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The Timing of (Green) Incentives: Exploiting Opportunity Windows

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Abstract: Incentives have been extensively studied in the management and policy literature, with most attention focusing on their type, magnitude, alignment, and effects. More recently, scholars paid attention to discounting issues and how these issues impact the effectiveness of incentives. Building on the nascent literature related to incentive timing, we argue that *timing* can offer an additional dimension to better characterize incentives and leverage their power by exploiting windows of opportunity. Using conceptual reasoning, we identify several mechanisms by which the timing of incentives can be used to increase their behavioral power. Specifically, well-timed (green) incentives can harness temporal landmarks, intermittence, immediacy and surprise effects, and intrinsic motivation reinforcement to reach environmental goals without significantly increasing the overall costs. We also indicate new avenues for further research such as designing a timing menu or considering time itself as an incentive.

Keywords: environmental policies; incentives; opportunity window; temporal landmarks; timing.

1. Introduction

Incentives are widely considered promising to motivate individuals and businesses to adopt environmentally friendly behaviors. For example, several European countries offer bonuses to encourage individuals and businesses to switch to electric vehicles (Langbroek et al. 2016). Payments for ecosystem services are increasingly used worldwide to incentivize agents (e.g., farmers, land owners) who can modify their practices to maintain or enhance ecosystem services (550 active programs around the world corresponding to \$ 36–42 billion US in annual transactions [Salzman et al. 2018]). More recently, a PricewaterhouseCoopers publication emphasized that governments increasingly use incentives and disincentives to speed up decarbonization (Murphy & Muller, 2022). As an illustration, “for one [cement] company [in Canada], projects with a capital value in the region of US\$1.5 billion were found to qualify for incentives equal to 50% of the spend” (Murphy & Muller, 2022). In the same vein, beyond their initial focus on financial performance, remuneration plans for top executives increasingly include sustainability targets. Although the greening of remuneration plans is still on-going and a lot remains to be done, it illustrates well how sustainability incentives pervades the whole business world (e.g., Maas & Rosendaal, 2016; Hill, 2021).

Incentives have been studied widely, with most attention focusing on their type (e.g., financial, social, moral), magnitude, alignment, and effects on behaviors. For instance, contrary to the conventional wisdom, well-intentioned incentives can undermine or crowd out intrinsic motivation (e.g., Frey 1994; Fehr & Falk 2002; Gneezy et al. 2011; Gneezy et al. 2020). Frey & Oberholzer-Ghee (1997) found that the percentage of individuals willing to accept a nuclear waste repository in their neighborhood dropped from about 50% to about 25% when financial incentives were offered. Similarly, when parents were fined for being late in picking up their children from daycare, they were more often late than before and even after the fine removal (Gneezy & Rustichini, 2000).

Scholars paid substantial attention to exponential *versus* hyperbolic discounting issues and understood that incentives design needs to take into account whether some agents discount in a time consistent way or not (e.g., Laibson 1997; Frederick et al. 2002; Duflo et al. 2011; Werthschulte, 2023). Similarly, they also found that loss *versus* gain framing (Hossain & List 2012; see also Ferraro & Tracy 2022 and Tversky & Kahneman, 1981) impacts the effectiveness of incentive schemes. Despite these two aspects that have generated a sizeable literature, there is a knowledge gap on the identification of other mechanisms by which the timing of incentives can be leveraged to increase their behavioral change power. We contend that filling this gap will open a new research and policy agenda and deliver innovative insights for a wiser use of incentives in various settings.¹

Our main argument is that there exists *opportunity windows* to be seized to substantially increase the power of incentives to modify environment-related behaviors. In other words, the incentives and their framing are an important part of the solution but not the whole solution. We posit that *the times at which similar incentives are introduced can substantially impact whether and how they will impact environment-related behaviors*. Several mechanisms can play a role in the timing of incentives such as temporal landmarks, intermittence, immediacy and surprise effects and intrinsic motivation reinforcement. For ease

¹ Our work also differs from the literature on dynamic incentives. While there is an explicit consideration of timing in this literature, our setting and goals are different. The literature on dynamic incentives analyzes the concept of time, within the paradigm of game theory, as a sequence within a game involving the regulator and a firm (Requate, 2005). The regulator has the option to either play first and propose an incentive based on the current technology and innovation levels, or play second, following the firm's choice of its R&D policy. The timing issue in this literature revolves around the decision of whether to play first or second in the game. This is how Requate (2005) refers to ex ante versus ex post regulation. Our objective is broader by considering various kinds of incentives, with or without strategic considerations, and we pay attention to behavioral insights that may seem irrelevant in a game theory setting.

of exposition, we mainly use examples in the environmental domain, notably incentives aiming at encouraging consumers to purchase preferentially environmentally-friendly products and those aiming to encourage companies to adopt conservation schemes and green practices. Nevertheless, our insights can be applied to many other organizations (e.g., NGOs, public administrations, universities) and domains where incentives are prevalent.

Our contribution has a conceptual nature. While it does not include empirical data and analysis, it builds on the existing literature to identify mechanisms by which incentive timing can be leveraged. It also uses a coherent and compelling logic to better understand the effects of incentive timing (Vargo & Koskela-Huotari, 2020) on influencing environment-related behaviors. Following the recommendation of Gilson and Goldberg (2015), we seek to bridge existing theories and disciplines in interesting ways, provide multi-level insights, and broaden the scope of scholarly thinking. Although such conceptual papers differ from usual contributions and do not follow the usual template, they can raise important issues and open pathbreaking research directions. As far as we know, the timing of incentives has not attracted a systematic analysis from incentive theorists and practitioners. This gap contrasts with the crucial need of innovative solutions to address the environmental challenges. Our research objective is thus to identify and describe various mechanisms by which the timing of incentives can shape their outcomes in terms of behavioral change. We draw innovative insights that call for empirical investigation on how to use this incentive timing to modify environmental behaviors in a context where other levers are less available.

Our paper can stimulate research on the timing of incentives. It can also enrich the toolbox of incentive designers and users, which is of paramount importance, especially as many organizations and policymakers combine a need to change behaviors and simultaneously face severe budgetary constraints. The novel contribution of the paper is mainly twofold. First, a better understanding of the timing of incentives can allow a better

characterization of incentives and offer a refreshing way to analyze the performance of similar incentives administered at different times, by introducing the concept of windows of opportunities. Second, considering systematically the timing of incentives helps solve puzzling situations (e.g., performance discrepancy for similar incentives, under- or counterproductive incentives caused by bad timing) and indicate unexpected directions for a better design and performance of incentive packages.

In Section 2, we provide an overview of the substantial literature devoted to incentives as motivators of behavioral change. According to the theory of incentives (Laffont & Martimort, 2009; Gneezy et al. 2011), people are pulled towards behaviors that are rewarded and pushed away from behaviors that generate negative consequences. In Section 3, we address how the timing dimension can influence the perception and effectiveness of incentives. Section 4 is devoted to practical implications, especially for policymakers and managers. Section 5 concludes.

2. Taking stock on the use of incentives to change behavior

Incentives are anything that motivates an individual to perform an activity or more generally anything that influences the behavior of an entity (e.g., a business) in a predictable way. In other words, incentives are stimuli that motivate someone to do something or discourage him/her to perform a behavior. Incentives aim at provoking or eliciting a particular response. Some leading scholars on the study of incentives, Gneezy et al. (2020, p. 524), proposed the following definition and distinctions:

“Incentives are rewards or punishments that motivate agents to take up an activity and guide the way they perform it. Incentives can be positive or negative and can be tangible or not. For example, positive incentives can take the form of tangible rewards such as money, vouchers, badges, and trophies or be intangible like feedback, praise,

or affection. Similarly, negative incentives can be tangible, such as fines, or intangible, like criticism or public berating and so on.”

2.1. The several dimensions of incentives

The literature characterized incentives according to several dimensions. An intuitive one is the incentive magnitude by distinguishing large versus small incentives. Large incentives frequently lead to reactions that show little deviation from rationality (although there are exceptions) while small incentives are more prone to the effect of irrelevant factors (McFadden, 2009). Another classical distinction is between intrinsic (the activity is performed for its own sake) and extrinsic motivations (the activity is driven by external rewards) (see, for example, Frey & Stutzer 2007).² For instance, when business executives are intrinsically motivated to perform green achievements (Graafland et al., 2012), introducing additional incentives to encourage these achievements can threaten and undermine this intrinsic motivation (Falchi et al., 2022). Moreover, incentives have a valence that is either negative (discouraging the activity) or positive (encouragement for the activity). They also can be applied at an individual or collective level. For example, some agri-environmental incentives target individual farmers while other incentives target a group of farmers (Kuhfuss et al., 2016; Kaczan et al., 2017). Furthermore, incentives can benefit the self or others (Imas, 2014). They can combine moral (person’s conception of right and wrong), social (emanating from interactions with others) and financial/economic components (cost-benefit analysis to

² Woolley and Fishbach, (2015, p. 968) distinguish extrinsic and intrinsic incentives. Extrinsic incentives “are the positive outcomes outside the activity that result from pursuing it (i.e., rewards)” while “intrinsic incentives” are “internal to the activity and cannot be separated from it (e.g., the positive experience delivered as part of pursuing an activity)”. For instance, “work tasks not only offer compensation (extrinsic incentives); they can also be challenging or interesting (intrinsic incentives).”

perform what is the best for the individual), including in the environmental domain (Mzoughi 2011).

While the distinction between moral, social and economic incentives is usually used, the term “incentives” is sometimes used in a broader sense to capture other situations such as reputational incentives, policy incentives, regulatory incentives and so forth, where the nature of what motivates the agent is indicated in the qualifying adjective accompanying the incentive. Sometimes, the context itself generates purposefully or not incentives to behave in some way that can (or cannot) correspond to the announced goal. For instance, the so-called Cobra effect describes a situation where an incentive promotes a behaviour that harms the pursued goal. In the 1800s, the British government paid bounties to eradicate cobras in Delhi, but people reacted by raising snakes to kill them to get the bounty.

For sake of convenience, we frequently refer to monetary incentives, but our reasoning can also be applied to other types of incentives although the effects are unlikely to be identical. Moreover, except when specified otherwise, we are interested in incentives used to motivate environmental behavior change.

2.2. The hidden cost of incentives

Historically, most incentive-based interventions have focused on financial incentives although several behavioral economics contributions pay attention to moral and social components and their interaction with economic ones (e.g., Frey & Oberholzer-Gee 1997; Kahneman 2003). Indeed, while the main message seems intuitively convincing (incentives matter in motivating behavioral change), well-intentioned incentives can have unintended consequences and sometimes backfire (Gneezy et al., 2011). In short, one-size-fits-all incentives are unlikely to deliver the expected results, emphasizing how much details matter. For instance, a poorly designed extrinsic incentive, activating a ‘doing it for money’ mindset, can crowd out intrinsic motivation, compared to a situation without extrinsic incentives (e.g., Frey & Oberholzer-Gee

1997). For instance, rewarding people for sustainable behaviors such as recycling can backfire because people infer that the incentive, rather than one's underlying attitude, is the motivation for considered behaviors (Lee, 2022).

Moreover, some non-financial incentives (e.g., in-kind incentives, (negative) awards, public recognition, status, or identity-related benefits) can be more effective than financial ones to encourage intrinsically or socially motivated efforts (e.g., Heyman & Ariely, 2004; Lequin et al. 2019; Celse et al., 2022), especially when the financial reward is small. Recent evidence supports that non-financial incentives can drive sustainable e-commerce delivery (Rai et al., 2021). For instance, companies can be harmed by negative awards such as being identified as the worst performers on a given environmental dimension. Financial rewards have to be large enough to compensate the undermining of existing motivations (Rare and The Behavioural Insights Team 2019; Gneezy & Rustichini, 2001). In other words, the design and implementation of incentives can be substantially enhanced by considering behavioral insights (e.g., Beretti et al., 2013).

Of course, these examples do not make justice to the whole range of existing studies. For instance, we did not discuss the studies arguing that incentives would have weak, unintended or even counterproductive effects. For example, Frey & Oberholzer-Ghee (1997) showed how the introduction of financial incentives reduced substantially the percentage of individuals willing to accept a nuclear waste repository in their neighborhood. In another domain, the Endangered Species Act may have generated perverse incentives for landowners to pre-emptively clear habitat if they think that an endangered species might someday be found on their lands and resulting in more severe land use regulations (Lueck & Michael 2003).

2.3. The framing effects

The framing of incentives can strongly influence their ability to influence behavior. The incentive framing can put the targeted individual or organization in a gain (generally

operationalized by delivering the incentive after the task completion) versus loss frame (frequently operationalized by delivering incentive before the task) with important behavioral consequences³ (see, e.g., Fryer et al., 2022; see also Kahneman & Tversky, 1979; Tversky & Kahneman, 1981). As an illustration, Homonoff (2018) examined whether the framing of a financial incentive (either as a fee for a bad action or a reward for a good action) influences policy effectiveness. She found empirical support that a five-cent tax on disposable bag use decreased disposable bag use while a five-cent bonus for reusable bag use generated no effect on behavior. Nevertheless, recent synthesis stress that evidence is more mixed than previously stated (Ferraro & Tracy, 2022).

In the same vein, the words used to describe an equivalent incentive can transform how the incentive will be perceived and result in a crowding-out or crowding-in effect (Farrow et al. 2018). For instance, proposing an identical incentive to farmers to adopt conservation practices as a *compensation* (supporting intrinsic motivation) versus a *payment* (risk of undermining intrinsic motivation) can impact farmers' reactions beyond what is predicted by a neoclassical approach that emphasizes the incentive amount (Clot et al. 2017).

2.4. 'Regret lotteries'

'Regret lotteries' or prize draws are sometimes preferable to fixed incentives. In a regret lottery, every participant receives a lottery ticket. Participants have to activate their ticket by meeting some requirements such as using public transportation to go to work. When the prize

³ The field experiment used in Hossain and List (2012) constitutes an illustration of such settings. Indeed, in the positively framed bonus treatment employees are notified that if their productivity reaches a certain threshold, a bonus is paid at the end of the period. In the negatively framed bonus treatment, however, employees are given the bonus before the work begins, but are notified that if their productivity does not reach a certain threshold, it is retracted at the end of the period.

is drawn, all the tickets are included, regardless of whether they have been activated. If a non-activated ticket is drawn (because the individual did not use public transportation), the corresponding participant cannot receive the prize and will be informed that s/he could have won it. The prize can be redrawn or jackpotted for a next draw. As a consequence, the individual will vividly feel the loss and is likely to experience a strong regret. ‘Regret lotteries’ do not require ticket purchase but use some identifiers (e.g., license number) and only those who have adopted the behavioral change can win.

The ‘regret lottery’ leverages the overweighting of small probabilities, loss aversion (i.e., framing earnings as lost money [Kahneman & Tversky, 1979]), and regret aversion since individuals who fail to take the rewarded action may have experience feelings of regret (Kessler & Zhang 2014, see also Zeelenberg & Beattie, 1997). A practical example is a lottery in a plastic bottle deposit return scheme, by offering people to get a small reward back (€ 0.10), but also to get entered into a lottery to win a bigger prize (€ 50) when the bottle is returned (Rare and The Behavioural Insights Team 2019). If an individual does not return his/her bottles, s/he can feel regret because s/he has missed the opportunity to participate in the lottery and potentially win an important prize.

2.5. The discounting dimension of incentives

It is important to emphasize a significant caveat. There exists an important literature on discounting (notably exponential versus (quasi-) hyperbolic) with several applications in the incentive domain. A major lesson is that upfront incentives can help to cope with the present bias, that is, individuals’ focus on immediate gratification (Gneezy et al. 2020). For instance, Duflo et al. (2011) argued that the low use of fertilizers by Kenyan farmers was related to timing issues rather than unaffordability. At harvest time, farmers have available cash, but are not motivated to buy fertilizers, and, later in in the season, when it is time to use fertilizers, they do not have enough money. Using a randomized controlled trial, Duflo et al (2011) tested

whether a nudge (specifically, free delivery if fertilizer is bought immediately after harvest) encouraging farmers to buy fertilizer when they have cash will augment fertilizer use. They found that this small incentive (free delivery) offered immediately after the harvest, pushing farmers to purchase fertilizer in advance, was much more effective than a similar offer at a later time and as effective as a 50-percent discount on fertilizer price, offered during the growing season. More recently, Werthschulte (2023) showed experimentally that while the predominant payment system for water or energy is pay-later billing, immediate payment or pay-as-you-go billing can alleviate present-biased discounting and lead to consumption reductions. We make the choice to not deal with the discounting dimension but focus on other and less known aspects of incentive timing.

3. Introducing the timing dimension of incentives

Our aim is to stress that paying attention to factors that are often left to the background, like timing issues, can be fruitful and offer new directions for future research and policy applications. Incentives can be characterized on several dimensions, such as type, magnitude, alignment with the pursued goal, timing and so forth. Interestingly, misalignment between goals and incentives have been found to be a major impediment that prevents incentives to deliver their full potential (Kerr, 1975; He et al., 2020; Blonz, Forthcoming). Indeed, rewarding individuals or businesses on the basis of some sustainable targets can push them to game the system, by hitting the target but missing the point (see, e.g., Hill, 2021 regarding executive remuneration on the basis of sustainability targets). For sake of clarity and to advance our argument, we consider in a simplified framework that incentives, regardless of their nature, can be distinguished along two dimensions related to the administration of incentives (Figure 1):

- (i) First, we consider the ‘*when*’ dimension on a spectrum from immediate incentives, delivered just after the task completion to delayed incentives that are delivered with

delay, well after the task completion. Indeed, the literature converges on the insight that immediate incentives, should be preferred over delayed incentives. The greater the delay, the weaker the incentive power. Delivering an incentive too late often leads to reduction in response rate.⁴

- (ii) The other dimension corresponds to ‘*how often*’ the incentives are administered from a one-shot incentive to a repeated and systematic administration (continuous reinforcement) once the targeted task/behavior is performed. In between, we have various partial intermittent reinforcement schedules (fixed-ratio, variable ratio, fixed-interval, variable-interval), with the variable-ratio which is usually considered as the most resistant schedule to extinction (Zuriff, 1970).

[Insert Figure 1 around here]

Let us briefly discuss the four quadrants depicted in Figure 1. While we may not have examples corresponding exactly to each polar situation, we provide real-world illustrations to stress the relevance of our framework. In the quadrant A, there is a one-shot and immediate incentive, which can fit a behavioral change that must be performed only once. An illustrative

⁴ Interestingly, this dimension can encompass other situations, such as when a regulator (or another entity) announces that it will introduce an incentive at a given point in time. This time point can be close, distant or unspecified, which leaves room for interpretation by the regulated entities. An important issue here is time (in)consistency, which captures whether what has been announced will be respected (or not) at the deadline, notably if there is a change of circumstances (see, e.g., Matsuyama, 1990; Cadot & Sinclair-Desgagné, 1994). For instance, a regulator can use an “announcement effect” or “threat” (e.g., threat of a tightening of environmental standards) to push regulated entities to undertake some actions (e.g., developing cleaner technologies to cope with those standards) (Cadot & Sinclair-Desgagné, 1994), but once the implementation time comes, can decide to respect or not its announcement.

example could be rebates or bonuses offered only once for new consumers. Recent research (Roberson & Helveston, 2022) has shown that individuals overwhelmingly prefer immediate rebates, valuing them more than sales tax exemptions, tax credits, or tax deduction.

Conversely, a one-shot incentive is unlikely to provoke a sustainable change if a new habit must be learned. The incentive described in quadrant B can be very ineffective if it is used to change a repetitive behavior, because the incentive is delivered with delay and without an intermittent reinforcement schedule. The quadrant C combines two key parameters of an effective timing: immediacy and continuous reinforcement. For example, it is possible to deliver both social and monetary rewards in real time via modern technology (e.g., offering praise and/or an immediate digital payment via a smartphone application when an individual meets a step environmental goal) (Gardiner & Bryan, 2017). The quadrant D corresponds to an intermediate situation where repetition facilitates a lasting change but the effectiveness is diminished by the delay. We suggest that managers and policymakers reflect on the timing of the incentives they are using or considering, rather than leaving this issue to chance.

In the following, we will give more flesh to the timing dimension by examining why it can impact the change power of incentives. Given the conceptual nature of our contribution, we draw arguments from two main sources, precisely, a literature analysis that has studied and discussed issues related to incentive timing but in a fragmented way and logical reasoning (see Gilson & Goldberg, 2015; Lindebaum, 2022) that allows us to consider the extension of some rationales to similar situations involving environmental issues. We also use examples, illustrations, anecdotal evidence and sometimes more formal empirical evidence to support our argumentation. We describe several mechanisms that can be regrouped under an incentive timing label.

3.1. Timing and temporal landmarks

Timing could be related to temporal landmarks and deadlines. Temporal landmarks are events that mentally structure and account for the passage of time (such as anniversaries, weddings, graduations, new jobs, promotions, and New Year's Eve). They notably include predictable life-cycle events and disruptive events that destabilize otherwise stable-contexts. These “moments of change” offer windows of opportunity where the effect of an incentive can be decoupled. The concept of temporal landmarks (Dai et al., 2014, 2015; Dai & Li, 2019) is a relevant axis of analysis that allows us to approach the issues of motivation. Dai et al. (2014) studied how Google searches for the terms “diet” and “gym visit” are much more frequent after certain temporal landmarks. They argued that this mental accounting can favor a “fresh start” effect: people may associate their past imperfections with their past personality, relegating them to a previous period. This will tend to motivate aspirational behaviors. Schäfer et al. (2012) proved that resistance to change decreases when change is proposed around temporal landmarks (such as becoming a parent, or retiring).

Another landmark can be natural disasters that make people more sensitive to the use of incentive to promote a green transition. For instance, Emam et al. (2020) found evidence that disruptive moments such as nuclear accidents reinforce society's disapproval of polluting technologies and open a window of opportunities to eventually initiate a change toward green energy. We argue that if people are concerned about the environment but feel guilty about their lack of action, there may be a window of opportunity to use certain temporal landmarks to trigger pro-environmental behavior or to achieve stronger support by these individuals for taxation that supports environmental goals.

Interestingly, the habit discontinuity hypothesis (see, e.g., Verplanken et al., 2008; Verplanken & Roy, 2016; Haggard et al., 2019) states that behavior change interventions are more effective when delivered in the context of life course changes. For instance, Verplanken

and Roy (2016) assumed that when habits are (temporarily) disturbed, people are more sensitive to new information and adopt a mindset that is conducive to behavior change. They found that relocation increases the effectiveness of an intervention promoting sustainable behaviors. Interestingly, their results suggest that “the duration of the ‘window of opportunity’ was three months after relocation.”

Several underlying mechanisms can lead to greater effectiveness when incentives are given around the time of a temporal landmark such as a higher saliency (the event or temporal landmark makes the issue that the incentive is targeting more salient), the event serves to unfreeze and break habits (as proposed by the habit discontinuity hypothesis). In this case, the event can also constitute a deadline for action, and the greater effectiveness of the incentive may simply arise from the fact that there is less opportunity to procrastinate and eventually forget to engage in an action. The event also opens new mental accounting periods and generates a sense of psychological disconnect between people’s past, current, and future selves. The temporal landmark creates a clean slate and allows people to relegate their missteps to the past and feel more confident. This elevated confidence provides “the impetus for people to strive toward their goals with renewed vigor in the present” (Dai & Li, 2019, p. 44). This process is often known as the fresh start effect.

In short, offering identical environment-related incentives to use ecofriendly transportation or recycling can be more effective *ceteris paribus* if they are delivered at temporal landmarks such as just after a move in a new location or before an important deadline.

A similar pattern can be considered for farmers at the set-up time, renewal of an agri-environmental contract or after a disease linked (either objectively or subjectively) to pesticides. Wallander et al. (2017) tested whether incentives would be more efficient if used right before a deadline (which could also be interpreted as a salient temporal landmark). They

wanted to test several information outreach methods on farmers to incentivize them to participate in the USDA's Conservation Reserve Program. They found that only the reminder letters sent to already-enrolled farmers immediately before the end of the program were efficient in incentivizing participation in the next program.

To be transparent, given that there are still several grey areas and knowledge gaps, we caution the reader against an over-interpretation of our insights. For instance, the distinction between an incentive before vs. after a temporal landmark is interesting and relevant although we are not in a position of suggesting which one will be the most effective in motivating change. Similarly, we are not in a position to disentangle the respective role of the various mechanisms mentioned above in driving the observed effect. In another direction, it seems relevant to explore whether specific temporal landmarks that have an explicit green dimension (Earth Day, Earth Overshoot) can open opportunity windows to trigger some environmentally-friendly decisions.

3.2. Timing in an intermittent incentive setting

Timing could also be an important factor in incentive issues when focusing on the impact of intermittent incentives. Intermittent incentives could be defined as incentives that happen at an unpredicted and stochastic moment. Arad et al. (2021) showed in a field experiment how intermittent incentives might be efficient in reinforcing long-term behavior and creating habits. Indeed, the effect of intermittent incentives lasted even after the ending of the reward period. Similarly, in a real-effort experiment, Hogarth and Villeval (2014) found that intermittent incentives led to a greater persistence of effort. They argued that it takes a long time for individuals during a long interval without an incentive to understand that the rewards have ended. Dai et al. (2015) suggested a similar concept regarding the effect of audits. They reported that when people experienced systematic audits, they reduced their contributions to

public goods immediately after the audit ended, whereas people experiencing random audits continued their contributions.

In an early contribution, Kohlenberg and Phillips (1973) found that an intermittent reinforcement schedule with in-kind incentives significantly decreased ground littering. Similarly, in the context of encouraging conservation on private lands, Stern (2006) argued that it is not necessary to reward the behavior every single time it is performed, but rather intermittently. Intermittent reinforcement is typically more effective at motivating long-term pro-environmental behavior maintenance than constant reinforcement (Winter & Koger 2011). Interestingly, operant conditioning –which is “the study of reversible behavior maintained by reinforcement schedules” (Staddon & Cerutti, 2003) – describes behavior “controlled” by its consequences where rewards and punishment are used to change behavior. Originating from the work of Skinner (e.g., Skinner, 1963), the operant conditioning theory relies on two fundamental hypotheses: (i) the cause of a behavior comes from the entity’s environment, where the entity is often an animal or a human being, (ii) the positive or negative consequence (being rewarded versus being punished) of the behavior on the entity determines whether the behavior will be repeated or not. A behavior that is rewarded is more likely to be repeated while a behavior that is punished is less likely to be repeated.

3.3. The immediacy effect

While the recommendation of delivering incentives almost immediately after the task completion was recognized few centuries ago (see, e.g. Beccaria, 1764), Schroeder and Fishbach (2015, p. 136) emphasized that “incentives should be paired as closely as possible to the task onset and conclusion. For instance, the effectiveness of bonuses should be negatively related to the delay in which they are delivered. The same reward (or bonus) will be valued less when it is given later rather than sooner after task completion, although the exact magnitude of

the reward difference necessary to equate the time delay will depend on individuals' discounting rate.”

In some situations, the temporal proximity between the targeted behavior and the incentive delivery can help to change behavior. For instance, immediate rewards can increase the positive experience of the task. These positive emotions can be stored and create a pattern where the brain realizes that the effort has resulted in something beneficial. Some corporations harness the opportunities offered by online interactions and designed programs to reward consumers, employees and other individuals in real time, instantaneously, “*at the exact moment they are the most engaged*” (Get Rewards 2019). For instance, Google have coined an expression “micro-moments” corresponding to the brief instants when “people are purchasing an item, researching something new, or discovering a new site” (Get Rewards 2019). Another counter-intuitive example of timing is used by Zappos, an online retailer. When recruiting new employees, this firm puts them in an intensive four-week training program, then proposes them after one week in to pay them \$2,000 (in addition of the time already worked) if they want to quit immediately (Taylor 2008). This practice uses a decisive moment to kick out the new hires who are not enough committed to and passionate about the company, to maintain and reinforce a happy and motivated workforce.

In experimental psychology, evidence exists that immediate punishment is more effective than delayed punishment in reducing undesirable behavior. Vogel-Sprott (1967) found that when people received a reward (money) and punishment (an electric shock) after pushing a button, they were less incentivized to push the button when the punishment was immediate than when it occurred a few seconds later. In this last condition, people tended to push the button much more often than when the punishment was immediate. While we believe that immediacy can constitute a valuable heuristic in many contexts, we are well aware that the reality can be more complex.

3.4. The potential of surprise and unexpected incentives

The element of surprise and unexpected incentives might also offer powerful leverage. Indeed, Mellers et al. (1997) emphasized that surprising outcomes (gain or loss) are overweighted. Unexpected outcomes have greater emotional impact than expected outcomes. They found that disappointment occurred when unexpected losses were higher on average than the relation of an unexpected gain. Similarly, a surprising gain provides a much more positive emotional response than a gain that is expected (Valenzuela et al. 2010). Symmetrically, a surprising loss entails a much more negative emotional response than an expected loss.

These results suggest that an unexpected tax could result in strong negative reactions and that incentives to voluntarily contribute to any public good, such environmental policies, could be inefficient. Therefore, from the perspective of incentivizing pro-environmental behavior, governments should communicate appropriately to tap in the effect of surprise. This concept also suggests that governments could require participation in a pro-environmental investment when unexpected tax reimbursements or unexpected reimbursements for other budgeted expenses are considered. For instance, authorities could require taxpayers to contribute to green energy investments precisely when they receive unexpected reimbursements for electricity bills. The idea would be to benefit from the “positive mood”, and the emotional availability generated by the surprise effect. Accordingly, it becomes crucial to identify early when those positive surprises occur. At the same time, imposing a green tax can lead to psychological reactance. For instance, Attari et al., 2009 (p. 1702) state that “hard regulations may evoke psychological reactance, with individuals seeking ways to re-establish their lost freedom.” This may negate any benefits arising from the unexpected gain, which stress the need to pay more attention to these situations where several factors play simultaneously.

3.5. Reinforcing intrinsic motivation and trust by appropriate timing

The optimal timing for incentives might be related to intrinsic motivation and trust. Woolley and Fishbach (2018; see also Liu et al., 2022) show that in a context where both intrinsic motivation and extrinsic motivation (reward) coexist for the execution of a task, intrinsic motivation will be higher if the reward is given before the execution of the task rather than after. One should note, however, that intrinsic motivation is measured with satisfaction questionnaire and that the reward is not related to any performance. Thus, the moral hazard and the incentive issue are not at stake. On the contrary, Boosey and Goerg (2020) showed that the timing of bonuses in a principal-agent configuration with moral hazard triggered either a trust and reciprocity mechanism or a reward mechanism from the agent, both of which tended to incentivize effort from the agent. According to this study, incentives are more efficient when bonuses are given during effort rather than before (which trigger only the trust effect) or after (which trigger the reward effect). Rewarding during effort would then trigger both mechanisms simultaneously. These seemingly divergent findings can be explained by variations in experimental set-ups, variations in used concepts according to the considered disciplines, and research goals, but they stress the need of further investigation to understand how an appropriate timing can lead to desired outcomes such as intrinsic motivation reinforcement or trust building. We posit that several moderators or variables could explain the discrepant findings such as the nature of the task and the preexisting relationship between the party that delivers the incentive and the performer.

Applied to environmental issues, these findings suggest that a good understanding of conditions required to provoke or sustain an environmental change can also indicate an appropriate incentive timing. An incentive timing can indicate to people whether they are trusted or not and can even trigger a self-fulfilling mechanism. For instance, a field experiment study conducted in the hotel sector found that when hotels promised to donate money later and conditionally, in exchange for towel reuse, towel reuse did not increase. But

when hotels stated they had already donated on behalf of guests, i.e., before the targeted green behavior, towel reuse rose significantly (Goldstein et al., 2007). The authors interpreted their findings in terms of reciprocity (Goldstein et al., 2007), but we argue that timing can constitute a strong lever to characterize the relationship nature between the incentive providers and targets.

4. Practical implications

Our analysis has several practical implications. We are well aware that more empirical testing is needed to fully validate a real-world implementation of time-based incentives.

Nevertheless, from a conceptual stance, we can advance some important insights. As a caution, let us repeat that we do not advocate that adding monetary incentives to preexisting situations is a catch-all solution that will lead to the expected outcomes. When their use is justified, incentive architects should also consider their timing. A good timing can increase the power of incentives and the timing strategy for (positive) incentives should be different from the timing for (negative) incentives.

Timing of incentive delivery is not a neutral and inconsequential choice. In what follows, we propose some major implications for incentive designers that can nudge the power of incentives at a modest cost. Our analysis suggests that it is fruitful to systematically consider whether timing can affect the perception of the incentives. For instance, if we combine the exacerbating effect of surprise with the concept of limited attention, one could think that a person could perceive an expected negative outcome as unexpected and thus, feel a high negative emotion because of it. For example, green tax rules may be hard to understand for most people. Some taxes could be perceived as being unexpected because of a wrong understanding due to inattention, leading to strong negative emotional effect. Choosing the right moment to communicate or to impose a green tax (or an environment-related price

increase) could become a major stake, as their lack of intellectual and emotional availability could lead people to perceive taxes as unexpected. In short, defining an opportunity window (e.g., temporal landmarks [Earth Overshoot]) that can be leveraged to increase the incentive performance constitutes an interesting strategy worthy of evaluation.

First, we recommend incentive designers to explicitly consider the timing of incentives. Are various timings possible and what are the expected consequences? Sometimes, managers and regulators lack evidence on possible consequences and may need experimental studies to get a better understanding of how targeted agents are likely to react to various timings. We emphasized that various temporal landmarks (e.g., move, Earth Day) can be leveraged to increase the incentive effect. Although the timing of some landmarks cannot be changed, *the way it is framed and communicated matters*. For instance, research has found that framing the same delayed reward at a precise date (October, 27st) rather than using time frames (in 6 months) decreases the discount magnitude (even if October, 27st is in 6 months) (Read et al. 2005).

Second, a recurrent lesson from the literature is that behavioral change can be reinforced when the incentive delivery is temporally well connected to the targeted behavioral change. A simple rule of thumb that is intuitively convincing: incentives should be delivered quickly (the faster, the better), otherwise they can lose their motivational power because the time span between the behavior and incentive obtainment is too long. Several environmentally-destructive behaviors are, indeed, difficult to change because of the short-term cost of breaking these habits, leading to the recommendation of aligning the short-term with the long-term consequences. Williams (2021) reports the example of a woman who refuses to purchase a parking permit at her workplace to not be tempted to drive. If she succumbs to the short-term convenience of driving, she will be immediately punished, i.e., by paying a parking ticket. By intentionally altering her contingencies, she is more likely to

control her behavior and to behave in accordance with her long-term concerns about climate change and pollution. In other cases, it is possible to use timing that is congruent with the expected behavioral change, such as proposing incentivized solar panels on sunny days (Liao, 2020; Clot et al., 2022). Using a quick response to incentivize people might sometimes be hard to imagine. Indeed, externalities like carbon dioxide emissions are permanent and would require immediate (or as early as possible) and permanent taxes, which corresponds to a clear timing dimension (see the reasoning and experimental evidence reported in Werthschulte, 2023). We argue, for example, that there are windows of opportunities or specific times where a higher saliency could be used. For instance, the Russia-Ukraine war can make people more sensitive to the need of reducing energy consumption. Another example is related to regulators that could intentionally communicate the amount of ecotax that individuals have to pay before and each time they fill up their gas tank.

Third, we believe that behind an average effect that can indicate a preferable timing to deliver incentives to reach a given goal, there can be variability among individuals. Indeed, rather than positing that all individuals have an identical reaction to the timing of incentives, we believe that individual heterogeneity is very likely. Consequently, we argue in some plausible circumstances, *offering a timing menu* where the incentive is identical, but the timing differs between options offers a way to address this heterogeneity and deliver unexpected benefits although the strategy is not risk free (e.g., increase of transaction costs to manage multiple timings). For instance, individuals can be offered a menu where they can choose at which time the incentive will be applied. Offering this choice can increase the procedural utility (which captures the insight that people value procedures or conditions that lead to the outcomes in addition the utility they get from actual outcome (Frey & Stutzer, 2005)) derived from the incentive.

In some situations, the incentives can be delivered in time units or currencies. For instance, noise pollution is a major issue in many countries. After attempting several approaches to curb this undesirable behavior, the Mumbai authorities, India, implemented a new policy titled 'Honk more, wait more'. When the noise from car horns goes beyond 85 decibels, the light is reset to red. This time incentive (i.e., waiting more at the red light) implemented at the right time seems very promising where other approaches such as fines have failed (Ellis-Petersen 2020).

We are also conscious that some mechanisms that could perhaps work well can be difficult to implement in real-life circumstances and would require political daring. Indeed, new approaches are not created from scratch and should consider the legacy of previous ones. Even if they are promising, their political feasibility can be questioned, given that they are likely to face substantial reluctance (e.g., intermittent incentives). Removing these barriers is more likely if the proposed changes are applied in new sub-domains where the legacy is not too strong and with samples more likely to react positively.

5. Conclusion

(Green) incentives play an important role in addressing the major challenges faced by humankind. Although they are not a catch-all tool that can solve any problem, we believe that their power can be harnessed to perform significant advances in the environmental realm. Getting them aligned with pursued goals is a crucial step, but more can be done if they are designed with the timing dimension in mind. While some timing-related aspects have benefited from academic attention, several dimensions of timing have been overlooked despite their potentials.

All timing for (green) incentives and opportunity windows are not created equal. We argued that there are choices to be made when developing a strategic approach as to the best

timing of introducing incentive scheme elements, and the advantages and disadvantages of options need to be carefully considered. We also draw some general principles (e.g., temporal proximity between the desired change and the incentive, introduction of incentives at temporal landmarks) that can help green incentive designers and users to get more with less. We caution executives and regulators to also consider an important caveat: while “manipulating” the timing dimension, it is also of huge importance to avoid triggering a reactance effect (due to the feeling of being controlled and manipulated) or fatigue.

More research is needed to better inform incentive designers and users. We posit that well-crafted experiments can elicit subtle influence of timing on participants’ behavior. Beyond environment-related behavior or performance, incentive timing could also impact other aspects such as subjective well-being of targeted people. Also, examining whether there is a gender difference regarding the timing of incentives could be promising, especially in view of the recent research in this area (e.g., Dreher et al. 2007).

Last but not least, we do not overlook the political feasibility and implementation issues of several insights developed in this paper. Rather than closing the debate, this contribution is a first step to invite not only public designers and users of green incentive systems, but also researchers to consider timing as an important component in designing incentive schemes that can help them to reach their goals.

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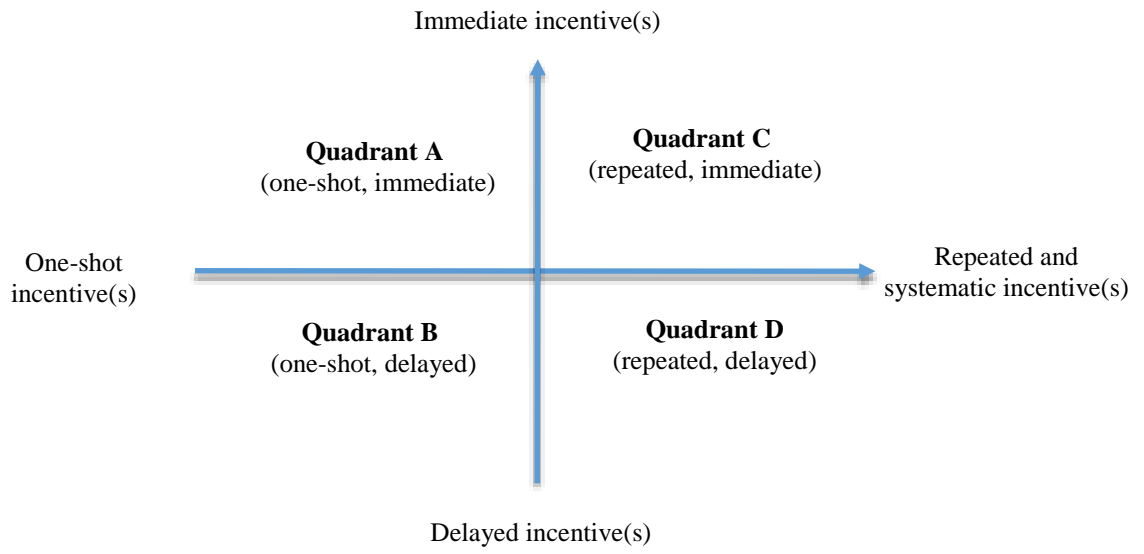


Fig 1. Characterizing incentives in a simplified 2-dimensional space