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The impact of attitudes and behavioral costs on environmental behavior: A natural experiment on household waste recycling

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ABSTRACT

Numerous studies have shown the importance of incentives as well as of attitudes in explaining pro-environmental behavior. Reported attitude effects, however, are generally rather small and exhibit considerable variation among studies. Different theoretical perspectives can account for this finding: whereas theories of rational action suggest additive effects of costs and attitudes, the low-cost hypothesis and dual-process theories imply interaction effects – in different directions, resulting from different mechanisms. The present study tries to overcome the shortcomings of past research by using advanced statistical methods to test competitive hypotheses in the context of post-consumer waste recycling. We utilize data from a natural experiment on recycling participation in Cologne/Germany ($n = 1882$) in which the incentive structure for recycling changed due to the conversion of the recycling scheme from a drop-off system to curbside collection. In order to avoid self-selection bias, we conducted pre- and post-treatment surveys and applied conditional fixed-effects regression models. We found that curbside collection had a strong impact on recycling participation and attitudes had a moderate effect. The interaction is negative but statistically insignificant. Our findings contradict the low-cost hypothesis and provide some evidence that environmental concerns moderate the effect of the recycling scheme. We cannot, however, reject the rational choice proposition of mere additive effects.

Over the last few decades, numerous studies have come out investigating individual determinants of environmental behavior. This research has led to several stable findings, in particular that the existence of favorable behavioral opportunities and of an appropriate incentive structure is of great importance for environmentally sound behavior (see e.g. Dunlap and Scarce, 1991; Stern, 2000; Kollmuss and Agyeman, 2002; Diekmann and Preisendörfer, 2003). The link between attitudes and behavior (Liska, 1974; Ajzen and Fishbein, 1980; Weigel, 1983) is empirically well established, but research is less coherent regarding attitudes to modify environmental behavior. Although the impact of environmental concern is always positive, there is tremendous variation in the magnitudes of the correlations and in their statistical significance (see, e.g., the meta-analyses by Hines et al., 1986; Bamberg and Möser, 2007).

We seek to contribute to the state of research by presenting an empirical study of household waste recycling. Waste recycling is important from a policy perspective because it exhibits great potential for energy and resource conservation, and helps to protect the environment by reducing the amount of waste to be land-filled or incinerated.[1] From a sociological point

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[1] Notwithstanding the positive consequences of household waste recycling, some negative effects should be kept in mind: first, the processing of recyclables may lead to harm to workers at recycling centers or residents of villages where recycling centers are located (see e.g. Pellow, 2002). Second, from an environmentalist perspective, the reduction of waste and recyclables as well as the direct re-usage of materials is favorable to post-consumer recycling.

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of view, two types of approach can be distinguished: one focusing on macro-structural aspects, the other dealing with micro-sociological and decision-analytical theories, respectively. A macro-structural analysis would ideally study why, when, and how environmental protection schemes are implemented; in this stream of research, approaches such as ecological Marxism (see e.g. Schnaiberg and Gould (1994) and O'Connor (1996) for general arguments; Schnaiberg et al., 2001 provide an interesting study on recycling) and ecological modernization (Mol et al., 2009; Fisher and Freudenburg, 2001) have proved extremely helpful. From a decision-analytical perspective the implementation of policies designed to increase participation in recycling activities should be based on a detailed understanding of the determinants of environmental behavior. In this paper we start from given structural changes and provide a micro analysis that studies why and how changes in the structural context of opportunities influence individual behavior (and therefore lead to aggregate changes in the human–environment interaction). To enhance our understanding of environmental behavior and the effects of macro-structural changes, we test competing hypotheses on the joint effect of environmental attitudes and behavioral cost on behavior based on different decision theoretical models – variants of rational choice, dual-process theories and the low-cost hypothesis (see e.g. Opp, 1999; Chaiken and Trope, 1999; Diekmann and Preisendörfer, 2003). The latter two approaches lead to the presumption of an interaction between attitudes and behavioral cost. We therefore address two questions that are important from a decision theoretical point of view: to what extent is environmental behavior influenced by incentives and opportunity structures, and to what extent by attitudes? Further, how is the attitude–behavior link structured?

Although there have been several studies on recycling (e.g., Tonglet et al., 2004; Ando and Gosselin, 2005; Do Valle et al., 2005; Palatnik et al., 2005), only a few investigated the interplay of opportunity structures, behavioral cost, and attitudes in detail. Furthermore, the field experiments found in the literature attempted to identify the effects of changes in behavioral cost (i.e. a change in the collection scheme) by using a one-stage design without pre-treatment observation (see e.g. Derksen and Gartrell, 1993; Guagnano et al., 1995). Such a design, however, is prone to bias and does not allow a reliable estimation of treatment effects. In the present study, we overcome these methodological limitations by using data from a natural experiment on recycling participation: between 2006 and 2008, the household recycling scheme in Cologne, Germany was transformed from a drop-off scheme (containers at street corners) to a curbside pickup scheme (bins in the houses). Since the conversion was implemented stepwise, that is, one district after another, we were able to set up an experimental design with pre- and post-treatment surveys, and use conditional fixed-effects panel-regression models to compensate for unobserved heterogeneity. We are thus able to estimate the effect of changing behavioral opportunities even under the condition of a non-randomized experiment.

The paper is structured as follows: In the next section we discuss different decision theoretical approaches that may shed light on the aforementioned puzzle of high variability in attitude effects on environmental behavior (1). These approaches are used to derive testable, mutually exclusive hypotheses (2). We then give some background information on the setting of the field experiment and describe the experimental design (3). After a description of the data and methods used (4), we present the empirical results (5). Finally, we discuss our results with regard to the respective theoretical perspectives and outline some policy implications (6).

1. Theory and state of research

The central question of this paper is how institutional change – the implementation of a new recycling scheme – leads to changes in recycling rates. The following theoretical considerations can be subsumed under the broader class of structural individualist explanations (see Coleman, 1990; Udehn, 2002). Structural individualism explains macro phenomena with recourse to individual behavior and aggregation of individual actions (see especially Coleman, 1990, pp. 1–23). The analytical part of this paper focuses on micro-level decision theories and studies how the implementation of curbside recycling affects recycling participation. A thorough explanation of recycling behavior should consider cost-benefit aspects as well as attitudes. At least three theoretical perspectives try to integrate these concepts: a wider rational choice approach, the low-cost hypothesis, and dual-process theories or framing models. We chose these three approaches – in the form presented below – as they *commonly* address the integration of behavioral cost and attitude effects in some way, but substantially *differ* in the theoretical mechanism as well as in their empirical predictions. We are aware that there are other theoretical perspectives that may lead to similar predictions. However, it is not the aim of this paper to engage in debates about multiple theorizations, but rather to empirically test fundamentally competing hypotheses.

1.1. Rational choice

Rational action models and the subjective expected utility (SEU) theory explain human behavior as the result of a choice among alternatives. Rational choice proposes that an actor is subject to certain (societal and individual) constraints that restrict the alternatives an actor can choose from. Given these constraints, the individual evaluates the action alternatives with respect to subjectively expected consequences and the subjective probability of these consequences. He or she then chooses the alternative that optimally satisfies his or her preferences (see Fishburn, 1981; Opp, 1999, p. 173). These basic considerations leave wide scope for interpretation, extension and specification. Opp (1999) differentiates between 'wide' and 'narrow' varieties of rational choice. Narrow approaches conceptualize the actor as *homo oeconomicus*. Among other things

they restrict preferences to be tied to 'hard' factors (like time or money). Wide variants of rational choice additionally take 'soft' factors into account (like the 'cost' of cognitive dissonance or deviant behavior).

For the matter of simplicity, we start with arguments that stem from the homo oeconomicus model, and extend this model in due course. In the case of recycling, a person would only engage in waste separation if the expected utility – minus the costs associated with that action – exceeded that of simply depositing recyclables in the garbage bin together with non-recyclable waste. From the perspective of economic theory both actions will essentially produce the same desired outcome (i.e., the removal of waste from the household), whereas the behavioral cost may differ in terms of effort and time required, depending on the opportunity structures present.[2] Since a transition from a drop-off scheme to a curbside scheme lowers recycling costs, it should lead to higher participation rates. By the same argument, the participation in recycling would be expected to decline with increasing distance to the next container if a drop-off scheme is implemented. This effect of utility considerations and opportunity structures on recycling behavior is very well documented (e.g., Guagnano et al., 1995; Porter et al., 1995; Barr and Gilg, 2005; Do Valle et al., 2005).

If the concept of utility is not interpreted in a narrow economical sense, this simple model can be supplemented with the impact of environment-related attitudes. One can argue that actions in accordance with attitudes and values lead to an intrinsic utility (the so-called "warm glow of giving", see Adreoni, 1990), whereas actions inconsistent with attitudes or beliefs generate cognitive dissonance (Festinger, 1957), or, in other words, cost. This leads to the expectation of a positive effect on environmental behavior due to environmental concern over and above the effects of constraints and opportunities. It is important to note that, following the wide variant of rational choice, we expect an impact of environmental concern *in addition* to the impact of behavioral opportunities: The more supportive the opportunities (that is, the lower behavioral cost), the higher the probability of recycling, and the higher an actors' environmental concern (that is, the higher the warm glow or the dissonance, respectively), the higher is the expected probability of recycling. These and other action consequences can be combined in a simple additive utility function. The effect of environmental concern on recycling behavior is empirically relatively well recognized (Guerin et al., 2001; Olli et al., 2001; Gatersleben et al., 2002), but the mean correlation is only of low to moderate strength, with a rather large variance (see, e.g., the meta-analyses by Hines et al., 1986; Bamberg and Möser, 2007).

1.2. The low-cost-hypothesis

The *low-cost hypothesis* (Diekmann and Preisendörfer, 1998, 2003) can be seen as an attempt to explain this finding without abandoning the rational action framework. Diekmann and Preisendörfer assume that attitudes influence behavior particularly in low-cost situations, that is, in situations that are characterized by only marginal additional costs of eco-friendly behavior as compared to those for environmentally ignorant alternatives. According to this model, the decision would be based solely on 'hard' utility factors if additional costs are high (i.e., in a high-cost situation). Attitudes would then be completely irrelevant to the decision. The authors introduce the dichotomy of low- and high-cost situations for the sake of simplicity; the low-cost hypothesis actually conceptualizes cost difference as a continuous construct.

Formally, Diekmann and Preissendörfer (2003, p. 449f) begin from a binary decision problem with a pro-environmental alternative x_1 and an environmentally less favorable alternative x_2. Both alternatives are characterized by their respective subjective costs $c(x_1)$ and $c(x_2)$. The authors assume that for most persons and most situations, the pro-environmental alternative is costly, hence the difference $d = c(x_2) - c(x_1) > 0$. If $d > 0$ and environmental concern is not an issue, rational actors will always choose the environmentally unfriendly alternative x_2. As laid out above, however, environmental concern can be included in the utility function as well. Diekmann and Preisendörfer conclude that "depending on d and the intensity of the attitude, the utility of complying with the norm may compensate for the cost difference of the pro-environmental behavior relative to its alternative. (...) In general, the larger d, the smaller is the proportion of actors with attitudes strong enough to compensate for the cost difference. If, with increasing d, this proportion approaches zero, the effect of the attitude on the behavior decreases, too" (p. 450f). Guagnano et al. (1995) give an alternative formulation of the same argument. In their *ABC*-model they propose the impact of attitudes (A) on behavior (B) to be weaker when external conditions (C) are unfavorable. In line with rational choice theory they argue that an individual actor will show a certain behavior if the expected utility is positive, such that $A + C > 0$. When the absolute value of $|A + C|$ is small, shifts in attitude A may change the sign of $A + C$ even if the value of A is not of great magnitude (that is, if attitudes are not very salient). The change of the sign, in turn, would change the observable behavior. In the aggregate this means that "greater behavioral effects will be realized from any given variation in attitude within the group" (p. 703f) when behavioral cost is low. Based on this derivation, statistically speaking, the low-cost hypothesis posits an interaction effect between the cost of environmentally friendly behavior and pro-environmental attitudes (Diekmann and Preisendörfer, 2003, p. 443).

In the case of household waste recycling, the average behavioral costs are lower for a curbside scheme than for a drop-off system. Under the condition of a drop-off system, many people are in a situation Diekmann and Preisendörfer describe as "high cost". Just as in traditional rational choice theory, the relatively high costs would then lead to a relatively low probability of recycling participation. But the low-cost hypothesis also states a second effect of behavioral cost and predicts the

[2] Recycling is – depending on the recycling scheme – more or less costly in terms of inconvenience. It should, however, reduce the financial cost of waste disposal if (residual) garbage collection is billed on a quantity basis.

impact of environmental concern on recycling behavior to be low in such a high-cost situation. When a curbside scheme is implemented, this leads to a reduction in average behavioral costs of recycling. Consequently many people are in a "low-cost-situation". The low-cost-hypothesis then predicts (a) rising participation rates due to the cost effect and (b) an increased strength of the attitude–behavior relationship.

Thus, the low-cost hypothesis assumes direct cost effects identical to traditional rational choice. In contrast to rational choice, however, the effect of environmental concern on recycling activity is moderated by behavioral cost. The empirical evidence on the low-cost hypothesis is ambiguous: certain studies on environmental behavior support the hypothesis in general (Derksen and Gartrell, 1993; Franzen, 1995; Diekmann and Preisendörfer, 2003), while others report contradictory results (Schultz and Oskamp, 1996; Kühnel and Bamberg, 1998; Palatnik et al., 2005; Best, 2010, 2009b). Experimental economics provides further evidence. Many experiments on fairness and reciprocity have shown that norm effects are stable, even if the incentives are raised (high stakes, see e.g., Cameron, 1999; Cherry et al., 2002; Diekmann, 2004). Camerer and Hogarth (1999) provide an overview of these experiments, concluding "that no replicated study has made rationality violations disappear purely by raising incentives" (p. 7).

1.3. Dual-process theories and the model of frame selection

Social psychological dual-process theories advance a very different argument. These models evolved in the late 1980s in the context of persuasion and attitude change (e.g., Petty and Cacioppo, 1986; Chaiken et al., 1989), stereotype formation (Fiske and Neuberg, 1990), and behavioral intentions (Fazio, 1990; Chaiken and Trope, 1999). They all argue that stored attitudes influence the processing of information in any given situation. If the accessibility of an initial attitude (or mental category) and its match with observed situational cues are strong, the attitude will activate *automatically* together with the cognitions, affects and behavioral dispositions related to it (see also Eagly and Chaiken, 1993).

The *Model of Frame Selection* (MFS, see Esser, 2001; Kroneberg, 2005; Kroneberg et al., 2010) constitutes a special case in the class of dual-process theories. We focus on this model as it is highly formalized and therefore has a notable advantage for our application: It allows for a precise delineation of its elements and their interrelation and is in this respect comparable to the competing rational choice models we test it against. Its key elements are (a) the idea that behavior is guided by frames and scripts, (b) the assumption of variable rationality, and (c) the specification of conditions for systematic consideration of consequences rather than spontaneous behavior. The latter is accomplished by formalizing two *modes* of information processing: a reflecting-calculating mode (rc-mode) and an automatic-spontaneous mode (as-mode). The distinction between these two modes is merely for the sake of simplicity. They might also be considered as the two extremes of a continuum.

Action in the rc-mode represents a deliberate choice between alternatives evaluated with regard to their expected consequences. The rc-mode corresponds to the conception of rationality employed in rational choice theory. In the as-mode, in contrast, behavior is based on a strongly activated *script,* encoded in the past (c.f., Vanberg, 2002). Scripts are programs of behavior or behavioral sequences corresponding to a mental model of a situation (or *frame* in the MFS) that matches the concrete situation the actor faces and subsequently defines it. If a certain action is selected in the as-mode, instrumental considerations play *no* role. The MFS specifies the determinants of mode selection and formalizes the relationships between them in analogy to an *unconscious* meta-decision. The mode selection depends on four parameters:

- opportunities for reflection such as time and available cognitive capacity (p),
- the motivation for reflection, i.e. the expected net gains from more deliberate considerations (U),
- the costs of reflection, i.e. the cognitive effort involved (C),
- how strongly a script j that prescribes action k is activated and hence makes a ready-to-use program for action accessible ($\mathrm{AW}(A_k|S_j)$).

The literature on dual-process theories (Fazio, 1990; Chaiken and Trope, 1999) has shown that these four variables determine the mode of information processing. Note that, despite the notation similar to that in RCT, p, U, and C reflect mentally encoded experiences and directly perceived properties of the situation. These parameters can also be linked to neurophysiological processes as pointed out by Marcus and colleagues (2000).[3] The mode selection does thus *not* represent a conscious decision as the decision of whether to search for more information cannot be based on properties of this unknown information.

A decision-theoretic specification of the mode selection implies that an actor will operate in the as-mode if the additional (expected) utility resulting from a more involved processing does not exceed the additional costs of the cognitive effort involved:[4]

$$p \cdot (1 - \mathrm{AW}(A_k|S_j)) \cdot U \leqslant C \tag{1}$$

[3] The Theory of Affective Intelligence (Marcus et al., 2000) was developed in the context of political judgment and is thus particularly recognized in political science. Although being in the tradition of social psychological dual-process theories, the TAI explicitly draws on insights from the neurosciences. It essentially incorporates all parameters identified in the dual-process literature but puts special emphasis on affect. The key elements of their model are "enthusiasm" and "anxiety" as instant physical responses to the perceived performance of routine behavior (AW in the MFS) on one hand and novelty or threat (U in the MFS) on the other hand.

[4] For the derivation of Eq. (1) (see Kroneberg et al., 2010, Appendix A).

Put another way, the as-mode will be selected if the activation weight does not fall below a certain threshold:

$$\mathrm{AW}(A_k|S_j) \geqslant 1 - \frac{C}{p \cdot U} \tag{2}$$

Assuming that the activation weight of action k in the as-mode depends solely on the cognitive availability of script j (a_j) and replacing $\mathrm{AW}(A_k|S_j)$ by a_j, this reduces to:

$$a_j \geqslant 1 - \frac{C}{p \cdot U} \tag{3}$$

A highly available script can be conceptualized as a strongly internalized norm or a strong attitude. The full model also takes into account that the activation of the script-based alternative might fall below a_j if the situation cannot be defined unambiguously, the particular script is not perfectly accessible in this kind of situation or it might not sufficiently regulate the respective behavioral choice (Kroneberg, 2007; Kroneberg et al., 2010). At least for the German context we can assume that persons with a high environmental concern will define a situation of waste disposal as ecologically relevant. In fact, a symbol for recyclables (green dot/"Grüner Punkt") serves as a situational cue. Moreover, in general environmental concern clearly prescribes participation in household waste recycling.

Thus, according to the MFS, strongly internalized norms or pronounced attitudes should *immediately* lead to consistent behavior *without* evaluating alternatives by reflecting on costs and benefits. With respect to environmental concern and recycling behavior, this leads to the prediction that the impact of recycling costs is moderated by environmental concern, interpreted as the availability of a script prescribing participation in recycling.[5] The introduction of a curbside recycling scheme should then have different effects in a population with mixed degrees of environmental concern: reduced costs of recycling should increase participation rates among those who are not-so-concerned (rc-mode), but they should be of *no* importance to the highly concerned (as-mode).

2. Hypotheses

Based on the theoretical considerations discussed above we can derive three competing hypotheses on the joint effects of opportunity structures, the related cost of recycling, and environmental concern on recycling participation.

A curbside scheme is associated with lower economic cost (in terms of time and effort). In a wide rational choice perspective, behavior in concordance with strong attitudes is associated with intrinsic utility. Both factors can be seen as part of the actor's utility function. Both lower cost and pronounced environmental concern should therefore *independently* increase the probability of recycling. We thus derive

H1. The type of recycling scheme and environmental concern have additive effects on the likelihood of participation in recycling (rational choice hypothesis).

The low-cost hypothesis argues that the presence of an attitude effect is contingent on the behavioral costs and hence on the recycling scheme. It argues that attitudes are especially important in a decision when the relative cost of environmentally friendly behavior is low. Therefore we postulate

H2. The effect of environmental concern should be stronger when a curbside scheme is installed (low-cost hypothesis).

In contrast the MFS distinguishes between two modes of information processing conditional on the strength of attitudes (and therefore on the availability of behavioral scripts). Thorough information processing, and therefore a strictly rc-based decision, is expected only if attitudes are rather weak. Accordingly we can formulate

H3. The recycling scheme does not play a major role for persons with very strong environmental concern, but becomes more and more relevant when attitudes are weaker (dual-process hypothesis).

All three hypotheses predict positive main effects of environmental concern and the curbside scheme on recycling participation. Beyond these main effects, the low-cost hypothesis (H2) and the dual-process hypothesis (H3) both predict an interaction effect between recycling scheme and environmental concern. Nonetheless, there are important differences between the two hypotheses. First, they *differ in the predicted sign* of the interaction term, thus giving us an opportunity to discriminate between the two hypotheses empirically: the interaction term is expected to be positive following H2 (the low-cost hypothesis), and negative following H3 (the dual-process hypothesis). Second – and more important – they *postulate different underlying mechanisms* (which variable moderates the effect of the other): based on H2, the effect of attitudes is moderated by behavioral cost, whereas H3 expects the effect of cost to be moderated by attitude strength. Consequently, the two hypotheses predict *specific patterns* of recycling propensities depending on the combination of costs and attitudes. This can easily be understood when the expected interaction patterns are visualized.

[5] Note that it follows from Eq. (3) that a change in environmental concern (a_j) will affect the impact of recycling costs on recycling behavior *irrespective* of the values of p, C, and U if these are no confounds of a_j.

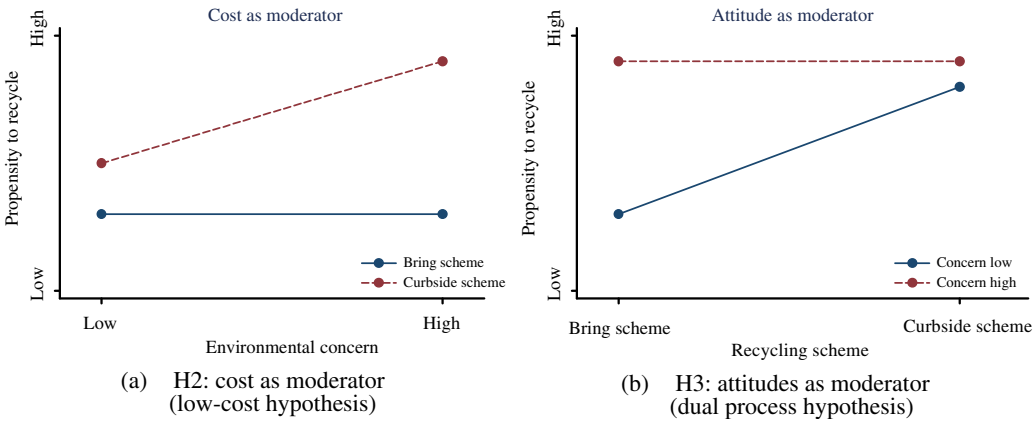


Fig. 1. Predictions of low-cost vs. dual-process hypothesis.

Table 1
Experimental design.

NR	Study group	(Nippes)		O_{t1}	X	O_{t2}
NR	First control group	(Innenstadt)		O_{t1}		O_{t2}
NR	Second control group	(Lindenthal)	X	O_{t1}		O_{t2}

X: treatment/transition of the recycling scheme; O_{tk}: observation at time tk.

Fig. 1 shows the expected propensities to recycle given the validity of the respective hypotheses 2 or 3 plotted against either environmental concern or the recycling scheme. Fig. 1a depicts the pattern of recycling propensity when H2, the low-cost hypothesis, is valid and the attitude effect is moderated by the recycling scheme. In contrast, Fig. 1b plots recycling propensities contingent on the validity of H3, the dual-process hypothesis. Here, the effect of cost is moderated by attitude strength.

3. Design of the field experiment

In most parts of Germany a two- or three-stream curbside system has been used for the collection of recyclables since the 1990s: in addition to a bin for residual waste, the households have a bin for paper, another bin – or yellow bags – for packaging materials (mainly plastic and metal), and sometimes a further bin for glass. In other cases the collection of glass is organized as a drop-off scheme with containers at street corners. By law, the industry is responsible for the collection and recycling of paper, plastics, and glass. The cost of recycling is added to products' prices; the consumer, therefore, pays for the recycling of the packaging materials when buying packaged products – regardless of his/her decision to recycle or not. Consequently, actual *participation* in recycling activities is free of charge.

In contrast to almost all other cities in Germany, the city of Cologne relied on a drop-off system (with drop-off containers at street corners) for all kinds of recyclables: glass, paper, and packaging. As late as 2006, the waste management authorities commenced a stepwise implementation of curbside collection. Between February 2006 and October 2007, the drop-off scheme for recyclable waste was replaced by a curbside recycling scheme for paper and packaging.[6] In one city district after another, the households were provided with blue and yellow bins for the collection of paper and plastic/metal cans free of charge. In one neighborhood, Lindenthal, the curbside scheme had already been implemented during a "pilot study" a few years earlier. This stepwise implementation provided an opportunity to design an experimental study with one treatment group and two control groups. In this experiment, the change in collection systems can be considered an experimental treatment to modify the behavioral cost of recycling. It should be kept in mind, that, as noted above, there was no change in the collection system for glass bottles.

The inhabitants of the district Nippes served as the experimental group. In this district, the curbside recycling scheme took effect in September/October 2006. The control groups came from two districts which were not subject to any change in recycling scheme during the relevant period. Inhabitants of Cologne-Innenstadt served as the first control group, as the curbside pickup had not been introduced in that district until September/October 2007. Cologne-Lindenthal served as the second control group; in this district paper and plastic had been picked up at the curbside for some years.

[6] The curbside scheme was not used for the collection of glass. Rather, recyclable glass had to be brought to drop-off containers by the participants.

The members of the study and control groups were randomly selected from their respective districts and were interviewed in a postal survey at two points in time (see below for details). The first wave of interviews was conducted in all districts before the curbside pickup was introduced in Nippes (the study group). The second panel wave followed about half a year later but well before the transition to curbside recycling in Innenstadt.

Using this pre-/post-test design (see Table 1 for a summary) it was possible to perform a rigorous test of the effects of opportunity structure, behavioral cost, and environmental concern on recycling behavior. There have been a number of field experiments on recycling participation (e.g., Derksen and Gartrell, 1993; Guagnano et al., 1995) only utilizing cross-sectional data and comparing the determinants of recycling participation in separate spatial units. Unfortunately, the causal interpretation of treatment effects in such a design is flawed, and self-selection into study and control groups can bias the results. In an extreme case, the results mirror selection effects rather than treatment effects. In the present study, the problem of self-selection and a lack of randomization was minimized by utilizing panel data collected before and after the implementation of a curbside scheme in Nippes. To compensate for selection and unobserved heterogeneity, we used conditional fixed-effects regression models. These models analyze the determinants of change between two or more sequential observations and yield results unbiased by time-constant heterogeneity (Wooldridge, 2002). Therefore, our results are unbiased with respect to differences among the districts in demographic structure or built environment, for example.[7]

4. Data collection and central variables

The following analyses are based on a two-wave panel postal survey of 4482 Cologne citizens. The participants were randomly selected from the population register of Cologne, distributed equally over the three selected districts: Nippes, Innenstadt and Lindenthal. The survey was designed following Dillman's tailored-design method (Dillman, 2000), using incentives and two follow-up reminders. The first panel wave was conducted during July/August 2006 and yielded a response rate of 64%. The second panel wave followed in May/June 2007 with a response rate of 83%. Overall, 1882 persons provided usable information in both waves of the panel[8] (Nippes: 630, Innenstadt: 585, Lindenthal: 667), and their answers will serve as the database for this paper.[9]

The questionnaire of the first wave comprised a slightly reduced standard demography, a number of questions on environmental attitudes, and a detailed account of recycling behavior. For each of the types of recyclables (paper, glass and plastic/metal cans), the frequency of participation in recycling was to be indicated on a four point ordinal scale.[10] For the purposes of this paper, recycling participation was dichotomized, with persons declaring that they "always" participated in recycling being coded as 1, the rest as 0. Dichotomization of the variable was necessary for two reasons: the variable is highly skewed, and there are no reliable statistical models to estimate panel-regression models with an ordinal variable. A reproduction of cross-sectional analyses with the four-category variable does not lead to results different from the results reported here. To measure environmental concern, we used a scale proposed by Diekmann and Preisendörfer (2000). The scale consists of nine items on general environmental attitudes.[11] It is conceptually based on the scale designed by Maloney and Ward (1973), and conceptualizes environmental concern as a construct made up of affective, cognitive and conative attitudes. In the second wave, the measurement of recycling behavior, the location of the collection containers, and environmental concern was replicated, employing the same questions as in the first wave.[12]

5. Results

The following sections document our testing of the hypotheses using data from two panel waves. We first study recycling participation and the attitude–behavior link at time t_0, that is, before the implementation of curbside recycling in the treatment group. Then we turn to an analysis of changes over time and identify the treatment effect using panel regression.

[7] As is always the case in survey research, we did encounter some problems resulting from non-response. However, given the high response rate in this study (see below) we do not expect a severe lack of representativeness. Additionally, participants in the first and second panel wave are almost identical in their demographic characteristics (no differences in education, income, or gender; a minor difference in age).

[8] As the questionnaires were accompanied by a personalized letter and they were sent by mail to individuals – not households, we strongly assume that the questionnaire has been filled by the same person in both panel waves. Even if an old-fashioned husband handles the entire household's official mail (like a letter from a University), and therefore falsely filled the questionnaire instead of his wife, we could assume that he would have done that in both panel waves.

[9] The data set is available for replication upon request from the first author.

[10] Answer categories: Always, often, sometimes, never.

[11] Scale items (translated from German): "When I think about the environmental conditions under which our children and grandchildren will have to live, I am worried." "If we continue to behave the way we used to do, we are heading towards an ecological disaster." "When reading newspaper articles on environmental problems, or when watching corresponding telecasts, I often become indignant and angry." "There are limits to growth which our industrialized world has already exceeded or will soon approach." "Up to now, the greatest part of the population does not behave in a very environmentally friendly manner." "In my opinion, the dimension of ecological problems is exaggerated by the environmentalists." "Politicians are still doing far too little to protect the environment." "In favor of the environment, all of us should be willing to cut down on our standard of living." "Environmental measures should be enforced even if there is a loss of jobs."

[12] Cronbach's alpha for the environmental concern scale was 0.80 in the first survey wave, and 0.81 in the second wave. Inter-individual comparisons over time are meaningful only if the scale additionally offers a satisfactory test–retest reliability. Using a student sample ($N = 60$, University of Cologne and University of Chemnitz, Germany, collected early summer 2007), we estimated the test–retest reliability over a 2-week period. The two measurements correlated with $r = 0.89$, pointing to a very good scale reliability.

Table 2
Recycling-rates by district (percent "always" recycling; first wave).

	Paper	Plastic	Glass
Nippes	75.4	50.8	74.2
Innenstadt	68.8	36.7	68.8
Lindenthal	84.5	61.1	75.8

Results based on 1868 respondents (cell minimum 599 respondents).

Table 3
Effect of environmental concern on recycling behavior ("always" recycling; biserial correlations; first wave).

	Paper	Plastic	Glass
Nippes	.19	.25	.27
Innenstadt	.19	.16	.22
Lindenthal	.14	.19	.06

Results based on 1850 respondents (cell minimum 594 respondents).

5.1. Pre-treatment setting

The citizens of Cologne proved to be very much engaged in recycling. In the first wave of the survey, more than 70% of the respondents reported that they "always" recycled glass and paper, and about 50% participated in recycling plastic. When the recycling rates are disaggregated by the three districts, notable differences are found.

The differences between the districts were as theoretically predicted: Lindenthal, the neighborhood with curbside collection of paper and plastic, had the highest participation rates for these two recyclables: 85% participation in paper recycling, 61% for plastic. Both districts with a drop-off scheme showed substantially lower rates (see Table 2). With regard to glass, however, there was no significant difference in participation in glass recycling between Nippes and Lindenthal. Only Innenstadt exhibited somewhat lower rates (as can be seen from Table 2, the latter is the case for all recyclables). This relatively small variation in glass recycling rates differences mirrors the fact that there are no differences in the collection scheme for that recyclable between districts: a drop-off system is used for glass in all neighborhoods. The results of cross-sectional comparison between the districts therefore can be seen as a first indicator of the relevance of behavioral cost and opportunities for participation in recycling activities.

The correlation between recycling and environmental concern in the first panel wave was of medium strength, yet statistically significant. Regarding paper recycling, we found a biserial correlation of .16 regarding plastic and .18 for glass. The moderate magnitude of the correlations in part reflects the fact that we employed a scale of general environmental concern. General environmental attitudes are interesting from a conceptual point of view, but lead to systematically lower correlations than do specific attitudes (Weigel et al., 1974; Weigel and Newman, 1976; Ajzen and Fishbein, 1977, 1980). To elaborate on the attitude–behavior relation, we computed biserial correlations between recycling participation and environmental concern separately for all combinations of district and type of recyclable (Table 3).

The effect of environmental concern, although always positive, displayed considerable variation between districts and materials. The weakest effect was estimated for glass recycling in Lindenthal at only .06, the strongest for the same material in Nippes (.27). The variation was not systematic, except for the uniformly relatively strong effects in Nippes. These strong correlations cannot be attributed to lower behavioral cost, as there was no curbside scheme in Nippes at the time of the first panel wave.

The descriptive cross-sectional findings can be interpreted as an indicator for the cost-reduction caused by a curbside collection scheme and for the relevance of environmental attitudes to recycling behavior (H1).[13] But they leave a number of open questions: there is no compelling evidence for or against any of the competing hypotheses on environmental concern (H2 and H3), and it is not at all clear why the strength of the attitude–behavior correlation varies between the districts. Additionally, the interpretation of the results is uncertain because observed behavioral differences may be due to selection effects and/or unobserved characteristics of the spatial units.

5.2. Changes over time and treatment effects

The field-experimental design of the present study enabled us to complement the descriptive comparisons between districts with an inspection of *changes over time*. Using data from the pre-treatment and the post-treatment observations, we can also study changes within districts as well as within actors. For that we will proceed in two steps: first we will describe aggregate developments in the neighborhoods. As this approach can still lead to results that are biased by characteristics of

[13] A more thorough discussion of the results of the first panel wave is given by Best, 2009b.

Table 4
Changes in recycling activity, 2006–2007.

	Paper	Plastic	Glass
Nippes	+9.2	+18.8	+5.1
Innenstadt	−0.2	−2.0	+1.0
Lindenthal	+2.6	−0.3	+0.8
DiD[a]	+7.9	+19.9	+4.2

[a] Difference-in-difference: differences in changes over time between Nippes and the weighted mean of Innenstadt and Lindenthal.

Table 5
Changes in the attitude–behavior relationship, biserial correlations, 2006–2007.

	Paper	Plastic	Glass
Nippes	−0.12	−0.05	−0.13
Innenstadt	−0.11	−0.09	−0.04
Lindenthal	+0.02	+0.04	+0.01
DiD[a]	−0.04	−0.02	−0.01

Values computed as $r_{bis\_t2} - r_{bis\_t1}$.
[a] Difference-in-difference: differences in changes over time between Nippes and the weighted mean of Innenstadt and Lindenthal.

the field experiment (e.g. due to self-selection), we will then proceed with a multivariate analysis using panel regression. Fixed-effects regression has two features that make it particularly appropriate for this study: (a) the models automatically control time-constant heterogeneity, thereby avoiding bias due to self-selection into the experimental groups. It is therefore unnecessary to include time constant control variables like gender, and education in the regression – possible differences between districts regarding the demographic composition or the built environment are automatically accounted for. (b) The models do not draw on a comparison between respondents but directly analyze changes within individuals over time. They therefore provide a strict test of the attitude–behavior relationship by asking whether changes in a person's attitudes also lead to changes in his/her behavior.

5.2.1. Descriptive findings

Overall, the engagement in recycling increased between 2006 and 2007. Participation rates rose from 76.5% to 80.5% for paper recycling, and from 49.9% to 55.6% for plastic recycling. Glass recycling increased as well but to a lesser extent (from 73.1% to 75.4%). According to Hypothesis 1, the implementation of the curbside collection scheme for paper and plastic recyclables in Nippes led to this rise in participation rates. To examine this proposition, we disaggregate the changes in self-reported recycling participation (see Table 4).

In Nippes – the treatment group – the recycling rate increased strongly between the two observations. The strongest increase occurred regarding plastic recycling (with a growth of almost 20% points), and even glass recycling increased by five points, although there had not been a change in the collection mode for the latter recyclable. All changes in Nippes are statistically highly significant (paired *t*-test). Both other districts faced only marginal, statistically insignificant changes in recycling participation. The results therefore clearly support the hypothesis that the implementation of a curbside scheme lowers behavioral cost and increases the participation in recycling activities (H1, rational choice hypothesis).

As the treatment has lead to substantial changes in behavior, it should – following the argument of the low-cost hypothesis (H2) – also increase the correlation between environmental concern and environmental behavior. Table 5 therefore shows the changes in the attitude–behavior relationship. To compile the table, we estimated biserial correlations for all districts × recyclable × panel wave combinations. The values in the table have been computed as the difference between the correlation in wave 2 and wave 1 (r_{bis_t2}-r_{bis_t1}). It is clear that, in spite of the lower behavioral cost, the correlation coefficients in Nippes have *not* increased. Rather, the association between environmental concern and recycling has weakened. As there were some changes in the magnitudes of correlation coefficients in the other districts as well, the observed decrease could possibly be due to external influences.[14] As these external factors affect all districts in the study equally, it makes sense to compensate for them by calculating differences-in-differences.[15] We find that, after we have accounted for external factors, only a slight decrease in bivariate correlations in Nippes remains attributable to the treatment.

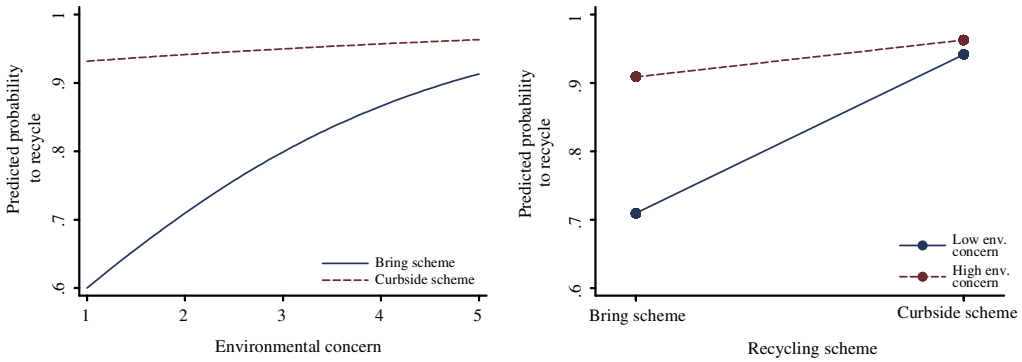
[14] An obvious candidate for such an external influence would be the growing intensity of the debate on climate change. In spring 2007, the International Panel on Climate Change's fourth assessment report was published, and the Stern Review raised serious concerns about the economic consequences of climate change (IPCC, 2007; Stern, 2007).

[15] Difference-in-difference estimation and two-stage fixed-effect-models allow us to disregard these external influences without obtaining a biased estimate of the treatment effect. This is a great advantage if one is mainly interested in studying specific micro-hypotheses, as is the focus of this paper. A different focus would necessarily demand for a different study design and, in general, we regard macro-structural perspectives highly relevant in the study of society–environment interactions.

Table 6
Logistic fixed-effects panel-regression models ("always" recycling, standard errors in parentheses).

	Paper		Plastic	
	Model 1a	Model 1b	Model 2a	Model 2b
Panel wave	0.13	0.13	−0.16	−0.16
	(0.18)	(0.18)	(0.15)	(0.15)
Curbside	0.74***	1.32	1.33***	2.53***
	(0.26)	(1.18)	(0.22)	(1.03)
Env. concern.	0.53**	0.61*	0.30	0.49*
	(0.26)	(0.31)	(0.22)	(0.27)
EC × curbside		−0.16		−0.32
		(0.32)		(0.27)
N	516	516	792	792

* $p = 0.10$.
** $p = 0.05$.
*** $p = 0.01$; two-tailed.



(a) H2: cost as moderator (b) H3: attitudes as moderator

Fig. 2. Results: EC × curbside-interaction, plastic recycling.

5.2.2. Estimation of the treatment effect

As noted above, the results presented up to now may be biased by self-selection into study- and control groups in the non-randomized experiment. To control for self-selection and unobserved heterogeneity we estimated logistic fixed-effects regression models.[16]

In the initial logit models we used the panel wave, presence of curbside recycling, and environmental concern as predictors (see Table 6). Model 1a is the reference model for paper recycling. There was a slight overall increase in recycling participation, a time trend which is neither traceable to changes in the opportunity structures nor in the subjects' environmental concern. As stated in H1, the introduction of curbside recycling led to a significant rise in recycling ($b = 0.74$, $z = 2.85$), and an increase in environmental concern does indeed encourage behavioral changes ($b = 0.53$, $z = 2.04$). The substantive results regarding plastic recycling (model 2a) do not differ widely from those for the paper models. Again, we find positive effects of curbside recycling ($b = 1.33$, $z = 6.05$) and of environmental attitudes ($b = 0.30$, $z = 1.36$). But in contrast to paper recycling, we observed a slightly negative time trend, leading to the conclusion that the overall growth in participation was due to the quite strong effect of the implementation of the curbside scheme. The effect of environmental concern was positive as well, but weaker than in the paper model and not statistically significant.

To test hypotheses 2 and 3, that is, to investigate a possible interaction between behavioral cost and environmental attitudes, we include multiplicative terms in models 1b and 2b. As Table 6 shows, the revealed interaction between curbside recycling and environmental concern is negative but statistically insignificant ($b = -0.16$, $z = -0.50$ for paper; $b = -0.32$, $z = -1.18$ for plastic). Based on H2, one would have expected a positive interaction effect, whereas H3 proposes a negative interaction. However, logistic regression is a non-linear model and therefore not the method of choice for easy detection of interaction effects (Ai and Norton, 2003). In logit models a variable's effect on the probability of $Y = 1$ can depend on the values of other variables even without the explicit inclusion of multiplicative terms. We therefore examined predicted probabilities and plotted the regression results following the template from Fig. 1. The predicted values in the figure refer to plastic recycling – model 2b – but there would have been no substantial difference had we used paper recycling.

[16] As there was no change in the collection scheme for used glass, the following analysis is restricted to paper and plastic.

Fig. 2a follows the mechanism posited by the low-cost hypothesis (H2): behavioral cost is expected to moderate the effect of environmental concern. As costs (and effort) are lower when a curbside scheme is provided one, would expect a stronger effect in that situation (dashed line). Conversely, without a curbside scheme, the hypothesis predicts a weaker effect of attitudes (solid line). As can be seen from the figure, the empirical data contradict H2 quite clearly, since the interaction is obviously contrary to its predictions. Empirically, the effect of environmental concern is stronger when the behavioral cost is higher. When we instead follow the logic of the dual-process hypothesis (H3), it is not cost that moderates the effect of attitudes, but attitude strength that moderates the effect of behavioral cost (Fig. 2b). Following that hypothesis, the effect of cost should be weaker when a person's attitudes are more pronounced. The regression results plotted in Fig. 2b show this to be the case empirically. Persons with high environmental concern (99%-percentile) exhibit only a minor difference in their recycling participation in curbside and drop-off schemes, whereas when environmental concern is low (1%-percentile), the implementation of a drop-off scheme substantially increases recycling participation. It must be emphasized, though, that the interaction effect in the fixed-effects logit model is statistically not significant. Based on these results we can reject the low-cost hypothesis (H2) because of contradictory results, but we also have to reject the dual-process hypothesis (H3) due to lack of statistical significance.

6. Summary and discussion

The primary concern of this paper was to evaluate empirically competing hypotheses on the relation between attitudes and behavior in the context of household waste recycling. We also addressed two questions of general concern: To what extent do incentives and opportunity structures influence behavior, and to what extent do attitudes? And how is the attitude–behavior link structured? We derived three hypotheses from the literature: rational action theory posits that subjective utility expectations determine behavior, and consequently opportunity structures and behavioral cost play a crucial role in decision making. Environmental behavior, however, is not solely determined by tangible utility factors such as time or effort. Rather, ecological behavior contributes to an environmentally concerned actor's intrinsic utility, and hence environmental attitudes directly increase the probability of recycling participation (Hypothesis 1). The low-cost hypothesis posits the effect of environmental concern to be stronger when behavioral cost is low (Hypothesis 2). Finally, the Model of Frame Selection leads to the expectation that effects of behavioral cost and instrumental considerations are lower when environmental attitudes are strong (Hypothesis 3).

The results showed that the citizens of Cologne were very much engaged in recycling, with up to 75% participation, even under the condition of a costly drop-off scheme. Nonetheless, the implementation of a curbside scheme further increased participation rates by 9% points with regard to paper recycling and 19 points with regard to post-consumer recycling of plastic and packaging. The effect of the curbside scheme was stable under statistical control of selection effects and (time constant) unobserved heterogeneity. Thus our results reconfirm important findings from previous research on the institution of curbside recycling (e.g. Derksen and Gartrell, 1993) using advanced statistical methods: Opportunity structures play an important role in predicting behavior, and relatively easy-to-implement policy measures such as curbside recycling can further enhance environmentally responsible behavior.

The attitude effect requires a more complex interpretation. First of all, we found a statistically significant medium-strength main effect of environmental concern. This effect could be identified in the cross-section data as well as in the panel-regression models. In cross-sectional analyses we found that persons with higher environmental concern are more engaged in recycling (that is, we identified a between-respondents effect). We could confirm the attitude–behavior link using panel data and within-respondent models; with these models we could test a rigorous specification of the attitude–behavior link by analyzing whether an intra-individual change in environmental concern increased the probability of recycling participation. As the empirical results show, this is indeed the case. Accordingly, persons with more pronounced environmental attitudes tend to behave in a more environmentally friendly manner, and a corresponding increase in these attitudes increases the probability of recycling participation (as stated in H1).

Other theoretical propositions, however, argue that the effects of environmental concern and behavioral cost are interdependent, and that the two variables are interacting (H2 and H3). To evaluate these hypotheses, we tested for an interaction in our cross-sectional and panel analyses. In the cross-sectional analysis using data from wave 1, we found the attitude–behavior correlations in Lindenthal (the neighborhood with curbside collection) to be lower than those in the two other districts. In the panel-regression models, the interaction between curbside collection and environmental concern (models 1b and 2b) was negative, indicating that the impact of environmental concern on behavior decreased when a curbside scheme was introduced. The interaction effect was not statistically significant, neither in the logit models, nor in a replication with linear models. Therefore, our analyses suggest rejecting the low-cost hypothesis (H2) as well as the dual-process hypothesis (H3), and instead assuming a direct effect of environmental concern on environmental behavior. However, there are three possible objections to this interpretation.

First, the low-cost hypothesis (H2) at least implicitly assumes that attitudes are not so intense for people as to outweigh the additional cost of a bring scheme. One could argue that in our study the environmental concern was too pronounced among our respondents or that the cost difference between recycling schemes was too small, respectively. In spite of this objection we adhere to our study as a valid test of the low-cost hypothesis. In fact, a substantial increase in recycling rates (ca. 10–20% points) is attributable to the treatment and hence to a change in behavioral costs. Furthermore, we found an interaction *contrary* to the low-cost hypothesis' prediction, not just a weak coefficient with the expected sign. With regard

to the salience of environmental concern, it should be kept in mind that we used a random sample of the general population of a major German city. If environmental concern was "too intense" in the population to meet the assumptions of the low-cost hypothesis, this would have to lead to its rejection as inappropriate to our research question in the first place. It should also be remembered that the low-cost hypothesis was formulated explicitly to explain environmental behavior (see Diekmann and Preisendörfer, 2003) and recycling participation (Guagnano et al., 1995).

A second objection concerns our test of the dual-process hypothesis and the MFS. One could argue that our test is incomplete as we only derive a single hypothesis from the theory, "other things being equal". This might lead to confirmation of the specific hypothesis even if the overall theory is wrong, or to a rejection of the hypothesis due to unmet assumptions even if the theory is valid. It would have been a more direct test if we had instead measured all theoretical concepts, and had we investigated the threshold hypothesis derivable from the mode selection equation. This is certainly true, and direct measurement of theoretical concepts has led to valuable insight on decision theory (see e.g. Opp (1989) or Best (2009a) for examples of direct applications of rational choice theory). However, the indirect strategy that we used is very commonly accepted in the social sciences and even radically advocated by some scholars (e.g. Friedman, 1958). In a cumulative research setting the sum of tests of specific hypotheses then sheds light on an overall theory. Either way, further research on the MFS may be profitable, especially when stricter tests are conducted.

Finally, a third objection might argue that our *sample data* indeed conforms to the pattern predicted by the Model of Frame Selection, i.e., with regard to not only the sign of the interaction term but also the virtual elimination of cost effects if attitudes are very strong. Therefore, a rejection of hypothesis H3 would exclusively be based on statistical inference, and would ignore substantial relations in the sample. We do agree that, following the controversy concerning statistical significance and null-hypothesis testing in the social sciences (Loftus, 1991; Krantz, 1999; Nickerson, 2000; Gigerenzer et al., 2004), the lack of significance should not lead to a blind rejection of hypotheses. In our study, however, the null-hypothesis of H2 and H3 is identical with the alternative hypothesis H1, and the objection raised above would lead to a situation in which H1, the rational choice hypothesis, were unfairly difficult to support (as any non-zero interaction effect would be interpreted, regardless of statistical significance). We therefore propose to reject the framing hypothesis for the time being, but recommend further study of the topic.

In our opinion, these objections do not challenge the validity of our results and conclusions; they rather provide opportunities for further research. The present study enhances the state of research by thoroughly identifying the treatment effect of cost reduction (the implementation of a curbside scheme) and by eliminating bias due to unobserved heterogeneity. Our results further suggest a direct effect of environmental attitudes on behavior, in addition to the impact of behavioral opportunities. The notion of an unconditional attitude effect (H1) offers three notable advantages: First, it is supported by inferential statistics. Second, it offers a parsimonious theoretical explanation. Third, one can integrate the interpretation into a wide variant of rational choice theory (Opp, 1999); therefore, the argument is linked to a general theory. Attitude (non)conformity can be incorporated into the actors' utility function either based on the cost of resolving cognitive dissonance (Festinger, 1957) or on intrinsic incentives for altruistic behavior (Adreoni, 1990). At the same time, our study points to the necessity of further research on the attitude–behavior link. As we were unable to reject the hypothesis of an additive model of costs and attitudes in explaining recycling behavior, the puzzle of large variation in effects from the previous research remains unsolved. The Model of Frame Selection may provide a promising framework that we could not nearly tap to its full potential. Further research would ideally implement the model in more detail by empirically capturing more of the theoretical concepts, and by applying a more direct testing strategy.

These rather complex theoretical considerations aside, our paper points to some important policy implications: As noted above the implementation of curbside recycling leads to a considerable increase in recycling participation, namely for plastics and packaging. Thus, opportunities are crucial for the modification of behavior and should therefore be considered when political actors seek to reduce the amount of waste to be land-filled or incinerated. Curbside recycling is an effective, yet easy-to-implement, policy measure: a well-planned curbside collection scheme proves to be an important contribution to the enhancement of environmentally responsible behavior. With regard to policy relevance, this is by far the most important result of our study. A careful consideration of our empirical findings furthermore shows that the utilization of household bins was more effective for plastics & packaging than for paper waste. This result can presumably be traced to the relatively greater reduction in behavioral cost: the overall amount of plastic and packaging that accumulates in an average family typically exceeds the amount of paper waste. Additionally, the storage of old magazines and newspapers is quite uncomplicated, whereas even temporarily storing the packaging of groceries can be a nuisance (space, smell, mold). Our results on the attitude effect suggest that policies aiming to modify the population's environmental concern can be important as well, but should be considered in addition to improved behavioral opportunities only. This is, among other things, due to the fact that triggering a major attitude change in the general population can be a difficult and lengthy task. An ideal package of measures therefore would combine campaigns aiming at the enhancement of environmental awareness with the implementation of easy-to-use, low-threshold behavioral opportunities.

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