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Individual behaviour and circular economy policies: Opportunities in Italy

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Individual behaviour and circular economy policies: opportunities in Italy

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Abstract

This paper takes stock of the literature on behaviourally informed interventions to facilitate the transition to a circular economy, and discusses measures that could be pilot tested in Italy. The paper provides an overview of the key concepts of behavioural economics and describes the main "biases" that could influence the adoption of behaviours aligned with the transition to a circular economy by consumers. It goes on to review the empirical evidence on the motivations that may affect the adoption of such behaviours, as well as taking stock of empirical insights into the effectiveness of implemented behavioural interventions relevant to the circular economy transition. Finally, the paper introduces three proposals for experimental pilots in Italy.

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Keywords: Circular economy, Recycling, Waste, Environmental Policy, Solid Waste, Waste Management, Economics, Environment, Urban, rural and regional development.

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This work was carried out in the context of the project "Advanced policy instruments to accelerate the circular economy".

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Executive Summary

The global use of primary materials is projected to double between today and 2060, with huge environmental implications. The extraction, processing and transportation of materials require substantial amounts of energy, contributing to deforestation, biodiversity loss, pollution and climate change. The OECD (2019[1]) estimates that greenhouse gas (GHG) emissions related to materials management, which account for more than half of global GHG emissions, are projected to increase from 30 Gt CO_2-eq. in 2017 to about 50 Gt CO_2-eq. by 2060.

The transition towards a circular economy (CE) can help limit the negative environmental impacts associated with materials use. The current economic paradigm is essentially a linear process, wherein raw materials are transformed into goods and then discarded at the end of their useful life cycle. Conversely, a CE paradigm aims to reduce materials use and its associated environmental impacts by extending the lifespan of products, facilitating the adoption of "sharing economy" practices, and recovering materials from waste streams for recycling. This transition will require wide-ranging changes to consumers' behaviour.

Empirical evidence reveals that the decision-making process, leading to adopting (or rejecting) behaviours, including those linked to the CE transition, is not always consistent with the assumptions of standard economic theory. Standard economic theory posits that individuals have complete information, consistent preferences over time, and make decisions to maximise utility and their own self-interest. However, empirical evidence shows that the human decision-making process does not always align with these assumptions. Standard economic theory assumes rational decision-making, but deviations include the use of heuristic methods (rather than utility maximization methods), imperfect information, and altruism. These deviations are often labelled as "biases".

Behavioural interventions (or BIs) can help governments accelerate the adoption of behaviours that are consistent with the circular economy. BIs can be defined as policy interventions that leverage findings from behavioural sciences (e.g. behavioural economics, psychology, neurology) to "nudge" people towards adopting socially desirable behaviours. In addition to more traditional policy instruments, such as taxes and regulations, they are increasingly recognised as an important tool available to governments to steer citizens' behaviours toward desired outcomes, including in relation to environmental objectives.

This paper takes stock of the literature on behavioural interventions for the CE transition and proposes measures that could be pilot tested in Italy. First, the paper introduces the key concepts of behavioural economics (Section 1) and describes the main "biases" that could influence the adoption of behaviours aligned with a CE transition across the product life cycle (Section 2). Next, the paper reviews the empirical evidence surrounding the motivations that may affect the adoption of CE-aligned behaviours (Section 3). Section 4 reviews the academic literature on implemented behavioural interventions that nudge consumers toward more circular practices. Lastly, section 5 summarises the main findings, introduces three experimental interventions that could be pilot tested in Italy, and details the key next steps to move forward with their implementation. A technical workshop, organised on 12 December 2022, also informed the findings of this paper.

The vast majority of BIs presented in peer-reviewed journals consist of interventions to influence households' waste-sorting behaviours. Behavioural interventions in this space are usually highly effective. Studies on how BIs influence behaviour upstream in the product life cycle (i.e. purchase and reuse/repair) are far more limited in the peer-reviewed literature. The literature provides some examples of effective behavioural interventions to reduce an individual's waste production, but only for selected materials, such as plastics, paper and food waste. There are also only a few empirical studies on the use of BIs to promote the reuse and repair of products, such as electrical and electronic equipment (EEE), making it difficult to draw general conclusions about their effectiveness. The lack of peer-reviewed studies on these product life phases represents an important gap in the literature, as the reduction in overall materials use and the promotion of reuse and repair are crucial pillars for the CE transition.

Based on the evidence collected, the paper identifies three interventions as possible candidates for pilot projects in Italy. The first is based on households signing voluntary commitments to help improve their waste sorting. The key reasons for suggesting this intervention are its relatively low administration cost and the evidence of a long-lasting impact on behaviour. However, the one-to-one interaction favoured at the time of signing the commitment, which could have been a key factor in the intervention's strong, positive impact in the reference study, may pose a key challenge in terms of scalability.

The second intervention involves giving participating households updated information about the waste they produce and that of their peers (i.e. normative feedback) as a way to encourage waste reduction, a less tested behaviour in the literature. This pilot has the potential to be very interesting as it targets the early stages of the product life cycle, leading to less waste overall. However, the pilot intervention (and further scaling up) requires the use of appropriate waste collection systems and infrastructure to help weigh the household waste generated and thus evaluate the impact of feedback. The intervention's applicability may therefore be restricted to geographic areas where such infrastructure is already in place.

The third intervention is the introduction of transparent bags to improve the quality of waste sorting. The results of the literature show that such an intervention encourages households to sort more and generate less waste overall. Furthermore, the intervention appears to have a relatively low cost, as it mainly involves switching the type of bags offered to households. The fact that some Italian cities already have these practices in place – even if their impact has not been studied, according to the research conducted for this paper – highlights the possibility of building on existing best practices. Overall, this appears to be a low-cost, high-impact intervention.

Sintesi

Secondo le previsioni, da oggi al 2060 l'uso di materiali primari a livello mondiale raddoppierà, con enormi implicazioni dal punto di vista ambientale. L'estrazione, la lavorazione e il trasporto dei materiali richiedono notevoli quantità di energia oltre a contribuire alla deforestazione, alla perdita di biodiversità, all'inquinamento e ai cambiamenti climatici. Secondo le stime dell'OCSE (2019[1]) le emissioni di gas a effetto serra legate alla gestione dei materiali, che rappresentano più della metà delle emissioni globali di tali gas, aumenteranno da 30 Gt di CO_2e nel 2017 a circa 50 Gt di CO_2e entro il 2060.

La transizione verso un'economia circolare può contribuire a limitare gli impatti ambientali negativi associati all'uso dei materiali. L'attuale paradigma economico si basa essenzialmente su un processo lineare, in cui le materie prime vengono trasformate in beni per poi essere scartate alla fine del loro ciclo di vita utile. Al contrario, un paradigma economico circolare mira a ridurre l'uso dei materiali e i relativi impatti ambientali, prolungando la durata di vita dei prodotti, agevolando l'adozione di pratiche di economia collaborativa e recuperando i materiali dai flussi di rifiuti destinati al riciclaggio. Per realizzare questa transizione sarà necessario cambiare radicalmente il comportamento dei consumatori.

Come l'evidenza empirica dimostra, il processo decisionale che porta ad adottare (o evitare) determinati comportamenti, compresi quelli legati alla transizione verso l'economia circolare, non è sempre coerente con i principi della teoria economica classica. La teoria economica classica presuppone che gli individui dispongano di informazioni complete, abbiano preferenze coerenti nel tempo e prendano decisioni volte a raggiungere la massima utilità e a perseguire al meglio il proprio interesse personale. Tuttavia l'evidenza empirica dimostra che il processo decisionale umano non è coerente con tali presupposti. La teoria economica classica presuppone un processo decisionale razionale, dal quale tuttavia capita di discostarsi, ad esempio ricorrendo a metodi euristici (anziché perseguire la massima utilità), affidandosi a informazioni imperfette e assumendo comportamenti altruistici. Questi scostamenti sono solitamente definiti “bias” (distorsioni).

Gli interventi comportamentali possono aiutare i governi ad accelerare l'adozione di comportamenti coerenti con l'economia circolare. Essi possono essere definiti come interventi politici che sfruttano i risultati delle scienze comportamentali (ad esempio, economia comportamentale, psicologia, neurologia) per indurre (“nudge”) le persone ad adottare comportamenti socialmente desiderabili. Oltre a strumenti politici più convenzionali, quali imposte e normative, i governi hanno quindi a disposizione questo ulteriore strumento, di cui si riconosce sempre più l'importanza, per orientare i comportamenti dei cittadini al fine di raggiungere i risultati desiderati, anche per quanto riguarda gli obiettivi ambientali.

Il presente rapporto fa il punto sulla letteratura esistente in materia di interventi comportamentali per la transizione verso l'economia circolare e propone misure che potrebbero essere sperimentate in Italia. In primo luogo, il rapporto illustra i concetti chiave dell'economia comportamentale (sezione 1) e descrive i principali “bias” che potrebbero influenzare l'adozione di comportamenti coerenti con la transizione verso l'economia circolare lungo il ciclo di vita del prodotto (sezione 2). Il rapporto passa poi in rassegna le evidenze empiriche relative alle motivazioni che potrebbero influenzare l'adozione di

comportamenti coerenti con l'economia circolare (sezione 3). La sezione 4 analizza la letteratura accademica esistente sugli interventi comportamentali messi in atto per indurre i consumatori ad adottare pratiche più circolari. Infine, la sezione 5 riassume i risultati principali, presenta tre interventi sperimentali che potrebbero essere testati in Italia e illustra le prossime tappe fondamentali per la loro attuazione. Ai risultati del presente rapporto hanno altresì contribuito le informazioni raccolte nel corso di un seminario tecnico tenutosi il 12 dicembre 2022.

La stragrande maggioranza degli interventi comportamentali presentati in riviste specialistiche consiste in interventi volti a influenzare i comportamenti dei nuclei familiari nel processo di raccolta differenziata. Gli interventi comportamentali in tal senso risultano solitamente molto efficaci. Nella letteratura specialistica sono presenti molti meno studi relativi all'influenza che gli interventi comportamentali hanno sul comportamento a monte del ciclo di vita del prodotto (cioè l'acquisto e il riutilizzo/la riparazione). La letteratura fornisce alcuni esempi di interventi comportamentali efficaci per ridurre la produzione di rifiuti a livello individuale, ma solo per materiali specifici, come plastica, carta e rifiuti alimentari. Inoltre sono stati condotti pochi studi empirici sull'uso degli interventi comportamentali per promuovere il riutilizzo e la riparazione di prodotti, come le apparecchiature elettriche ed elettroniche (AEE), ragion per cui è difficile trarre conclusioni generali sulla loro efficacia. La mancanza di studi specialistici su queste fasi di vita dei prodotti rappresenta una lacuna significativa all'interno della letteratura, dato che la riduzione dell'uso complessivo dei materiali e la promozione del riutilizzo e della riparazione sono pilastri fondamentali per la transizione verso l'economia circolare.

Sulla base dei dati raccolti, nel rapporto sono individuati tre interventi come possibili candidati per progetti pilota in Italia. Il primo si basa sulla sottoscrizione di impegni volontari da parte dei nuclei familiari a contribuire a migliorare la raccolta differenziata. I motivi principali per cui si suggerisce questo intervento sono il suo costo di gestione relativamente basso e il fatto che ha un comprovato impatto a lungo termine sul comportamento. L'interazione uno a uno promossa al momento della sottoscrizione dell'impegno, che ha probabilmente influenzato in maniera decisiva il forte impatto positivo registrato dall'intervento nello studio di riferimento, potrebbe tuttavia rappresentare un importante ostacolo in termini di scalabilità.

Il secondo intervento consiste nel mettere a disposizione dei nuclei familiari partecipanti informazioni aggiornate sui rifiuti prodotti da loro stessi e da altri nuclei familiari affini (ossia un feedback normativo) in modo da incoraggiarli a ridurre la quantità dei rifiuti, un comportamento che è stato sottoposto a un minor numero di sperimentazioni in letteratura. Questo progetto pilota potrebbe essere molto interessante in quanto riguarda le prime fasi del ciclo di vita del prodotto, consentendo una riduzione complessiva dei rifiuti. Tuttavia l'intervento pilota (compreso il suo ulteriore sviluppo) richiede l'uso di sistemi e infrastrutture di raccolta dei rifiuti appropriati che consentano di pesare i rifiuti prodotti dai nuclei familiari e quindi di valutare l'impatto del feedback fornito. Si potrebbe dunque limitare l'applicazione dell'intervento alle aree geografiche in cui tali infrastrutture sono già presenti.

Il terzo intervento prevede l'introduzione di sacchi trasparenti per migliorare la qualità della raccolta differenziata. I risultati presenti in letteratura dimostrano che un intervento di questo tipo incoraggia le famiglie a differenziare maggiormente e a produrre meno rifiuti in generale. Inoltre l'intervento sembra avere un costo relativamente basso, in quanto consiste essenzialmente nel cambiare la tipologia di sacchetti offerti alle famiglie. Come emerge dalle ricerche condotte per il presente studio, l'impatto di tali pratiche non è stato studiato, tuttavia il fatto che esse siano già state adottate in alcune città italiane mette in risalto la possibilità di utilizzare le migliori pratiche già esistenti come punto di partenza. Nel complesso questo sembra essere un intervento a basso costo e ad alto impatto.

1 Introductory concepts

1.1. Behavioural biases

Standard economic theory posits that individuals are "fully rational". This suggests that decision makers i) possess unlimited attention, cognitive ability, and time to make their decisions; ii) can correctly process information and follow the laws of mathematics and statistics; iii) hold beliefs that are duly revised as new information is obtained; and iv) have preferences that are stable across logically equivalent choice scenarios over time.

Starting in the 1950 to the 1970s (Tversky and Kahneman, 1974[2]), experimental evidence increasingly showed that an individual's decision-making process does not always conform to the assumptions of standard economic theory. Individuals may fail to process information correctly (e.g. people subjectively distort objective probabilities), they may hold beliefs that do not correctly assimilate new in-coming evidence (e.g. people may be over reliant on initial pieces of evidence and dismiss new, contrasting evidence), and their preferences may change dramatically across equivalent choice scenarios simply because they are presented differently (e.g. food choices may be determined by the arrangement of food items on display). Systematic deviations from full rationality are termed "biases".

Empirically validated findings on how biases can affect decision-making processes are part of a general study of human behaviour called "behavioural insights". More specifically, behavioural insights can be defined as the effects that the diverse aspects of a decisional context (often subliminal and inconsequential) can have on human behaviour, as informed by social, cognitive and behavioural sciences (i.e. psychology, sociology, economics, marketing, among others).[1]

1.2. Behavioural insights in policy making

Policy making has traditionally tried to influence consumer choices through policies coherent with full rationality, such as taxes and subsidies, bans and mandates. For example, a ban on the consumption of alcoholic drinks for people under the legal age prevents them from purchasing and consuming alcohol, while a fine on smoking indoors in public places penalises such behaviour with monetary prompts.

More recently, governments are increasingly leveraging behavioural insights into their policy making. The presence of "behavioural biases" (see Section 2) causes people to respond to aspects of the decision context, which would be considered irrelevant if full rationality is assumed. Understanding these deviations from the assumptions of standard economic theory is essential to influencing real world behaviours and to designing effective policies.

The application of behavioural insights in policy making is known as "behavioural interventions" (or BIs). Broadly speaking, BIs are changes in aspects of a decisional context that exploit a bias to drive behaviour in a way that improves the welfare of the intended individual without dismissing options or changing

[1] For more information on behavioural insights, see https://oecd-opsi.org/guide/behavioural-insights/

economic incentives. Rearranging food items in a grocery store to highlight healthier options is a classic example of a BI. It is an intervention that attempts to improve the selection of food by the decision maker (and thus their welfare) without banning unhealthier options or increasing their price using the salience bias (i.e. food items placed in specific positions stand out from the rest and are thus more likely to be selected).

The OECD BASIC Framework for Applied Behavioural Insights (OECD, 2019[3]) details a process aimed at developing BIs systematically and responsibly. The BASIC toolkit suggests a five-step approach to the design and introduction of BIs: Behaviours, Analysis, Strategies, Interventions and Change (Table 1). The first step defines the behaviours the policy maker seeks to change, such as repairing objects instead of discarding them. The second step focuses on understanding the psychological and cognitive factors behind the observed behaviour. Once such factors have been recognised, the third step focuses on studying the strategies to effectively change the behaviour. The last two steps test the BIs and, if successful, scales them up.

This paper focuses on the first three steps of the BASIC framework. Section 1 provides a brief introduction of the key concepts, and sections 2 and 3 analyse the factors driving consumer behaviours that are relevant for the CE transition. Section 2 discusses the "biases" that may affect consumers' "circular" behaviours at three key points of the product life cycle (i.e. purchase, repair/reuse and waste sorting). Section 3 focuses on the motivations that could be driving these behaviours. Section 4 reviews the findings related to the impact of implemented interventions on changing consumer behaviour across the product life cycle. Lastly, section 5 discusses possible interventions that could be considered for implementation in Italy.

Table 1. The five steps of the OECD BASIC Framework

Stage	Description
Behaviours	Identify and better understand your policy problem.
Analysis	Review the available evidence to identify the behavioural drivers of the problem.
Strategies	Translate the analysis to behaviourally informed strategies.
Interventions	Design and implement an intervention to test which strategy best addresses the problem.
Change	Develop plans to scale and sustain behaviour.

Source: (OECD, 2019[3])

2 Main behavioural biases and instruments relevant to the circular economy transition

Section 1 introduced the concept that an individual's choices can deviate from the prescriptions of standard economic theory and that such deviations are commonly referred to as biases. This section examines some of the biases that can impact the adoption of consumer practices aligned with higher sustainability and circularity, as well as interventions to harness these biases in favour of the circular economy (CE) transition.

This paper follows the taxonomy of biases adopted in a previous OECD report (2017[4]) and borrowed from Mullainathan and Thaler (2000[5]). According to this taxonomy, behavioural biases can be grouped into three main categories, depending on the primary point of departure from standard economic theory. These are bounded rationality, bounded willpower and bounded self-interest. Bounded rationality refers to the cognitive limitations that constrain individual problem solving. Bounded willpower captures the fact that the choices made by consumers are sometimes inconsistent with their interests in the long run and may be based on the wrong cost estimates of some actions. Bounded self-interest biases refer to deviations from the behaviours of fully rational individuals due to preferences related to the social context (Montibeller and Von Winterfeldt, 2015[6]).

Table 2 summarises these categories of biases and their potential to affect CE-aligned behaviours at each stage of the product life cycle, namely: i) purchase and waste reduction; ii) product reuse and repair; and iii) waste sorting and disposal.

Table 2. Examples of behavioural biases and their possible impact on consumer decisions across the product life cycle

Behavioural biases...			.. and their impact on consumer decisions across the product life cycle		
			Purchase/Reduction	Reuse/Repair	Sorting/Disposal
	Bounded rationality biases	Loss aversion/endowment effect	Loss aversion may lead consumers to prefer the "safe bet" of a new product and prevent them from switching from new to second-hand and refurbished products.	The endowment effect may lead individuals to prefer to repair a product they own over buying a new product.	Loss aversion may lead people to separate waste when the downsides of not sorting waste are highlighted (i.e. the negative consequences of landfilling).
	Bounded willpower biases	Attitude-behaviour gap	Consumers do not adopt second-hand products because they lack a correct understanding of costs (e.g. they believe that acquiring second-hand products is more complex than acquiring new ones).	Consumers may want to reuse or repair their own possessions, but they overestimate the effort involved (e.g. reaching a suitable repair centre).	Waste sorting and disposal might be negatively impacted by the decision maker's overestimation of the effort involved.
	Bounded self-interest biases	Social norms	The human tendency to behave like the community of reference may promote (or constrain) the adoption of second-hand, reusable or refurbished products.		The human tendency to behave like the community of reference may promote (or constrain) waste-sorting efforts.
		Social identity	The desire to express one's identity as a pro-environment individual can promote the adoption of second-hand, reusable or refurbished products.		The desire to broadcast one's identity as a pro-environment individual can influence waste-sorting efforts.

Note: Table 1 reports the main biases identified in the literature. The effect of each bias is placed in relation to each stage of the product life cycle, namely, purchase and waste reduction, product reuse and repair, and waste sorting and disposal.

Behavioural interventions (BIs) may influence the decision maker at a sub-conscious level, that is, below their level of awareness. For this reason, the ethical admissibility of using nudges in policy making, through BIs, has faced numerous criticisms (Schmidt and Engelen, 2020[7]; Congiu and Moscati, 2022[8]). This is discussed in more detail in Box 1.

Box 1. Criticisms and Good Practice Principles for the ethical use of BIs

One common criticism of BIs is that they might infringe upon the decision maker's freedom by influencing behaviour without soliciting deliberate reflection on the decision at hand (Grüne-Yanoff, 2012[9]; Saghai, 2013[10]). For example, it is implausible that a cafeteria user would understand that food items had been arranged in such a way as to draw their attention to specific items (with the intention of encouraging healthy eating) (Hansen and Jespersen, 2013[11]; Gold et al., 2023[12]).

Other criticisms are linked to the welfare distribution of BIs. For example, "pro-social" BIs, primarily aimed at increasing society's welfare, may sometimes lower the decision maker's welfare by leading them to make a choice that they would not have ordinarily made. Examples are interventions aimed at raising donations for charitable causes, such as when first-time donors are automatically enrolled in a recurring donation plan. Since pro-environmental interventions are typically pro-social, their use is particularly susceptible to the problem of welfare allocation.

Furthermore, policy makers should consider whether the same intervention might have other implications for different socio-economic groups. For instance, automatic enrolment in a savings plan may be beneficial for individuals who do not need much liquidity but detrimental to those having trouble

making ends meet. However, such distributional concerns are common to all government interventions as all policies are likely to create "winners and losers".

Scholars have developed several frameworks to guide policy makers in the responsible use of behavioural interventions (Hansen and Jespersen, 2013[11]; Schubert, 2017[13]; Lades and Delaney, 2022[14]). The OECD *Good Practice Principles For Ethical Behavioural Science in Public Policy* provides a set of standards for applying BI responsibly and effectively in policy making. The *Principles* set out the key ethical standards for government officials seeking to apply BIs in government. They provide a number of guiding questions designed to stimulate debate along the main ethical principles to be considered when designing interventions, reviewing good practice principles, and providing case studies designed to take users from broad principles of ethics to targeted and feasible actions (OECD, 2022[15]). The *Principles* are structured as a step-by-step guide to support a sound and ethical use of BIs, from scoping and designing the intervention to its scaling up. Prompts and best practices are reviewed and presented for each step of policy making.

2.1. Bounded rationality biases

Bounded rationality includes biases such as constrained cognitive ability, limited mental energy and information processing skills, and selective attention.

The concept of "bounded rationality" refers to the idea that individuals have boundaries in their cognitive architecture that prevent them from making optimal choices, such as limited cognitive ability, limited mental energy and information processing skills, and selective attention. These cognitive boundaries can lead the individual to *incorrectly* assimilate and update the information they receive.

Anchoring, availability and representativeness biases were the first cognitive biases to be discovered (Tversky and Kahneman, 1974[2]) and stand as the most well-known judgement biases known in the cognitive sciences. For example, individuals tend to "anchor" to the first piece of evidence that supports a held belief, and to dismiss new, contrasting evidence ("anchoring" and "confirmation" biases). They also tend to overestimate the likelihood of experiencing an accident just because an acquaintance of theirs experienced it ("availability" bias). These were later followed by two other biases: "loss aversion" (Kahneman and Tversky, 1979[16]) and the "endowment effect" (Thaler, 1980[17]). As the latter two biases are among the most studied in the domain of pro-environmental behaviours, they are particularly relevant for the CE transition, and are the focus of the rest of this section.

The tendency to give more weight to a loss than to an equivalent gain is called loss aversion. As documented by compelling experimental evidence (Kahneman and Tversky, 1979[16]), the disutility associated with a monetary loss is approximately twice the utility associated with an equivalent gain. Put simply, individuals strive more to avoid a loss than to obtain a gain. For instance, in experiments, the subject typically tends to reject an option involving a moderate but guaranteed loss (say, a $50 loss) in favour of an option that yields a higher loss but with a higher probability (say, a $100 loss with 50% probability), that is, people are willing to take a higher risk if there is a greater probability of avoiding a total loss. Interestingly, decision makers tend to favour an option involving a moderate but certain gain (say, $100) over an option involving a higher gain with a lower probability (say, $200 with a probability of 50%), that is, they tend to minimise risk for the sake of a gain.

The endowment effect is closely related to loss aversion and refers to the higher perceived value of an object when it is part of one's endowment, compared to when it is not. In fact, the higher perceived value may be explained as a reluctance to experience a loss in case one has to part with the object, which would supplant the pleasure associated with acquiring it. In the experiment that popularized it (Kahneman, Knetsch and Thaler, 1990[18]), participants were asked the maximum price they would pay to acquire a mug they did not own (willingness to pay) and the minimum price they would charge to relinquish a mug they owned (willingness to accept). The results show that the median price to sell was considerably higher

(more than double) than the median price to buy the item, implying that the mug held a higher value for the participants when it was part of their endowment. This finding holds true in other settings. For instance, in jobs where the salary is performance based, workers tend to show lower commitment if they are promised a bonus than when they obtain a bonus upfront and have to work not to lose it. In this case, the bonus is part of their endowment, and individuals respond more strongly to potential losses than gains.

Both loss aversion and endowment effect biases can be harnessed to promote "circular behaviours" through defaults and framing nudges.

Loss aversion and endowment effect biases can be harnessed through two nudges: defaults and framing. A "default" is an option that automatically applies to the decision maker unless they actively choose an alternative. An automatic enrolment in a savings plan (in the example given in Box 1) is the archetypical default option, which requires individuals to "opt out" (Thaler and Benartzi, 2004[19]). However, there exists countless instances of defaults in several other policy areas, such as the promotion of energy conservation and waste reduction. Examples of defaults include energy providers that automatically select their customers' energy plans based on renewable resources, or customers who receive bills via email rather than physical mail[2]. Individuals tend to stick with defaults because deviating from them might result in a loss (e.g. the alternative energy plan might be more expensive) and losses weigh more than equivalent gains, not to mention the effort required to switch plans.

The second nudge that targets loss aversion and the endowment effect is known as "framing". Framing concerns an alternative but equivalent presentation of the same choice scenario, for example, using different wording or numerical figures. Consider the message "Properly sorting waste is beneficial to the planet". It attempts to promote an environment-led behaviour by signalling the positive effects associated with it. This message can be reframed in the equivalent message: "Failing to properly sort waste is harmful to the planet". Conversely, this highlights the negative consequences of not adopting the recommended behaviour. The core meaning of the message is identical in both forms. However, as people seem to respond more strongly to downsides (losses) than to upsides (gains), the negatively framed message would be more effective than the positively framed one (Grazzini et al., 2018[20]; Homar and Cvelbar, 2021[21]). Similarly, consider the case of a clothing manufacturer attaching a label on an item of clothing that reads: "70% recycled polyester". Although this message implies that 30% of the item is made from non-recycled materials, if the message is replaced with an equivalent label, "30% non-recycled polyester", it would draw attention to the non-recycled materials, which in turn could discourage the customer from buying the item in question (especially among pro-environment individuals).

2.2. Bounded willpower biases

Bounded willpower biases refer to the gap between a person's attitudes and behaviours.

Individuals do not always behave in ways that are consistent with what they believe is in their best interests. In fact, even though individuals know that a particular behaviour would benefit them and they would therefore like to adopt it, they fail to do so when given the opportunity. Examples would be individuals who say they want to quit smoking or stop eating junk food but still engage in these behaviours. In such cases, individuals lack the required "willpower" or "self-control" to resist the temptation of indulging in the undesirable behaviour. Bounded willpower is often related to the overestimation of the costs associated with the virtuous behaviour, a phenomenon that may play a role in the decision to adopt pro-environmental behaviours.

[2] Several examples of default applications to waste-related behaviours are provided in Section 4.1.

People will avoid behaviours that are too costly or time consuming, even though they have positive attitudes towards them.

First, people may fail to adopt pro-environmental behaviours because they overestimate the costs associated with them and believe that they lack the resources to adopt them effectively (i.e. they lack self-efficacy). A consumer may have positive attitudes towards buying second-hand clothing or repairing their own electronic devices rather than purchasing new ones (as they believe that doing so contributes to reducing textile and electronic waste). However, the consumer may choose to buy a new product simply because they believe it requires too much effort or time to obtain a second-hand equivalent (e.g. in order to complete a purchase, they would need to communicate with the owner, show up in person, or find a suitable repair centre).

The gap between attitudes and behaviour can be bridged through nudges that increase salience, promote habit-formation and provide information.

The gap between attitudes and behaviour can be bridged through nudges that target self-efficacy, including accessibility (and salience) nudges, habit-formation nudges, and informational nudges.

The first type of nudge to increase self-efficacy is the accessibility and salience nudge. The idea of accessibility-salience nudges is to facilitate virtuous behaviour by making it easier to adopt. For instance, companies or public institutions that have a bike- or scooter-sharing programme make the service accessible and salient by sending their workers emails about the existence of the service and how to access it.

A second type of nudge attempts to create a habit with respect to the behaviour in question. There are two complementary ways to form a habit. First, the individual can be prompted to subscribe to a “commitment” plan, in which they pledge to exhibit the behaviour by formally committing to it. Commitment, per se, may work because it “primes” the individual’s mindset in the direction of the intended action. Commitment programmes can be accessed through dedicated apps, which allow the user to select or create a task and define temporal boundaries and other constraints (e.g. the number of times the behaviour must be exhibited in a week). For example, one might commit (or be invited by municipalities to commit) to trying a car-sharing service, or visiting a municipal repair/ reuse centre at a given time. In its “soft” form, the commitment is not punishable if one fails to comply with the target behaviour. However, there is also the “hard” form (also known as the “deposit contract”), whereby the subscriber “forfeits” a sum of money in case of failure (e.g. it is donated to a charity or to the app itself).

Second, individuals might be given access to a product or service for free as a prompt to try the behaviour. Examples are free trials that give access to free 30-minute rides on a shared bike, or gifting a refillable water bottle to attendees of an event. This could be complementary to the commitment programme, which could increase the likelihood that consumers take advantage of the free trial.

2.3. Bounded self-interest biases

The influence of social norms and social identity helps to explain why individuals do not always act in their own interest.

Standard economic theory has always struggled to understand and explain selfless behaviour. One of the first findings that conflicted with the predictions of standard decision theory was derived from the “dictator game” (Camerer and Thaler, 1995[22]). This is an experimental task whereby the subject (the dictator) decides how to split a given sum of money between an opponent (the receiver) and themselves. In this scenario, standard economic theory would predict the selfish conduct of the dictator, that is, keeping the whole endowment. However, results generally show that “dictators” tend to donate a small amount of their endowment to the receiver, even though the receiver cannot punish or interact with them in any way in

subsequent rounds. This implies that individuals have an inherent drive to pursue altruism and fairness, even though this behaviour diminishes their monetary or material payoff. Instances in which one's behaviour deviates from standard economic theory as a matter of "desirability or undesirability of events, consequences, outcomes, or choices" are sometimes referred to as "motivational" biases (Montibeller and Von Winterfeldt, 2015, p. 1231[6]).

Generally, two main social phenomena influence decision making: social norms and social identity. Social norms are unwritten rules of social conduct. Deviating from a social norm can clash with people's morality and generate a feeling of guilt, as well as reputational damage in the community of reference.

The literature typically distinguishes between:

- "Descriptive" social norms, which refer to what others commonly do in a given social situation: e.g. shaking hands when introduced to others.
- "Injunctive" social norms, which relate to what others generally approve of in a given social situation: e.g. greeting strangers in certain public places, such as in waiting rooms or offices.
- "Moral" norms, a rule for social living based on what is perceived as "right" and "wrong": e.g. protecting the planet can be considered as a right moral norm.

An additional distinction is made between "positive" and "negative" social norms. A positive social norm suggests that a particular behaviour is expressed (for example, shaking hands), whereas a negative social norm suggests that a particular behaviour is *not* expressed (for example, not talking in a library). Note that this distinction applies to any social norm, whether descriptive, injunctive or moral (see Table 3).

Social norms can also be "dynamic" in that they refer to how behaviour shifts over time rather than being "static", that is, referring to the current situation (as implicitly done thus far). For example, suppose that only a minority of consumers buy second-hand products, but this share increases every year. The *static* descriptive social norm could be "most consumers do not buy second-hand products" or "only a minority of consumers buy second-hand products". In contrast, the *dynamic* descriptive social norm could be "an increasing number of customers is switching to second-hand products".

The second social phenomenon is the generation and preservation of one's social identity. Individuals adhere to the social norms shared by a given community as, by doing so, they maintain and enhance their social identity. An individual's social identity is the part of the self that is determined by one's group memberships[3]. As an individual may simultaneously belong to different groups, they may have different social identities. Perception of self and others depends on the extent to which an individual identifies with a particular group, as well as the most salient identity at a given time.

Interventions that help to reinforce and broadcast the person's social identity and inform the behaviour of the community of reference can help leverage the bias towards more environmentally friendly behaviours.

Nudges can use social norms and social identity by increasing their salience to the decision maker through written messages, such as those specified in Table 3. Another way to exploit social norms is by making the "position" of the decision maker salient with respect to the average (or median) position, thus triggering social comparison. For example, Allcott (2011[23]) sent households their energy reports which included their energy consumption, the average of their eco-friendly neighbours, and a direct comparison of the two

[3] Specifically, social identity encompasses "those aspects of a person's self-concept based upon their group memberships together with their emotional, evaluative and other psychological correlates" (Turner and Oakes, 1986, p. 240[123]).

values (for example, “Last month you used 15% less energy than your efficient neighbours”).[4] Alternatively, social norms can be made salient by directly showing what others do or approve of, using social media, for example. Retailers or governments can ask individuals who adopt a sustainable product or service to share it on their social media platforms. Seeing others engage in eco-friendly behaviour may inspire others to adopt similar practices. A dynamic norm can be effective, especially when the static descriptive social norm refers to a minority (see Section 4.1 for examples).

Table 3. Examples of nudges based on social norms and social identity

	Positive	Negative
Descriptive	“Most of your peers drink water from reusable bottles.”	“Most of your peers avoid buying non-reusable bottles.”
Injunctive	“As someone who cares for the environment, you should drink water from reusable bottles.”	“People who protect the environment expect you not to buy water in disposable plastic bottles.”
Moral	“It is your duty to save our planet and its wildlife by reducing the use of plastic bottles.”	“It is wrong to use plastic bottles because doing so endangers wildlife and our existence.”

Note: Table 2 reports some examples of messages aimed at activating different types of social norms.

The power of social norms and identity can also be harnessed through interventions that allow an individual to broadcast their identity to the community. In fact, buying products that are advertised as sustainable or “green” can socially convey the identity of the individual who is concerned about the environment and who does their part to protect it. In other words, “green” products can signal membership to a group (in this case, a pro-environment group), and policy makers should consider interventions that reinforce and broadcast this membership. For example, if an individual buys a second-hand or recycled product, they might be given a sticker to place on a bag, for example, or they may be invited to share their purchase by posting it online. Similarly, as bike- and scooter-sharing systems are often apps-based, it should be relatively easy to incentivise the user to share their experience on social media.

[4] In his natural field experiment, involving around 600 000 households in the United States, Alcott (2011[23]) estimated that the intervention reduced energy consumption by 2% on average, with a peak of 6.3% for households in the top decile of the energy-consumption distribution.

3 Review of evidence on the motivations affecting behaviours relevant to the circular economy transition

Bounded self-interest (or motivational) biases refer to those deviations from perfect rational behaviour due to other motivations, beyond personal profit, in the decision-making process. These biases are typically linked to the socio-cultural context (e.g. considerations as to what is considered appropriate behaviour by someone's peers, and how objects and decisions can allow one to communicate certain aspects of their personality and lifestyle). The motivations for adopting or resisting a certain behaviour tend to vary depending on a number of factors, including personal identity, the behaviour of peers, the place where a behaviour takes place, a desire to fit in or stand out from a specific social group, among other considerations. This section examines the empirical literature on the motivations influencing waste prevention, reuse/repair and waste sorting behaviours. It also highlights how relevant motivations can be adapted, depending on the considered product.

3.1. Motivations affecting waste prevention and waste sorting behaviours

Waste sorting behaviours are more affected by extrinsic motivations than waste prevention behaviours because of their greater visibility to peers.

Sorting actions tend to be more visible to neighbours[5], whereas waste prevention practices, which involve avoidance actions, such as buying or choosing products with less packaging, are "discreet" and are mainly driven by personal values (Barr, 2007[24]; Cecere, Mancinelli and Mazzanti, 2014[25]). Waste reduction actions are difficult to measure and have been minimally investigated. An exception is a study by Cecere, Mancinelli and Mazzanti (2014[25]). By exploiting a large consumer survey for EU countries (Flash Eurobarometer Survey #316), they were able to show the role of intrinsic motivations in driving waste reduction behaviours for food waste. They found that extrinsic motivations, related to the effects of social norms, do not affect waste reduction choices.

Several studies have confirmed the importance of adherence to social norms for engaging sorting behaviours. Among them, Hornik et al. (1995[26]), based on a meta-analysis of 67 empirical studies, revealed that in addition to the level of knowledge and consumer awareness of waste sorting programmes, one of the main factors influencing the likelihood of sorting waste was perceived social influence. Through a self-report questionnaire of 673 residents in Exeter (UK), Barr (2007[24]) found that convenience and

[5] For sorting, "engagement in the behavior is visible every time someone puts their container at the curbside" (McKenzie-Mohr, 2011, p. 78[134]).

acceptance of the norm "to sort" encouraged sorting behaviour. Along the same lines, Abbot, Nandeibam and O'Shea (2013[27]) and D'Amato, Mancinelli and Zoli (2016[28]) found that the individual perception of the social norm that "people have a duty to recycle" strongly affected waste sorting choices in UK households. Brekke, Kipperberg and Nyborg (2010[29]), in a study specific to glass sorting in Norway, concluded that consumers are motivated to sort their waste because they want to maintain their reputation of being a responsible person. To this end, they fulfil their perceived responsibility to sort, which is strictly related to the sorting behaviour of others. It is the social norm for sorting that determines its importance and engages reciprocity.

Box 2. Impacts of public policies on non-monetary motivations

The analysis of motivations behind individual behaviours is relevant because they may interact with already existing and new policy interventions, strengthening (crowding-in) or lowering (crowding-out) the effectiveness of public policies (Frey and Jegen, 2001[30]). This happens because public policies may substitute or complement personal motivations (Bowles and Hwang, 2008[31]). Several examples are provided by the literature on the unintended behavioural consequences of public policies in many contexts (Andreoni, Payne and Smith, 2014[32]; Titmuss, 1970[33]; Mellström and Johannesson, 2008[34]; Chan and Gillingham, 2015[35]).

For example, Qi and Roe (2017[36]) found a crowding-in effect between food waste reduction and waste sorting strategies in a dining study where participants, provided with a free meal, are randomly exposed to different information treatments: some receive no information, some receive information about the negative effects of landfilling food waste, and some are informed that their leftovers will be composted or landfilled. The results show that providing information about the negative effects of food waste significantly reduces the total amount of leftovers compared to a control situation when no information is given. However, when participants are informed that their leftovers will be composted (not landfilled), the amount of food waste is significantly higher than when they receive no information at all. In contrast, Halvorsen (2012[37]) found that different types of monetary incentives have a different effect on crowding-out of intrinsically motivated behaviour.

Concerning waste related policies, a possible consequence of making waste sorting mandatory may be to strengthen existing social norms or to set new norms, thus enhancing feelings of guilt and social sanctions when individuals do not comply. As a result, sorting efforts may improve. Instead, the introduction of Pay-As-You-Throw (PAYT) fees may be interpreted as a payment for non-sorting, signalling that it is acceptable to pay instead of sorting, weakening the social norm-inducing sorting behaviours (Halvorsen, 2012[37]). Importantly, it should be noted that the overall impact of PAYT schemes can be positive despite a negative impact on social norms (e.g. households would sort more, not because of social norms but because of monetary incentives).

Overall, the empirical evidence provided by the literature recommends that policy makers carefully consider potential interactions between policies and intrinsic motivations, as well as between different monetary and non-monetary policies, in reaching their environmental targets. Furthermore, the studies emphasise the need to treat each waste management behaviour as driven by different factors, which must be clearly understood to implement policies effectively.

The literature does not provide clear evidence of the main non-monetary motivations affecting waste prevention and sorting in Italy.

Empirical evidence on the motivations behind waste prevention and waste sorting in Italy consists of only a few articles and is therefore inconclusive. Gilli, Nicolli and Farinelli (2018[38]) examined the impact of motivations on waste prevention and sorting behaviours of Italian households by exploiting a national-level

survey administered in 2014 on 618 individuals. They argue that waste prevention behaviours are driven by intrinsic motivations, while the frequency of sorting specific types of materials (glass, plastic and organic waste) is positively affected by economic incentives.

Testa et al. (2020[39]) provide one of the few recent surveys on the criteria and motivations of Italian consumers to buy more "circular" products. The authors found that consumers are concerned for the environment, but this interest does not always lead to a purchasing behaviour consistent with the multi-dimensional concept of circular products. In addition, they underline that this discrepancy, between a positive attitude toward circularity and the inconsistent behaviour, highlights the existence of an attitude-behaviour gap. In particular, the gap appears to be lower for the purchase of certain products, such as the purchase of energy-efficient products, and durability when purchasing furniture products. In addition, socio-demographic variables, such as gender, age and geographical origins, are found *not* to significantly influence circular purchasing behaviours.

Aprile and Fiorillo (2019[40]) examined how different environmental concerns affect waste sorting actions using data from the ISTAT 1998 Multipurpose Survey on Households. Analyses showed that greater concerns for environmental protection (waste production and disposal, pollution, climate change, resource depletion, and alteration of environmental heritage) are positively correlated to a greater likelihood of household sorting. However, the higher the number of separate waste collections, the lower the positive influence gained from environmental concerns, suggesting the significance of marginal costs in motivating households' sorting efforts. Unlike Gilli, Nicolli and Farinelli (2018[38]), these results indicate the potential impact of intrinsic motivations to influence sorting behaviours, together with the positive role of social relations and social capital. Analysing the same dataset, Fiorillo and Senatore (2020[41]) found a positive relationship between waste "concern" and sorting behaviour.

Corrado et al. (2022[42]) have further contributed to the investigation of sorting behaviours in Italy by jointly considering non-economic motivations (general interest in environmental issues) and economic motivations (easy access to sorting bins, lowering the costs of the action). Their econometric analysis shows that a higher interest in environmental issues and easier access to sorting facilities are associated with an increase in sorting. The interaction between these two motivations highlights that intrinsic motivation, proxied by environmental interest, is a more powerful driver (when sorting efforts cost more because of difficulties in accessing sorting facilities). Conversely, the probability of sorting is negatively affected when people view their environment as degraded, that is, if people perceive the streets as dirty or they live in a degraded environment, they will be less likely to sort waste. This suggests that sorting behaviours could be affected by environmental degradation, as individuals are less willing to co-operate if they think that others do not comply, and if there is no social norm for sorting.

Privacy concerns and perceived value are key motivations for explaining consumer behaviours in relation to waste from electrical and electronic equipment.

Most academic studies address motivations for waste sorting in general, without referring to a specific type of material. This implies that findings related to sorting behaviours or habits can be generalised to all materials. This is generally confirmed by a few studies investigating drivers for selected product types, even though some peculiarities emerge, as the following paragraphs show.

Regarding waste from electrical and electronic equipment (WEEE), the literature on factors that affect sorting behaviour is quite extensive due to the specific characteristics of these products and the user-item relation. Thukral, Shree and Singhal (2022[43]) provide a systematic review of the literature of 85 articles on consumer awareness and participation in waste disposal and sorting activities of WEEE. The critical factors identified by these contributions are in line with those previously identified for general waste, with two key features. First, electronic waste is a relatively new stream of waste, which is generally not disposed of with other household waste, and sorting this waste has not become a social norm. Second, electronic waste is perceived as valuable and clean, reducing the urgency of waste disposal (Parajuly et al., 2020[44]).

The economic value consumers assign to electronic waste explains why one of the main drivers motivating them to participate in electronic waste sorting is the provision of economic incentives to return the end-of-life product to a certified recycler where the consumer will expect something in return. Consequently, several studies recommend implementing economic schemes, such as deposit refund programmes, tax rebates and subsidies, as well as discounts and store credits (Saphores and Nixon, 2014[45]; Ongondo and Williams, 2011[46]).

A primary barrier to returning electronic waste for sorting, especially smartphones and laptops, is fear of a data breach. Consumers are concerned that personal information and confidential data stored on their devices may be recovered and misused, therefore preferring not to return them. In a survey conducted in China over several years, Liu et al. (2019[47]) found that 30.45% of mobile phones are stored at home due to the perceived risk of an information leak[6]. Similarly, Wilson et al. (2017[48]) found that the reasons motivating consumers to stockpile their unused mobile phones at home range from using them as spare phones to concerns about losing the stored private information to the sentimental value attached to them. These concerns explain why mobile phone sorting rates remain low. Based on answers to a survey in Finland, Ylä-Mella, Keiski and Pongrácz (2015[49]) found that, while awareness of the importance of mobile phone sorting is high, up to 85% of the respondents store their non-used mobile phones at home rather than recycling them. The same result is confirmed, among others, by Echegaray and Hansstein (2017[50]) for Brazil, and in a report of the European Commission (2018[51]) for a selection of EU countries.

Social norms and concerns about the negative impacts of plastic pollution explain plastic waste sorting behaviour and prevention.

Environmental concerns are more relevant for plastic waste than for other materials. Klaiman, Ortega and Garnache (2016[52]), through a choice experiment conducted to assess the willingness to pay for the recyclability of packaging materials of a fruit juice drink product, found that the willingness to pay for packaging recyclability is positive for all materials, but it is higher for plastic than for other materials (aluminium, glass and carton). According to the authors, this result suggests that consumers consider plastic more harmful to the environment when it is landfilled. An information treatment about the positive effects of sorting on the environment (i.e. saving space in landfills and energy) increases consumer willingness to pay an average of 24% more, irrespective of the packaging material, compared to non-treated packaging.

Unlike other waste materials, social norms and extrinsic motivations have been found to significantly impact “intentions”, i.e. not actual behaviours, to avoid plastic packaging waste. Borg, Curtis and Lindsay (2020[53]) found that descriptive social norms, highlighting what most other people do, strongly impact an individual’s self-reported avoidance of single-use plastic items. This finding led the authors to suggest that policy makers should nudge consumers using social norm messaging to reduce plastic waste, that is, to inform consumers that avoiding single-use plastics is becoming a common and expected behaviour (see Section 4.1.1).

These findings should be carefully considered as they are based on sorting intentions, not actual behaviours. Some contributions show that, in several cases, intentions are not followed through with actions (Klaiman, Ortega and Garnache, 2016[52]).

Sorting of textile products is mainly motivated by habitual sorting behaviours of other products.

Only a few studies have investigated motivations for sorting clothing and other textiles. Domina and Koch (2002[54]) found that the availability of sorting facilities and knowledge of sorting programmes were the main factors motivating households to participate in sorting. Daneshvary, Daneshvary and Schwer (1998[55]) showed that the likelihood of support for a curbside textile-sorting policy is significantly influenced by

[6] These drivers and barriers also affect consumer attitudes and behaviours to reuse/purchase refurbished electronic devices (see Section 4.2.3).

regular waste-sorting habits, suggesting that a sort of behavioural snowball effect might arise when participation in one behaviour stimulates the uptake of other related actions (Barr, 2007[24]).

3.2. Motivations that affect behaviour towards the use of repaired/second-hand products

The transition to a circular economy requires the adoption of new consumption models[7], including a greater use of second-hand products, access-based consumption (i.e. buying a product for its use or functions rather than the product itself) and collaborative consumption (or sharing economy)[8] (Hamari, Sjöklint and Ukkonen, 2016, p. 2047[56]).

Knowledge about users' attitudes and perceptions, as well as their willingness to engage in these alternative consumption models, is still limited[9]. Scientific contributions that deal with the issue, without explicit reference to specific materials, found that the primary motivations for adopting these new approaches to consumption are for practical and economic reasons, with environmental concerns still only playing a minor role (Bardhi and Eckhardt, 2012[57]; Edbring, Lehner and Mont, 2016[58]). A few studies offer specific insights into the priority areas identified by the Italian government, mainly on clothing and electrical and electronic equipment (EEE).

Concerns about their social image hamper the circulation of second-hand clothes and their repair.

Generally, embarrassment and stigma that comes from being associated with low socio-economic status, and anxiety about the image conveyed to their peers are among the main obstacles to the use of second-hand clothing (Laitala and Klepp, 2018[59]; Lo, Tsarenko and Tojib, 2019[60]; Silva et al., 2021[61]). Safety and hygiene concerns are also strong barriers to buying second-hand clothes (Edbring, Lehner and Mont, 2016[58]). However, according to Silva et al. (2021[61]), hygiene is a major obstacle only for consumers who do not have previous experience in buying second-hand items, while it does not affect experienced consumers. Instead, altruistic values, such as environmental and ethical concerns related to clothing production, can motivate consumers to buy second-hand clothes. Other relevant factors include the characteristics of the second-hand store (organisation and presentation appeal), price, and the product's brand.

Safety concerns about buying pre-used goods are also relevant in explaining attitudes toward access-based clothing consumption. Armstrong et al. (2015[62]) investigated consumer perceptions around the introduction of clothing product-service systems (e.g. rental, lending). Consumer opinions were collected through focus groups involving fashion-oriented female consumers. One of the main barriers to the adoption of second-hand use is the lack of trust in the service provider, and issues such as damage, size and quality, as well as hygiene concerns. Conversely, participants recognized the potential benefits of such models, which enhanced the overall quality and durability of their clothing purchases, extended their lifespan and reduced the need for premature disposal. One of the main driving factors is the perceived environmental benefit associated with increased longevity and decreased material consumption.

[7] For a detailed analysis of these models and references see Edbring et al. (2016[58]).

[8] Collaborative consumption (or sharing economy) differs from access-based consumption and can be defined as "the peer-to-peer-based activity of obtaining, giving, or sharing access to goods and services, coordinated through community-based online services". See Bardhi and Eckhardt (2012[57]) for an extensive explanation of the difference between access and sharing.

[9] An exception is given by studies on car sharing, which until now has been one of the most developed types of collaborative consumption models.

Several barriers to consumer engagement in mending (i.e. repairing clothes) have been identified by McLaren and McLauchlan (2015[63]). Beyond practical reasons (e.g. lack of access to materials, skills, limited availability of original spare parts and manuals), social barriers have also been identified. It was found that consumers consider that wearing repaired clothes is a sign of financial hardship and that wearing visibly repaired clothes is socially unacceptable (Gwilt, 2014[64]). In addition, psychological factors, such as a lack of emotional attachment to a product or the desire to have a new product, may justify consumer resistance to repair clothing.

The environmental attitude of consumers may also have an ambiguous impact. Gwilt (2014[64]), for the United Kingdom, found that participants in the study did not associate mending with a positive environmental impact. Conversely, Diddi and Yan (2019[65]) found that US consumers perceive mending as possibly helping to reduce their environmental footprint. Along the same lines, Laitala and Klepp (2018[66]) showed that environmental values are significantly correlated with mending clothes in their sample of Norwegian households.

Looking specifically at Italian consumers, Colasante and D'Adamo (2021[67]) investigated attitudes and habits toward second-hand clothes. They focused on the preference of Italian consumers for eco-friendly clothes over bio-based and second-hand clothes[10], both classified as sustainable behaviours. Using an online survey administered to 402 Italian customers, the authors found that, while the motivation to purchase bio-based[11] clothes is mainly driven by environmental concerns, second-hand clothing purchases are mainly motivated by the quality-price ratio. Although respondents know that the second-hand market can contribute to environmental protection, only some are willing to purchase second-hand items, and an even smaller number are willing to specifically purchase second-hand clothes. Unlike perceptions about bio-based items, which are considered high-quality and good for the environment, second-hand clothes are considered poor quality, with cleanliness and hygiene issues creating relevant barriers. Furthermore, while respondents declared a positive willingness to pay for a bio-based T-shirt compared to a traditional one (+ EUR 2.2/unit), the willingness to pay for a second-hand T-shirt was negative (- EUR 5.5/unit). Interestingly, these results are interpreted by the authors as signalling a "sustainability bias", that is, being overwhelmed with information on the relevance of buying bio-products to protect the environment. This contrasts with second-hand purchases that have not been promoted as equally good for the environment, with customers preferring to buy bio-based over second-hand items.

Testa et al. (2020[39]) surveyed a sample of Italian consumers in 2020 and found that Italian consumers are particularly attentive to the durability of the garments purchased within the circular dimensions considered in the analysis. They also underlined that the limited considerations given to other dimensions, such as reparability, reuse and sharing, are probably due to cultural barriers which associate sharing or reuse with financial or social hardship.

Unlike clothing, the purchase of second-hand phones and their repair are driven by environmental concerns and the desire to improve one's social image.

There is broad consensus in the literature that the main factors affecting consumers' purchase intentions for refurbished mobile phones include the financial benefit, namely, the lower price compared to a new product (Van Weelden, Mugge and Bakker, 2016[68]; Ongondo and Williams, 2011[46]), the perceived environmental benefit, and awareness of the existence of refurbished products.

[10] As the authors underline, while Italy enjoys a leading position in the manufacturing of bio-based textiles, a flagship product in the country, the market for second-hand clothes is still underdeveloped. According to a 2020 report by Ipsos (https://www.ipsos.com/en/ipsos-update-april-2020), quoted by the authors, only 28% of Italian consumers purchase (often or occasionally) a fashion item from a second-hand shop or app, against a global average of 41%. Furthermore, 45% of Italian customers have never purchased second-hand clothing (compared to the global average of 32%).

[11] The authors employ 'bio-based' to refer to the use of biological resources to produce goods.

Furthermore, according to the findings of Mugge, Jockin and Bocken's (2017[69]), purchasing refurbished smartphones has a relevant social component: some consumers use refurbished smartphones to enhance their social image and broadcast their environmental awareness to their peers. Making environmental benefits more salient in refurbished devices may thus nudge consumers to use them more. The importance of environmental benefits related to consumers' intentions to use refurbished smartphones is also highlighted by Sharifi and Shokouhyar (2021[70]) who analysed users' opinions of refurbished devices shared on Twitter.

Van Weelden et al. (2016[68]) identified the following concerns that deterred users from adopting refurbished phones: i) performance and financial risks, related to the fear that a refurbished phone may have lower functionality despite the relatively high cost; ii) time risk, i.e. the fear of losing time if the refurbished phone fails to work as expected; and iii) obsolescence risk, related to the fear that the phone will quickly become obsolete and have reduced capabilities (Van Weelden, Mugge and Bakker, 2016[68]).

The European Commission (2018[51]), through a consumer survey and behavioural experiment, investigated attitudes towards the repair of mobile phones in some EU countries. The results indicate that consumers generally prefer to repair their phones, and most of them have repaired products in the past. However, repair behaviours decrease rapidly if the process requires effort or repair costs are high. Similarly, a large share of the consumers declared their willingness to explore alternative models of consumption, such as leasing products, but experience with renting/leasing remains extremely limited. The main reason behind the reticence to repair phones is that consumers are still attached to owning a new product. However, the same study shows that attitudes may change when other product categories are considered. For example, consumers are more willing to repair or lease more expensive and less "fashion dependent" items, such as white goods (e.g. dishwashers). Additionally, while not addressed in the paper, it should be highlighted that white goods elicit fewer privacy concerns.

4 Review of case studies of existing behavioural interventions targeting consumer waste management choices

This section reviews the academic literature on behavioural interventions (BIs) to promote behaviours that would support the shift toward a circular economy, that is, waste reduction, sorting and reuse/repair. The focus is on the "priority areas" identified by the Italian government, that is, plastics, textiles and electrical and electronic equipment (EEE).

Table 4. Available evidence on the effectiveness of nudges to address/exploit biases to drive consumer behaviour toward a circular economy

		Behavioural biases...	.. and evidence in the literature about nudges that address/exploit this bias		
			Purchase/Reduction	**Reuse/Repair**	**Sorting/Disposal**
	Bounded rationality biases	Loss aversion/endowment effect	Information framing is effective in reducing demand for plastic bags (Nelson, Bauer and Partelow, 2021[71]); changes in defaults are effective in reducing paper waste (Endendijk and Botzen, 2023[72])	Very limited evidence	Strong evidence that information framing improves waste sorting (Homar and Cvelbar, 2021[21])
	Bounded willpower biases	Attitude-behaviour gap	Very limited evidence	Very limited evidence	Significant improvement in waste sorting from goal setting and commitment devices (Alonso-Paulí et al., 2022[73]) and changes to the physical environment (Best and Kneip, 2011[74]; Best and Kneip, 2019[75])
	Bounded self-interest biases	Social norms	Strong impact of social norms and comparison on energy conservation (Allcott, 2011[23]) and plastic waste reduction (Salazar et al., 2021[76]; Loschelder et al., 2019[77])	Very limited evidence	Strong evidence of the effectiveness of social norms and comparison (Akbulut-Yuksel and Boulatoff, 2021[78]; Dupré and Meineri, 2016[79]), feedback mechanisms (Meineri, Dangeard and Dupré, 2021[80]), and reward and punishment (Alpízar and Gsottbauer, 2015[81]) in stimulating proper waste sorting.
		Social identity	The impact of nudges that promote second-hand and reusable products as channels to communicate one's identity needs to be investigated.		Very limited evidence

4.1. Reducing waste

4.1.1. Plastic waste reduction

Normative signs and framing nudges are often leveraged to reduce plastic waste.

Several contributions that address the problem of plastic waste reduction assess the impact of activating social norms to induce behavioural changes. Section 4.2.1 presents scientific contributions of interventions aimed at encouraging the reuse of plastic packaging and bags, which indirectly contribute to reducing plastic waste.

Salazar et al. (2021[76]) undertook a comprehensive study on the impact of normative signs (i.e. signs referring to a social norm) on the reduction of plastic waste. The authors ran two field experiments at a marine park in south Portugal to determine which normative sign would be the most effective in reducing the demand for plastic straws in cups. The first experiment tests three (descriptive, injunctive, moral) × two (positive, negative) normative signs, plus a non-normative control, displaying each message at the concession stand cashier, close to the paper straw dispensers (messages are presented in Table 5). Except for the control sign (no information), the messages were displayed for 36 days in total, with each normative sign displayed for six days. All signs were changed every 3 days. The ratio of straws taken to sold cups was recorded daily and used as the variable of interest. In total, 15,279 drinks were sold during the observation period. The straw-to-cup ratio was 0.347 in the control, with 0.215 the most effective treatment, namely, the negative injunctive message: "Choose not to use straws with your drink. The planet thanks you!". Although the negative injunctive message reduced the straw-to-cup ratio by 38% compared to the control, the difference is not statistically significant.

Table 5. Normative messages tested by Salazar et al. (2021)

Normative messages	Text of the message
Descriptive Positive	"80% of our visitors choose to drink directly from the cup or can. The planet thanks you!"
Descriptive Negative	"80% of our visitors choose not to use disposable straws with their drinks. The planet thanks you!"
Injunctive Positive	"Choose to drink directly from the cap or can. The planet thanks you!"
Injunctive Negative	"Choose not to use disposable straws with your drink. The planet thanks you!"
Moral Positive	"Protecting our planet is our duty. Choose to drink directly from the cap or can."
Moral Negative	"Protecting our planet is our duty. Choose not to use disposable straws with your drink."
Control	No message

The second experiment focuses on the normative signs that proved to be the most promising in the first experiment. Specifically, the negative injunctive norm and its positive counterpart were selected, plus a non-normative control. In total, 11,346 drinks were sold during the observation period. The straw-to-cup ratio was 0.172 in the control, 0.111 in the treatment with the positive injunctive norm, and 0.152 in the treatment with the negative injunctive norm. Although both positive and negative normative signs reduced straw consumption compared to the control (by 35% and 11%, respectively), only the positive injunctive message ("Choose to drink directly from the cap or can. The plant thanks you!") produced a statistically significant decrease. These findings confirm the effectiveness of introducing normative messages in nudging consumers to reduce plastic waste.

Similarly, the study by Loschelder et al. (2019[77]) tests the impact of normative messages to limit the use of disposable cups for hot beverages in cafeterias in favour of reusable mugs. Specifically, the authors ran two studies: a large-scale field experiment (N=23,946 beverages sold) and an online experiment (N=265). The field experiment was conducted in a café at Leuphana University in Lüneburg, Germany, where customers are responsible for operating three coffee machines. They can bring their own cup or choose

between a reusable porcelain mug or a single-use plastic cup. Both containers are available next to the coffee machines. To use the reusable mugs, customers have to pay a deposit of EUR 1, refunded upon return, or they are charged EUR 0.10 for using a disposable "to-go" cup. The experiment covered a ten-week baseline period that served as a control, plus a four-week intervention period. During the intervention period, signs were displayed next to each of the three coffee machines. The signs displayed a dynamic norm message, letting guests know that the café was changing its policy, switching from the to-go cup to a sustainable alternative. Customers were then invited to participate by choosing a reusable cup (e.g. coffee mug or keep-cup) to help protect the environment. The introduction of the normative message was highly effective in getting the customers to use reusable mugs, reducing the use of disposable cups. Consumption increased by 4 percentage points, corresponding to 84 reusable mugs per week, and 252 during the full intervention period.

In the follow-up online experiment, conducted among randomly selected university students, the authors asked respondents to imagine themselves as customers of a local university café about to buy a hot drink. Participants were asked to select the desired beverage from a list, and state their willingness to choose a sustainable container ("Which cup are you more likely to choose?") on a 7-point Likert scale, ranging from 1=*to-go cup* to 4=*unsure,* to 7=*reusable mug*. Depending on the experimental condition, participants received a normative message, and were asked to imagine that the given message was displayed next to the coffee machine where they were making their purchase. In total, five conditions were tested (Table 6).

Table 6. Normative messages tested by Loschelder et al. (2019)

Normative messages	Text of the message
Dynamic norm	"Our guests are changing their behaviour: More and more are switching from the to-go cup to a sustainable alternative. Take part in this: Choose a sustainable cup (for example, coffee mug or keep cup) and help to protect the environment."
Descriptive norm	"Our guests are showing the following behaviour: Approximately 25% are choosing a sustainable cup (e.g. coffee mug or keep-cup) instead of a to-go cup."
Injunctive norm	"Choose a sustainable cup (e.g. coffee mug or keep-cup)!"
Descriptive + Injunctive	"Our guests are showing the following behaviour: Approximately 25% are choosing a sustainable cup (e.g. coffee mug or keep-cup) instead of a to-go cup. Choose a sustainable cup (for example, coffee mug or keep-cup)!"
Control	No message

The results suggest that dynamic norms[12] work slightly better than injunctive norms and significantly better than descriptive norms. In particular, the use of the dynamic norm message increased the average willingness to adopt a reusable mug to 5, from 3.9 in the control condition. Another interesting result is that the combination of injunctive norm plus descriptive norm works significantly better than the static/descriptive norm alone. One possible explanation is that the descriptive norm refers only to a small percentage of people currently engaged in the desired behaviour. Accordingly, the norm is not sufficiently effective in getting other people to adopt the same behaviour. On the contrary, a dynamic norm, which emphasises the changing norm (that an increasing number of people are adopting a certain behaviour), is conducive to nudging people in the desired direction.

Despite their widespread use and estimated efficacy in other fields, the use of changes in the default option to nudge plastic waste reduction has not yet been widely explored. One of the exceptions is the study by Mundt, Carl and Harhoff (2020[82]), which assesses the use of defaults by running a field experiment in three locations in the city of Kassel, Germany: the foyer of a family education centre, the surroundings of

[12] As explained in Section 2.3, dynamic norms are defined as social norms about how other people's behaviour and attitudes are changing over time.

the education centre, and the summer festival at the University of Kassel. Participants (N=195) were invited to drink a 75ml cup of self-mixed lemonade. In the control condition, half of the cups already had straws and the other half did not. In the treatment group, none of the cups had straws. However, straws were freely available in a coverless box placed next to the cups so that customers could easily decide to take one. This experiment was designed to administer the no-straw default in a discreet way. Empirical estimates show a strong and statistically significant reduction in the probability of straw uptake in the treatment group (no straws) compared to the control (around 60% for the control and around 30% for the treatment).

Another type of behavioural intervention used to reduce plastic waste involves framing nudges that emotionally trigger the decision maker to react to the issue at hand. An effective way to do this is by using graphic warnings that visually depict the harm associated with a certain conduct, or the benefits associated with the opposite behaviour. By way of an example, Chatterjee and Barbhuiya (2021[83]) administered an online questionnaire to 336 randomly selected subjects in India to understand the extent of emotional involvement in the consumption of bottled water. Depending on the experimental condition, one out of three images was shown at the start of the questionnaire. Each image attempts to evoke a negative, positive or "neutral" emotion. The negative emotion picture showed a forest littered with plastic, whose goal was to trigger an aversion to the consumption of bottled water by evoking negative emotions (e.g. disgust, pensiveness). The positive emotion picture depicted bottled water in aesthetic packaging immersed in a suggestive natural environment, which attempted to increase the appeal of bottled water by evoking positive sentiments (e.g. admiration, joy). Lastly, the image of a person drinking water from a plastic bottle was used as a control, aimed neither to elicit a positive nor a negative emotion. Respondents were asked about their willingness to pay (WTP) for an environmental tax on bottled water. The results indicate that the mean WTP increases when moving from positive to neutral to negative conditions. Ultimately, the results support the idea that associating negative emotions with environmentally harmful conduct, such as the consumption of bottled water, can considerably increase one's WTP for a tax to discourage such behaviour.

Similarly, Luo et al. (2022[84]) ran an experiment in an office building in Canada to test the impact of different signages encouraging plastic waste reduction. Before the experiment, the company had already introduced informational signs above the kitchen countertop and above the bins to guide employees in disposing of their waste. The authors proposed three alternative signs. First, the existing signs were enlarged and showed simplified images of trash items of a given category ("improved signage"). The second sign was created by adding an image of a marine animal trapped in plastic debris to the same sign as in the improved signage ("signage + animal"). The third sign had a message encouraging the employees to sign a pledge to protect marine wildlife by being responsible in terms of plastic waste disposal ("signage + pledge"). Pre-existing signs were used as the control. The results show that only the "signage + animal" condition presented a statistically significant reduction in plastic waste from the baseline to the intervention period, with a reduction from 50.5% to 42%. In summary, visualising the consequences associated with non-behaviour appears to be a more promising way than eliciting one's pledge to avoid it.

The experiment by Nelson, Bauer and Partelow (2021[71]) provides an example of how messages can be framed to highlight either the positive consequences of adopting the suggested behaviour or the negative consequences of failing to adopt it. Specifically, they introduced a sign depicting a turtle eating plastic debris, complemented by a written message. In its positive framing, the message reads: "Do you really need a plastic bag? Refuse it and you will save the ocean!". In its negative framing, it reads: "Do you really need a plastic bag? Refuse it or you will destroy the ocean!". The sign was displayed at the counter of a convenience store in Indonesia, in either its positive or negative frame. In addition, regardless of the sign exhibited, the store assistant could either ask the customer if they needed the bag, or assume consent to it and directly place products into the bag. Ultimately, the experiment had six conditions, composed of 3 (positive framing, negative framing, no sign) × 2 (asking, not asking), and the control (no sign and no asking). In total, 721 individuals shopped at the convenience store. The most promising intervention was

the positive sign with the store assistant asking about the bag ("positive asking"), with 58% of consumers actively refusing the bag. This was followed by the "negative asking" and "positive, not asking" conditions, with a share of demanded bags at around 50%. The least effective intervention was the control treatment with a share of 30%.

Lastly, the experiment by Truelove and Nugent (2020[85]) used a video of a marine turtle being freed from a plastic straw stuck in its nose to elicit guilt for the harm caused by plastic waste. The experiment was carried out online with a randomly selected sample of 234 respondents. At time 1 (T1), participants completed a survey in which they had to indicate how frequently they consumed plastic straws. The subjects were then assigned to a treatment group (to whom the video was shown), and a control group (to whom the video was not shown). One week later (T2), all participants were asked again to complete the same questionnaire. The results reveal that the video was successful in increasing the scores that elicited "environmental guilt". Despite the higher guilt score, the reduction in the stated frequency of plastic straw use between T1 and T2 remained marginal and was not statistically significant. A possible explanation is that the feeling of guilt elicited by the video faded during the week following the intervention, and the consumption of straws stayed the same. Given that appeals to guilt seem to be effective only for a limited length of time, it may be advisable to design interventions in which the desired behavioural response immediately follows the introduction of the stimulus (e.g. showing a guilt-eliciting picture or message at the counter, before the customer asks for a plastic straw).

4.1.2. Paper waste reduction

Default options and moral norms are the most common examples of nudges to reduce paper waste.

In January 2018, the municipality of Amsterdam changed default consent for the reception of unaddressed direct mail advertising from "presumed" to "explicit". Under presumed consent, citizens were assumed to consent to the reception of unaddressed mail (such as brochures, flyers, and other junk mail). Under explicit consent, citizens only received unaddressed mail if they opted in by attaching a sticker to their mailbox. Endendijk and Botzen (2023[72]) analysed the impact of this default change by using the other nine Dutch municipalities as the control. As a result, in the municipality of Amsterdam, paper waste decreased from 1.85 kg per person to 1.6 kg following the change, leading to an overall reduction in paper waste of around 17-20%. The annual benefits associated with this reduction were estimated to be around EUR 500 000, with the potential of reaching around EUR 50 million if all Dutch municipalities adopted the change.

In a field experiment conducted in a large public university in Sweden, Egebark and Ekström (2016[86]) tested both a change in the default option and a message aimed at eliciting the environmental responsibility of the university's employees[13]. The default nudge involved changing the setting on university printers from single-sided to double-sided printing. The message, sent by email to a subset of university departments that included more than 300 university employees, invited recipients to join the university in reducing the environmental impact by limiting printing and resorting to double-sided printing whenever possible. Compared to the baseline period, with single-sided printing, the number of sheets used per day decreased by 15% on average under the double-sided printing default. By contrast, the moral appeal message proved ineffective.

[13] Even though the subjects involved in the experiments by Egebark and Ekström (2016[86]) and Chakravarty and Mishra (2019[87]) are not "consumers" in the strictest sense, these examples are useful in demonstrating the impact of the adopted BIs in reducing paper consumption and waste. These channels can be exploited to affect other behaviours relevant to the CE transition.

Similarly, Chakravarty and Mishra (2019[87]) ran a field experiment at three IT companies in India. In two of them, a poster, depicting a sad cartoon-like tree with an appeal to "use less paper", was displayed next to office printers to activate a social norm. Weekly data on paper waste was collected over a period of 6 months, with the first 13 days serving as a pre-nudge baseline, followed by 45 days of intervention and 45 days of post-intervention. The results show that between the baseline and the intervention period, the companies (where the nudge was applied) saw a significant decrease in paper waste per employee. In the post-treatment period, the paper waste per employee in one of the two treated companies did not increase significantly, whereas it increased in the other company, but it still remained significantly lower than in the pre-treatment period (i.e. the pre-nudge baseline). Additionally, the treated firms reduced the number of sheets used, several weeks after the end of the intervention.

4.1.3. Food waste reduction

The activation of descriptive social norms can effectively reduce food waste in restaurants.

Interventions that lead the decision maker to limit the amount of food they consume at a given time can generally reduce food waste. In an experiment conducted at hotel chain restaurants, Kallbekken and Sælen (2013[88]) tested two nudges to encourage hotel guests to keep to small portions when visiting the buffet restaurant. First, the restaurant provided guests with smaller plates; the amount of food is estimated by anchoring the plate size, with the same quantity of food appearing larger on a smaller plate. Additionally, smaller plates have less capacity, which should further limit excessive food consumption. Second, a sign encouraged guests to instead visit the buffet multiple times and load small quantities of food each time. The message attempted to make salient to guests that such frugal/attentive behaviour was socially acceptable. Compared to restaurants that had no intervention, those that introduced smaller plates saw their food waste reduced by 19.5%, while those that introduced the normative sign saw it reduced by 20.5%. Both effects were statistically highly significant.

Doggy bags are a promising way to reduce food waste in restaurants because they allow customers to take leftovers home. However, in some countries, customers may feel embarrassed to ask for a doggy bag, notably because it might signal financial hardship. The experiment by Giaccherini et al. (2021[89]), conducted in a sample of 14 restaurants in Turin and with more than 23 600 customers, tested two nudges aimed at reducing the feeling of embarrassment associated with doggy bags. The first is a dynamic social norm: a message is displayed via a table tent informing diners that an increasing number of their peers ask for doggy bags. The second nudge is a default: the table tent informs diners that the waiter will give them a doggy bag at the end of the meal unless they decline it. Five restaurants received the dynamic social norm nudge, four received the default nudge, and the last five received no intervention (control). Compared to the baseline of no intervention, the dynamic social norm (the first nudge) doubled the number of doggy bags requested by customers. Conversely, the default doggy bag (the second nudge) did not significantly affect the number of doggy bags used, although it increased the probability of the diner eating the entire meal. A possible reason for this result is that the default nudge works as a behavioural prescription by the restaurant, implying that in those restaurants, leaving food uneaten is considered socially inappropriate behaviour. Consequently, in restaurants with the default message, diners preferred to leave less on their plates than take a doggy bag home.

The difficulties in quantifying the impact of BIs limit the development of experiments to elicit food waste behaviours at home.

The few empirical studies that explore the role of nudges on food waste behaviours are mainly related to dining out occasions, such as in restaurants and canteens. Food waste behaviours at home have rarely been investigated due to the limited possibilities of measuring the separate collection of food waste and the difficulties in quantifying the impact of BIs as objective outcome measures, such as the weight of waste (Linder, Lindahl and Borgström, 2018[90]). In Leverenz et al. (2019[91]), self-reporting is used to evaluate the impact of awareness-raising interventions on avoidable food waste. The authors conducted two studies

in the Ludwigsburg district, Germany, using an offline self-reporting system (based on notebooks or paper sheets) in the first case, and a web-based online platform in the second, to collect household data related to their kitchen diary. After an initial period of simple data collection without any intervention, both panels received three consecutive coaching sessions with different levels of awareness-raising information. In the first coaching session, participants were given information about their current buying and waste disposal behaviour (based on the pre-intervention period). The aim was to increase the sensitivity of households to a more conscious decision-making process when buying and discarding food. In the second session, participants were advised of smart shopping and adequate food storage practices. In the third session, subjects were encouraged to develop new and personal strategies to reduce food waste. Following the interventions, both groups of households reported a significant reduction in avoidable food waste, in both cases by a mass of more than 50%.

Importantly, there is a wide body of evidence to suggest that inattention and misunderstandings around date marking ("best before" or "use by") result in unnecessary food waste, as consumers discard food products despite them being safe to eat (D'Amato et al., 2023[92]). However, causal evidence of BIs to address this issue is scarce because of empirical challenges that must be overcome when analyses move beyond surveys and laboratory experiments to real-life contexts.

4.2. Promote reuse of plastic, clothing, and electrical and electronic equipment

4.2.1. Reuse of plastic containers

Small monetary incentives can be used as nudges to signal a norm for the reuse of plastic bags and food packaging.

Generally, interventions aimed at reducing plastic consumption or stimulating the reuse of plastic items are mainly regulatory measures or economic instruments, such as bans or taxes (Wagner, 2017[93]). Economic instruments, such as taxes and subsidies, can also be used as nudges to overcome individual cognitive biases and encourage a desired behavioural change. For instance, the introduction of a plastic bag levy aims to discourage their use in favour of reusable ones. The levy works by reminding consumers of the choice they can make at the check-out counter. As such, it encourages behavioural change through a non-coercive measure that does not restrict individual choice.[14]

As plastic bag fees have been widely adopted by several countries to discourage their use, including in Italy, studies that quantitatively assess their potential impact are particularly relevant. Generally, all contributions examining the impact of small mandatory charges on disposable bags report significant increases in the percentage of customers bringing their own bags when they shop[15], although some of the effects may be overestimated (Rivers, Shenstone-Harris and Young, 2017[94]). To overcome previous limitations in the literature, Rivers, Shenstone-Harris and Young (2017[94]) evaluated the impact of a mandatory fee levied on plastic bags in the city of Toronto by using data from four rounds of a large Canadian survey. In particular, by exploiting the introduction of the fee solely in Toronto, the rest of the country (not subject to the introduction of a plastic bag levy) can be used as the control. The control is used to test the effectiveness of the measure by considering other unobservable factors that may have affected the results, such as the evolution of social norms about the acceptability of disposable bags. Their empirical analysis showed that the plastic bag levy increased the number of people who used reusable

[14] In other terms, the plastic bag levy can be considered a nudge because it does not impose a substantial increase to the cost of a good or service but is intended to remind the consumer that they are presented with a choice, that is, the decision is in their hands (Rivers, Shenstone-Harris and Young, 2017[94]).

[15] See, for instance, Poortinga, Whitmarsh and Suffolk (2013[125]) on the impact of a GBP 0.05 pence fee on Welsh consumers, and Convery, McDonnell and Ferreira (2007[124]) on a EUR 0.15 tax in Ireland.

bags by 3.4 percentage points. However, the impact of the policy is heterogeneous across the socio-demographic groups, having no effect on middle- and lower-income households and on households where respondents have a low level of education. Most of the increase can be attributed to wealthier households with a higher level of education. Additionally, the levy encourages an increase in the frequency of reusable bag use for those customers who already use them, while it does not affect infrequent users. Although these results are consistent with the idea that the levy works as a behavioural prompt, reminding people to avoid producing plastic waste and increase the saliency of adopting reusable bags, they also suggest the need to integrate this nudge with other policy interventions.

Chandra (2023[95]) highlights that the introduction of a plastic bag fee may have some unintended (and undesirable) consequences, such as a diminished sense of guilt associated with plastic consumption, which may in turn increase consumption. The idea is that paying for plastic disposable bags can be perceived as a payment for the negative externality generated. On the one hand, this may erode the individual's intrinsic motivation to choose more environmentally friendly alternatives and, on the other hand, crowd out feelings of guilt associated with the environmentally harmful behaviour. Furthermore, given the small cost requested for the bag, it may be more convenient to pay the tax rather than endure the cognitive costs of having to remember to bring a reusable bag. These unintended effects are supported by evidence from several countries, showing that the use of disposable bags decreased immediately after the levy's introduction but, after some time, increased again, leading governments to raise the tax to maintain lower levels of plastic bag use. To overcome the limits of the tax, Chandra (2023[95]) proposes a behavioural intervention aimed at changing the perceived social norm around the use of disposable bags. This is achieved through a change in the framing of the question relative to the number of desired bags that customers ask for right before concluding their shopping[16]. Through a combination of laboratory and online experiments, the author confirmed that among the subjects who asked for disposable plastic bags, those who paid the levy reported lower levels of guilt than the participants who did not face a charge. Furthermore, changing the frame of the question seems to be as effective as the plastic bag charge, presenting an alternative route to encouraging the adoption of reusable bags.

The effect of changing the framing is also investigated by Homonoff (2018[96]), where the impact of a tax on the use of a disposable bag is compared to a bonus for a reusable bag for the same amount (EUR 0.05). The analysis takes advantage of the implementation of a plastic bag tax in three counties in the Washington, D.C. metropolitan area (United States), and is based on the observed shopping behaviour of more than 16 000 grocery-store customers. Empirical results testify that the tax leads to a significant decline in the share of customers using disposable bags (by 42 percentage points), while no impact for the bonus can be detected. This result is consistent with the hypothesis that individuals suffer from loss aversion[17], i.e. they react more to policy interventions in which the incentive is framed as a loss than when it is framed as a gain, even though the loss and the gain are the same financial amount. This suggests that loss aversion is a relevant bias that policy makers should consider when they design BIs to reduce plastic consumption by providing small financial incentives.

Another way to overcome the limited attention given to reuse is to offer reminders that can bridge the gap between intentions and actions. Essl, Steffen and Staehle (2021[97]) conducted a field experiment on 287 customers of a Swiss agricultural association that provides weekly food boxes with vegetables in plastic bags. To encourage the return of plastic bags for reuse, a group of customers received weekly reminders: some reminders come as a flyer attached to the food box, while other boxes have a sticker placed directly on the plastic bag in the box. The idea is that the sticker on the bag works as an "action-close" reminder,

[16] Before the intervention, the question was framed as: "How many plastic bags do you need?". According to the author, this framing could imply that taking plastic bags is the norm. The new framing implied a binary yes/no response option, which is more likely to convey the idea that the desired behaviour is "bringing one's own carrier bag".

[17] This concept has been explained in section 2.1.

i.e. customers notice the sticker when they decide whether to reuse or discard the bag itself, which works differently to the reminder on the food box that works as a conventional, "action-distant" reminder. The results confirm that both the flyer and the sticker have a statistically significant and quantitatively large effect on the return rate for plastic bags, increasing it by 83% compared to the control group that did not receive any reminders. Furthermore, the probability of returning a bag with the action-close reminder (the sticker) is higher than the probability of returning a bag without the sticker, confirming that reminders in proximity to the point of action are more effective in overcoming attentional bias.

Several studies dealing with the issue of reducing the consumption of single-use items, by promoting reusable items, underscore the need for BIs to break habits. Using disposable plastic bags at the grocery store, having coffee in single-use cups, or drinking a straw-filled beverage are all habitual behaviours, performed without much thought. In contrast, bringing one's own reusable bag or cup every time it is needed requires cognitive effort, unless it becomes a new habit. Santos and Van Der Linden (2016[98]) took advantage of the "Drink Local" programme started by Princeton University in 2009, which provided reusable water bottles to all new students, to evaluate the influence of a social cue on the behaviour of Princeton students. Their results, based on more than 1 300 students, revealed that students who received the reusable "Drink Local" bottles were significantly less likely to use disposable bottled water. Interestingly, they were also more likely to support a campus-wide ban on bottled water.

4.2.2. Reuse/repair of clothing

Second-hand clothing purchases and reuse can be promoted by innovative informational campaigns, but the evidence is limited.

Policy initiatives to reduce clothing consumption and stimulate reuse/repair practices have traditionally relied on conventional information-based campaigns that have generally been ineffective (Goworek et al., 2012[99]). As explained in section 3.2, this may be related to the specificities of clothing consumption, mainly driven by motivations, such as the value of clothes, the rewarding experience of shopping, and the role of social norms. For example, high-fashion clothing can improve one's image by signalling membership to a higher social class, whereas buying second-hand clothing can, in some cases, convey the opposite. Not to mention that clothing is worn in direct contact with the skin, which may add to the avoidance of wearing second-hand clothing, especially if the history of the product is unknown, thereby increasing the perceived risk to one's health. Consequently, BIs in this domain should take into account the specificities of the consumption experience.

The only empirical study on this topic is by Frick et al. (2021[100]) who reported on the results of a behavioural intervention aimed at promoting the concept of "clothing sufficiency", i.e. reducing new clothing purchases, extending the shelf life of the product, and participating in such behaviours as care, repair, second-hand acquisition and clothing exchange. The authors conducted a field experiment to examine the impact of a social media campaign promoting clothing sufficiency to a treated subset of customers of an online store. Their results show that the campaign reduced clothing consumption in the treated group, but also in the untreated control group, without showing a statistically significant difference between them. Although this result can be interpreted as the consequence of the exposure of all participants to a preliminary questionnaire on clothing sufficiency, the non-significant results suggest that the social media campaign, realised through single posts in newsfeeds, was not effective in capturing the group's attention given the abundant amount of competing information online.

Scientific studies on BIs to encourage the reuse of clothes are in their infancy. McEachern, Middleton and Cassidy (2020[101]) explored the possibility of using an innovative campaign method called the social practice-based approach[18], where the need to adopt sustainable clothing is made salient through upcycling

[18] "Creative, practice-based approaches are wide-ranging and can include writing, painting, music, drama,

workshops[19] as well as a contemplative theatre performance intended to inform participants about the actual overall costs of "cheap" clothes[20]. Although the impact of these interventions is not quantitatively estimated, qualitative evidence suggests that the adoption of practice-based interventions can help elicit behavioural change in the context of clothing consumption.

An alternative communication method to promote sustainable clothing consumption was also investigated by Stein, Spinler and Vanthournout (2020[102]). In a field experiment conducted during fashion week in Berlin, the study assesses the effect of face-to-face communication in the form of an event on second-hand fashion purchases. Face-to-face communication is suggested as a behavioural intervention because it can potentially have a different impact from written communication, as it adds non-verbal visual cues to verbal information and allows for interpersonal interaction and an exchange of opinions. However, it only had a short-term effect on increasing second-hand sales, and the results are based on a very small number of participants.

4.2.3. Reuse/repair of electrical and electronic equipment

There needs to be more empirical work on the use of nudges in encouraging the reuse and repair of electrical and electronic products to draw general conclusions on their effectiveness.

In the context of EEE, only two policy reports have been identified[21] that evaluate the impact of BIs on repair and reuse.

In the report by the European Commission (2018[51]), participants are involved in two experiments administered within a general consumer survey. In the first experiment, subjects face a scenario in which they must choose whether to repair or replace a broken product and, in the case of the replacement decisions, whether they want to buy a second-hand or a brand new product. Participants are financially incentivised, and the different options have different prices chosen to mimic real decisions. The BIs modified elements of the survey by including an effort treatment, which changes the relative effort costs in terms of search costs or time to repair the product, and two framing treatments. The first treatment changes the subject in charge of repairing the product (i.e. the manufacturer or an independent repair shop) and whether the repair is done using only original parts or also non-original parts. The second treatment changed the framing of repair as including VAT or not, without changing the actual prices (i.e. the cost of repair with or without VAT was equal).

In the first experiment, the most relevant finding is that respondents are generally willing to repair products, with more than 90% of the respondents deciding to have at least one product repaired during the repair task. However, increasing the effort costs reduces the attractiveness of repairing the product, whereas it does not have any effect on the replacement decision. Regarding the choice of replacing rather than repairing items, most respondents preferred to buy new products. Only 20% of the respondents chose the second-hand option. Concerning the framing treatments, repair revealed to be less attractive when it is done using both original and non-original parts, and respondents were indifferent to whether the repair was done by the manufacturer or the repair shop.

The second experiment evaluates how the information about the durability and reparability at the point of sale affects the choice and willingness to pay for more durable and repairable products. In this case,

and textile arts" (McEachern, Middleton and Cassidy, 2020, p. 401[101]).

[19] The practice of upcycling implies that garments are broken down into their components, which are then incorporated into newly designed products.

[20] For a detailed description of the performance, see McEachern, Middleton and Cassidy (2020[101]).

[21] Given the limited evidence, the results of these reports are presented as being the only exception in the academic literature review for this report.

subjects faced a scenario in which they must choose among six products on an e-commerce website. The intervention manipulates the framing of information on the durability and reparability of products. The results show that providing information about durability significantly increases the probability that respondents choose more durable items. Similarly, providing reparability information convinces subjects to choose more repairable products, although the magnitude of the effect is smaller compared to the findings for durability. Combining the information about durability and reparability resulted in a lower probability of choosing durable products, compared to respondents who received information only on durability. However, receiving both pieces of information is associated with a higher probability of choosing durable items than not receiving any durability information.

Stefansdotter et al.[22] (2016[103]) realised a pilot study for the Nordic Council of Ministers with the aim of evaluating the impact of nudges on the consumption of mobile phones by young people (in the 19 to 28 years age group). By simulating a hypothetical purchasing situation, the study showed that offering only new mobile phones in the market results in the purchase of a new phone in 29% of cases. Conversely, presenting together both new phones and a green alternative, involving the repair of the old mobile phone, results in the purchase of new phones in only 11% of cases. A higher effect is found when the green alternative is actively offered.

Even though previous results about the effectiveness of nudges on electronic waste-related behaviours are promising, they must be interpreted with caution as, until now, they are based on simulated purchasing situations. Their validity should be confirmed in a real-world setting.

4.3. Promoting waste sorting

Waste sorting facilities are made more visible by increasing proximity or introducing stickers or coloured containers to encourage sorting.

The review of the literature in section 3.1 identifies the convenience of sorting infrastructures as one of the main driving factors of waste sorting behaviours. It is well known and established in the literature that providing appropriate sorting services is essential for encouraging separate collection (Oskamp et al., 1991[104]; Folz, 1999[105]; Sidique, Lupi and Joshi, 2010[106]). However, from a behavioural perspective, enhancing the convenience of waste separation may work both as an economic intervention, by reducing the effort cost of the separate collection, and as a nudge, by increasing the salience of the desired behaviour. Furthermore, changes in the physical waste collection context and in the appearance of the stations/bins may activate a framing effect and serve as a reminder.

Changes in the design of sorting bins clearly affect behaviours by attracting attention and recalling the related action that would otherwise be overlooked. Zhang and Wang (2020[107]), for instance, found that manipulation of the waste collection facilities framework, through the introduction of containers of different colours to separate recyclable materials, increases the frequency of waste sorting in the eight treated cities in China compared with the non-treated ones. Shearer et al. (2017[108]) evaluated the impact of stickers attached to bins as visual prompts to encourage the separate collection of household food waste in a randomised control trial run in two local authorities in Surrey. Their results show a statistically significant increase (almost 21%) in the average weight of food waste collected in the group of treated households compared to the pre-treatment period, while no impact can be detected for households in the control group. Interestingly, the effect was found to be persistent, and increased in the long term (11–16 weeks after the intervention).

Several studies have evaluated the behavioural impact of improving the proximity of sorting schemes. As noted earlier, accessibility to a sorting facility increases the salience of appropriate behaviour and helps

[22] This report is not available in English. The reported findings are based on the conclusions included in the executive summary, which is the only section available in English.

overcome inattention bias. Best and Kneip (2019[75]) estimated the effect on the participation of households to a change in a waste sorting scheme in Cologne, Germany, which switched from a drop-off scheme, with containers at street corners, to a door-to-door curbside collection scheme. In a quasi-experimental setting, they found an overall increase in sorting participation rates, especially for packaging (between 10% and 25%); the effect increased relative to the distance to the nearest collection point under the previous drop-off system. The effectiveness of improving sorting facilities in boosting waste sorting is testified, among others, by Chong et al. (2015[109]) in Peru, and by McCoy et al. (2018[110]) in a series of experiments run in a university setting in Colorado. However, in these studies, it is difficult to determine whether the improved collection system promoting sorting is due to the reduced time and effort costs or because of the visual cue.

Waste sorting is motivated by the desire to improve reputation through adherence to social norms.

Another important leverage for sorting behaviours emerges as the result of social interactions. As discussed in section 3.1, waste sorting efforts may be motivated by an individual's desire to improve their reputation or social image. Several contributions from both the psychological and economic literature have evaluated the impact of nudges that exploit these motivations to encourage waste-sorting behaviours.

Feedback can be impactful and largely independent of how the normative message is administered. Schultz (1999[111]) provides one of the first studies that adopt a normative feedback approach to encourage sorting for curbside sorting. The author evaluates the impact of two feedback interventions and an information treatment. In the first treatment, households receive feedback on their own sorting behaviour, while in the second treatment, the feedback is on the volumes of collected materials in their residential area. In the information condition, households are simply informed about the type of recyclable and non-recyclable materials collected, the frequent contaminants, and the benefits of waste sorting in terms of energy reduction and landfill use. The study demonstrates that feedback interventions are effective in improving both the frequency of participation and the weight of recycled materials, while the information treatment does not provide significant results. In the same spirit, Nomura, John and Cotterill (2011[112]) explore the impact of normative feedback on participation in a food waste sorting programme. In their experiment, households in the treatment group receive feedback on their street's performance compared to the neighbourhood average through a postcard that shows a smiley or a frown face depending on the relative performance. The feedback is given twice after two rounds of participation monitoring. Although the first feedback did not significantly increase the participation rate, the cumulative impact of receiving the second postcard was effective, increasing the participation rate by 2.8% compared to the base rate.

Mertens and Schultz (2021[113]) evaluated whether the effectiveness of feedback changes with the proximity of the reference group. In other words, they presume that feedback related to the average behaviour of a more refined group of people, with whom the individual has closer connections, such as neighbours, may have a stronger influence than a more distant norm, related to other households in the same city, for example. In a field experiment involving more than 1 500 households, the authors tested four different social normative feedbacks related to the reference groups, varying in their level of specificity: highly specific; exemplary (informing about the performance of the top 20% of recyclers across all households in the study); generic; and state-wide. They found that feedbacks are generally effective in increasing sorting rates, without significant differences among the reference groups. Furthermore, for households below the norm and before the intervention, the feedback led to an increased sorting rate, while for households above the norm, there was no significant impact.

The provision of normative feedback has also proven to be effective in improving the quality of the sorting. Timlett and Williams (2008[114]) reported on the results of three BIs carried out in Portsmouth in 2005-2006, one of which included the delivery of personalized feedback about the presence of contaminants in sorting bins. In another treatment ("doorstepping"), households were treated with conversations in which "doorsteppers" asked the households why they were not regularly sorting their waste, providing

suggestions. In the third treatment ("incentives"), "traffic light" stickers were attached to the bins, signalling the degree of contamination of their separate collection bins; the best-performing households were awarded a voucher, whose exact amount was communicated only at the end of the experiment. The results show that both incentives and feedback interventions significantly reduced contamination, halving the number of bins that included contaminants. However, the doorstepping intervention was not statistically significant. A similar result was obtained by Dupré and Meineri (2016[79]). In a field experiment run in three university cafeterias, the authors found that the provision of a social comparison feedback led to a statistically significant increase in sorting behaviours and a reduction in the number of sorting errors compared to the pre-treatment period. These positive effects continued even after the removal of the feedback. In a recent paper by Meineri, Dangeard and Dupré (2021[80]), the impact of households receiving feedback on their current and past household waste turned out to be effective in reducing unsorted waste in France (see section 5.2 under pilot suggestion 2 for a more detailed description).

Several studies explore the motivations behind waste sorting and highlight the importance of social approval and the effect of peer influence on driving behaviours. Among them, Alpízar and Gsottbauer (2015[81]) ran a framed field experiment in Costa Rica to assess the impact of reputation on sorting actions. By assuming that time is the more relevant cost associated with sorting activities the authors ran a modified "public good" game where participants were asked to individually choose how much time to dedicate to sorting. If the minimum total sorting time threshold is reached by the participants, it was assumed that the municipal authority could keep the waste separated for final disposal or reuse. The corresponding monetary value of the sorting time spent by the participants was then donated to finance an education programme on waste management in their community. If the threshold is not met, the monetary value of the sorting time would be lost. Two different treatments were used to elicit the participants' feelings of shame or pride by assigning publicly visible red flags to participants with low contributions and green flags to participants who contributed more than the threshold. Both public rewards and forfeits turned out to be effective in encouraging sorting efforts, increasing the average individual contribution compared to the group without public disclosure. However, by comparing the two treatments, the findings show that the reputational effects brought about by shaming increased contributions compared to feelings of pride.

The power of peer pressure to encourage sorting efforts is also testified by Akbulut-Yuksel and Boulatoff (2021[78]) who examined the impact of a moral nudge on waste sorting. Specifically, the study analyses the effect of the "Clear Bag Policy" introduced in a medium-sized municipality in Canada in 2015 aimed at promoting more responsible sorting behaviours and waste reduction. Under the new policy scheme, households were required to use transparent bags for all waste destined for landfill instead of traditional black bags (except for one dark bag allowed for privacy reasons). The clear bag allowed waste collectors to inspect its contents and refuse bags found to contain materials not destined for landfill, such as recyclables, food waste and hazardous waste. Furthermore, the clear bags also exposed waste items to other people, revealing the recycling and waste habits of the household. This policy is an example of a moral nudge, which creates normative pressure and exploits an individual's desire for social approval. By exploiting an extremely rich administrative dataset, with daily information on the amount of refuse, sorting, organics and total solid waste over several years before and after the implementation of the policy, and applying an econometric analysis, the authors found that the introduction of clear bags reduced the overall production of municipal solid waste by 27%, while increasing sorted material by 15%, with respect to the pre-intervention period. In addition to its impact, this study also provides suggestive evidence of the heterogeneous effect that the policy had on different socio-economic groups, revealing, for instance, that lower-income areas recorded more significant improvements in their waste management practices. The policy also had positive side benefits. The authors' assumption that the visibility of potentially reusable items in bags, such as clothing and small appliances, could motivate residents to donate them to charity organisations instead of dumping them was confirmed by interviews with a manager of a charity organisation, who noted a relevant increase in the number of donations after the introduction of the policy.

The use of voluntary commitments is another effective behavioural instrument to create a habit of waste sorting.

Another type of intervention tested by the literature to encourage waste sorting is commitment. As explained in section 2.2, commitment works by exploiting an individual's motivation to appear consistent when inconsistency is socially disapproved. According to Cialdini (1985[115]), the extent that people feel responsible for their behaviours may change their self-concepts. A commitment may also be helpful in creating a habit, which is essential for such repeated behaviours as waste sorting. As argued by Katzev and Pardini (1987[116]), voluntary commitment can stimulate individuals to develop internal mechanisms of behavioural control that lead them to assign a value to sorting efforts, encouraging them to continue recycling.

Early psychological studies on the impact of commitment have shown that a written behavioural commitment leads to high rates of immediate participation in waste sorting and long-term follow-up (Wang and Katzev, 1990[117]; Cobern et al., 1995[118]; Katzev and Pardini, 1987[116]). In some cases, commitment has appeared to be more effective than information provision (Werner et al., 1995[119]) and persuasive communication[23] (Dupré, 2014[120]). However, in these initial contributions, the impact of the intervention is evaluated on self-declared behaviours using questionnaires on the frequency of sorting actions or through observational studies, and generally on small samples. More recently, Alonso-Paulì et al. (2022[73]) analysed the impact of a soft commitment in promoting waste sorting behaviours in a field experiment involving more than 1 500 households in Palma, Spain. The study takes advantage of a pre-existing informational campaign organized to encourage citizens' participation in the separate collection of bio-waste, as well as real-time data on bio-waste sorting, thanks to the introduction of electronic bins requiring people to scan a personal card to open the lid. In the experiment, randomly selected participants in the treated group were given the opportunity to sign a "soft" commitment consisting of a pledge to sort bio-waste. Their results show that the soft commitment increased regular participation in waste sorting by 23% compared to the control group without the intervention, and the effect persisted over time. An interesting finding is that the treatment was effective on the extensive margin, that is, it increased the number of households that started sorting, but not the participation of those who already recycled (the intensive margin). This finding led the authors to suggest that the use of a soft commitment should be recommended in contexts where large subgroups of the population are not involved in waste separation. In these cases, this nudge can be very effective in encouraging people to start sorting. In contrast, the intervention has limited impact in areas where the majority of the population is already actively sorting waste.

[23] According to Dupré (2014[120]), government information and awareness campaigns for household waste sorting are based on persuasion and moral considerations, i.e. they prescribe the "right act" and proscribe the "wrong act".

5 Conclusions and proposals for pilot projects in Italy

5.1. Key takeaways and knowledge gaps from the literature review

There are numerous studies aimed at identifying the motivations behind consumer behaviours that can contribute (or hinder) the circular economy (CE) transition. However, there is only a limited number of studies that estimate the impact of behavioural interventions (BIs) to nudge consumers towards the adoption of behaviours aligned with the CE transition. From the review of the literature, the following main findings can be summarised.

Empirical evidence on the effectiveness of BIs in promoting waste prevention is available mainly for interventions in public spaces.

BIs have successfully led to reductions in waste generation, specifically for food waste in public places (restaurants and canteens) and the use of plastic bags, cups or straws in shops or cafés. For waste prevention actions at home, behaviours are almost impossible to measure because they cannot be observed by researchers and, if observable, they may raise privacy concerns.

Normative feedbacks appear to be particularly effective in improving sorting behaviour.

Engagement in sorting behaviour is often motivated by the desire to improve one's reputation by adhering to social norms. Several studies in the literature have shown that normative feedback interventions are effective in increasing the frequency of sorting activities and the quality of separate collection. In contrast to feedback, which provides only information about the performance of the household, normative feedback provides information on the average behaviour of peers. The quantitative results on the use of feedback in the literature are mainly positive and largely independent of the way in which the messages are administered. Furthermore, normative feedback effectively encourages waste sorting of below-average sorters by triggering the desire for social *conformity*, whereas for average sorters, the desire for social *approval* is triggered. For above-average sorters, the risk of precipitating a decrease in sorting motivation is ambiguous.

High-frequency data on waste behaviours offer the opportunity to design more robust experiments on waste prevention and sorting.

Technological innovations, such as electronic cards and smart bins, can accurately quantify the volumes of waste materials produced/sorted, and thus enable researchers to test the effectiveness of different monetary and non-monetary schemes. As the study by Alonso-Paulì et al. (2022[73]) clearly demonstrates, the opportunity to have real-time, or at least high-frequency, data on household waste behaviours is essential in order to assess the impact of a BI in promoting appropriate waste behaviours, but also to analyse how different BIs operate. The availability of these new technologies in the pilot regions would provide more detailed analysis and a sophisticated pilot design. At the same time, municipalities – where advanced measurement technologies like smart bins are already in place – tend to be municipalities where households' waste sorting performance are above average. In this respect, the choice of pilots and the

locations where BIs could be introduced needs to take into account the possible trade-off between the availability of the appropriate measurement system and the identified regions for the pilots, as well as scaling up[24].

BIs are context specific.

Although studies in the literature provide evidence of the effectiveness of a specific BI, its impact needs to be carefully evaluated on a case-by-case basis. For example, interventions realised through improving the salience of waste sorting facilities have been effective in encouraging sorting, whereas improper waste disposal is a habitual behaviour due to inattention.

Importantly, BIs applied in the "wrong" context might not work as intended and might even backfire ("boomerang effect"). For example, in a degraded environment where citizens do not properly sort waste or where the collection system is inadequate, a nudge that makes a descriptive social norm salient may exacerbate the detrimental behaviour already in place and prevent the adoption of the opposite, desired behaviour (Cialdini, 2003[121]). Intervening at a more structural level, for instance, by enhancing the waste collection system, may nudge citizens by promoting a virtuous descriptive social norm and even improving their feeling of self-efficacy with respect to proper waste sorting.

A clear picture of the main drivers and barriers that can affect consumer behaviours throughout the product life cycle (e.g. sorting or reuse) is needed to identify the most appropriate BI. These may also vary in relation to the considered products.

BIs are not only context specific, they are also behaviour specific, and strategies that are effective in tackling a specific behaviour may not be effective in affecting others (Parajuly et al., 2020[44]). A clear picture of the main drivers and barriers that may affect a specific waste management activity (e.g. sorting or reuse) is needed to identify the most appropriate behavioural channel and nudge selection. For instance, when people do not engage in reuse or waste reduction behaviour due to inattention, reminders at the point of action can be more useful than general reminders on the consequences of pollution of incorrect waste disposal. In addition, the literature highlights that waste-related behaviours for certain products, such as electronic and electric equipment (EEE) and textiles, can be driven by specific motivations (e.g. image or privacy concerns). For example, as argued earlier (see Section 4.2.2), wearing second-hand clothing may threaten one's projected self-image. Interventions should consider these factors and work to counteract them (e.g. to guarantee the safety and social desirability of purchased goods with the help of third parties).

BIs may have different effects on different subgroups of the population.

BIs may have different impacts depending on the characteristics of the social group. Some BIs may be generally effective in encouraging a target behaviour, but they may not be equally effective on all socio-economic groups. For instance, insofar as individuals view possessions as a way to communicate and enhance their image, a campaign promoting reuse might be less effective on lower-income individuals, who may be more focused on communicating ownership of certain goods to avoid the social stigma that comes from belonging to a lower social class. By contrast, the campaign might be effective on higher-income individuals, who may embrace reuse as a way to communicate their environmental interest without compromising their social image.

The heterogeneity in responses to BIs across subgroups of the population is not well explored by the existing contributions and deserves further careful evaluation, as it indicates relevant limitations in the adoption of BIs as policy instruments. An exception in this respect is Rivers, Shenstone-Harris and Young (2017[94]), reviewed in section 4.2.1, which shows that the introduction of a small-size plastic bag levy

[24] Less advanced but still reliable technologies for quantifying waste generated by households include bin bags with bar codes, containers with RFID (smart) tags, and locked containers with chamber systems.

effectively reduces the use of single-use bags by more affluent households, whereas it had no effect on lower-income households[25].

As many BIs, aimed at encouraging proper waste-related behaviours, work through habit formation, the persistence of their effect needs to be carefully evaluated.

The persistent effects of BIs is a research gap that needs to be explored. Only a few studies have reported results for post-treatment periods, and usually within a restricted time span, generally a few months after the treatment. An exception is, however, Alonso-Paulì et al. (2022[73]), who tested persistence after 35 weeks and after 36-47 weeks. Fully understanding the long-term impacts of BIs is crucial to understanding whether the manipulation has stimulated a short-lived behavioural change or the formation of a new habit. This is especially relevant for waste-related behaviours, which are mainly habitual and repeated behaviours. Persistence may be strictly dependent on the nudge type and the behavioural channel employed.

A relevant but often neglected aspect is that there are potential spill-overs and interaction effects of BIs with pre-existing policies.

Waste behaviours may be related to each other and with other behaviours relevant to the CE transition; both substitutability and complementarity relations may exist. Consequently, the impact of BIs should be carefully evaluated by looking not only at the target behaviour but also at other potentially correlated choices. BIs that target waste-related behaviours may interact with traditional (monetary) policies already in place, such as Pay-As-You-Throw (PAYT) programmes. In some cases, the interactions could be positive and BIs may amplify the impact of traditional policies. For instance, by activating an injunctive social norm, the nudge may reduce the risks of illegal dumping usually associated with the use of monetary policies, such as fines. In other cases, however, the interaction could reduce its effectiveness if the PAYT triggers a crowding out of intrinsic motivations. Importantly, even if the measures reduce intrinsic motivation, overall outcomes could still be positive because consumers would change behaviours as a consequence of monetary incentives (i.e. behaviours are driven by both intrinsic factors, such as the desire to comply with social norms, and monetary incentives, such as reducing household expenditures).

Another relevant but still neglected aspect of the academic literature is the analysis of behavioural biases behind purchase decisions relevant to waste production and the interventions to address them.

Consumer purchase choices have a relevant impact on determining the amount of waste produced. For some categories of goods, such as food, the literature has already shown the impact of BIs on consumer choices at the point of purchase. In the case of other categories, such as EEE, there are no experiments in the peer-reviewed literature that show how the impact of nudge interventions elicit behavioural changes, that is, limiting purchases of new electronic products, increasing the consumption of long-lived goods, and reusing and sorting electronics. An evaluation of the impact of these interventions is needed to complement policy measures targeting these products.

5.2. Selection of pilots from the literature

Based on the key insights from the literature review and the technical workshop on “Behavioural interventions for the circular economy transition in Italy” organised in December 2022 (see Annex A), the following section presents a list of BIs that could be pilot tested to evaluate their impact in regions in Italy.

[25] Another example is Gillingham and Tsvetanov (2018[135]) who evaluated the impact of providing information to influence the uptake of residential energy audits, with the finding that the intervention is more effective among higher-income households.

The list includes both BIs that have been proven to work in various contexts and more innovative interventions. The decision on which pilot(s) to implement would need to be built following in-depth discussions with key stakeholders in the pilot and scale-up regions, including waste management companies, to ensure that the impact of the intervention can be properly measured over the medium term and, if successful, scaled up. BIs tend to be context (and product) specific, and therefore it is important to test their effectiveness before broader implementation.

Pilot suggestion 1: Exploring the use of voluntary commitments to waste sorting

As shown in section 4.3, several contributions in the literature have demonstrated the effectiveness of soft commitments in stimulating waste sorting. Among the different experiment designs, the one proposed by Alonso-Paulì et al. (2022[73]) (described in section 4.3) is suggested as a possible design for the first pilot.

Table 7. Key elements of pilot suggestion 1

	Key elements
Targeted behaviour	Waste sorting
Main relevant bias(es) addressed	Attitude-behaviour gap
Outcome variable of interest/unit of measurement	Number of bin openings
Measurement method	(Real-time) data on the individual number of openings

Source: Authors' elaboration

Brief description of the experimental design

A group of citizens are randomly selected and offered the possibility of signing a soft commitment consisting of a pledge to sort bio-waste. The behavioural change of this subgroup of the population (the treated group), in terms of waste sorting, is subsequently compared to the behaviour of a control group, which is not asked to sign the commitment. The impact of the intervention is evaluated by looking at the number of bio-waste-specific bins that require personal cards to be opened, used as a proxy for participation in waste sorting.

Reasons for recommending this pilot

- **Innovative measurement technique**. The use of "smart bins" is an innovative tool for quantitatively evaluating the impact of adopting a soft commitment on households' sorting decisions.
- **Clear and persistent impact.** The estimation results in Alonso-Paulì et al. (2022[73]) show that the soft commitment effectively encourages participation in waste sorting and that the effect persisted over time.
- **Cost.** In Alonso-Paulì et al. (2022[73]), the commitment intervention was administered by exploiting an existing environmental campaign aimed at educating and encouraging households to sort bio-waste, a newly introduced typology of waste sorting. Specifically, individuals approached by the environmental educators were offered the opportunity to sign a soft commitment, consisting of a pledge to sort bio-waste. Similarly, the initiative could be introduced to citizens in the selected pilot

areas by taking advantage of existing environmental awareness campaigns. If the intervention can be administered by exploiting synergies with existing initiatives, the intervention will be low in cost.

- **The nudge could be tested with the aim of improving sorting in regions that are lagging behind or in the sorting of priority materials/products.** The treatment was effective in increasing the number of households that started sorting, but it did not improve the performance of those who already sorted. This finding suggests that the introduction of voluntary commitments should be recommended in contexts where large swathes of the population are still not engaged in waste sorting, and where separate collection rates are relatively low, or to stimulate the separate collection of new types of materials (like textiles).
- **Synergies with communication and awareness plans prepared by regions and municipalities could be considered.** The intervention could be introduced as part of a general environmental campaign on waste and CE behaviours.

Possible limitations

- **The availability of smart bins and the cooperation of the municipal company managing the waste collection are essential to run the pilot.** This can limit the scaling up of the intervention.
- **The intervention requires face-to-face interaction with citizens when signing the commitment**. Its success requires the participation of the institutions involved in the educational campaign (e.g. local administrations, universities and private actors) as well as citizens' trust in them. This may limit the applicability of the interventions in geographical areas where social capital and trust in institutions are low and where people may be reluctant to sign commitments out of fear of being deceived.

Pilot suggestion 2: Exploring the use of normative feedback to encourage waste reduction

The second potential proposed pilot to promote waste reduction behaviours is normative feedback, a less tested waste-related behaviour. Although normative feedback to enhance waste sorting has been widely explored by the literature, only Meineri, Dangeard and Dupré (2021[80]) (mentioned in section 4.3) have – to the best of our knowledge – evaluated its impact on waste reduction behaviours. The proposed nudge therefore builds on the work of Meineri, Dangeard and Dupré (2021[80]). The main reason for selecting this nudge is that it addresses waste reduction, which is a key action area for the CE transition.

Table 8. Key elements of pilot suggestion 2

	Key elements
Targeted behaviour	Waste reduction
Main relevant bias(es) addressed	Inattention, attitude-behaviour gap
Outcome variable of interest/unit of measurement	Weight of waste
Measurement method	Data on the individual weight of waste produced

Source: Authors' elaboration

Brief description of the experimental design

Meineri, Dangeard and Dupré (2021[80]) tested the effect of providing regular feedback on the weekly weight of residual household waste on overall waste production. In the experimental period, treated households received feedback through weekly emails (in the first 8 weeks) and then monthly emails (over the following 10 months). The emails included information on the rate of waste production (kg in residual waste) in the previous period (the previous week or month), on the (short-term and long-term) history of the household's waste production, as well as detailed tips on how to reduce waste (e.g. using reusable bags, composting bio-waste, drinking tap water). Thanks to the cooperation of the local waste authority and the adoption of a waste weighing system, the weight of each household's waste was collected over 3 years (pre-treatment, treatment and post-treatment years).

Key reasons to suggest this experiment include

- **It addresses the problem of waste reduction, which is high in the EU waste hierarchy.** It is also a very original intervention because, as noted throughout the paper, only very few studies have evaluated the impact of BIs on waste reduction actions.
- **Evidence of persistent impact.** Results in Meineri, Dangeard and Dupré (2021[80]) confirm the impact of feedback as a nudge to stimulate waste reduction. They found a significantly lower amount of unsorted waste in the experimental period than in the control period, and the effect also persisted in the post-treatment stage (52 weeks).
- **The nudge could be tested in both high- and low-performing regions**. The use of feedback to reduce household waste could be effectively introduced in all contexts, independently of the level of waste production. By including only feedback on household performance in the message, without making comparisons with other (better performing) households, rebound effects can be excluded.
- **This behavioural intervention has the potential to encourage waste reduction without the risk of illegal dumping.** Monetary interventions aimed at reducing household waste production through PAYT tariffs or fines may have the added negative effect of increasing illegal disposal practices. However, these practices are not stimulated by this nudge, as they do not involve any coercive payment or sanction for not reducing waste.
- **The feedback can be easily administered at a low cost.** The feedback can be sent by email (as in the Meineri et al. experiment) or by using other online channels, like the apps already adopted by several municipalities to help citizens engage in the separate collection.

Possible limitations

- **Measuring the impact of the intervention requires infrastructures capable of weighing different kinds of waste materials.** The ability to scale up the intervention in pilot 1 is limited by the availability of measurement systems and the cooperation of the municipal company managing the waste collection. In this pilot, it is also crucial to be able to monitor the correct separation of the different materials in the different bins.
- **Administration of the feedback requires a communication channel with the citizens.** To communicate with the citizens, the intervention can be administered by ordinary mail, email or other digital channels. The choice of the information channel must be tailored to the socio-economic characteristics of the population (especially in terms of age, digital literacy, and Internet access).

Pilot suggestion 3: Exploring the use of social norms to stimulate waste sorting

The third possible pilot to consider is a social norm-based nudge to improve waste sorting. The pilot could build on the "Clear Bag Policy" study in place in Halifax, Canada, since 2015 (Akbulut-Yuksel and Boulatoff, 2021[78]). See a description of the intervention in section 4.3.

Table 9. Key elements of pilot suggestion 3

	Key elements
Targeted behaviour	Waste sorting
Main relevant bias(es) addressed	Bounded self-interest, concerns about the social image and reputation of individuals
Outcome variable of interest/unit of measurement	Weight of unsorted and sorted waste (distinguishing different materials)
Measurement method	Daily information on the weight of separate collection and total solid waste

Source: Authors' elaboration

Brief description of the experimental design:

In Halifax, households were typically provided with containers to sort waste into four categories: i) plastic, glass and aluminium in a transparent "blue bag"; ii) paper and cardboard in a paper bag; iii) organic food waste in a green bin provided by the municipality; and iv) the remaining undifferentiated waste (destined for landfill) in black garbage bags. The intervention required households to replace the black garbage bag for undifferentiated waste with a clear and transparent bag. This intervention allows neighbours and passers-by to see whether the household is properly sorting its waste. Any deviation from the socially desirable behaviour (of differentiating waste) is thus immediately visible to everyone, creating a strong incentive to comply, averting feelings of shame and reputational loss, especially as residents are likely to know each other.

Reasons for recommending this pilot

- **Evidence of the impact on waste prevention and sorting. The results of the analysis by Akbulut-Yuksel and Boulatoff (2021) revealed that the policy encouraged households to separate more and generate less waste overall.** The adoption of transparent bags can potentially divert more recycled items, clothing and small appliances away from landfills and improve the sorting rate of traditional and new materials. In addition, this pilot has the potential to improve the quality of separate collection, increase the value of recycled materials, and reduce the costs for waste sorting companies.
- **This nudge could be effectively introduced in municipalities where separate collection rates are already high, as well as in areas where sorting behaviours need improvement.** In the first instance, the activation of a descriptive social norm should be triggered. In the second instance, the municipality should encourage the activation of an injunctive social norm.
- **Some municipalities in Italy have already adopted clear bags for certain waste materials (e.g. Milan).** To determine the potential advantages and disadvantages of this intervention in the Italian context, it is important to first acknowledge existing experiences.
- **Unlike monetary policies, such as the PAYT system and fines for users not complying with the mandatory rules for waste sorting, the introduction of clear bags could improve the quantity and quality of separate collection without provoking undesirable behaviour.** As the use of clear bags is not associated with monetary payments in the case of non-compliance or in the case of errors in sorting, the pilot does not create an incentive for households to disguise their waste by illegal dumping or by disposing their waste in neighbouring municipalities.

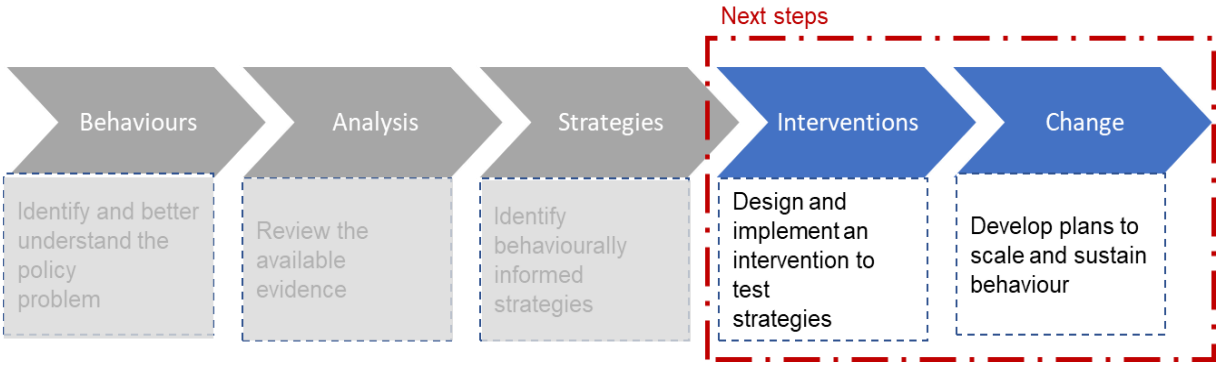
Possible limitations

- **Measurement of the impact requires quantifying the weight of the different materials disposed or the number of bags.** As for other pilots, this may be a problem in municipalities that do not have the necessary infrastructure.
- **The intervention will be less effective in places where waste disposal is not visible to neighbours as the social norm cannot be activated.**
- **The feasibility of using clear bags for specific types of materials should be established in terms of the bag's resistance to chemicals and the opportunities for composting or recycling the bags.**

5.3. Moving forward with the implementation: key steps and issues to discuss with stakeholders for piloting the interventions

The previous sections focused on the first three steps of the OECD BASIC Framework for applied BIs (i.e. Behaviours, Analysis, Strategies). More precisely, the paper analysed the peer-reviewed evidence of the drivers of consumer behaviours relevant for the circular economy transition and on the results of strategies implemented to nudge consumers toward more sustainable outcomes. Taking stock of the literature and summarizing insights from consultations with experts and workshop participants, the following section outlines the key next steps to move forward with the intervention and, if outcomes are positive, change (or scale up) stages (see Figure 1).

Figure 1. Overview of the next steps of the analysis



Source: Authors' elaboration

The first key step in moving towards the intervention stage is to identify the geographic areas for the pilot(s) and for the scale-up, as well as the key stakeholders in both groups of regions. The objective of the pilot(s) is to test an intervention that, if successful, can be replicated in other areas. As such, it is important to ensure that the areas selected for the pilot exhibit characteristics similar to those for the scale-up. This requires clearly defining the perimeter of the possible scale-up (e.g. other similar small cities in mountainous areas across different regions, municipalities in the same region where the pilot is carried out, etc.). Scale-up and pilot regions need to share several key characteristics, including similar demographics, similar social norms, and the presence of the required infrastructure to administer the nudge and monitor its impact.

Once the regions for the pilot and scale-up have been identified, and support from local stakeholders has been secured, the analysis could move to discussing in detail the requirements for the implementation of

the suggested pilots, feasibility and possible impacts. A key outcome of this phase would be to decide which pilot(s) to implement, in which regions, and to develop a high-level plan to carry out and evaluate the experiment.

As highlighted in section 5.1, BIs must be tailored to the specific needs and characteristics of the geographic context and reference population. Accordingly, an analysis of the context is essential in order to assess the characteristics of the population (e.g. the different socio-economic groups, different sorting capabilities) and the institutional framework (e.g. characteristics of the waste collection system, access to sorting facilities). The degree of trust in local institutions should also be determined before introducing the behavioural treatment: the effectiveness of treatments, like information provision or voluntary commitments, will depend on people's perception of the reliability of authorities. Furthermore, all options related to the experimental stages should be discussed with the relevant stakeholders.

To inform this discussion, the following section describes the key implementation requirements of each suggested pilot. Their presence in both pilot and scale-up regions must be ensured.

- **Key requirements for the implementation of pilot 1**
  - **Impact measurements require the use of smart bins, which are available in several Italian cities**. This technological requirement does not appear particularly demanding as the use of smart bins is already in place in several Italian cities (e.g. Florence). It is essential to have the cooperation of the municipal waste collection company to obtain the detailed data (possibly real-time/daily level) on household waste sorting behaviour. The impact of the treatment could be evaluated at the household level (preferred option) or at the street/neighbourhood level. In both cases, the treatment should be randomised and introduced at the street/neighbourhood level, with some non-treated streets or neighbourhoods serving as a control.
  - Another option is to directly measure the weight of the materials disposed in the separate bins as a gauge of interest. This is clearly a more accurate way to measure the effectiveness of the nudge. Moreover, this approach does not appear particularly problematic as the bins or bags with bar codes assigned at the household level have already been adopted in several Italian cities.
  - **Cooperation with the local waste utilities services and approvals from the local municipalities are required to administer the intervention and monitor its implementation.** The effectiveness of the intervention will be determined by the level of trust the population has in its institutions, especially those involved in the educational campaign and administration of the commitments. The choice of intervention should consider that face-to-face interaction when signing the commitment may impact an individual's decision to comply. Accordingly, several institutions should be involved in the educational campaign and its setting (e.g. local administrations, universities, private actors). Furthermore, it is essential to determine in advance whether the municipality has the appropriate waste collection facilities in place to avoid the risk of the citizens losing trust.
- **Key requirements for the implementation of pilot 2**
  - **Measurements of the impact require the use of either a bag-based or a weight-based system**. As for pilot 1, the weight of waste should be measured at the household level at various stages: before, during and after the intervention. It will be important to weigh the different types of waste to correctly evaluate the impact of the experiment, as waste may be diverted to different bins (e.g. plastic waste that is incorrectly placed in the wrong bin for undifferentiated waste is now correctly disposed of in the bin reserved for plastics).
  - **The feedback can be administered through different channels**. When selecting pilot cities, prioritise those that rely on digital channels to communicate with citizens in order to keep costs low and minimise paper waste. However, the choice of the information channel must be tailored

to the socio-economic characteristics of the population (especially in terms of age, digital literacy, and Internet access).

- If the feedback inadvertently brings about social comparison, it may lead people to default to the average behaviour, with the risk of decreasing the sorting rate of high performers. In this scenario, the feedback intervention could be combined with conventional monetary policies, such as offering rewards to households that perform well (e.g. a discount on waste taxes).

- **Key requirements for the implementation of pilot 3**
  - **The intervention should first be introduced in municipalities that adopt door-to-door waste collection.** The first requirement for the intervention to work is that citizens place their waste bags near their homes, making it easier to track their behaviour. In addition, participating municipalities must use a black or dark bag for undifferentiated waste for privacy reasons (see below).
  - **As with other pilots, it will be necessary to measure the weight of the different materials disposed of, or the number of bags.** The use of transparent bags should be combined with the use of bar codes associated with each bag, specific for each household, thereby linking the amount of sorted waste with the household. In this case, the cooperation of the municipal company that is managing waste collection is essential in order to obtain detailed data on households' waste sorting behaviour. The impact of the treatment could be evaluated at the household level (preferred option) or at the street/neighbourhood level. The treatment should be administered by introducing mandatory clear bags only in some areas of the city, and comparing the effect with results in other areas, or two similar cities (with respect to waste data, but also relevant socio-demographic variables), that is, one introducing the treatment and the other serving as a control.
  - It is essential to ensure that the nudge still allows households to discreetly dispose of certain types of waste in a dark bag that they may wish to hide from the community, protecting their privacy. This distinction is crucial for qualifying the intervention as a nudge: households can still dispose of certain undifferentiated trash in a dark bag, the policy simply "suggests" that households save the bag for when they need to hide their waste.
  - **A preliminary investigation of potential barriers to the use of clear bags for a specific type of material should be carried out.** For instance, the possibility of using clear bags for bio-waste must be established, both in terms of the bag's resistance to chemicals and the opportunities for composting them.

Once the pilot intervention(s) are chosen, candidate areas for the pilots and for the potential scale-up is taken, followed by the preparation of the implementation and monitoring plan for the selected pilot(s) with key stakeholders. The analysis can initially focus on the areas selected, but should always consider the need to replicate the same experimental conditions in the scale-up regions. In-depth discussion should be conducted following the guidelines provided in the OECD BASIC Toolkit (OECD, 2019[3]). It is important to note that the development of the detailed plan can uncover unexpected barriers to the implementation of the pilots in the selected areas. It may be necessary to revisit the selected interventions or the regions of implementation for potential changes. Based on the suggested pilots, key steps in this phase include the following:

- **Evaluation of the availability of the proper infrastructure required to measure the impact and, when needed, to administer the intervention (i.e. feedback provision).** The objective of the pilots is to establish whether a nudge had a positive impact. To this end, the extent to which the appropriate infrastructures are available in the target region to both administer and evaluate the impact of the intervention should be carefully assessed. The absence of an adequate infrastructure can undermine the credibility of institutions and reduce citizens' trust and participation in appropriate waste-related behaviours.

- **Evaluation of intervention risks**. An assessment of possible risks and potential unintended outcomes of the intervention should be made with stakeholders and experts. Ethics should be a crucial element of this assessment.
- **Protect confidentiality of data analysis**. The BIs have the potential to collect sensible data at a very disaggregated level. Appropriate procedures and protocols need to be in place for their management.
- **Scale-up strategy of the pilots.** Before the implementation of the pilot, the key next steps for the scale-up of the intervention, if successful, should be identified with stakeholders from the scale-up regions. It is also important that scale-ups involve the participation of behavioural experts to ensure that critical aspects of pilot BIs are not overlooked. This may happen because certain aspects of the behavioural-informed intervention may seem unimportant to policy makers not trained in this field.
- **Pre-test the intervention with a target sub-sample and partners before launching the pilot.** A preliminary test of the intervention with a small group of consumers that share the same characteristics as the target sample and which involve relevant actors (e.g. waste collectors) is recommended to ensure the sound design of the intervention.
- **Evaluation and communication of the results.** The results of the experiment need to be carefully evaluated by a scientific team, possibly through a peer-review process. The results of the experiment should be made public, even in the case of null or negative outcomes, so that citizens are not exposed to similarly ineffective interventions in the future.

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Annex A. Agenda of the workshop on behavioural interventions for the circular economy transition in Italy

Title of the workshop: Workshop on behavioural interventions for the circular economy transition in Italy

Date and time: 12th December 2022, 9:30 – 13:30

Location: Tor Vergata University of Rome (Sala del Consiglio, 2nd floor, Building B, via Columbia 2, Rome

Format: The event took place in a hybrid format, with both in-person and online participants.

Opening remarks	
9:30– 9:33	Vincenzo ATELLA, Head of the Department of Economics and Finance, Tor Vergata University of Rome.
9:33 – 09:36	Luca DI DONATANTONIO, Policy Officer and Country Coordination for Italy, DG REFORM, European Commission
9:36 – 09:39	Silvia GRANDI, Director, Directorate for the Circular Economy, Ministry for Environment and energy Security
9:39 – 09:42	Peter BORKEY, Principal Administrator, OECD.
Round-table discussion on the use of voluntary commitments to waste sorting	
09:45 – 10:00	Understanding soft commitment: evidence from a field experiment on recycling Lara EZQUERRA, University of the Balearic Islands
10:00-10:05	Kick-off open discussion (5 minutes) Mariangela ZOLI, Tor Vergata University of Rome.
10:05 – 10:40	Tour de table (3-4 min each speaker): • Elisabeth GSOTTBAUER, University of Innsbruck and LSE • Amanda FUSO NERINI, Head of International Affairs, CONAI • Pier Giuseppe MORONE, UnitelmaSapienza, University of Rome • Luca CONGIU, Tor Vergata University of Rome • Gustavo PIGA, Tor Vergata University of Rome

Key questions for discussion:

- How should the campaign to sign the voluntary commitments be "promoted" (e.g. public "lecture", meetings with an expert, online advertisement with the form to sign, posts/hashtags on social media)? And who should be the sponsor for the campaign (e.g. local administrations, universities, public institutions)?
- What criteria need to be used to select the cities where to run the pilot (e.g. current rate of waste-sorting, support of local administrations and collecting companies in measuring the results)?
- What type of waste should the experiment focus on (e.g. organic waste, textiles)?
- Would it be useful to involve local shops in the experiment (e.g. signing the commitment in the EEE shop)?

10:40 – 11:00 Coffee-break

Round-table discussion on the use of normative feedback to improve sorting, quality of separate collection and waste reduction

11:00 – 11:15 The Long-Lasting Impact of Long-Term Feedback on Waste Management
Sebastien Meineri, Université Bretagne-Sud

11:15-11:20 Kick-off open discussion (5 minutes)
Mariangela ZOLI, Tor Vergata University of Rome

11:20 – 11:55 Tour de table (3-4 min each speaker):

- Elisabeth GSOTTBAUER, University of Innsbruck and LSE
- Lara EZQUERRA, University of the Balearic Islands
- Amanda FUSO NERINI, Head of International Affairs, CONAI
- Susanna MANCINELLI, University of Ferrara
- Gustavo PIGA, Tor Vergata University of Rome

Key questions for discussion:

- How to best phrase the "feedback message" on the household's sorting performance to avoid citizens feeling reprimanded and reacting adversely (i.e. "boomerang effect")?
- What are the implications of enriching the feedback with information on the average behaviour of neighbours or neighbours with similar demographics? How to avoid that social comparison triggers a rebound effect?
- What criteria need to be used to select the cities where to run the pilot (e.g. use of digital channels to communicate with citizens)?

Round-table discussion on the use of social norms to stimulate waste sorting

11:55 – 12:10 The effects of a green nudge on municipal solid waste: Evidence from a clear bag policy
Mevlude AKBULUT-YUKSEL, Dalhousie University

12:10-12:15 Kick-off open discussion (5 minutes)
Mariangela ZOLI, Tor Vergata University of Rome

12:15 – 12:40 Tour de table (3-4 min each speaker):

- Elisabeth GSOTTBAUER, University of Innsbruck and LSE
- Lara EZQUERRA, University of the Balearic Islands
- Amanda FUSO NERINI, Head of International Affairs, CONAI
- Francesca CAPPELLARO, Division to support coordination on Circular Economy activities, ENEA
- Massimiliano MAZZANTI, University of Ferrara

Key questions for discussion:

- What are the implications of collecting dark bags, which are reserved for unsorted waste, with lower frequency?
- What are the implications of enriching the experiment with the provision of separate transparent bags for textiles and clothing waste? Which specific agreements with the collecting companies are needed for this integration, and how can their support be secured?
- What is the evidence on the impacts of the adoption of clear bags in Italy?
- What criteria need to be used to select the cities to run the pilot?

Academic evidence on nudging consumers more upstream in the product life cycle (e.g. purchase, waste prevention)

12:40 – 12:45 The challenges and opportunities of BI upstream at the purchase and use phase, Mariangela ZOLI, Tor Vergata University of Rome

12:45 – 13:25 Tour de table (3-4 min each speaker):

- Elisabeth GSOTTBAUER, University of Innsbruck and LSE
- Lara EZQUERRA, University of the Balearic Islands
- Mevlude AKBULUT-YUKSEL, Dalhousie University
- Amanda FUSO NERINI, Head of International Affairs, CONAI
- Francesca CAPPELLARO, Division to support coordination on Circular Economy activities, ENEA
- Fabio IRALDO, Sant'Anna University
- Luisa LORÈ, University of Innsbruck

Key questions for discussion:

- What is the evidence in the literature on behavioural interventions (BIs) promoting waste prevention?
- How to measure the impact of waste prevention BIs at home while ensuring privacy?
- Which kind of behaviours and materials could be tackled more effectively?

13:25 – 13: 30 Closing
Aldo RAVAZZI DOUVAN, Tor Vergata University of Rome, Environmental Global Governance, MASE-MIT