018).[1]

Figure 1: Google search trends for the term »Nudging« worldwide and in Denmark*
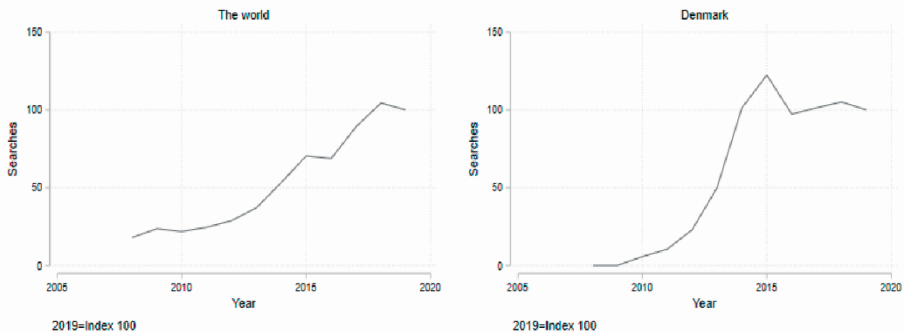
Notes: Created using data from https://trends.google.dk/trends. The graphs do not reflect the absolute number of searches on the terms and level comparisons between the two graphs cannot be made. * Data from Denmark includes searches on the terms »Nudging« and »Adfærdsdesign«.

1. Denmark nudging initiatives have been implemented by e.g. The Danish Agency for Labour Market and Recruitment (STAR), Municipality of Copenhagen, Statens Serums Institut, The Danish Customs and Tax Administration (SKAT), Copenhagen Airport, and many more public and private organizations.

The remainder of the paper is organized as follows. Section 2 introduces a slight simplification of the model by Chetty (2015). This serves as the theoretical foundation for the discussion of the effects of nudging. Section 3 presents three examples of influential empirical evidence on the effects of nudging. In section 4, I take my own research as the starting point and discuss selected empirical papers that have subsequently nuanced our knowledge about the effects of nudging. Section 5 concludes

2. Theoretical framework

In this paper, I focus solely on the effects of nudges and therefore it suffices to consider a model with nudges as the only available policy tool. This slight modification of the model in Chetty (2015) is purely expositional. The social planer then choses a vector of nudges n to maximize the well-being of the agent, as captured by her experienced utility $u(c)$ for choice c, subject to two constraints. The first constraint is a public-revenue constraint, which ensures that the costs of implementing the nudge $C(n)$ are lower than the public revenue $\bar{R}$. The implementation cost $C(n)$ is, for example, the cost of sending e-mails or the cost of changing the text in standard letters. The second constraint is a consumption constraint determined by the agent's optimization problem. The planner's problem is then:

$$\max_{n} u(c) \text{ s.t.} \tag{1}$$

$$C(n) \leq \bar{R} \tag{2}$$

$$c = \operatorname*{argmax}_{c}\{v(c|n, d) \text{ s.t } p \cdot c = I\} \tag{3}$$

where Equation (3) gives the agent's problem. The agent chooses c to maximize decision utility $V(c|n, d)$ subject to the budget constraint $p \cdot c = I$ with price vector p and income I. We use c_i to denote the i'th choice in the choice vector and let $i = 1, \dots, m$. Decision utility $v(\cdot)$ may differ from experienced utility $u(\cdot)$ due to nonstandard preferences, nonstandard beliefs, or nonstandard decision-making (DellaVigna 2009). Therefore, the functions u and v may differ and in particular v is affected by ancillary conditions d and nudges n that do not directly enter experienced well-being. In contrast, in the standard economic framework $v = u$ and hence when making decisions the agent maximizes experienced utility. The standard model therefore does *not* leave room for nudges and ancillary conditions to influence behavior.

In the framework given by Equations (1)-(3), there is scope for nudging *if* the agent, without a nudge, chooses a choice vector, c^0, that does not optimize experienced utility (i.e. $c^0 \neq c^* = \operatorname{argmax} u(c)$), and if a nudge n exists such that the choice with the nudge, c^n, improves experienced utility (i.e. $u(c^n) > u(c^0)$).

However, choosing the optimal nudge to maximize Equations (1)-(3) is informationally demanding as it requires the planner to have information about both experienced and decision utility such that optimal behavior can be derived (Benkert & Netzer 2018). Such information is generally not available, and instead applied nudges often takes as given a behavior that the regulator wants to implement. For example, healthy eating, better exercise habits, less energy consumption, etc. In most applications, it is an implicit assumption that experienced utility is either increasing or decreasing in c_i and that a nudge is beneficial if it alters c_i in the desired direction (as implementation costs of nudges often are negligible). In the discussion that follows, I let an increase in c_i represent a desirable behavioral change. This is without loss of generality as choices for which a reduction in c_i is desirable can easily be negated to fit the theoretical framework

While the focus of nudges, as formulated by Thaler & Sunstein (2008) and captured by the model above, originally was to address *internalities*, i.e. errors in decision-making that lowers experienced utility, nudges have in practice also been used to target *externalities*, i.e. choices that influence others, in cases where internalities are not necessarily present (Carlsson et al. 2021). To capture this in the framework above, one would need to let the planner maximize $\sum_k u_k(c_k, c_l)$, where u_k is the utility of individual k, rather than the utility of a representative agent $u(c)$. With this modification, there is also scope for nudging if the choices of the k'th agent, c_k, harms another agent, even if agent k behaves to maximize his own experienced utility (i.e. if $c_k^0 = c_k^* = \operatorname{argmax} u_k(c_k)$). However, for nudging to have an effect it must still be the case that ancillary conditions and nudges can influence decision utility, otherwise there is no room for nudging

3. Nudges that influence behavior

A number of influential papers have provided examples of nudges that lead to desirable behavioral change. In this section, I highlight a few examples but do not conduct a thorough review. See e.g. Benartzi et al. (2017), Damgaard & Nielsen (2018), Hummel & Maedche (2019), Jachimowicz et al. (2019) and Carlsson et al. (2021) for reviews of nudging interventions.

An early and highly influential example of a nudge is the »default nudge« studied by Madrian & Shea (2001), which studies a change in the default scheme for employee enrollment into 401(k) retirement savings, from an opt-in scheme, to automatic enrolment with possibility to opt-out. Prior to the default change, employees could opt-in to the savings scheme after one year of employment at which point they would also choose their contribution rate and fund allocation. After the default change, employees automatically participated in the savings scheme immediately upon hire with a default contribution rate of 3 percent of compensation and funds allocated to a money market fund (unless employees ac-

tively chose another contribution rate and/or allocation). Madrian & Shea (2001) document large default effects, suggesting that about 40-50% of employees follow the default plan. In particular, participation increases from around 50% to 86%, the share of employees contributing 3% of their compensation increases from 4% to 65%, and the average share invested in the money market increases from around 8% to around 80%. Madrian & Shea (2001) further show that the change in eligibility (from a one year waiting period to immediate eligibility) cannot explain the change in behavior. This conclusion arises from studying the behavior of employees, who had been employed for less than a year at the time of the rule changes and therefore also gained immediate eligibility but without default participation. This group behaves almost identically to employees before the rule change suggesting that earlier eligibility alone did not drive the results.

Another early example of a successful nudge is the social nudge by Schultz et al. (2007). The study provided people with personalized information comparing their energy consumption to that of their neighbors and happy or sad emojis to indicate below and above average consumption, respectively. This nudge made use of a human desire to conform to social norms and documented an 11% decrease in energy consumption for high consuming households with no impact on consumption for below average consuming households.

A more recent example of a nudge with large positive effects is Bettinger et al. (2012). In the intervention, low-income individuals who received assistance completing their tax returns were provided with basic personal assistance to complete financial student aid applications. In addition, individuals were given personalized aid estimates that were compared to local college tuition fees. The intervention led to an increase in financial aid applications, college enrollment, persistence, and aid receipt in the treated families. The effect was sizable as high school seniors whose parents received the treatment were 8 percentage points more likely to complete two years of college. The welfare effects of the interventions are therefore likely to be large when taking into account the returns to schooling both for the individual and for society (Heckman et al. 2006, Bhuller et al. 2017, Lochner 2011).

These three examples of successful nudges all achieved a rather large behavioral effect, at a relatively low implementation cost. A common feature of the studies is that the nudge n_i was designed to target a particular choice variable c_i (401k enrollment, energy use and financial aid applications, respectively) and that the studies document a positive short term effect on c_i, denoted $c_i^{n_i} - c_i^0 > 0$. In addition, Bettinger et al. (2012) evaluates the effects on longer-term outcomes such as college completion as well. When comparing nudges and their potential for long-term effects, one should keep in mind that some nudges target a »one shot« choice (e.g. 401k enrollment and financial aid applications) while others target repeated choices (e.g. energy use). Nudges that influence »one shot« choices may induce large long-term effects if individuals are pushed to different trajec-

tories as in Bettinger et al. (2012). In comparison, long-term effects for nudges targeting a repeated choice, requires either rapid habit adjustment, giving rise to persistent effects of the initial nudge, or a repeated nudge (Allcott & Rogers 2014). In a setting similar to that studied by Schultz et al. (2007), Allcott & Rogers (2014) show that for energy use there is a relatively low persistence of effects

4. A maturing field

Using examples from my own research as the starting point, this section discusses how our knowledge of the effect of nudges has recently been nuanced. I discuss examples of null effects for primary outcomes, heterogeneous effects, effects of repeated nudges, unintended spillover effects, and welfare effects.

4.1. Effect om primary outcomes

One conclusion that has recently emerged is that on average nudges are less effective at changing targeted behavior in the short term, than suggested by the (initial) studies of nudges published in the economic literature (DellaVigna & Linos 2020). In terms of the theoretical framework, the effect of the nudge $c_i^{n_i} - c_i^0$ may be small or even negative.

For example, in a joint paper with Christina Gravert, we tested a deadline nudge. In a fundraising appeal sent to 53,289 warm-list donors of a large Danish charity, we asked for donations by a certain date and offered a small matching donation per donation given by the deadline. Note that as the recipients were warm-list donors they had given to the charity in the past and were presumably interested in doing so again. We used two different modes of communication: In total 20,293 individuals received a text-message donation request, and 32,996 individuals received the request via email. We varied the length of the deadline and found a small but statistically insignificant effect of shorter deadlines on the response rate. In addition, we found evidence that, conditional on giving, average and median giving was considerably lower for people facing short deadlines. This is suggestive of a negative intensive margin effect of the nudge and could be caused by the additional pressure to give that the short deadlines imposed.[2]

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2. This would be similar to the (social) pressure effect in DellaVigna et al. (2012)

Figure 2: Response rate and amount donated
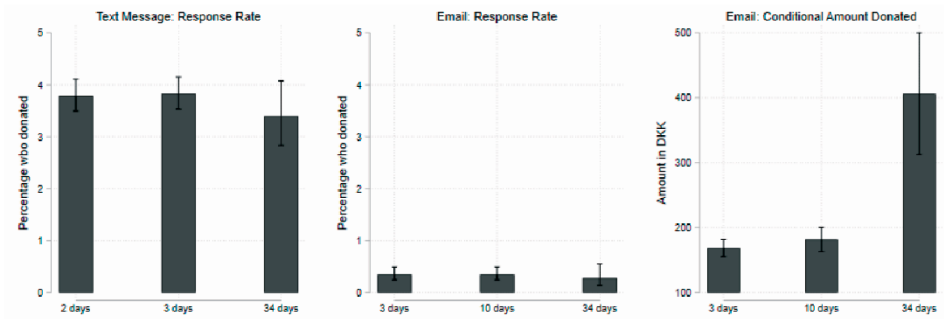
Notes: This figure reproduces Figure 1 in Damgaard & Gravert (2017) and adds a panel with the average amount donated conditional on donating

Our paper provided a setting where a deadline nudge proved ineffective. This conclusion was similar to the findings of Bertrand et al. (2010) who found no positive effect of shorter deadlines on demand for loans.

It turns out that not only deadline nudges but also other types of nudges, across various settings, may be ineffective or have smaller effects than suggested by the initial nudge papers published in academic journals. In a survey of nudge interventions in the educational sector, Helena Skyt Nielsen and I find that many of the nudging interventions considered had no or even negative effects on primary outcome variables (Damgaard & Nielsen 2018). In addition, DellaVigna & Linos (2021) provide new evidence suggesting that non-default nudges published in academic journals on average report greater effects than comparable nudging interventions implemented by two of the largest US nudge units. They exclude default nudges to make the two samples as similar as possible, given that there are almost no default nudges in the nudge unit sample. The results of their meta-analysis shows an average 8.7 percentage point increase in target behavior in a sample of nudges published in academic journals. In comparison, the average increase in the nudge units sample is 1.4 percentage points. DellaVigna & Linos (2021) show that this gap is explained partly by publication bias in the sample of published papers, and partly by differences in implementation. The nudge unit interventions were typically implemented at larger scale (median sample 10,600 versus 484 in academic publications) and therefore required, for example, email communication rather than in-person contact. In the nudge unit sample, a much larger share of interventions have insignificant or even significantly negative effects, than in the sample of nudges published in academic journals. It is worth noting that our deadline nudge was also implemented at a large scale with a sample size and implementation method comparable to the typical example of the nudge unit sample in DellaVigna & Linos (2021).

The characteristics of the nudge and its implementation may of course also impact the short-term effect of the nudge on primary outcomes. For example, based on a systematic review of 100 academic nudging papers Hummel & Maedche (2019) show that on average *default nudges* have the largest effect compared to other types of nudges. Further, Bregn (2019) discusses a number of examples of nudges that had very different and sometimes opposite effects when applied to different contexts for example with a different target population, or with small changes in the implementation. This is also true for default nudges (Jachimowicz et al. 2019).

In terms of the persistence of effects over time, there is evidence to suggest that nudges which target one-time decisions with potentially long-term consequences, have the largest long-term effects. Examples of this are: a default nudge to contribute to a pension scheme as in Madrian & Shea (2001) discussed above, a nudge to actively pick a pension portfolio as in Cronqvist et al. (2018), a social nudge to reduce energy consumption that leads to investment in more energy efficient appliances is in Brandon et al. (2017), and the financial student aid nudge by Bettinger et al. (2012) discussed above. In all these examples, a one-time change has long-term effects because it shifts behavior permanently to a new trajectory, unless active action is later taken to revert the change. In contrast, the results by e.g. Allcott & Rogers (2014) show low long-term persistence of nudges targeting repeated behavior.

4.2. Heterogeneous effects

Over the past decade, there has also been an increasing focus on heterogeneous effects of nudges across individuals. Clearly, a nudge does not influence everyone in the same way, and in particular the effect for individual l and k may be different, i.e. $c_{il}^{n_i} - c_{il}^0 \neq c_{ik}^{n_i} - c_{ik}^0$ is possible. In the deadline example discussed above, some responded to the nudge by choosing a smaller donation and some did not change any of their choices. In some cases, effects of nudges arise only for selected groups and may depend on e.g. gender, socio-economic status and time-preferences (Damgaard & Nielsen 2018). In fact, based on our review of nudges in the education sector, we conclude that few nudges produce positive effects for everyone. Whether or not effects arise depends on at least three factors.

First, there must be scope for an improvement in behavior. This is, for example, illustrated by Allcott (2011) who showed that a social norm nudge led to large reductions in energy consumption for households in the highest decile of pre-treatment consumption, but almost no impact on consumption in the lowest decile. In this case, the greatest scope for improvement was present for the ex-ante high consuming households. These results are also similar to those of Schultz et al. (2007) discussed in the previous section.

Second, choices must be constrained by the specific behavioral barrier targeted by the nudge. For example, the effect of providing information about financial student aid to students with low socio-economic background may be greatest for students who are of relatively high ability (as in Dinkelman & Martinez (2014)). These students could be at the margin of attending college, but lack of attention to the returns may very well be a constraining factor. Similarly, reminders of college matriculation tasks may only yield positive effects for low income and first generation students (as in Castleman & Page (2017)) for whom lack of awareness of the tasks and the risk of procrastination may be significant barriers.

Finally, the people targeted by nudging interventions must have at least a basic motivation for changing their behavior in the intended direction. For example, it may be hard to nudge meat lovers into eating a vegetarian dish, but it may be possible to nudge them into eating a fish dish. Similarly, it may be possible to nudge a person who would normally pick a fish dish to eat vegetarian (Gravert & Kurz 2019). In this example, some individuals are likely to be interested in making a small adjustment to their eating habit but they may not be motivated to make a more radical change. Other examples are related to student behavior. A nudge giving students several interim deadlines in the form of frequent exams (De Paola & Scoppa 2011) and a nudge making feedback information more salient (Bandiera et al. 2015), have shown greater impact on high ability students who are presumably also more motivated to perform well.

4.3. Repeated nudges

Given that nudges have heterogeneous effects and negligible implementation costs, it might be appealing to repeat nudges with the aim of influencing the behavior of more people and achieving larger extensive margin effects.

The Smithsonian Institution did exactly that. Their activities are funded partly by memberships and members would receive up to 8 rounds of reminders to renew their membership in the months just prior to and just after their membership expired. Christina Gravert, Laura Villalobos, and I analyzed individual level data on membership renewals and additional donation gifts given to the Smithsonian (Damgaard et al. 2018). We found that the first reminder was quite effective and led to a 23.2% response rate. However, we also found that subsequent reminders were much less effective and had much lower response rates (see Figure 3), i.e. the probability of observing an effect is greater initially, $P\left(c_{it}^{n_i} \neq c_{it}^{0}\right) > P\left(c_{is}^{n_i} \neq c_{is}^{0}\right)$ where $t < s$ denotes the round of repetition. We demonstrated in the paper that the decline in the response rate cannot be explained by transaction costs arguments. Instead, we found that those members who had a history of being more generous donors, where more likely to renew early (in one of the first

three rounds) while those who renewed later seemed to be more reluctant and more marginal donors (see Table 1). This evidence suggests that nudges become less effective as they are repeated because those exposed to many repetitions of the nudge are those who have intentionally not altered their behavior and therefore are less motivated to do so.

Gravert & Kurz (2019) also found decreasing effects of repeating a nudge. They implemented a framing nudge aimed at shifting restaurant orders from meat dishes towards vegetarian options. The results in the first week indicated a 21% increase in the probability of selling a vegetarian dish, but the effect decreased to around 6% in week 3.

The repeated nudges in the Smithsonian example and in Gravert & Kurz (2019) both targeted a specific task (renewing a membership and ordering a dish in a restaurant, respectively). In contrast, repeated nudges could also target behavior, which requires sustained effort, e.g. improved study effort, reduced energy consumption, healthy eating habits, and physical activity. In such cases, a one-off nudge may not be very effective because it may not create the required persistent change in habits (Carrera et al. 2018, Gravert & Collentine, forthcoming). Therefore, repeating a nudge may help establish and sustain intensive margin effects. Tiefenbeck et al. (2018) for example used a repeated nudge providing real-time feedback about water consumption in the shower. In a self-selected sample of participants already interested in energy conservation, they found immediate effects on average water consumption that was sustained at the same level as the nudge continued to be in place. The study did not investigate extensive margin effects (which in this case would have been whether more people would begin lowering their consumption) but the stable overall effect suggests that extensive margin effects might have been limited. Another example of a repeated nudge is Allcott & Rogers (2014) who studied total effects on energy consumption of repeating a social comparison nudge over a long period. They found that, although average energy consumption remained below pretreatment consumption if the nudge was not repeated, there continued to be a positive incremental effect of repeating the nudge. Taken together, the evidence on repeated nudges seems to suggest that repeated nudges may do little on the extensive margin. However, repeated (and timely) nudges can help ensure that changes to repeated behavior persist over time for those who alter their behavior in the first place.

Figure 3: Response rate by reminder round
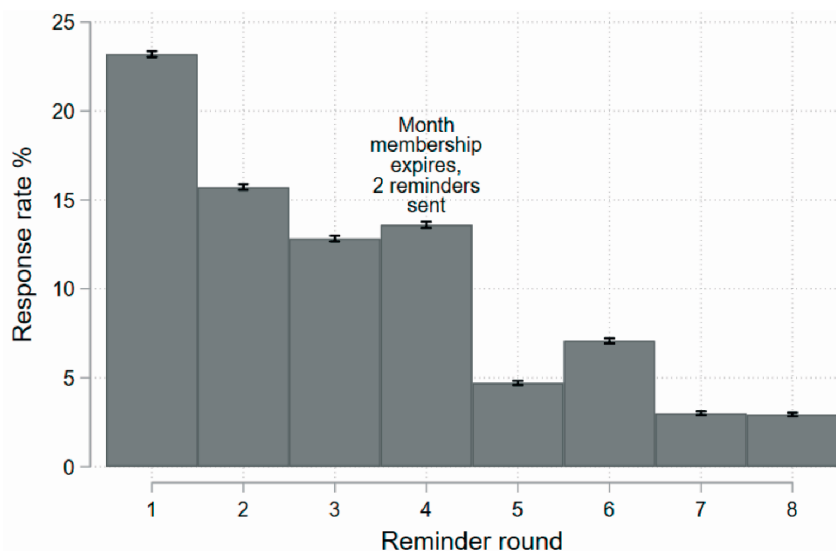
Notes: Adjusted from Figure 11.2 in Damgaard et al. (2018). The response rate is defined as the ratio of people who renew their membership out of those who receive a reminder, by reminder round (only people who have not already renewed receive a reminder). Each reminder round consists of reminders sent within a month. Reminder round 4 coincided with the month where the previous membership expired and that round consisted of two reminders. All other reminder rounds consisted of just one reminder

Table 1: What explains renewals of Memberships at the Smithsonian Institution

Dependent variable	Renewed at all	Renewed in Rounds 1-3
Membersip fee year *t-1*	0.0004***	0.0004***
	(0.000)	(0.000)
Donation gift year *t-1*	-0.0003***	-0.00003*
	(0.000)	(0.000)
Years since first membership	0.0064***	0.0055***
	(0.000)	(0.000)
Observations	301,656	122,584

Notes: Reproduces Table 11.2 in Damgaard et al. (2018). »Renewed at all« is a dummy equal to 1 if the member was registered as a member the following year. »Renewed in Rounds 1-3« is a dummy equal to 1 if the member received a reminder and renewed in rounds 1-3, conditional on renewing at all. Age, a dummy for females and a dummy for residents of the DC area were included as controls. The table reports marginal effects and standard errors in brackets. All standard errors are robust. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

4.4. Unintended spillover effects

The evaluation of the effectiveness of nudges has often focused on the effects on a few selected primary outcomes and an evaluation of the implementation costs. That is, if the nudge n_i is designed to target the choice c_i, evaluations have focused on $C(n_i)$ and the effect oc_in. However, in another joint paper with Christina Gravert, we demonstrate that it is important to take a more comprehensive approach to policy evaluation and also consider long-term effects and possible spillover effects on other outcomes (Damgaard&Gravert 2018). In particular, we allowed n_i to also influence another choice c_j. In our setting c_j was the choice to unsubscribe from additional mailings - a choice which has long-term effects.

We worked with a Danish charity to understand the effect of reminders on giving behavior. Our sample consisted of 17,391 warm-list donors who all received an e-mail with a donation request. Approxi mately half the sample also received an unannounced reminder one week later. When evaluating the reminder nudge using primary outcomes, we found small but positive effects of the reminder nudge on the probability of donating to charity and no effect on the amount given. However, a closer inspection of the data showed that the additional increase in donations came at the cost of a remarkably large increase in unsubscriptions from the charity mailing list (see Figure 4). In the paper, we demonstrate that an unsubscription provides a revealed preference measure of previously overlooked costs of nudging which are not captured by the implementation costs. We estimate a cost to every person who is exposed to the nudge to approximately 13 DKK for every reminder.[3] These costs can include time, effort, and attention costs of having to pay attention to the nudge but also psychological costs of nudging such as feelings of guilt or shame

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3. We estimate this cost by structurally estimating a model of giving and unsubscription behavior using Simulated Method of Moments to match empirical donation and unscubsciption data from the charity. Individual level donation histories is used to identify giving behavior and the underlying process for the weight on warm glow giving. The unsibscription rate is used to identify an »annoyance« cost of being reminded to give on an monthly basis.

Figure 4: Donations and unsubscription

Notes: This figure reproduces Panel A of Figure 1 in Damgaard & Gravert (2018). The difference in giving is significant at 10% level and the difference in unsubscription is significant at 1% level

In an additional experiment, we increased future benefits from being reminded by announcing a matching scheme in a future period and we reduced future costs of staying subscribed by announcing a reduced frequency of reminders in subsequent months. We found that people responded to increases in the future benefits and reductions in future costs by being less likely to unsubscribe. This result has two important implications. First, it demonstrates that people anticipate future costs and benefits of being nudged and respond accordingly. Second, it suggests that repeated nudges not only can be ineffective in terms of the primary extensive margin outcomes (as discussed above) but also might cause unintended negative effects on secondary outcomes. This concern is further supported by evidence from the Smithsonian sample. The Smithsonian data suggests that people who renewed in response to one of the last reminder rounds and therefore had received many reminders, gave smaller additional donation gifts in the subsequent year even when controlling for the generosity of the individual last year and including individual fixed effects (see Table 2). That is, people who reluctantly alter their behavior in response to repeated nudges may take action to counteract the nudge: In the charitable giving examples discussed here, this was done either by reducing the size of additional gifts given or by unsubsribing.

Table 2: Effect of reminders on additional gifts in $

Dependent variable		Gift given in year t	Gift given in year t	Gift given in year t
Reminder year t-1	Round	-0.7051*** (0.204)	-0.3616 (0.280)	-0.6853*** (0.201)
Reminder year t	Round		-0.3621 (0.332)	
Gift year t-1				-0.1636*** (0.056)
Observations		116,297	72,682	116,297

Notes: Reproduces Table 11.4 in Damgaard et al. (2018). Individual fixed effects and year dummies included as controls. Standard errors in parentheses. *p < 0:10, **p < 0:05, ***p < 0:01.

A few other papers have also considered spillover effects. For example, Donkers et al. (2017) studied the case where c_i were donations in a different time-period and donations to other charities. They showed that donation requests by a particular charity cannibalized future donations of the charity but had relatively little and only short-lived impact on donations to other charities. Tiefenbeck et al. (2013) and Jessoe et al. (2021) considered cross-sectoral spillover effects of green nudges. In both cases c_i was consumption of another energy component than that targeted by the nudge. Tiefenbeck et al. (2013) studied the effect of a social comparison nudge providing weekly information about water consumption to residential consumers. They found a reduction in water consumption in the treatment group (i.e. a positive primary effect) but also an increase in electricity consumption (i.e. a negative spillover effect). In contrast, Jessoe et al. (2021) provide a rare example of positive spillover effects. They found that their social norm nudge (that informs households about *water* use); led to a reduction in *electricity consumption* and they argued that this strengthened the argument for applying the nudge. Regardless of the direction of the spillover effects, all of these examples illustrate that spillover effects – whether intended or not - are important to consider when evaluating the effectiveness of a nudge.

4.5. Welfare effects
In addition to evaluating a nudge (n_i) based on whether or not it lead to different choices, i.e. the impact on c_i and c_j, one might also evaluate the welfare effects, i.e. ultimately the effects on u(c) relative to the implementation costs. This is particularly relevant when nudges involve spillover effects or hidden costs other than the implementation costs.

The unsubscription results in Damgaard & Gravert (2018) reveal that in addition to implementation costs, nudges can also involve costs to the individuals who are nudged. The presence of these costs may cause unsubscriptions, and this in turn leads to long-term costs for the nudging charity, which is unable to remind the unsubscribed warm-list donors to give and as a result loses future revenue.

We analyzed the welfare effects for donors as well as for the charity. Based on a structural estimation of our model of donation and unsubscription behavior, we found a sizable warm-glow welfare gain for the few individuals who donated in response to the nudge even after accounting for the cost of being nudged.[4] However the vast majority of the contacted individuals do not donate and hence experience a welfare loss equal to the cost of being nudged (Table 3). On average, there was a small positive effect of being nudged for the potential donors. For the charity there was a positive immediate revenue effect of about 3 DKK per individual contacted, but assuming a discount rate of 2-10% the present value of the long-term revenue loss was in the interval from 1.75 DKK to 5.27 DKK. So depending on the charity discount rate, the net revenue effect for the charity could have been negative.

Table 3: Welfare effects

	Welfare in DKK per individual
Potential donors who were nudged	
Welfare for donors	1,191.02
Welfare for non-donors	-12.95
Average welfare	1.50
Nudging charity (2-10% discounting)	
Immediate revenue	3.07
Long-term loss	[1.75; 5.27]
Net effect	[-2.19; 1.33]

Notes: Adapted from Damgaard & Gravert (2018).

These results also illustrate that heterogeneity in the behavioral response to the nudge also leads to heterogeneity in welfare effects as donors and non-donors are impacted very differently. Allcott & Kessler (2019) also document heterogeneous welfare effects because people in their setting have widely different willingness to pay for a social comparison nudge aimed at reducing energy consumption. Some people wanted to be paid to receive the nudge. This would be similar to a negative welfare effect and Allcott & Kessler (2019) argue that moral costs associated with consuming energy can explain this. Their results are similar to ours since both studies find that ignoring non-implementation costs leads to an overestima-

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4. See also footnote 3 for further details.

tion of the welfare effects. As a possible solution Allcott & Kessler (2019) find that, in their setting, using an optimal targeting algorithm to target the nudge to individuals with a high willingness to pay for the nudge and a large expected behavioral response, could potentially double the welfare gains. In comparison, an opt-in nudge is judged to be much less effective in terms of raising total welfare, because inertia leads to a very low opt-in rate

5. Conclusion

Initial nudging research focused on demonstrating that nudges could produce positive effects despite standard economic theory leaving no room for nudges to influence behavior. Initial nudging publications provided examples of nudges producing sizable effects on primary outcomes at low implementation costs. Subsequent research has nuanced our view of nudging in several ways.

First, it appears that nudges on average (and at scale) have rather modest effects on primary outcomes. Recent research by DellaVigna & Linos (2021) puts the average effect at 1.4 percentage points for non-default interventions. Of course, greater effects may arise but similarly negative or statistically insignificant effects are possible. Nudges leading to a one-time behavior change with long term consequences may be more successful.

Second, effects are heterogeneous: Some people respond as intended, some people do not respond at all and some people may respond in unintended ways. A nudge seems to be able to influence an individual if (i) there is scope for improvement in behavior, (ii) the nudge removes or softens a relevant behavioral constraint, and (iii) the individual has a basic level of motivation to act in the desired way. Therefore, understanding behavioral constraints causing people to deviate from desired behavior as well as their motivation for behaving as desired could be key to designing more effective nudges.

Third, repeated nudges do not seem particularly good at moving people on the extensive margin but may be useful for ensuring persistent behavior change on the intensive margin

Finally, nudges might also have unintended spillover effects. This is the fourth topic, discussed in this paper. I have provided multiple examples of nudges causing unintended negative spillover effects, although at least one study has also documented positive spillover effects. This suggests that we should be careful to consider both intended and unintended effects when evaluating nudges. Especially since unintended effects and intangible costs of nudges may cause negative welfare effects for some individuals and not accounting for this will upward bias estimates of the welfare effects of nudges.

Taken together, this suggests that nudges should not stand alone as a policy tool. While nudging may continue to do well in cost-benefit comparisons of dif-

ferent policy options, despite the modest behavioral effects, it is possible that other policy tools such as bans, regulation, taxes, and subsidies are better at providing large shifts in behavior. At the same time, the discussion in this paper suggests that the case for nudging could be improved if we become better at targeting nudges and their design towards the individuals and situations where individuals are likely to benefit from them

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