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Nudging as a new 'soft' tool in environmental policy

An analysis based on insights from cognitive and social psychology

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Abstract

The idea of nudging has become increasingly popular in both academic and political circles. There are, however, many different interpretations of the term 'nudge' which blurs its scope. In this paper we focus on the conceptualization of nudges and its functionality in reference to the Dual Process models. Further, we discuss the potential applications of nudging in the field of environmental policy as an important extension of the current policy framework. In particular, we identify areas where nudges could be most effective. We also consider different combinations of nudges with other policy instruments. Our theoretical discussion is illustrated by a couple of examples concerning practical implementation of nudging.

Keywords: nudging; green nudges; behavioural economics; household emissions; environmental policy.

1. Introduction

Household emissions make up a considerable share of global GHG emissions. This is especially true when the carbon emissions embedded in products and services are traced from their origin, through the world's supply chains up to the end consumers (households). Following this logic, the carbon footprint (CF) of an average (two-person) German household amounts to 30 tons of CO_2 equivalents per year. Indirect emissions spanning not only domestic but also foreign supply chains contribute in a major way to that figure (Miehe et al. 2015).[1] Thus, interventions that target emissions at the level of household consumption display considerable potential for mitigation, albeit potential that extends beyond administrative borders. As a consequence, they can also be used to address the growing problem of 'weak' carbon leakage.[2]

[1] Please note that in this context direct emissions are considered to be those caused by direct use of fossil fuels, e.g. by burning coal for heating or petroleum for private transportation, while indirect emissions are considered as those released during the production of goods and services consumed by private households.

[2] 'Weak' carbon leakage, defined as the net emission transfer between Annex B and non-Annex B countries, is a burning issue for climate policy, one which undermines its effectiveness and increases total mitigation costs. For a detailed discussion of this and other types of carbon leakage, see Michalek and Schwarze 2015.

This mitigation potential, however, is very unlikely to be exhausted by the 'classical' production-based emissions control mechanisms such as cap-and-trade (Vandenbergh et al. 2008) or improved knowledge about climate change. This is because human behavior and, with it, individual consumption decisions are determined by several factors in addition to prices, product information or bans on goods and practices (behaviours) that are especially harmful for the environment. Specifically, factors such as structural barriers, the decision-making context, people's heuristics and cognitive biases have been proven to play an important role in the process of deciding what goods or services to purchase (Reisch and Hagen 2011).

These behavioural factors have recently attracted considerable attention, both from the research community as well as from policy makers, as offering a potential means of 'nudging' human behaviour in a desirable direction. The governments of several countries including the US, the UK and, more recently, Germany have established special advisory divisions to design policy measures on the basis of insights from human behavioural research. The proponents of the nudging approach argue that this type of intervention may be particularly useful and effective in the 'pockets of behaviour' where existing instruments have turned out to be virtually ineffective or politically unfeasible (Science and Technology Committee 2011). Other arguments in favour of nudges include the relatively low implementation costs and a high degree of compatibility with the values of modern individualistic societies (Moseley und Stoker 2013).[3]

In this paper we focus on a conceptualization of nudging and consider its potential for becoming a component of environmental policy. In particular, we investigate at what points and in what form nudging interventions could be deployed in order to achieve the best possible outcome on the basis of a positive economics approach. We begin our analysis in section 2 by introducing some basic concepts from cognitive and social psychology relating to Dual Process theories, which underlie the basic idea of nudging (Thaler and Sunstein 2008). This allows us to determine, in Section 3, the clear boundaries of the definitional and functional scope of nudges – an important task in view of the huge variety of interpretations of nudging in the literature. We also explain in this section how nudges can influence our intuitive and automatic decision-making process. The overview of the environmental policy toolkit, provided in Section 4, presents the options available to policy makers to control

[3] Please note that the nudging approach has also been heavily criticized, among other things, for manipulation, for impairment of choice and for compromising citizens' empowerment. For a normative discussion of nudges, see e.g. Goodwin 2012, Hagman et al. 2015.

emissions and identifies nudges as an important complement to 'soft' (non-restrictive) policy interventions and one which, up to now, had been absent from the toolkit. Section 5 discusses the effectiveness of nudges and related implementation issues. In particular, it identifies situations in which nudges may be most useful and effective. In section 6 we analyse the use of nudges in a policy instrument mix and investigate how nudging might improve the effectiveness of environmental regulation. Section 7 presents concrete examples of nudging options in Germany based on previous findings and on recent data regarding the CF of German households. Section 8 briefly summarizes our discussion, provides conclusions and highlights future research questions.

2. Human behaviour from the perspective of cognitive and social psychology

Analysing processes of human thinking and decision making is often based on the assumption that observed behaviour arises from two distinct but interacting cognitive processes. The same framework also applies to the social context, where an individual is defined as a member of a group (see e.g. Evans 2003, Chen et al 1999).

The distinction goes back to research conducted in the 1970s and 1980s on attitudes and human behaviour, which gave rise to the Dual Process theories. Although these models differ in their details, they are all based on the same underlying concept of two different cognitive processes and are thus mutually compatible and consistent (McElroy and Seta 2003). The first of these processes is automatic, intuitive and often emotion-driven, while the other is analytical, conscious and can be deliberately controlled (Petty and Cacioppo 1986: 'peripheral vs. central routes of processing', Epstein et al. 1992: 'rational vs. experiential systems', or Evans and Stanovich 2013: 'process 1 vs. process 2').[4] This paper adopts the terms cognitive process 1 and process 2, coined by Evans and Stanovic (2013), to refer to automatic and reflective cognitive processing respectively.

The cognitive operations entailed by process 1 can be described as fast and intuitive, and they often (but not always) lead to different types of cognitive biases that may result in suboptimal decisions. However, it should be stressed that intuitive actions can also be accurate and highly appropriate in certain decision–making situations (Simon and Chase 1973; Wilson and Schooler 1991; Klein 1998). For example, they have proven superior in decision-making contexts that demand fast decisions with minimal effort, such as those taken in traffic or while doing sports (see e.g. Gigerenzer and Brighton 2009). Further, process 1 is also responsible

[4] For a brief discussion of the Dual Process models, see e.g. Lee et al. 2009 or McElroy and Seta 2003.

for frequently repeated and highly skilled actions which often require considerable experience (Kahneman 2003b). Process 1 was also proven to drive many social judgments when people's level of motivation is low (Chen et al. 1999). It is precisely such reactions that are difficult to influence by means of regulatory tools on account of their reflexive and habit-bound nature. In contrast, the deliberately controlled cognitive operations of process 2 are relatively flexible and thus adjust easily to any pre-defined rules. They are slower and more effortful than reactions governed by process 1 (Kahneman 2003b), although this does not mean that they are error-free. Extended use of process 2, for example, can lead to the so-called overthinking bias. This in turn can lead to so-called 'cognitive noise' and, as a consequence, reduce the consistency of the preferences (Amir and Lobel 2008, Lee et al. 2009).

It is important for our conceptualization of nudges to note that the boundaries between the two processes are fluid. Indeed they often interact in practice. Effortless processes such as habitual behaviour generally neither cause nor are affected by much interference when combined with other more effortful tasks. On the contrary, actions governed by process 2 tend to disrupt parallel cognitive processes, as the overall capacity for mental effort is limited. Nonetheless, deliberate reasoning is to some extent always involved in controlling both mental processes (Kahneman2003a). Thus, cognitive processes can be arranged in the following order with regard to the frequency of their occurrence. First, the output generated by process 1 is always (though often very loosely) controlled and accepted by process 2. Second, the latter process intervenes and modifies intuitive judgments based on the perceptions and frameworks generated by process 1. Third, the decision results from a 'pure' process 2 judgment because no intuitive cues are available. Least frequently, intuitive input is rejected by reflective process 2 (Kahneman 2002).

3. What is nudging and how does it work?

The term 'nudge' has been popularized by Richard Thaler and Cass Sunstein. They describe a nudge as *'any aspect of the choice architecture* [decision environment[5]] *that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not.'*(Thaler and Sunstein 2008:6).

[5]In environmental psychology the key term 'environment' is typically used in a broader sense to encapsulate both physical and conceptual factors (Kaplan and Kaplan 2009).

The above definition mentions some important characteristics of a nudge; however, it lacks a crucial reference, namely, to the Dual Process theory of thinking, which underlies the fundamental idea of nudging and distinguishes it from other interventions. This omission has blurred the definition of nudge and nudging and has led to the emergence of different interpretations of the concept depending on the research question and/or area of application concerned (Ölander und Thøgersen 2014; Science and Technology Committee 2011).

In order to clarify this issue, we argue that behavioural interventions that are effected automatically and intuitively (process 1) and without restricting the choices available are at the heart of the nudging paradigm (Grüne-Yanoff and Hertwig 2015). However, in many cases process 1 output serves as a starting point for an informed decision and thus has only an indirect impact on the final decision; this is consistent with findings from cognitive psychology (see e.g. Kahneman 2002; Evans and Stanovich 2013). In consequence, a distinction has emerged in the literature between 'pure' type 1 nudges, which address process 1 outputs (e.g. reflexes) and type 2 nudges (e.g. 'social' nudges), which target reflective decision-making processes based on the underlying intuitive and automatic stimuli (Hansen and Jespersen 2013).

Some studies on nudging also refer to 'fuzzy nudges', a term which describes 'hybrid' instances. These can work either as a nudge (addressing process 1) or as a non-regulatory instrument such as 'pure' information provision (targeting process 2) (Selinger and Whyte 2011). The way a 'fuzzy nudge' works can be illustrated by the example of an Ambient Orb, a device that indicates real-time energy use by means of coloured light signals. The colour red, for example, represents high energy usage and can be interpreted rationally as an instruction (or recommendation) to turn off some electric appliances. However, it may also evoke an unconscious response to reduce energy use as a result of intuitive negative associations with the colour red [6] (Selinger and Whyte 2011, Maan et al. 2010).[7]

Apart from the Ambient Orb, the literature (including the book by Thaler and Sunstein) contains many other contentious examples. Some of these measures were designed to

[6] This kind of behavioural intervention is particularly effective because many people have been exposed to colour priming from their early childhood. Consequently, red is often unconsciously associated with negative features such as risk, danger or error (examples include the red traffic light, the school teacher's red pen to correct mistakes, red warning signals etc.; see Selinger and Whyte 2011). When the Ambient Orb glows with an amber-coloured light, indicating moderate levels of energy use, an observer's attention will be heightened. Green, on the other hand, indicating low energy demand, is a symbol of a stable situation and has been proven to exert a calming effect. For further details concerning the influence of colours on cognitive processes, see Gerend and Sias 2009, Elliot and Maier 2007.

[7] In our view, however, the Ambient Orb could also be interpreted as a 'pure' type 2 nudge, as the information it provides is particularly intuitive and accessible.

explicitly to target conscious decision making governed by process 2, but have nevertheless been classified as nudges. They include, inter alia, financial incentives, bans, educational campaigns, and attempts at persuasion or creating norms (for a discussion of *'mistaken nudges'*, see e.g. Selinger and Whyte 2011, Hausman and Welch 2010).

Some of these 'outliers' have been explicitly addressed by Barton and Grüne-Yanoff (2015) who, in addition to identifying well-established heuristic-triggering nudges, have also specified two other distinct functional groups, namely, heuristic-blocking and informational nudges.

It is worth noting that the latter two categories of nudging are very distinct from the former one, although they all have a common aim: to ensure that an individual makes an 'optimal decision'. While heuristic-triggering nudges work within the environment of cognitive process 1 and thus **bias or re-bias** intuitive and automatic perceptions (so-called type 1 bias), the two remaining groups try to push an individual away from process 1 and towards the reflective thinking governed by process 2. These tools have also been referred to as self-deliberation and correction mechanisms, since they correct and/or eliminate cognitive biases often resulting from intuitive and automatic thinking (Amir and Lobel 2008). In other words, they **de-bias** our judgments. Such de-biasing can work well in the case of 'purely' automatic and/or intuitive judgments (addressed by type 1 nudges) in contrast to thoughtful decisions based on intuitive input (Amir and Lobel 2008; Kahneman 2002). Intuitive judgments can be relatively easily corrected by explicitly pointing out possible biasing factors and logical inconsistencies and thus stimulating reconsideration (Amir and Lobel 2008; see also Fischhoff 1981 for a detailed discussion of de-biasing techniques).[8] Increasing the time available for deliberation may also improve a person's ability to make the 'right' decision (Kahneman and Frederick 2002). In such a case the intervention seeks to correct the 'monitoring error' of reflective process 2 which gave the biased intuitive input the 'green light'. In consequence, the intuitive judgment can be adjusted accordingly (correction) or rejected in toto (elimination of bias) (Kahneman 2002; Amir and Lobel 2008).

It should be noted, however, that cognitive process 2 can also generate biases (the so-called type 2 bias), which are generally very difficult to correct (Amir and Lobel 2008).[9] What is meant here is the so-called 'overthinking' bias caused by extensive use of process 2. Nudging

[8] Please note that 'de-biasing' - like nudging - has its limitations and may result in unexpected counter-effects. It is possible, for example, for someone to start paying particular attention to some factor that has been rendered salient by a regulator and in the process to begin to neglect another relevant factor. (Amir and Lobel 2008).

[9] At this point we do not refer to 'deliberate heuristics' because, due to the lack of information or time, a conscious use of such shortcuts is often the only possible solution. As a result, it cannot be classified as a decision-making error (Kahneman and Frederick 2002).

interventions can support the elimination of type 2 biases. In order for this to occur, an individual should be pushed towards an intuitive, heuristic-driven mode of thinking so that the 'rationale' for deploying nudges can be established.[10] Such a shift can be achieved, for example, by reducing the time available for deliberation and thereby impeding the person's ability to make a reflective decision (Amir and Lobel 2008). Figure 1 summarizes the above account and indicates how policy interventions can help people to make better decisions. This includes *unconscious* **biasing and re-biasing** by means of nudging (blue area) as well as *conscious* **de-biasing** by applying self-correction and self-deliberation techniques (red area), both interventions being aimed at reaching an 'optimal' decision (Amir and Lobel 2008; Selinger and Whyte 2011).

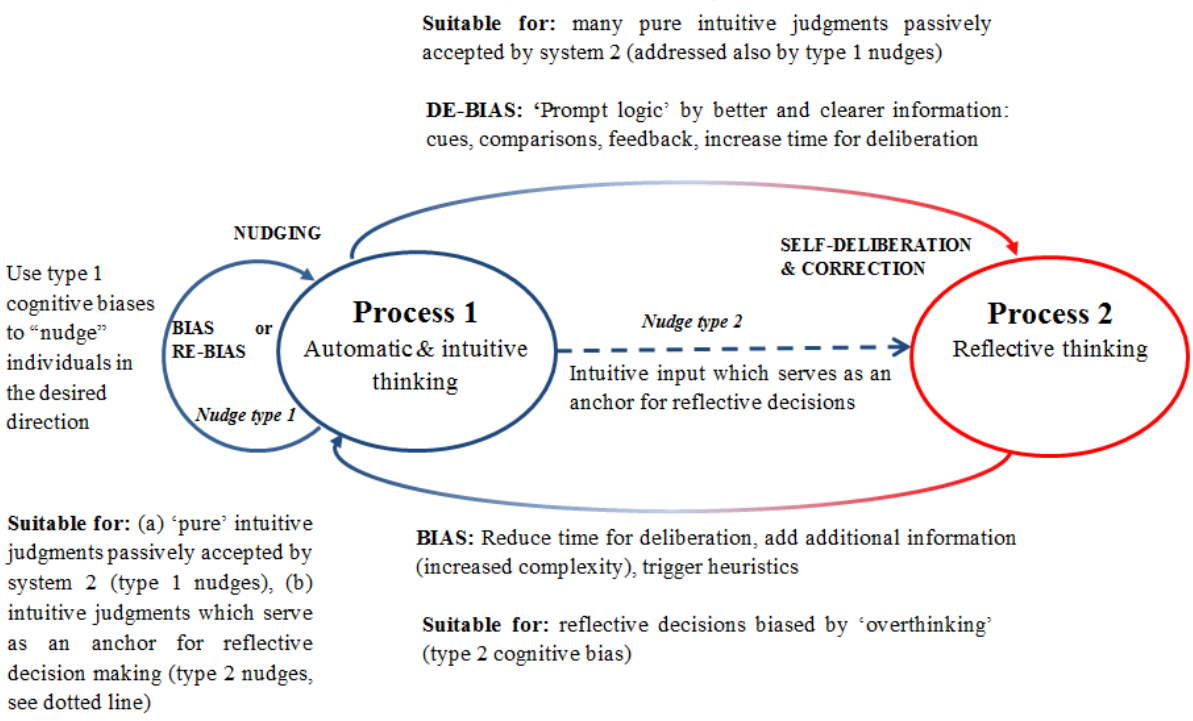

Fig. 1: A graphical representation of nudging, self-deliberation and correction process in relation to the interplay of cognitive process 1 and process 2.

In this paper we follow the 'moderate' line of argument suggested by Hansen and Jespersen (2013) and assume that nudging interventions *always* aim at influencing cognitive process 1 and that this can evoke a behavioral change, both directly (type 1 nudge) and indirectly, through cognitive process 2 (type 2 nudge), (Hansen and Jespersen 2013, see Appendix for specific examples of nudges).

[10] Please recall that a nudge can bias or re-bias only when cognitive process 1 is involved.

But how does nudging work in practice? People often have to make decisions on the basis of incomplete information. Decisions based on complete information, if possible at all, are extremely rare and costly (in terms of time and cognitive effort). The resulting 'bounded rationality' can be the outcome of either deliberate or intuitive processing (dominated by process 2 or process 1 respectively) (Kahneman and Frederick 2002). The first case is usually determined by time and informational constraints which make an individual decide *consciously* to focus solely on a particular dimension or aspect. The second arises more naturally due to a limited attention span and cognitive capacity. Experiences, associations and heuristics stored in the associative memory which are easily accessible play an important role in this context since they enable a fast reaction. Due to the so-called 'attribute substitution' process heuristics are often used as a proxy for a related attribute to be assessed, which is not accessible in a given choice situation (Kahneman and Frederick 2002; Kahneman 2002). Some attributes, especially those encountered repeatedly in daily situations, are always at hand.[11] Others need to be made readily accessible, e.g. by exposure near in time to the decision or by a prior priming process (Kahneman and Frederick 2002). Such heuristic-driven behaviour often leads to cognitive biases which, however, are generally fairly predictable (Kahneman and Frederick 2002).

Nudging is based on knowledge about such intuitive, heuristics-driven processes. It takes advantage of the fact that a particular choice architecture is always present. By adjusting this architecture appropriately, nudges can shift human attention to a particular aspect of the choice and thus trigger corresponding heuristics and associations. This affects the output of cognitive process 1 and makes an individual much more likely to make a choice in accordance with the regulator's expectations. Popular nudging techniques used to implement this knowledge in practice include framing, defaults (which can be considered as a special form of framing) and priming. While the first two methods influence the decision-making process through direct changes to the choice architecture, the second of these does so indirectly by referring to a previously primed piece of information or impression (Scheufele and Tewksbury 2007).

[11] Kahneman and Frederick present a short list of attributes – heuristics which are accessible by principle. These include e.g. size, distance or similarity, to name only a few (Kahneman and Frederick 2002).

In particular, framing refers to the presentation of a given choice situation where particular attributes are made salient.[12] This evokes information and/or associations and feelings connected with the emphasized attribute (Morewedge and Kahneman 2010). In consequence, the perception of a given choice situation as well as the preferences of the choice maker can become affected (Kahneman 2002).

In a similar vein, defaults can be considered as a special type of framing. Simple defaults denote a pre-defined (standard) option in addition to the other choice options.[13] The pre-selected option is determined in advance by the regulator and remains unchanged in most cases. The reasons for such 'stickiness' can vary greatly and include first and foremost (a) limited cognitive capacity to make a decision (e.g. due to thinking effort, time pressure etc.) as well as several cognitive biases.[14] These encompass (b) the perception of a default as an implicit recommendation evoked by uncertainty or a lack of expertise in a given field, fear concerning changes in the status quo resulting from (c) the endowment effect (Ölander and Thøgersen 2014; Sunstein and Reisch 2013) or (d) the so-called omission bias. In the latter case, an active negative behaviour is considered to be worse than inaction with an equivalent final outcome (Beretti et al., 2013). Finally, some scientists have tried to explain the effectiveness of defaults by means of 'query theory', according to which the order of a person's thoughts influences their decision-making process (Johnson et al. 2007). Thus, the first thought or choice option can be understood as an anchor in relation to which other options are considered (Reisch and Hagen 2011).

Priming, in turn, influences cognitive process 1 only indirectly by means of a stimulus experienced prior to the choice situation in question, e.g. a stimulus of self-confidence before solving a complex mathematical problem. Such previous exposure increases the accessibility of particular thoughts, attributes and impressions and thus makes them more likely to appear in subsequent – sometimes thematically very different – situations (Hallahan 1999). The

[12] Depending on the type of feature emphasized (risk connected to choice, characteristic of an object or outcome of a behaviour), the factor affected (preferences for risk, assessment, intention to engage in a particular behaviour) and the resulting evaluation of the framing intervention, one can distinguish between 3 categories: risky choice, attribute and goal framing (Levin et al. 1998).
However, the notion of framing can also be extended beyond the conceptual level to the physical environment. In art sciences, for example, the term framing refers typically to the position of physical objects and pictures. In these cases framing influences the interpretative meaning and subjective understanding of the situation or observed object (Brown et al. 2015). Please note that physical positioning is also an example of a nudge.

[13] For a detailed discussion of different types of defaults, see Johnson et al. 2012.

[14] It should be noted that, like heuristics, defaults can also be effective in the framework of reflective thinking governed by process 2. This is the case when a person decides rationally to rely on the pre-defined option and thus saves cognitive effort and time which they can invest in other activities to maximize their own utility. The potentially broad application of defaults (in decisions governed by both process 1 and process 2) explains the high degree of effectiveness of this tool.

frequency and recent timing of exposure to a stimulus (which determine its accessibility in the memory) are of crucial importance to the effectiveness of priming (Brewer et al. 2003).

4. Nudges as an extension of the policy toolkit

Environmental policy which seeks to prompt behavioural change at the consumer level (e.g. consumption of low-carbon goods, use of renewable energy, sorting waste, or buying energy-saving appliances etc.) encompasses a wide range of different interventions. Here we focus on those that target individual consumers directly. However, most of them (including nudges) can also affect consumers indirectly by directly regulating the supply side; this is sometimes called 'budging' (Oliver 2013; Oliver 2015; Science and Technology Committee 2011).

Environmental interventions can be broadly divided into two categories: those that restrict choice and those that are non-restrictive. The former include primarily mandatory regulations and bans as well as command and control (CAC) measures, such as standards. They influence human behaviour by restricting or eliminating particular choice options e.g. a smoking ban in public areas, an obligation to vaccinate etc. The overall improvement in social welfare that can be achieved by these behavioural commands constitutes the main legitimization behind this kind of policy to control externalities, and it is *normatively undisputed*. However, potential societal resistance towards the regulation, which may significantly undermine its effectiveness, constitutes a *non-negligible* problem within this group of instruments (Science and Technology Committee 2011).

The second category encompasses tools that guide individual behaviour in a direction deemed beneficial by the regulator (e.g. environmental protection and/or sustainability), but *does not formally restrict* an individual's freedom of choice. As such, these tools can be called 'soft' policy instruments. This group includes in particular such established policy instruments as economic incentives (positive or negative monetary incentives), persuasion through information provision, moral suasion and educational campaigns.

These instruments clearly differ in their degree of 'softness'. The high costs of a particular option do not formally prohibit its being chosen, but they do often rule it out of the set of feasible choices due to budgetary constraints.[15] Information and appeal to moral arguments, on the other hand, have a much lesser impact on this set of feasible choices; they may be acknowledged or neglected regardless of the financial conditions. Despite these differences, all the instruments mentioned above have one important feature in common: they assume that

[15] One can argue that this point is significantly weakened by the broad availability of financial instruments such as loans.

people think about and compare the options available and finally make a utility-maximizing decision in accordance with their individual (stable) preferences. Thus, the underlying cognitive operation is ruled by reflective process 2. However, human behaviour is much more often driven or strongly influenced by the automatic and intuitive responses generated by process 1 (cf. section 2). These are, in turn, determined by various heuristics, mental short-cuts and cognitive biases arising from restricted cognitive capacity and attention span (Reisch and Hagen 2011). This particular type of decision-making process is addressed explicitly by nudges, which exploit the above-mentioned characteristics of intuitive thinking. Thus, nudges extend the spectrum of 'soft' policy instruments beyond interventions that address deliberate thinking into the sphere of intuitive and automatic decision making. This extension constitutes an important step forward towards more effective regulation that targets changes in human behaviour. Table 1 illustrates how nudges complement the existing policy toolkit from a regulator's perspective, taking into account the psychological foundations of human behaviour.

Degree of softness		Dominated by process 1		Dominated by process 2
	Instruments that restrict choice*	Regulation that has become deeply rooted in the culture, beliefs, societal style of life	Bans Mandatory rules CAC measures	Bans and mandatory rules with *low-level* punishment for non-compliance (incentive to consider whether obeying the regulation 'pays off', Tenbrunsel and Messick 1999)
	Instruments that do not restrict choice ('soft' tools)	'Pure' Nudge (Type 1)	Nudge (Type 2)	Monetary incentives Non-monetary incentives Persuasion Moral suasion Pure information provision etc.

* In an extreme case, instruments that restrict choice can lead to a *physical elimination of choice*, e.g. command-and-control measures such as technical standards, which prohibit non-complying products from entering regulated area. If a particular option is not available in the choice architecture, the individual cannot process it mentally, and so this extreme case is not reflected in the table above. Please note that in the case of choice restricting instruments the undesirable options do not vanish from the choice architecture – they are simply beyond the scope of choice due to the regulatory stipulations. Disobeying the regulations may broaden the scope of choices but is done at the expense of incurring the consequences of non-compliance (punishment).

Table 1: Regulatory vs. psychological perspective on policy instruments to control emissions at the household level.

5. On the effectiveness of nudges

The practical application of any policy instrument is determined largely by its effectiveness. Other important factors include the costs associated with the intervention (will it be cost efficient?) and political feasibility (will the citizens of a given society accept it?). Since most nudges can be implemented at a *relatively* low cost and are less restrictive of choice than standard economic instruments such as price mechanisms (cf. degree of 'softness'), we need to focus primarily on effectiveness when discussing nudging in the policy making context. One important question to be answered is this: to what extent and in what situations can nudges be particularly effective?

Evaluating the effectiveness of a policy tool is not an easy task. A naive approach would be to infer a general statement about the performance of nudges based on a large number of relevant case studies. Following this logic, it could be said that nudges can induce behavioural changes in a number of different domains such as environmental policy and energy efficiency (see e.g. Pichert and Katsikopoulos 2008; Sunstein and Reisch 2013; Ölander and Thøgersen 2014), health (see e.g. Downs et al. 2009; Marteau et al. 2011; Dayan and Bar-Hillel 2011), organ donation (Johnson and Goldstein 2003; McKenzie et al. 2006), savings (see e.g. Madrian and Shea 2001; Willis 2013; Clark et al. 2014), insurance decisions (see e.g. Johnson et al. 1993), and car purchase decisions (see e.g. Park et al. 2000), to name a few examples.

However, it has to be acknowledged that methodological issues and the design of the study (such as characteristics of the study participants and the experimental setting or the type of nudge involved) can have a substantial influence on the final results. This makes it very difficult – if not impossible – to make any reliable statements about the general effectiveness of nudges. Consequently, different nudging tools implemented in specific environments (determined by the decision-making context, population etc.) can be expected to show different levels of effectiveness (Baldwin 2014; Bao and Ho 2015).[16] Finally, it should be noted that experimental tests do not always accurately predict how individuals would behave under real-world conditions (Alemanno and Spina 2014).

In light of these limitations, theoretical insights from cognitive and social psychology concerning human decision-making may prove to be very helpful. Based on the theoretical discussion in section 2 one can deduce that nudges, which are rooted in automatic and intuitive processes, should be *most effective* when applied to behavioural situations dominated by cognitive process 1 such as reflexes and to frequent (repeatable) actions characterized by a

[16] See different results on saving behaviour in Madrian and Shea (2001) compared to Beshears et al. (2010) and Bronchetti et al. (2011).

relatively low degree of personal relevance. Such 'low involvement' decisions[17] include many activities performed on a daily basis such as choosing a lunch option, doing the grocery shopping, using a means of transport to go to work/school etc. Many of these decisions become 'automatic' habits over time. It is worth noting that this category can also include highly complex behaviours that have become extremely well learned and thus no longer require any (conscious) thinking (cf. section 2).

This hypothesis has been supported empirically by analysing people's susceptibility to framing effects, an established nudging technique. As anticipated, the respondents working on a personal low-relevance task (the effect obtained by purposeful manipulation) were more likely to modify their judgment as a consequence of a corresponding framing than those who received personally relevant tasks. Similar though less homogenous results were obtained in a second experiment where natural predispositions towards 'analytic' vs. 'holistic thinking' were studied (see McElroy and Seta 2003 for a detailed description of both experiments and a brief overview of other studies with similar results). The enhanced performance of nudging interventions (in this case 'social nudges' relating to the social context) in low-involvement situations was also confirmed in a large field experiment. The results showed that people were much more likely to follow the descriptive normative beliefs (anticipation of another's behaviour - a form of 'social nudge') if they were not personally involved in the issue. The effect of descriptive normative beliefs on the behaviour of highly-involved people was proven to be still positive but weaker (Göckeritz et al. 2010).[18]

This effect could not be observed, however, in the studies on framing effects in personally relevant situations (McElroy and Seta 2003). Thus, the results on the nudges' impact on behaviour under conditions of high involvement are not unambiguously conclusive. From the psychological perspective, this can be explained by several different reasons. First and foremost, the two cognitive processes are not entirely unconnected to one another – very often they are both involved in the decision-making process. In particular, intuitive input such as emotions or impressions can underlie and thus indirectly influence a reflective judgment (see

[17] The term 'low involvement' is commonly used in marketing research to describe activities or products that induce low personal motivation to consume a specific product, search and/or interpret relevant information concerning this product (cf. Gordon et al. 1998). In fact, some academics argue that the nudge approach is not new and that it has been used for many years in practice by marketing people. Thus, they argue, nudging as a policy tool is very similar to marketing efforts, with one substantial difference: the maximization of individual/social welfare instead of profit maximization which can result in substantial redistributive effects (cf. Mont et al. 2014, Reisch and Hagen 2011, Amir and Lobel 2008).

[18] It should be noted that involvement can be defined and measured in many different ways, depending on the subject of the study. The common denominator of these definitions is high personal relevance and potential consequences for the individual taking the decision (Petty et al. 1983, Göckeritz et al. 2010).

e.g. Kahneman 2002). Second, individuals differ in their 'need for cognition', i.e. some people tend to engage in the decision-making process in a deliberate and reflective way more than others (Petty et al. 2009). Third, the same stimuli can be processed in different ways, depending on which process dominates: deliberative or automatic. For example, a picture can influence a judgment by evoking particular associations or impressions (an intuitive process). Alternatively, it can be interpreted and evaluated by another person as a source of relevant information (see e.g. Petty and Wegener 1999). Last but not least, the effortful and deliberate decision-making process is determined not only by motivation (e.g. personal relevance) but also by one's own (perceived) ability to solve the problem. The latter factor can be broken down further into the person's capability (e.g. knowledge of the specific subject, necessary skills etc.) and mental capacity (reduced by other tasks that need to be done in parallel, by time constraints, and by distractions) to perform the task in question. Thus, constraints affecting a person's ability to make a judgment exert a negative impact on the reflective decision-making process and encourage intuitive and automatic processing (McElroy and Seta, 2003, Ronis et al. 1989).

Changes (in attitude) evoked by automatic and intuitive process 1 are generally temporary and context dependent (Petty and Cacioppo 1981). In fact, some 'pure' nudges (type 1) that are driven primarily by process 1 (such as visual illusions) can be very strong – indeed almost irresistible, especially upon initial exposure.[19] However, as times passes and people gain experience with particular types of nudges, there is a high risk of the effect wearing off. This is very likely to occur in the case of visual illusions like speed control markings on roads. Local drivers travelling along a dangerous route every day may start to ignore the markings, whereas non-local drivers (to whom the markings are new or unfamiliar) are likely to heed them (Amir and Lobel 2008). In addition, there is a risk that individuals aware of such 'unavoidable' (quasi coercive) nudging might feel manipulated. This, in turn, may evoke psychological reactance, leading perhaps to an intentional countervailing action that is undertaken in an attempt to preserve one's own 'perceived freedom of choice' in response to a restrictive regulation (see e.g. Brehm and Brehm 1981; Bovens 2009; Wortman and Brehm 1975).

The performance of 'pure' nudges in canteens (a 'technical' adjustment of the choice architecture involving the highly accessible and visible positioning of healthy food) has not so far been reported to deteriorate over time, although serious concerns have been raised when it

[19] However, professionals familiar with visual illusions (such as photographers or painters) tend to be an exception to this rule - they can often recognize visual illusions immediately (Kahneman 2002).

comes to people's behaviour after they leave the canteen. This situation has barely been addressed at all by studies of nudges used to promote healthy food. However, Wisdom et al. (2010) have highlighted the plausible risk that, after having had a light (low calorie) and healthy meal, people may become hungry and/or more tempted to eat more after lunch, to buy snacks etc., and that this can undo the good done by eating a healthy meal. In addition to this, very slight nudging interventions involving only one category of food (sandwiches, but not beverages or starters) have been shown to be ineffective due to an increased consumption of soda (fizzy) drinks and high-calorie snacks (Wisdom et al. 2010). Similar problems may arise in other domains as well. For example, the policy goal of reducing GHG emissions may be easily undermined by spending the money saved through energy saving on other aspects of consumption (e.g. going on holiday by plane) - the so-called indirect re-bound effect (see Druckmann et al. 2011 for a study on rebound effects with respect to GHG emissions).

The cases discussed so far refer to situations in which a nudge is used continuously. One might expect that the effectiveness of a nudge would be eliminated (or would decline rapidly) after it has been removed from the choice architecture because the 'decision' to engage in a particular action has been automatic and/or intuitive (one cannot expect drivers to slow down at a particular spot if the visual illusion is not evoked). In a similar vein, a person is rather unlikely to look for a healthy food that used to be located at the canteen entrance if they always take 'whatever' option is placed near the entrance[20]. Behavioural persistence could be generated by deploying four different techniques: (1) habit formation, (2) influencing a person's way of thinking, (3) changes in future costs, and (4) creating behaviour-reinforcing loops in the choice environment (for a detailed discussion, see Frey and Rogers 2014).

'Pure' type 1 nudges operating in the domain of cognitive process 1 are rather unlikely to fully exploit these 'persistence pathways' when used as a standalone tool. However, when combined with some deliberate thinking to initiate a new behavioural pattern (either a type 2 nudge or a type 1 nudge combined with a 'classical' non-restrictive instrument), nudges might become capable of developing persistence, provided that the intervention was repeated over a fairly long period of time. This can be illustrated by the example of Home Energy Reports (HER), sent out as a special service by the US energy efficiency company OPOWER, which are based on social comparisons and are thus a 'social' nudge. Initially, HERs were proven to prompt significant reductions in energy use a couple of days after being received; after that,

[20] This example assumes that the choice of a meal (e.g. during a short lunch break) is almost automatic. Of course, the situation might be different if the person has a lot of time to think about their choice and displays high involvement in relation to nutrition (e.g. I may choose my food very carefully because I am on a diet and am therefore determined to spend time and effort on finding suitable food).

however, the effect dropped off so fast that it would most likely disappear totally if the intervention was halted. However, after 2 years of regularly receiving the service, some indications of persistence were observed, albeit decreasing at a rate of 10-20 % each year. Such long-term effects could be explained primarily by a strengthening of habitual behaviour (HER acts as a 'reminder' to repeat daily energy-saving actions) and by a growth in 'physical capital' (HER encourages people to invest in energy-saving equipment that produces energy savings in the long run[21]). The habit was not fully developed after two years, however, as households that continued to receive their HERs achieved much better energy-saving results than those which discontinued the service (Allcott and Rogers 2014).[22] Since habit formation was proven to follow an asymptotic curve in terms of effectiveness (Lally et al. 2010), it is important to continue with the intervention until the curve becomes flat and a habit is fully established.

The psychology literature provides some evidence that nudging can indeed facilitate habit formation – 'habit' referring to an *automatic* behaviour which is activated by a contextual cue and does not involve conscious thinking. Habits can evolve as a consequence of a repeated behaviour performed in a stable context (Lally et al. 2010; Orbell and Verplanken 2010).

The two stages of each repeated behaviour, *initiation* and *persistence*, are usually determined by different factors. Initiation requires that, in order to engage in a particular action to achieve a specific goal, a person attains awareness and engages in an 'active' mode of thinking. This process typically occurs in novel situations or when accustomed conditions change. In such a case the degree of thoughtfulness and thus the potential to establish or modify a behavioural pattern will depend on the personal relevance of the new situation. This can range from 'naturally' occurring changes, such as a change in appearance or changes in the choice environment (e.g. the unexpected absence of an option that is usually selected), to planned interventions, such as informational campaigns, attempts at persuasion, and so forth (to be discussed in greater detail in the following section on potential policy mixes). Persistence, on the other hand, is strengthened by resources and enabling factors such as skills, knowledge and, most importantly, memory (Ronis et al. 1989).

The so-called favourable environment – one which does not hinder but rather makes it easier to perform the desired action – also plays an important role. Actions that are easy to

[21] Psychological studies show that even the first small positive changes in behaviour (e.g. energy-saving behaviour) can enhance a person's perception of their self-efficacy and thus encourage them to continue to behave accordingly; this can lead to involvement in further related activities (such as buying energy-saving appliance that amplify the initial effect, see e.g. Gardner et al. 2012).

[22] The time required to form a robust habit is still the subject of extensive research. Experiments indicate that it takes about 10 weeks on average to form a habit if an action is performed daily (Gardner et al. 2012).

accomplish can be turned into automatic habits faster with the passing of time. Further, successful accomplishment reinforces the behaviour in question and encourages further related outreach possibilities (Gardner et al. 2012). Since many people decide deliberatively to start a certain behavioural pattern but then falter when it comes to continuing it, persistence plays a crucial role in habit formation (Ronis et al. 1989).

Nudges encompassing a wide range of different measures could effortlessly adjust a given choice architecture to facilitate the enactment of certain behaviours in the habit formation stage. These might include physically re-arranging objects (positioning), providing memory-enhancing cues (implemented by the means of framing or priming), implicitly offering a recommendation in complicated knowledge-intensive decisions (defaults) and, finally, inducing specific thoughts and associations to trigger the automatic response when the habit has been already formed (cf. Orbell and Verplanken 2010).

To sum up, we can conclude that there is a positive relationship between the involvement of cognitive process 1 in the decision-making process and the effectiveness of nudging. Nudging interventions can undoubtedly improve and simplify the human decision-making process by creating or re-shaping the cognitive biases generated by process 1 (so-called **type 1 bias**), which determines automatic responses or generates the cues that underlie reflective decisions (Amir and Lobel 2008). In particular, 'pure' (type 1) nudges can be recommended when a *fast, accurate*[23]*and situation-specific* response (no durable behavioural change) is desired. In such a case, however, policy makers must bear in mind the risk of psychological reactance. Nudges which encompass a degree of deliberate thinking (type 2), on the other hand, can prove highly suitable when regulators are seeking to achieve a lasting effect and have enough time and other resources to continue nudging over quite a long period of time. In fact, a nudge that involves some deliberate thinking to engage in a particular behaviour may help to develop a habit – a highly robust and durable form of behavior which may persist even once the underlying intention or motivation has disappeared (Ronis et al 1989; Gardner et al. 2012). Particular attention should be paid, however, to the design of such interventions in order to avoid the formation of a bad habit – which is equally difficult to change as a good one. Last but not least, it should not be forgotten that nudging is also used to correct biases generated by cognitive process 2 (the so-called **type 2 bias**), which are generally very difficult to tackle (Amir and Lobel 2008, cf. section 3).

[23] It should be noted that 'pure' nudges such as reflexes or visual illusions are almost irresistible.

6. Nudges in the Instrument Mix

The following section extends our conceptual and functional analysis by discussing the way nudges can be combined with other types of policy measures and the possible results of such instrument mixes.

The idea of implementing nudges 'in a package' to prompt behavioural change on a large scale has generally been supported by policy makers (Science and Technology Committee 2011). However, so far there are no coherent guidelines in existence for creating an effective mix of instruments containing nudges. This section aims to fill out this gap. First, we discuss the characteristics of an instrument mix and a more comprehensive policy mix. In a second step, we present some specific instrument mixes which contain elements of nudging.

The debate about 'instrument and policy mixes' in the domain of environmental and sustainability policy and analyses of their respective effects have recently attracted considerable attention in the literature (e.g. Howlett and Rayner 2007; Flanagan et al. 2011). This has resulted in a diversity of definitional approaches, ranging from equating the term 'policy mix' with the term 'instrument mix' to more nuanced approaches. According to the former view, the term 'instrument mix' refers to the combination of different instruments and their interaction (e.g. influences and modifications resulting from this interaction). In contrast to this, a more comprehensive definition of the term 'policy mix' includes a process-oriented perspective, i.e. it also considers the processes by which policies emerge and the long-term strategic implications of a policy (Rogge and Reichardt 2013). In the following, the focus will be on the 'instrument mix' perspective and on a discussion of the effects of their combined use.

Beginning with a discussion of the mixed use of nudges with bans, mandates and command and control mechanisms (collectively sometimes labelled as 'shoves', see e.g. Sunstein 2014), these policy instruments are generally considered to be of a highly intrusive character. As such, they can hardly be regarded as a policy intervention derived from insights about the cognitive characteristics of decision making. In fact, regulators might be aware of various behavioural patterns that influence a person's decision making but may nonetheless consider the risk of the regulated subject not responding to a non-restrictive measure to be too high or not acceptable at all. Critics point out that bans and mandates can lead to over-regulation. Hence, if (empirical and/or experimental) evidence is gathered to show that a detrimental behaviour can be avoided by nudges (at least for the majority of the population), then

replacing restrictive mechanisms with nudges might avoid over-regulation from a strategic point of view (Di Porto and Rangone 2013).

Because of the restrictive nature of bans, mandates, and command and control mechanisms, a strategy that involves mixing them with nudges (i.e. mixed strategies) hardly seems feasible. Nonetheless, it might be possible to deploy such a combination in the form of mandatory cool-off periods (e.g. Guala and Mittone 2015; Mills 2015). The cool-off period can be described as a temporary limited ban aimed at reducing or eliminating fast and emotional responses often characterized by type 1 bias (Barton and Grüne-Yanoff 2015). With regard to our discussion above we would classify this intervention as a mix of self-deliberation (cf. section 3) and regulation. However, it can be also regarded as a nudge enhanced by a ban when viewed from another point of view (cf. heuristic-blocking nudges described by Barton and Grüne-Yanoff 2015). In addition, it should be borne in mind that command and control policies implicitly include some elements of nudging because the 'command' sets the normative default of socially desired behaviour.

In addition to the human-centric perspective that usually underlies nudges, the rationale behind them – i.e. knowledge of cognitive processes, decision making and resulting behavioural patterns – can be the starting point for regulation informed by behavioural economics. This instrument (that is, combining the idea behind nudging with the tools of regulation and labelled in the literature as 'budging') starts from a supply side perspective in order to counteract efforts at manipulation by the private sector on their own territory, instead of developing measures to counter harmful effects through behavioural changes on an individual, demand-side level. Behavioural economics in this context, then, is not a rationale for choice-preserving nudges but rather provides a theoretical foundation for the limits of nudging (Oliver 2013). According to the idea of behaviourally informed regulation, budges can be divided into two types. In the first type, policy makers require knowledge of behavioural economics in order to detect private sector actions that are aimed at exploiting the behavioural patterns of individuals. A second type goes one step beyond this, consisting of regulatory measures that are informed directly by insights from behavioural economics in order to strengthen the effect of a budge. An example of the first type would be a ban on positioning unhealthy food at eye level in a supermarket in order to avoid companies using the influence of salience on individual behaviour. An example for the second type would be to introduce a ranking system that addresses the characteristic of loss aversion and motivates companies to aim for a higher ranking (Oliver 2015).

Turning our focus to nudges combined with classical non-restricting policy tools, such as monetary incentives or the provision of information, we now offer a (brief) review of these tools in light of the insights about human decision making and cognitive processes presented above. Policy makers' expectations of these established tools are often shaped by the linear thinking of the neoclassical model, where individuals consciously process the information they are given[24] and respond 'rationally' to it. Thus, policy makers considering the use of these established non-restrictive policy measures generally depart from this perspective when making projections on their expected effects (Selinger and Whyte 2011).

In contrast to these projections, the analysis of monetary incentives in particular suggests that a more differentiated perspective is needed. Here, a large amount of empirical and experimental evidence suggests that price instruments tend to be not as effective as expected (see e.g. Chetty et al. 2009; Gneezy et al. 2011; Bowles and Polania-Reyes 2012; Goldin and Lawson 2015). In this context, insights from cognitive processing and human decision making reveal that the informational effects of monetary incentives are accompanied by various behavioural patterns that operate through process 1 (i.e. intuitive and affective behaviour). One significant example is salience: individuals know about monetary incentives when their attention is drawn to them but pay no attention to instruments that are not transparent to them when deciding what to buy (Chetty et al. 2009). Other affective patterns of monetary incentives include the importance of reference points when judging the value or utility of a monetary incentive, loss aversion (which makes losses appear larger than gains), the greater significance accorded to small probabilities, and the allocation of money to 'discrete mental accounts' (Dolan et al. 2012). A third aspect is the interaction between social norms and monetary incentives. Here, the introduction of monetary incentives may crowd out intrinsic motivations and consequently diminish the incentives' effects (Gneezy et al. 2011).

Nudges place a greater emphasis on the duality of intuitive and deliberate thinking and work explicitly with the influence of intuitive thinking on human decision making (Selinger and Whyte 2011). In particular, they acknowledge that there is a heterogeneous population consisting of both active and passive choosers. Here, active choosers are representative of the deliberative decision process in that they consider the available information and make a choice according to their preferences. In contrast, passive choosers follow the pattern of intuitive behaviour which (among other behavioural patterns) implies that they often simply pick whichever option is the default one (Goldin and Lawson 2015). Taking this

[24] Monetary incentives are a type of information but are also considered to have affective components, as we shall discuss below.

heterogeneity into account, a mixed strategy of nudges and other non-restricting tools seems particularly appealing, as the mix would influence each group in turn, both the active and the passive choosers, through the appropriate channels (Griffith et al. 2014). However, there is still little knowledge about how these groups of policy interventions operate in practice, mainly due to the rather limited amount of empirical and experimental evidence available. Given the crowding-out effects of monetary incentives on voluntary contributions to public good provision due to social norms, an analogous situation might be conceivable here.

In this context, existing empirical findings so far have not revealed any negative interaction between nudges and pure information provision or feedback. In fact, health and nutrition studies have suggested that a combined use of both these tools may have a habit forming impact (Wisdom et al. 2010). Further research indicates that information and advice which explicitly address the techniques of how to engage cognitive process 1 can significantly increase the chances of producing long-term behavioural change (Gardner et al. 2012). Hence, habit formation might be one of the most promising aspects of an instrument mix that includes nudges and other non-restrictive policy instruments.

Additional implications for the design of an instrument mix emerge when efficiency is taken into account. Given a set of heterogeneous actors addressed by a certain policy intervention, the above mentioned rationale of active and passive choosers implies that there might be scenarios (e.g. a high proportion of passive choosers) in which command and control policies outperform monetary incentives. This evaluation of the efficiency of policy tools changes again when a particular type of nudges – namely defaults – are considered. As mentioned above, both defaults and command and control mechanisms set a standard for the addressees of a policy measure. In contrast to the restrictive command and control policy which solely foresees sanctions in the case of non-compliance, the default can be combined with explicit incentives so that deviations from the standard lead to additional costs *and* benefits. This mixed strategy offers active as well as passive choosers flexibility and 'allows' them to make optimal choices according to their preferences. The result of this mixed strategy therefore outperforms one-dimensional policy measures, be they monetary incentives or command and control policies (Meran and Schwarze 2015).

Alongside the discussion of various instrument mixes that include nudges, it is also interesting to consider the parallel use of multiple nudging interventions ('a double nudge'). The empirical and experimental research in this area is still very limited. Empirical evidence from social psychology indicates that the effectiveness of descriptive norms (often used as a 'social' nudge) can be greatly enhanced by salience. In particular, it has been shown that in a

littered environment (circumstances clearly implying a negative descriptive norm) people pay greater attention to the status quo when they see a person dropping waste and thus tend to litter more compared to a 'neutral' passer-by. In a similar vein, they litter less in a clean environment if their attention is caught by a person dropping waste and thus *evidently* violating the existing descriptive norm compared to the case of a person just passing by (Cialdini 2003). Further, empirical experiments indicate that using descriptive and injunctive norms in combination to point at desirable behaviours can be particularly effective. It has been hypothesized that this effect can be explained by the fact that these two types of social norms involve a different degree of cognitive processing and thus impact intentions and behaviour in different ways. While descriptive norms are rather intuitive, injunctive norms typically require more cognitive effort, such as the interpretation and assessment of their content (Cialdini 2003) These considerations could be further extended to discuss the combined use of type 1 nudges (e.g. defaults) and type 2 nudges (e.g. an additional reference to social rules – a 'social nudge'). Since these two types of nudge would also require different levels of cognitive processing and use different impact channels (cf. section 3), one might expect a mix of the two to improve their performance, particularly within a heterogeneous population (a hypothesis requiring empirical validation).

7. Possibilities for applying nudges – the example of Germany

The above theoretical discussion of nudges and of the situations in which they can potentially be applied has been based on insights from the Dual Process model and on considerations of efficiency and can be illustrated by reference to practical examples from the environmental domain. A recent study conducted by Miehe et al. (2015) identified those areas of consumption that contributed most to the average German household's carbon footprint in the year 2008 (GHG emissions were calculated using the MRIO model and were thus traced through global supply chains to German household final consumption). The results indicate that the largest amounts of (global) emissions induced by an average German household come from housing (34%), transportation (24%), food (18%), goods (15%) and services (9%). A considerable proportion of housing emissions come from direct use of fossil fuels, including oil and gas for heating and cooling, or electricity (indirect emissions). As regards transportation, most of the emissions comprised a direct use of fuel, followed by emissions from air transport. In the food category, most of the emissions were traced back to products of animal origin such as meat, eggs or cheese, largely due to the high amount of methane (CH_4) generated, which is a by-product of livestock farming. In the category 'consumption of goods'

many embedded emissions could be accounted for as a result of recreation, culture and sports as well as clothing. Services entailed the lowest share of embedded emissions, which derived mainly from health care, education and other services (Miehe et al. 2015).

Empirical studies show that many nudges have been implemented successfully in areas of consumption such as housing, transportation and traffic, and food as a means of achieving various socio-political goals (see e.g. Rozin et al. 2011 and Marteau et al. 2011 for a study on how nudges can be applied to tackle the obesity problem, and Putnam 2015 for a system of 'dancing traffic lights' that helped to increase pedestrian safety). It is interesting to note that these areas also turn out to be the most carbon-intensive. Within these broad categories, however, it is necessary to identify concrete mitigation actions where nudges could make a significant contribution towards climate protection.[25] The analysis presented above of the effectiveness of nudging in low- vs. high-involvement situations may be very helpful in this respect.

Home insulation can reduce direct energy use considerably; it is usually a decision taken just once, but one that requires significant investment. As a novel situation that places a burden on a household's budget, it can be considered a high-involvement decision which will not be taken without careful consideration and a comparison of options available on the market. A similar logic applies to private investments in renewable power generation, such as solar panels installed on the roof of a house. Here, monetary incentives, tax deductions, and educational campaigns that highlight the long-term savings can be expected to be most useful. However, as already mentioned, the benefits of taking particular actions may be stressed or made 'more intuitive' by the use of nudges. This will make the decision-making process easier and faster for those who would use logic in any case to arrive at the optimal solution ('active choosers') and will help those who may stumble during that process (e.g. due to information overload, limited attention), that is, the 'passive choosers' (Goldin and Lawson 2015).

Several studies have shown that applying defaults to electricity contracts increases the rate of use of renewable energy. Choosing an electricity provider is also a task undertaken rather infrequently; however, the cost difference connected with the choice of energy provider/ energy mix is rather small compared to the above mentioned investments. This activity can therefore be assumed to be lower in involvement than the previous two. It is very difficult to state clearly, however, the reasons why defaults show a high level of stickiness in this area

[25] Grießhammer et al. (2010) identified ten activities to reduce GHG emissions most effectively at the household level using data from Germany (Table 51). In the following we refer to some of these examples.

and achieve results comparable to monetary incentives. A recent experiment conducted by Ebeling and Lotz (2015) revealed that almost 84% of respondents recalled well their choice of renewable energy as a default and thus took the decision consciously. This may indicate that, in many cases of choosing an electricity provider, people decide consciously to stick to the default, perhaps because of an implicit recommendation, their lack of expertise in the area, time constraints etc. It should be kept in mind, however, that defaults may be effective for any number of reasons and that these can vary between individuals (cf. section 3). Regardless of the underlying reason, defaults display a high level of effectiveness in increasing the proportion of renewable energy used by household consumers; this suggests they should be applied increasingly in that particular domain. The question that policy makers should keep in mind concerns available renewable energy capacity: if from tomorrow all German households were to update their energy contract and a considerable proportion of them decided to keep the renewable energy mix set as a default, could this demand be satisfied (Ebeling and Lotz 2015)?

At the same time, nudges can prompt behavioural change much easier and faster than economic instruments when they are applied to many simple, repeatable activities performed daily, in other words in 'low-involvement' situations. The decisions taken on a daily basis are usually associated with rather low costs; they are of rather low or moderate personal relevance, and they often turn into 'automatic' habits. Although the potential GHG emissions reductions are rather low within each individual activity, when combined and aggregated over a longer period of time they make a significant difference. Such behavioural change could be achieved, for example, in the domain of transportation by improving public transportation to workplaces and schools (better coordinated network with a high-frequency service, increased number of stops which are visible and available within walking distance etc.) while also making appropriate infrastructural adjustments. This might include new bus and bicycle lanes as well as an altered 'street geometry' – the strategic arrangement of parking spaces that makes it impossible for drivers to reach their destination faster than pedestrians (Kordansky and Hermann 2011).

Considerable emissions reductions – often underestimated – could also be achieved in the category of food and nutrition. By placing seasonal, locally grown fruit and vegetables appropriately in shops (preferably those from organic farms that use no synthetic fertilizers, which are a source of nitrous oxides N_2O, a long-lived GHG, see United States Environmental Protection Agency), regulators can nudge consumers towards low-emission food that does not have to be transported by plane or ship or be stored for months in cooling warehouses. Even

greater GHG emissions reductions in private consumption could be achieved by promoting vegetarian (non-meat) dishes in canteens and cafeterias, by improving the visual presentation of such meals, by making them more accessible (e.g. placing them near the entrance) or by applying knowledge about favourable ambient features (e.g. appropriate lighting, temperature, aroma etc. (Wansink 2004). A study of the carbon footprint of the most popular food products in Sweden conducted by Carlsson-Kanyama and Gonzalez showed that the consumption of 1 kg of beef results in the same amount of GHG emissions as the average emissions per passenger generated over a distance of 160 km using the European car fleet benchmark (Carlsson-Kanyama and Gonzalez 2009).[26] In addition, the use of 'green' nudges to reduce GHG emissions in low-involvement areas of everyday life could in many cases create desirable socio-political co-benefits, such as the health benefits of healthier food, a reduction in local pollution, not to mention individual budgetary savings.

8. Conclusion

By focusing on the use of nudges in environmental policy, we have obtained a number of insights concerning both the fundamental conceptualization of nudging and the practical implementation issues involved.

Nudges are often introduced to a broader audience through the work of Sunstein and Thaler, who, by way of numerous case studies, describe how nudges might alter people's choice architecture and consequently influence their behaviour. However, as we have shown, a closer look at the cognitive and social psychology literature is necessary in order to better understand the nature of nudges and their distinctive characteristics. With regard to our findings on Dual Process theories, one distinguishing characteristic of nudges is that they explicitly work with behavioural patterns resulting from intuitive and automatic cognitive processes. This accentuation of the importance of intuitive cognitive processes allows for a clear distinction between nudges and other 'soft' policy measures such as monetary incentives or educational campaigns, which are intended to target deliberate thinking. It also makes it possible to identify different types of nudges; 'pure' type 1 nudges and type 2 nudges, to use the nomenclature introduced by Hansen and Jespersen (2013).

Starting from these findings and the resulting categorization, nudges prove to be an important instrument within the environmental policy toolkit, as they are a key mechanism when it comes to addressing intuitive and habitual environmental behaviour through policy

[26] In the case of a tropical fruit an analogically calculated distance to produce the same amount of embedded emissions would be 60km.

instruments. Nudges can serve as a corrective measure in order to bias or re-bias human judgments in a desired direction without the use of active reflective reasoning. They therefore fill an important gap in the domain of non-restrictive, 'soft' policy instruments targeting reflective cognitive processes.

When evaluating the effectiveness of nudges, a variety of aspects have to be taken into account. Cognitive psychology offers a rationale of how nudges work, but when it comes to practical implementation, it becomes clear that the 'nudgee's' personal attributes and social circumstances as well as the broader perception of the nudge in society can result in a range of context-specific outcomes for the same tool, including potentially unexpected countervailing effects. Thus, policy design issues should be particularly well thought through.

With regard to a mixed strategy including other policy tools, nudges can be combined – as the group of type 2 nudges implies – with other non-restrictive policy measures. Here, a combination of nudges and other 'soft' measures promises to address both kinds of cognitive processes and therefore to be particularly efficient given a heterogeneous population consisting of active and passive choosers (Goldin and Lawson 2015). A mixed strategy that includes restrictive measures ('shoves') seems to be difficult due to the intrusive character of the latter. However, 'budges' – behaviourally informed regulation – combine the rationale underlying nudges with restrictive measures and provide a tool for supply side interventions.

Although the amount of research on nudging is growing continuously, a number of research questions still remain unanswered. The theoretical rationale for nudging along with numerous case studies provide evidence for the effectiveness of nudges in many different domains, but there are also a few empirical examples of nudges having failed (see e.g. Beshears et al. 2010; Willis 2013). Some of these unsuccessful attempts at nudging might also have negative consequences for individuals. Given a heterogeneous population, particularly simple defaults or 'social nudges' can potentially damage the welfare of some individuals (Madrian 2014). Hence, further research is urgently needed regarding the effectiveness of nudges in the face of heterogeneous 'nudgees' and the possible negative spillovers. Furthermore, the combined use of classical policy tools with nudges is an area that requires further empirical verification. In the context of the long-term effects of nudges and their use in a mixed strategy, additional empirical and/or experimental research could be very useful when it comes to designing policies that reinforce certain beneficial habits. Finally, the combined use of different types of nudges ('double nudges') also largely remains an area in need of further research, especially in terms of practical implementation.

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Appendix: Examples of type 1 and type 2 nudges

Type 1 nudge		**Type 2 nudge**	
General application →	Extensions to environmental domain	General application →	Extensions to environmental domain
1. Visual illusions:		**1. 'Social' nudges**:	
- traffic control: they make drivers believe they are going faster than they really are (see e.g. Thaler and Sunstein 2008)	- support for fuel-efficient driving: speed reduction on highways (driving at 90 km/h reduces fuel consumption by 20% compared to 120 km/h),[27] cf. (Thaler and Sunstein 2008)	- applied in several different domains to guide behaviour.	- prevention of timber theft and littering in the forest (Cialdini 2003)
		References to *positive* descriptive (practised) and / or injunctive (approved of) norms	- water and energy conservation through multiple use of towels by hotel guests (Goldstein et al. 2008)
		Using social comparisons	- energy conservation by sending reports indicating a household's own energy usage and a comparable neighbourhood household's energy usage (see e.g. Schultz et al. 2007; Allcott 2011; Costa and Kahn 2013, Ayres et al. 2013)
2. Physical and ambient features of the choice environment		**2. Framing /salience**	
• Positioning of objects: - Obesity prevention,	- propagation of low-carbon food: placement of vegan dishes and food	- Presenting choice in positive or negative terms (based on a typology by Levin et al. 1998): • Framing risky choices: positive framing (emphasis	- climate change communication (see e.g.

[27] http://eartheasy.com/move_fuel_efficient_driving.html

propagation of healthy nutrition: healthy food is presented in visible and easily accessible places in canteens, lunch bars and shops (see e.g. Marteau et al. 2011; Rozin et al. 2011; Skov et al. 2013) • Using ambient characteristics: - 'soft lighting' such as candlelight encourages people to stay longer in a restaurant and order additional food (Wansink 2004) - classical music played loudly in public areas and shops deters vandalism and misbehaviour among young adults (Hirsch 2007)	made from locally grown organic products in visible, accessible places in supermarkets and canteens, see e.g. Reisch and Hagen 2011) - public transportation: improved accessibility by public transportation (more forms of transport operating at shorter intervals) - using ambient techniques to encourage pro-climate consumer choices , e.g. divisions in a shop/ canteen where low-carbon food is sold, cf. (Wansink 2004), in public transportation etc.	on gain) supports risk aversion, while negative framing (emphasis on loss) encourages risk taking. - bargaining: risk-averse decisions were made more frequently when the emphasis was put on the potential gain; risky behaviour was observed more often when potential loss mitigation was stressed (Schurr 1987) • goal frame: positive framing stresses gains from performing an action / negative framing highlights losses resulting from doing nothing. - increasing work productivity by framing performance bonuses in terms of a loss (Hossain and List 2012) - effective healthcare and disease prevention: loss-framed messages increase mammography and HIV test rates; gain framing is very useful for encouraging physical exercise, application of sun screen (Salovey and Williams-Piehota, 2004) • attribute framing: placing emphasis on a particular aspect of an object influences its evaluation - labelling: a product contains 10% fat vs. a product is 90% fat-free (Levin and Gaeth 1988, Levin et al. 1998)	Morton et al. 2011) - presenting inertia/ inaction as a loss: non-adoption of energy-saving behaviour and appliances results in a monetary loss (see e.g. Beretti et al. 2013) - eco-labelling: a product has been manufactured using 80% 'grey' coal energy vs. a product has been manufactured using 20% 'green' renewable energy, cf. (Levin et al. 1998)
3a Defaults (Opt-out) - Organ donation: organ donation is presented as a pre-defined option (Johnson and Goldstein 2003)	- Promotion of renewable energy: a renewable energy mix is a pre-defined option in an energy contract (see e.g. Pichert and Katsikopoulos 2008, Sunstein and Reisch 2013) - Paper savings: double-sided printing defaults (see e.g. Sunstein and Reisch 2013; Egebark und Ekström	**3. Prompted defaults (people are forced to make an active choice)** - Retirement savings plans: enforcement of active choice increases enrollment in 401(k) savings plan compared to an opt-in option. This solution is particularly useful when the population has heterogeneous preferences (see e.g. Carroll et al. 2009).	- Paper savings: stickers 'no ads please' half-attached to mail boxes (attach or remove) (Liebig and Rommel 2014)

	2013) - Heating savings: pre-defined settings on office thermostats (Brown et al. 2013), air conditioning. - CO_2 compensation payments: compensation for CO_2 emissions is included in price (Araña and León 2013)	
3b Default size/amount of goods - obesity prevention: smaller plate and glass in canteens and lunch bars (Wansink 2004)	- water/ paper conservation: pre-defined amount of water in tap to wash/ paper towel to dry hands	
		4. Intuitive labelling, symbols (***accessible*** information) - obesity prevention, healthy nutrition: traffic light labels on products - green: healthy, yellow: caution recommended, red: unhealthy (Hagen 2010) - propagation of low-carbon (climate friendly) food: traffic light labels on products (green: low, yellow: moderate, red: high CF compared to other food products), cf. (Hagen 2010)

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