MEMORANDUM

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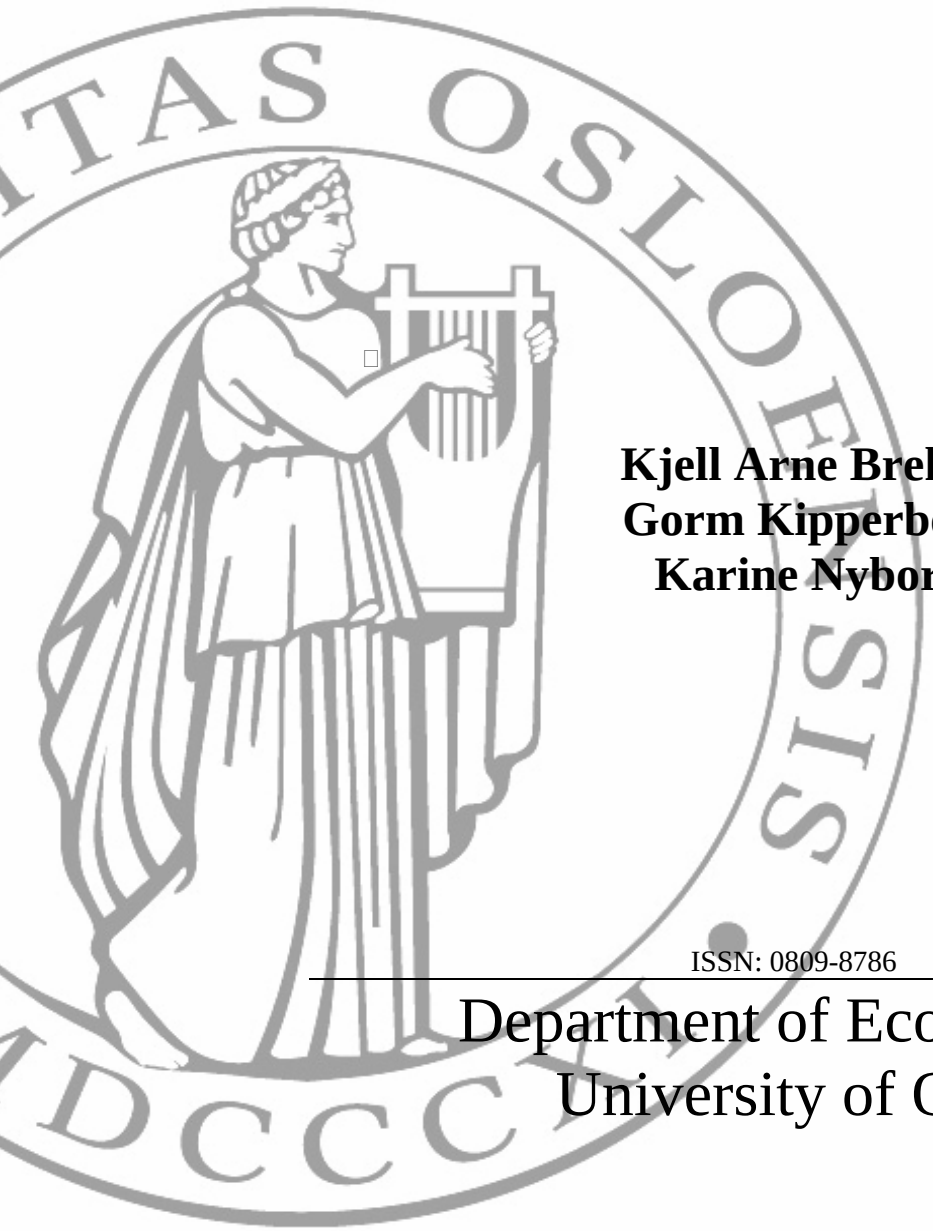
Reluctant Recyclers:
Social Interaction in Responsibility Ascription



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Reluctant Recyclers: Social Interaction in Responsibility Ascription

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Abstract

Several studies have demonstrated that individual contributions to public goods are increasing in others' contributions. The underlying causes for this, however, are not yet fully understood. We present a model of duty-orientation in which moral responsibility is learned through observations of others' behavior. Since, in our model, responsibility is a burden, we hypothesize that individuals will be reluctant to accept responsibility based on uncertain information. Econometric analysis of data from a survey on households' glass recycling indicates that perceived responsibility is a major determinant for reported recycling; that responsibility ascription is influenced by beliefs about others' behavior; and that people are indeed reluctant to accept responsibility based on uncertain information.

JEL codes: D11, D12, D64, Q53

Keywords: Voluntary contributions, duty-orientation, recycling, joint FIML estimation.

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1. Introduction

A substantial number of experimental studies have concluded that individuals contribute more to public goods when *others'* contributions increase (see, for example, Fishbacher et al. 2001, Krupka and Weber 2004, Croson et al. 2005). Nevertheless, the underlying motives causing such social interaction are still insufficiently understood. Recent research indicates that preferences for social approval, reciprocity, and conformity are all at play (Rege and Telle 2004, Bardsley and Sausgruber 2005). Moreover, several studies have indicated that people ascribe to many different, possibly conflicting norms, and that observations of others' behavior serve as a means to activate specific norms in the observer's mind (Reno et al 1993, Cialdini et al. 1990, Krupka and Weber 2004). Social psychologists further emphasize what they call *informational social influence*: "we conform because we believe that others' interpretation of an ambiguous situation is more correct than ours and will help us choose an appropriate course of action" (Aronson et al. 2005, p.241).

In this paper, we wish to focus on what we will call *duty-orientation,* a type of motivation which has been relatively little discussed within the economics literature. A duty-oriented individual prefers a self-image as a decent or socially responsible kind of person; moreover, he suffers a loss of self-image if he does not fulfill his perceived personal responsibilities. Like the impure altruist (Andreoni 1990), the duty-oriented person may experience a "warm glow of giving", but since he compares his actual giving to what he thinks he ought to have given, there may also be a "cold shiver of not giving enough". If the perceived responsibility is kept fixed, duty-orientation is behaviorally indistinguishable from a "warm glow" model. As soon as perceived responsibility changes, however, behavior and utility will generally be affected (Brekke et al. 2003, Bruvoll and Nyborg 2004, Nyborg 2006).

While the concept of responsibility is rarely invoked in economics, it is a core concept in the psychological literature on moral behavior. The *norm activation theory*, originally formulated by Shalom Schwartz (1970, 1977), posits that two conditions are required for an individual to activate a norm. First, the individual must accept that there is a public good/bad aspect of his private actions. This is called awareness of consequences.

Second, the individual must ascribe personal responsibility for the issue at hand. These conditions are necessary, but not sufficient, conditions for making moral decisions. Empirical tests of the theory in general support its main claims (Stern et al. 1999). In the present paper, we will follow Nyborg et al. (2006) in assuming that, if in doubt about the right thing to do, people infer their individual responsibility by looking at others' behavior: That is, informational social influence comes into play, causing social interaction in individual contributions.

A proper understanding of the causes of social interaction effects in voluntary contributions to public goods is potentially important for policy analysis. One reason is that, since responsibility may be felt as a burden, duty-oriented individuals may, for example, consciously or unconsciously avoid situations in which they fear a heavy burden of responsibility will be imposed upon them. Similarly, they might try to shy away from information which could potentially indicate that they ought to take responsibility (Lazear et al. 2005, Dana et al. 2005, Nyborg 2006). They could also, as our data indicates, be reluctant to accept responsibility on the basis of uncertain information, giving themselves the benefit of the doubt. Hence, if duty-based motives are important for voluntary contributions, policies designed to increase contributions should take into account that although people may contribute out of a feeling of responsibility, they may also try to avoid situations in which this feeling arise.

To test the hypothesis of duty-oriented social interaction, we have collected survey data on glass recycling in Norwegian households. Recycling of household waste is a prime example of voluntary contributions to a public good: typically, it is costly to the individual in terms of time or inconvenience, while the environmental benefits resulting from the individual's efforts are non-rival, non-excludable, and hardly noticable to the individual himself. Glass recycling systems in Norwegian municipalities differ both in the private cost of recycling they induce on the households, due to differing local recycling policies, and in the degree to which other households' recycling behavior is observable.[1] The survey was conducted in 2004 by Statistics Norway and provides a substantial amount of background information on each respondent. Our empirical results are consistent with the claim that duty-orientation is central to recycling behavior; that

responsibility ascription is influenced by the perception of what others are doing; and, finally, that people are reluctant to accept responsibility based on uncertain information.

As is well known from the literature (see Manski, 2000 for a survey) it is difficult to identify social interaction effects empirically. People living in the same neighborhood, or groups of friends or relatives, may behave similarly for many other reasons than social interaction; they may, for example, face the same waste collection system. We partially control for this by including data for a large number of factors that should pick up some of these effects, including policy variables, average levels of glass recycling in the respondent's municipality, family status, income, education level, political preferences and environmental attitudes; but of course, this does not grant complete avoidance of the problem.

Social interaction in recycling behavior could be caused by several different mechanisms. One is that of socially enforced norms, where recycling is motivated by the desire to gain social approval from one's peers, or to avoid negative social sanctions (see, e.g. Coleman 1990, Lindbeck et al. 1999, Rege 2004).[2] If it is primarily those who comply to a norm themselves who sanction non-compliers, the expected social sanction for violating a norm will be increasing in the share of norm compliers. Another possible cause of social interaction is pure conformism, that is, individuals may prefer to consider themselves "normal", thus preferring to conform to commonly expected standards of behavior. Finally, the existence of reciprocal preferences, meaning that individuals prefer to repay kindness with kindness and meanness with meanness, is by now well documented by experimental research (e.g. Fehr and Gächter 2000, Fehr and Fischbacher 2002, Camerer 2003). In a public good context, this may imply that reciprocal individuals are willing to contribute only if others are doing so too (Ledyard 1995). However, the distinction between reciprocity and duty-orientation is not necessarily clear-cut: For example, a duty-oriented person *A* may ascribe to a "meta-norm" saying that if another person *B* exploits *A*'s ascription of responsibility, *A*'s responsibility (towards *B*) is cancelled. This interpretation views reciprocity as a special case of duty-orientation.

In our survey, we asked respondents to report their *beliefs* about others' recycling behavior, their own assessment of the uncertainty of these beliefs, and about responsibility ascription. We also asked individuals directly about whether they feared

social sanctions if not recycling. If, after adjusting for the effect of background variables and the reported fear of social sanctions, there is still a correlation between recycling behavior and beliefs about peer recycling, we interpret this as indications of social interaction caused by conformity, reciprocity, or duty-orientation. If the correlation is indirect, through the effect of peer recycling on responsibility ascription, we will consider this evidence indicating duty-oriented motivation. This interpretation is strengthened if, as explained below, data indicates reluctance in responsibility ascription. If the correlation between believed peer recycling and own behavior is direct, however, not operating through perceived responsibility, this is taken as an indication that recycling is motivated by conformity, or by reciprocal preferences which do not operate via duty-orientation.

2. Duty-orientation

2.1. Cognitive dissonance: Actual vs. ideal behavior

The main hypothesis we study in this paper is that recycling decisions may be motivated by duty-orientation, and that this can lead to interaction effects through social learning of individual responsibility.

A duty-oriented individual prefers to keep a self-image as a decent or responsible kind of person, someone who can be trusted to do what "a person such as I do in a situation such as this" (March and Olsen, 1995, p.7). Further, if he does not live up to his perceived responsibilities, this will impair his self-image. Duty-orientation can thus be viewed as a conditional version of Andreoni's (1990) impure altruism model (Konow 2006): The duty-oriented may receive a "warm glow of giving" (a better self-image) from giving, but only if giving helps him fulfill his perceived responsibilities.

Brekke et al. (2003) proposed a model in which person *i*'s self-image as socially responsible is decreasing in the distance between *i*'s actual contribution and a morally ideal contribution. Moreover, they assumed that the morally ideal contribution was that contribution which would have maximized social welfare had it been provided by everyone. Other examples of models in which individuals suffer disutility from the distance between actual and some "ideal" behavior can be found in Sudgen (1984),

Woodward and Warren-Boulton (1984), Cappelen et al. (2007), and Konow (2006).[3] These specifications relate nicely to what psychologists call *cognitive dissonance* (Festinger 1957), the idea that a divergence between a person's behavior and his values causes discomfort (see Aronson et al. 2005, p. 166, for a discussion).

If the individual's perception of the ideal contribution is zero, he can keep a good self-image (or avoid cognitive dissonance) by contributing nothing. The higher the ideal contribution, however, the harder it is to keep a good self-image. With the model specifications of the above papers, a high perception of the ideal contribution is, all else given, a burden; so if responsibility ascription were an ordinary choice, we would expect every individual to choose no responsibility at all. In the present paper, we will assume that responsibility ascription is an inference – the result of a learning process – and not a choice as such.

Assume that the individual's choice of whether or not to recycle glass waste is discrete: either he recycles ($RECY_i=1$), or he does not ($RECY_i=0$). Assume, moreover, that the individual does not consider recycling a morally inferior activity; thus, we can disregard the possibility that he feels a moral duty *not* to recycle. A duty-oriented individual will experience a self-image loss if he does not fulfill his perceived responsibility to recycle. Let $RESP_i=1$ denote that *i* perceives glass recycling as his responsibility, while $RESP_i=0$ means that he does not. Thus, we will assume that a duty-oriented individual *i*'s self-image benefit S_i from recycling glass can be written[4]

$$(1) \qquad S_i = \begin{cases} -K & \text{if } RECY_i = 0 \text{ and } RESP_i = 1 \\ 0 & \text{otherwise} \end{cases} .$$

This reflects the view that for a duty-oriented individual, cognitive dissonance will arise if his actual contribution falls short of what he believes he ought to have contributed.

2.1 Responsibility ascription

As mentioned above, we will consider responsibility ascription an inference, not a choice. Following Nyborg et al. (2006), we will assume that, if in doubt about the right thing to do, people infer their individual responsibility by looking at others' behavior.

Several reasons can be given for this hypothesis. First, as mentioned above, the empirical existence of reciprocal preferences is, by now, well documented, and reciprocity might possibly operate via meta-norms for responsibility ascription among duty-oriented individuals. Second, the individual may interpret others' behavior as an indication of the social importance of glass recycling (informational social influence). Thirdly, in a complex world, no-one can take responsibility for everything, and this generates a need for formal or informal rules for division of labor in society; including norms for whether individuals, firms, or the public sector are the ones responsible for provision of public goods in various contexts. In some communities, for example, the waste treatment system is based on household sorting at source, while elsewhere, sorting is done at central facilities or not at all, leaving households with little or no responsibility for waste sorting. If an individual is uncertain of whether glass recycling is indeed an individual responsibility in his community, the behavior of comparable others is an indication of the role he is expected to take.

The hypothesis of social interaction in responsibility ascription can then be specified as follows: All else given, an individual *i* accepts responsibility whenever the share of others who recycle glass, *P,* is sufficiently high. Let T_i be an individual threshold, which is unknown to the researcher; our assumption is that individual *i* accepts responsibility whenever $P > T_i$.

An individual's knowledge of *P* will usually be imperfect. Assume that P_i is an estimate of *P* such that *i* finds it equally likely that the true *P* is higher or lower than P_i , that is, P_i is the median of *i*'s subjective probability distribution for the true *P*. If the individual is equally averse to making errors in both directions, he will conclude that recycling is his responsibility whenever $P_i > T_i$. This makes it equally likely to erroneously take responsibility (when this was not in fact warranted) as erroneously *not* taking responsibility (when it *was* required). Since T_i is unknown, our empirical prediction is that the probability of responsibility ascription is increasing in P_i.

2.2 Reluctance

Recycling is usually costly in terms of time and effort. Consequently, as explained above, every individual would be weakly better off if he did *not* accept responsibility. It

seems reasonable to assume, thus, that some individuals may be reluctant to accept responsibility based on uncertain information.

In accordance with this argument, we will allow the possibility that an individual accepts responsibility *only when reasonably confident* that the share of others who recycle glass exceeds this individual's threshold level.

(2) $RESP_i(P_i) = 1 \text{ if } \Pr(P_i > T_i) > \alpha_i$

Here, α_i is the level of confidence required to accept responsibility.

If $\alpha_i = ½$, uncertainty of P_i will not matter for responsibility ascription. If $\alpha_i > ½$, however, we will define *i* as *reluctant* to accept responsibility. That is, although he does his best to make a correct guess about how common it is to recycle glass, and does infer his responsibility by comparing this estimate with his threshold value, he gives himself the benefit of the doubt if he is very uncertain about whether the true share *P* is really above his threshold T_i.

When $\alpha_i > ½$, uncertainty does matter for responsibility ascription, but only if the level of P_i is relatively high. For low levels, i.e. when $P_i < T_i$, *i* will not accept responsibility anyway. When $P_i > T_i$, however, the probability of responsibility ascription will be higher the more certain the individual is about his estimate P_i.[5]

In the questionnaire, our question about P_i is formulated as a question about how common respondents think glass recycling is in their peer group. If the threshold T_i always corresponds to the respondent's interpretation of the word "common", the above theory would imply that for reluctant individuals, uncertainty would only be expected to matter for those reporting that recycling is common (high P_i). However, some individuals may be willing to accept responsibility even if recycling is relatively uncommon; that is, it is possible that threshold levels are quite low. Hence, it is possible that uncertainty also has an impact for P_i classified as low in our data. Both for high and low P_i, however, the effect of certainty on responsibility ascription is weakly positive for reluctant individuals.

If individuals were, on the other hand, eager to accept responsibility, we would have $\alpha_i < ½$. This might be expected if responsibility were not a burden but rather, for example, increased the warm glow of giving, in which case it seems reasonable to expect that some individuals would rather risk taking too much than too little responsibility. The

eager person would readily accept responsibility whenever $P_i > T_i$, so for the highest P_i uncertainty would have no effect. When $P_i < T_i$, however, i may still accept responsibility if she is sufficiently uncertain whether the true share is above or below her threshold (whether $P < T_i$). Again, we do not know the extent to which T_i corresponds to i's perception of "common".

Hence, all else given, certainty weakly *decreases* the probability of responsibility ascription for eager individuals; presumably more so for low values of P_i. For reluctant individuals, certainty weakly *increases* the probability of responsibility ascription; presumably more so for high values of P_i.

2.3 Predictions

Our main hypotheses, taking into account that our data on recycling and responsibility are binary, can now be summarized as follows:

a) *Social learning of responsibility:* The probability that $RESP_i = 1$ is increasing in P_i.

b) *Reluctance in responsibility ascription:* The probability that $RESP_i = 1$ is increasing in reported certainty about P_i.

c) *Duty-orientation:* The probability that $RECY_i = 1$ (recycling is chosen) is increasing in responsibility ascription $RESP_i$ (higher when $RESP_i = 1$).

If people are duty-oriented and infer their responsibility via peer behavior, we expect a positive correlation between P_i and $RECY_i$ in our data. However, we expect this relationship to be indirect, via the impact P_i has on responsibility ascription. The duty-orientation model itself provides no reason to expect a *direct* relationship between P_i and g_i. A direct relationship could arise, however, if glass recycling is motivated by the fear of social sanctions and recyclers are more active sanctioners than others. It could also arise due to preferences for conformity, or reciprocity which is not duty-oriented.

On the other hand, if recycling were motivated by the fear of social sanctions and/or conformity, but not duty-orientation, it is hard to see why ascription of responsibility would be a relevant concept at all. We can see no reason why *uncertainty* of P_i would matter, neither for responsibility ascription, which seems irrelevant anyway, nor for the recycling decision itself.

Hence, if we observe that P_i increases recycling indirectly, via its impact on responsibility, we will interpret this as support for the duty-orientation model. Further, if we observe that responsibility ascription is increasing in the certainty of P_i , we interpret this as support for the idea that responsibility is a burden which consumers accept only reluctantly.

3 Data

The empirical application in this paper is based on data from a Statistics Norway household survey conducted in Norway in 2004 (Hougen, 2005).[6] Descriptive statistics for the variables we employ are reported in Table 1.[7]

3.1 Dependent variables

The first outcome of interest, responsibility ascription, is measured by the variable RESP. This variable was constructed from a survey question that asked the participants to indicate their extent of agreement with the statement *I feel a responsibility to recycle glass*. It takes the value 1 if the respondent agreed (either completely or partially) with this statement, and the value 0 if the respondent disagreed with it.[8] The second outcome of interest, recycling behavior, is measured by the variable RECY, which represents *reported* recycling behavior.[9] It takes the value 1 if the respondent indicated that either *most* or *all* of the household's recyclable glass (not considering deposit-refund items) is typically recycled, and 0 otherwise. As reported in Table 1, the sample mean for RESP is 0.86, meaning that 86% of the respondents are classified as ascribing responsibility for glass recycling. The mean for RECY is 0.77, which means that 77% of the respondents are classified as living in households that recycle glass materials.

Further statistical explorations reveal a strong correspondence between the two outcome variables; the correlation coefficient is 0.395 and RESP takes the same value (0 or 1) as RECY in 81% of the cases. This suggests a strong positive relationship between the psychological responsibility inference process and recycling behavior. At the same time, it is noteworthy that as many as 16% of the people who feel glass recycling is their responsibility, do not recycle glass. This shows that responsibility ascription is not a sufficient condition for responsible behavior. Furthermore, among the people who are

classified as *not* ascribing responsibility, 36% nevertheless do recycle. This result indicates that behavior, which is of ultimate interest, could be driven by other motivations than a sense of responsibility, including standard economic incentives, social sanctions, and conformity. The goal of the econometric estimations is to disentangle different motivations, with particular attention given to social interaction mechanisms.

3.2 Independent variables

The available variables for explaining ascription of responsibility and recycling behavior can be categorized as a) social interaction measures, b) waste policy variables, c) standard socioeconomic and demographic variables, d) other background variables. The *social interaction* measures are SOCGR1, SOCGR2, and SOCSANC. The first of these, SOCGR1, measures the respondent's assessment of how common glass recycling is within her immediate social group, corresponding to P_i above.[10] Second, SOCGR2 measures the degree to which the respondent was certain about this assessment. According to our *learning* and *reluctance* hypotheses, respectively, RESP is expected to be positively associated with these two variables. Furthermore, SOCGCR1 could also be a positive determinant of RECY (for example, if people have conformity preferences), whereas we have no prior for the relationship between SOGCR2 and recycling. Finally, SOCSANC captures fear of social sanctions (by not recycling). These three variables take on discrete values between 1 and 4 in our sample data. The sample means for SOCGR1, SOCGR2, and SOCSANC are 3.06, 3.14, and 1.98, respectively. This suggests that, on average, the respondents think glass recycling is common in their immediate social groups, are sure about this assessment, but do not necessarily fear social sanctions.[11]

The *waste policy variables* include CURBGR, MSAVE, and GLASSKG. Theory on household waste management decisions suggests that CURBGR (presence of a curbside recycling program) and MSAVE (presence of a user fee on waste disposal) should operate as positive inducements for recycling (Jenkins 1993, Fullerton and Kinnaman 1996, Morris and Holthausen 1994). However, the empirical literature is mixed with regards to their effects on recycling of particular materials (see, for example, Jenkins et al. 2003, Ferrera and Missios 2005, and Kipperberg 2007). These policy variables could also be potential determinants for RESP. For example, households may perceive the presence of a (voluntary) curbside recycling program as a signal that sorting

glass is their responsibility. Unobserved variation in local waste policies may also affect all households in a municipality. As one means to (at least partially) account for this, we include GLASSKG (per capita kilo of glass recycled at the municipality level) in our empirical specifications. This variable may also partially capture the effect of other unobserved variables such as local geography, local culture, and so on.[12]

The socioeconomic and demographic variables (MALE, HHSZ, KIDS1, KIDS2, EDU1, EDU2, HWORK, INCH, INCL, AGE) are intended to capture any potential gender, education, age, income, and more generally, life-cycle, effects in both responsibility ascription and recycling behavior. As far as recycling behavior goes, these variables typically have ambiguous theoretical priors and yield mixed empirical results (both in terms of estimated signs and statistical significance), as discussed extensively in the empirical literature (for example, Kipperberg 2007 studies recycling in Norway, Ferrera and Missios 2005 recycling in Canada, and Jenkins et al. (2003) study the recycling behaviors of households in the United States).

Other respondent background information is captured by the variables GOVERNM, ENVIRON, ENAWARE, and BLUE. The variable GOVERNM measures the perception that recycling is mandated by the government. This variable is expected to have a positive influence on RECY, and possibly also directly on RESP.[13] The variables ENVIRON and ENVAWARE are environmental attitudinal measures, the former directly related to recycling and the latter measuring general awareness. We include these variables in our estimation as it seems reasonable that such attitudes could affect positively both outcomes.[14] The variable BLUE is an indicator variable for whether the respondent had voted for a political party to the right of the Norwegian political center (symbolized by the color blue in Norway) in the last election. To the extent that people with such political affiliation are less environmentally concerned and less likely to engage in (voluntary) actions to protect the environment, one might expect this variable to have a negative effect on the two outcomes.

Finally, it is worth pointing out that the latter three variable categories play the role of *ceteris paribus* controls for the social interaction hypotheses tested in this paper. By including these variables in the estimation, we hope to reduce (though we cannot eliminate) the likelihood of finding statistical support for any given hypothesis due to

spurious correlation, omitted variable bias, or an endogeneity issue, econometric challenges extensively discussed in the social interaction literature (see, for example, Manski 2000 and Brock and Durlauf 2001).

4. Econometric model

Our econometric strategy is to estimate a full information maximum likelihood (FIML) joint responsibility-recycling model that *implicitly* captures the role of duty-orientation in recycling behavior. Below we propose model specifications for responsibility (whether a person ascribes responsibility or not) and recycling (whether glass materials are recycled by the household or not), based on our conceptual framework. We link the two econometric specifications through a joint error structure and derive a quantitative measure of the effect of responsibility ascription on recycling behavior. Examples of other studies that have taken a similar approach to investigating connections between two discrete outcomes are Berrens et al. (1998), Bohara et al. (2007), and Greene (1998). To set up the econometric model exposition, recall first that responsibility ascription is not conceptualized as the outcome of an optimizing choice problem. Instead it is thought of as a psychological inference process, which may be influenced by perceived peer behavior and other factors. Recycling, on the other hand, can be regarded as the outcome of a utility maximizing choice problem, involving considerations of both pecuniary and non-pecuniary factors relevant to the specific choice context. Hence, the below recycling component of the joint model can be viewed as a random utility specification. The key idea behind the joint model is that the responsibility inference alters payoff from recycling; specifically, ascribing responsibility leads to a recycling utility premium, or conversely, a utility loss from not recycling. A priori, we therefore expect a positive correlation between the two outcomes, holding all else constant.[15]

4.1 Specification for responsibility ascription

The parametric specification for the inference individuals draw about their responsibility starts by noting that the threshold T_i from Equation 2 is a random (unobserved) variable from the econometrician's point of view. This threshold may be influenced by individual characteristics and other background variables, including,

possibly, the fear of social sanctions (SOCSANC). It is conceivable, for example, that social sanctions serve to remind people about their moral obligations. An individual *i* is therefore assumed to ascribe responsibility ($RESP_i = 1$) if and only if

$$(3) \qquad Z_{1i} = \varphi_0 + \varphi_1 \cdot SOCGR1_i + \varphi_2 \cdot SOCGR2_i + \varphi_3 \cdot SOCSANC_i + \boldsymbol{\lambda}'\mathbf{X}_i > -\varepsilon_{1i},$$

where Z_1 represent the observable (parametric) part of the responsibility ascription data generation process, and, ε_1 represents the part that is unobservable, at least from the point of view of the researcher, assumed to have zero mean and standard deviation σ_1. The vector **X** includes covariates besides the explicitly recognized social interaction variables, namely, the waste policy, socioeconomic and demographic, and other background variables, and has a conformable parameter vector **λ**. In this specification, $\varphi_1 > 0$ if there are social interactions in responsibility ascription. As explained earlier, individuals who are reluctant to accept responsibility will be more likely to do so the more certain they are about others' behavior, holding all else constant. This implies $\varphi_2 > 0$ if individuals are reluctant, $\phi_2 = 0$ if they are neutral, and $\varphi_2 < 0$ if they are eager.[16] Moreover, when $\varphi_3 > 0$ respondents who fear social sanctions have a larger propensity to ascribe responsibility for glass recycling than others. The probability that *i* will take responsibility for glass recycling equals the probability that Equation (3) holds:

$$(4) \qquad \Pr(RESP_i = 1) = \Pr(Z_{1i} > -\varepsilon_{1i}).$$

4.2 Specification for recycling behavior

The glass recycling outcome is specified in terms of net recycling utility. Individual *i* is assumed to recycle ($RECY_i = 1$) if and only if

$$(5) \qquad Z_{2i} = \gamma_0 + \gamma_1 \cdot SOCGR1_i + \gamma_2 \cdot SOCGR2_i + \gamma_3 \cdot SOCSANC_i + \boldsymbol{\beta}'\mathbf{X}_i > -\varepsilon_{2i},$$

where Z_2 can be viewed as the difference in the deterministic components of a random utility model with two choice alternatives (recycling versus not recycling), and ε_2 represents the difference in the stochastic utility components of these alternatives,

assumed to have zero mean and standard deviation of σ_2. Note that $RESP_i$ is not included explicitly in equation (5); the idea that recycling is affected by responsibility ascription is captured, instead, through the error structure of the joint estimation model explained in more detail below.

According to our theoretical framework, $\gamma_1 > 0$ if motives for recycling are of the conformist type (or if there is reciprocity which is not linked to duty orientation), and $\gamma_3 > 0$ if some people are motivated by the fear of social sanctions. The parameter γ_1 could also capture the desire for social approval since we only asked whether the respondent feared negative reactions from *not* recycling. If people are motivated by positive social reactions, and individuals who recycle provide more approval than others, this would not be captured by SOCSANC, giving rise to $\gamma_1 > 0$. Further, while we do not have a theoretical prior for the parameter on SOCGR2 in the recycling specification, if certainty about others' behavior matters for utility, in addition to its effect through responsibility, $\gamma_2 \neq 0$. Finally, all other control variables (including the waste policy variables) are captured in the vector $\mathbf{X}$, which has a conformable parameter vector $\boldsymbol{\beta}$. The probability that individual *i* will recycle is given by the probability that Equation (5) holds

$$(6) \qquad \Pr(RECY_i = 1) = \Pr(Z_{2i} > -\varepsilon_{2i}).$$

4.3 The joint FIML responsibility-recycling model

The hypothesis that behavior is motivated by a sense of duty through ascription of responsibility is tested by specifying that the error terms in Equations 3 and 5 have a jointly normal distribution

$$(7) \qquad \boldsymbol{\varepsilon}_\mathbf{i} \sim N\left(\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\sigma_1^2 & \rho\\ \rho & \sigma_2^2\end{pmatrix}\right),$$

where $\boldsymbol{\varepsilon}_\mathbf{i} = (\varepsilon_{1i}, \varepsilon_{2i})'$ σ_1 and σ_2 are standard deviations, and ρ is the correlation coefficients that captures the extent to which the error terms are correlated. As shown

below, this permits us to derive conditional expectation expressions that can be used to quantify the effect of responsibility ascription on recycling behavior.[17]

The probability that a person both ascribes responsibility and recycles glass (denoted P_1), dropping the *i* subscript for notational convenience, can be written as

$$(8a) \qquad P_1 = \Pr(Z_1^* > -\varepsilon_1^*, Z_2^* > -\varepsilon_2^*) = \Phi_2(Z_1^*, Z_2^*, \rho),$$

where $Z_1^* = Z_1/\sigma_1$, $Z_2^* = Z_2/\sigma_2$, $\varepsilon_1^* = \varepsilon_1/\sigma_1$, $\varepsilon_2^* = \varepsilon_2/\sigma_2$, and Φ_2 is the *bivariate* standard normal cumulative density function. For implementation, both σ_1 and σ_2 are normalized to one, which is unproblematic as there are no structural links, or parameter restrictions between the deterministic portions of the responsibility and recycling equations. The probability of ascribing responsibility and *not* recycling glass (denoted P_2) can be written as

$$(8b) \qquad P_2 = \Pr(Z_1^* > -\varepsilon_1^*, Z_2^* < -\varepsilon_2^*) = \Phi(Z_1^*) - \Phi_2(Z_1^*, Z_2^*, \rho),$$

where Φ is the univariate standard normal cumulative distribution function. For completeness, the probability of *not* ascribing responsibility and recycling glass (denoted P_3), and the probability that the person neither ascribes responsibility nor recycles glass (denoted P_4) can be expressed, respectively, as

$$(8c) \qquad P_3 = \Pr(Z_1^* < -\varepsilon_1^*, Z_2^* > -\varepsilon_2^*) = \Phi(Z_2^*) - \Phi_2(Z_1^*, Z_2^*, \rho)$$

$$(8d) \qquad P_4 = \Pr(Z_1^* \le -\varepsilon_1^*, Z_2^* \le -\varepsilon_2^*) = \Phi_2(-Z_1^*, -Z_2^*, \rho).$$

The joint likelihood function $L(\boldsymbol{\varphi},\boldsymbol{\gamma},\boldsymbol{\lambda},\boldsymbol{\beta},\rho)$ used to estimate the responsibility-recycling model can be written as

$$(9) \qquad L(\boldsymbol{\varphi},\boldsymbol{\gamma},\boldsymbol{\lambda},\boldsymbol{\beta},\rho) = \prod_{\forall i} (P_1^{\text{RESP}\cdot\text{RECY}} \times P_2^{\text{RESP}\cdot(1-\text{RECY})} \times P_3^{(1-\text{RESP})\cdot\text{RECY}} \times P_4^{(1-\text{RESP})\cdot(1-\text{RECY})}).$$

As shown in Greene (2002), the above probability expressions can be utilized to formulate conditional mean functions for the recycling outcome *given* the responsibility ascription outcome. In particular, the expected recycling mean when responsibility *is* ascribed $E[RECY \mid RESP = 1]$ is given by

$$\text{(10a)} \quad E[RECY \mid RESP = 1] = \frac{\Pr(RESP = 1, RECY = 1)}{\Pr(RESP = 1)} = \frac{\Phi_2(Z_1^*, Z_2^*, \rho)}{\Phi(Z_1^*)}.$$

Similarly, the expected recycling mean when responsibility is *not* ascribed $E[RECY \mid RESP = 0]$ is given by

$$\text{(10b)} \quad E[RECY \mid RESP = 0] = \frac{\Pr(RESP = 0, RECY = 1)}{\Pr(RESP = 0)} = \frac{\Phi(Z_2^*) - \Phi_2(Z_1^*, Z_2^*, \rho)}{1 - \Phi(Z_1^*)}.$$

These conditional expectations, or recycling mean functions, can be interpreted as the expected share of individuals who recycle among people ascribing responsibility, and, the expected share of individuals who recycle among people not ascribing responsibility, respectively. Computing these expectations holding covariate values constant yields a *quantitative* measure of the effect of duty-orientation on recycling behavior. Specifically, $E[RECY \mid RESP = 1] - E[RECY \mid RESP = 0]$ can be interpreted as the *ceteris paribus* marginal effect of ascribing responsibility on the probability of recycling.

We can now formalize the main hypotheses of this paper, stated verbally in Section 2.3, with specific references to the empirical specification as follows: a) *social learning of responsibility* implies $\varphi_1 > 0$, b) *reluctance in responsibility ascription* implies $\varphi_2 > 0$, and c) *duty-oriented behavior* implies $\rho > 0$ and E[RECY|RESP =1] – E[RECY|RESP = 0] > 0.

5. Estimation results

Table 2 presents results from estimation of the joint responsibility-recycling model, when all categories of explanatory variables are used, and constitutes the main results of this paper.[18]

5.1 The social interaction hypotheses

The *social learning of responsibility* parameter (estimated φ_1 on SOCR1 in the RESP equation) is statistically significant and positive at the 0.01 level. This result indicates that people's propensity to ascribe responsibility is increasing in how common they think recycling is in their immediate social group, which supports the social learning hypothesis. *Reluctance in responsibility ascription* is tested by the estimated parameter on SOCGR2 in the RESP equation (estimated φ_2). A positive sign implies that people are reluctant to take responsibility, whereas a negative sign would imply they are eager. The parameter estimate is positive and statistically significant at the 0.05 level, which supports our reluctance hypothesis: holding everything else constant, certainty in one's assessment of peer behavior increases the probability of taking responsibility. Conversely, uncertainty decreases this probability. For the *duty-orientation* hypothesis, we have already noted that estimated ρ is statistically significant and positive. From the estimated model, we compute the conditional mean functions given in Equations 10a and 10b at the sample averages of the covariates. The expected value of the variable RECY given RESP = 1 is 0.856, whereas the conditional mean of RECY given RESP = 0 is 0.576. This implies, *ceteris paribus*, that ascribing responsibility increases the probability of recycling, to wit, by about 28%. These results provide strong evidence in favor of the duty-oriented behavior hypothesis.

Several additional social interaction-related results are worth pointing out. First, the parameter on SOCGR1 is statistically significant at the 0.01 level with expected positive sign in the RECY equation (estimated γ_1), which is indicative of a direct social influence of peer behavior on own behavior (through conformity, reciprocity mechanisms, or through positive social approval). In contrast, SOGCR2 is insignificant in the RECY equation, suggesting that informational certainty does not play a direct role in actual behavior. Finally, we can note that SOCSANC enters positively into the RESP equation, but not the RECY equation. Hence, it appears that fear of social sanctions can invoke a sense of duty, but does not have a direct behavioral impact in our recycling context.

5.2 Estimated marginal effects

Above we summarized the *qualitative* estimation results. It is also of interest to investigate the *quantitative* implications of the parameter estimates. For this purpose, marginal effects were computed for the social interaction variables and are reported in Table 3. Here, a marginal effect (ME) is defined as the change in probability that an outcome variable (either RECY or RESP) takes the value 1 associated with a 1 unit change in the social interaction variable of interest, evaluated at the sample averages of all other control variables. In joint estimation, ME's must be evaluated conditional on the specific possible values of other outcome variables, and are therefore, not straightforward to interpret. For this reason, we start by reporting estimated ME's from independent estimations ($\rho = 0$). When the RESP equation is estimated separately (with the same covariates as in the joint model), the ME's of SOCGR1, SOCGR2, and SOCSANC are 0.067, 0.029, and 0.020, respectively. So for example, a 1 unit increase in SOCGR1 increases the probability of ascribing responsibility by 6.7%. In separated estimation of the RECY equation, the ME's of these variables are 0.156, 0.005, and 0.013, with the latter two being statistically insignificant. A 1 unit increase in SOCGR1 increases the probability of recycling by 15.6%.

For the joint model, ME's are reported for recycling behavior, conditional on whether responsibility is ascribed or not. First note that ME's for SOCGR2 and SOCSANC are not statistically significant, consistent with the qualitative findings reported in Table 2. We therefore focus on SOCGR1; perception of peer behavior. A 1 unit increase in this variable is associated with an increase in the probability of recycling by 13.1% and 19.2%, when responsibility is ascribed and not ascribed, respectively. The ME from the separate estimation of 15.6% lies neatly between these estimates. This makes sense, since the separate estimation did not account for the role of responsibility ascription in recycling behavior. Results from the joint model are intriguing: when responsibility is (already) ascribed, a change in perception of other people's behavior can only affect individual behavior directly. However, when responsibility is (initially) not ascribed, an upward revision of how common recycling is in one's immediate social group increases the probability of taking responsibility, which has an indirect positive affect on recycling, as well as increases the recycling probability directly.

5.3 Alternative Model Specifications

Several robustness checks can be performed for the estimated joint model. Of particular interest is what role each variable category plays in the estimation results and hypotheses tests above. To explore this issue we drop one category at a time (leaving the remaining categories in place) and re-estimate the FIML model. Selected results are reported in Table 4. The first two columns give result for the full model (repeat from Table 2) and an intercepts-only model, for comparisons. For each alternative specification, we report the joint log-likelihood, selected parameter estimates (φ_1, γ_1, and ρ) and the computed conditional means. In general, the previously reported results are qualitatively robust.[19]

Removing the waste policy variables (Model 3), or the socioeconomic and demographic information (Model 4), does not qualitatively or quantitatively affect the social interaction results, nor does it lead to a substantial reduction in the overall goodness of fit as measured by the joint log-likelihood. This is consistent with the parameter estimates for these variables from Table 2. None of the waste policy variables are significant in the RESP equation. For the RECY equation, MSAVE is insignificant, whereas CURBGR and GLASSKG are borderline significant (depending on significance level, and whether a one or two-sided hypothesis test is used).[20,21] For the socioeconomic and demographic category, KIDS2, EDU1 (and marginally EDU2), and HWORK are statistically significant in the RESP equation, whereas HHSZ, KIDS2, HWORK, and the income variables (INCM and INCH) show some significance in the RECY equation.[22] The important implication of this robustness check is that it is unlikely that other similar types of control variables omitted from our main model specification (due to data unavailability), lead to biased or spurious correlation results.

When the social interaction variables are dropped from the model specification (Model 5), there is a substantial increase in estimated ρ vis-à-vis Model 1 (from 0.421 to 0.537), and the implied impact of responsibility on the recycling probability (from 0.279 to 0.378). This suggests that ignoring social interaction effects operating *directly* on the two outcomes will exaggerate the *indirect* linkage between them. A similar observation can be made when the *other* background variables are dropped (Model 6). In this case, the outcome correlation is 0.501 (versus 0.421) and the predicted effect of ascribing

responsibility on the probability of recycling is 0.345 (versus 0.279). In addition, the parameter estimates for SOCGR1 are larger. Hence, it appears that ignoring perception of government pressure, environmental attitudes, and political party affiliation leads to exaggerated quantitative predictions of social learning of responsibility, and the effects of direct social interactions and duty-orientation on recycling behavior. However, it should be noted that in neither of these alternative specifications do our (qualitative) hypotheses inferences change.

6. Discussion and Conclusions

Our empirical results indicate that there are strong social interaction effects in recycling behavior. This holds even after accounting for *stated* fear of social sanctions. As in any econometric analysis, apparent social interaction effects might possibly be explained by omitted variable bias, spurious correlations, or endogeneity effects which are unaccounted for. Nevertheless, our results are consistent with the idea that duty-based motivation is important for recycling, that individual responsibility is socially learned, and that responsibility is a burden which individuals are reluctant to accept. In particular, we find that while there is a direct social interaction effect, possibly caused by conformity preferences, there is also a strong indirect social interaction effect, which operates through ascription of responsibility.

The direct interaction effect is unaffected by the certainty of individuals' assessments of peer behavior. For the indirect interaction effect, however, certainty is important: The more uncertain respondents are about their peers' recycling behavior, the less likely they are to accept responsibility. This is consistent with the hypothesis that people learn their responsibility from observing others, but that responsibility is a burden one is reluctant to accept.

Ascription of responsibility is not an element of standard economic models, and a final question is whether this is an interesting concept from an economic point of view. Certainly, moral norms are important for economic outcomes in many settings, and to the extent that norm activation theory (Schwarz 1970, 1977) is correct, the moral norm will affect individual behavior more strongly when individuals have ascribed responsibility

for the issue at hand. The concept of responsibility proved helpful in explaining the data in our case.

While a policy analysis is outside the scope of the present paper, let us briefly mention some arguments indicating that duty-orientation and responsibility ascription may indeed be important for policy. First, if responsibility ascription is endogenous, economic incentives for voluntary contributions might, under certain circumstances, be counterproductive, leading to *lower* contributions (as observed by e.g. Gneezy and Rustichini 2000a, b, Brekke et al., 2003). Lazear et al. (2004) show that most subjects playing the role of "dictator" in a dictator game experiment, even those who do share a lot within the context of this game, prefer to opt out of the game and keep a sum corresponding to the dictator allocation for themselves, thus sharing nothing. One explanation is that the role of dictator in such games is naturally associated with a responsibility for sharing; while when not placed in this role, no such responsibility applies. Their result provides an important reminder that although people appear to behave quite altruistically in a context associated with responsibility ascription, actual giving may be substantially lower if people can in fact choose to avoid those contexts.

Second, if social interaction in responsibility ascription is sufficiently strong, there may be multiple equilibria, and this should be taken into account in policy formation. Formalizing this idea, Nyborg et al. (2006) show that imposing a tax on "brown" products can move the economy from an equilibrium in which everyone purchases the "brown" product to another equilibrium in which everyone chooses, instead, the more costly but "green" product. Moreover, they show that the required tax is strictly lower than the Pigou level, and that the resulting change in consumption can be permanent even if the tax is temporary. This further emphasizes the need for considering economic incentives and moral motivation jointly.

The main hypotheses tested in this paper has been that duty-orientation is an important motive for recycling of glass; that there is social interaction in responsibility ascription; and that responsibility is accepted only reluctantly, implying that social interaction effects are stronger when information about others' behavior is relatively certain. Although we cannot fully exclude the possibility of spurious relationships, the

empirical predictions emerging from these hypotheses are confirmed nicely in the econometric analysis.

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Table 1: Data Description and Statistical Summary*

Name	Description	Mean	SD	Min	Max
RESP	Ascribes responsibility or not	0.86	0.34	0	1
RECY	Recycles glass or not	0.77	0.42	0	1
SOCGR1	Thinks glass recycling in nearest social group is common	3.06	0.80	1	4
SOCGR2	Certainty about social group's behavior	3.14	0.66	1	4
SOCSANC	Fear of social sanctions	1.98	1.05	1	4
CURBGR	Presence of a curbside glass recycling program	0.07	0.25	0	1
MSAVE1	Can save money by recycling glass	0.05	0.22	0	1
GLASSKG	Municipal glass recycling in kilos per capita	8.07	2.62	1.5	12
MALE	Gender indicator (male = 1)	0.49	0.50	0	1
AGE	Respondent age	42.89	16.80	15	79
HHSZ	Household size	2.69	1.34	1	7
KIDS1	Presence of children age 6 or younger	0.18	0.38	0	1
KIDS2	Presence of children 7-19 years old	0.14	0.35	0	1
EDU1	Respondent has high school education	0.54	0.50	0	1
EDU2	Respondent has college education	0.27	0.44	0	1
HWORK	Respondent hours of house work per week	9.71	7.56	2.5	45
INCM	NOK 100,000 < HH Income < NOK 500,000	0.77	0.42	0	1
INCH	HH Income > 500,000	0.18	0.38	0	1
GOVERNM	Thinks government mandates glass recycling	2.39	1.15	1	4
ENVIRON	Thinks glass recycling helpful to the environment	3.29	0.96	1	4
ENVAWAR	General environmental awareness	3.38	0.68	1	4
BLUE	Voted for "blue political party last election	0.29	0.45	0	1

* N = 1104 for all variables.

Table 2: Joint FIML Estimation of RES and REC

	RESP EQUATION (Z_1)		RECY EQUATION (Z_2)	
Variables	**Est. Par.**	**t-Stat.**	**Est. Par.**	**t-Stat.**
CONSTANT (φ_0, γ_0)	-3.689	-6.19	-3.572	-6.88
SOCGR1 (φ_1, γ_1)	0.485	6.71	0.623	8.86
SOCGR2 (φ_2, γ_2)	0.197	2.19	0.025	0.31
SOCSANC (φ_3, γ_3)	0.133	1.70	0.049	0.88
CURBGR (λ_1, β_1)	-0.305	-1.20	0.255	1.30
MSAVE1 (λ_2, β_2)	-0.290	-1.15	-0.052	-0.21
GLASSKG (λ_3, β_3)	0.009	0.36	0.037	1.74
MALE (λ_4, β_4)	-0.196	-1.55	0.006	0.05
AGE (λ_5, β_5)	0.003	0.64	0.001	0.18
HHSZ (λ_6, β_6)	0.052	0.83	0.101	1.69
KIDS1 (λ_7, β_7)	-0.160	-0.83	-0.217	-1.25
KIDS2 (λ_8, β_8)	-0.459	-2.32	-0.435	-2.27
EDU1 (λ_9, β_9)	0.320	2.06	0.053	0.37
EDU2 (λ_{10}, β_{10})	0.261	1.43	-0.127	-0.78
HWORK (λ_{11}, β_{11})	0.019	2.03	0.013	1.56
INCM (λ_{12}, β_{12})	-0.237	-0.83	-0.596	-1.74
INCH (λ_{13}, β_{13})	-0.170	-0.54	-0.621	-1.71
GOVERNM (λ_{14}, β_{14})	0.143	2.21	0.187	3.97
ENVIRON (λ_{15}, β_{15})	0.178	2.84	0.211	4.03
ENVAWAR (λ_{16}, β_{16})	0.450	5.38	0.391	5.58
BLUE (λ_{17}, β_{17})	0.025	0.18	-0.174	-1.55

Notes:
Estimated $\rho = 0.42$
Joint Log-Likelihood = -751.30
Sum of Independent Log-Likelihoods = -768.98 (LR Statistic = 35.30, $\chi^2_{0.01} = 10.83$)
E(RECY|RESP = 1) = 0.856
E(RECY|RESP = 0) = 0.574
N = 1104.

Table 3: Marginal Effects of Social Interaction Variables on Outcome Variables

	Marginal Effect on E(RESP)[a]		Marginal Effect on E(RECY)[a]		Marginal Effect on E(RECY|RESP = 1)[b]		Marginal Effect on E(RECY|RESP = 0)[b]	
	ME	**t-Stat**	**ME**	**t-Stat**	**ME**	**t-Stat**	**ME**	**t-Stat**
SOCGR1	0.0672	6.131	0.1564	9.039	0.1313	7.900	0.1915	6.589
SOCGR2	0.0287	2.416	0.0049	0.254	0.0000	-0.002	-0.0190	-0.559
SOCSANC	0.0200	2.139	0.0133	0.989	0.0075	0.591	0.0007	0.030

Note:
ME's are computed for a 1 unit change in the relevant independent variable holding all other covariates at sample means. In the joint model, asymptotic t-statistics are computed using standard errors derived from the delta-method.
a. from independent RESP and RECY estimations ($\rho = 0$)
b. from joint estimation model

Table 4: Alternative Joint Model Specifications

	Model 1: Full	**Model 2:** Intercepts	**Model 3:** Drop Policy	**Model 4:** Drop Dem	**Model 5:** Drop SI	**Model 6:** Drop Other
Log-Likelihood	-751.297	-964.288	-755.898	-769.824	-823.829	-803.964
Estimated φ_1	0.623	.	0.629	0.609	.	0.717
Estimated γ_1	0.485	.	0.484	0.464	.	0.603
Estimated ρ	0.421	0.655	0.415	0.428	0.537	0.501
E(RECY|RESP=1)	0.856	0.837	0.854	0.853	0.849	0.848
E(RECY|RESP=0)	0.576	0.355	0.579	0.572	0.471	0.500
E-Difference*	0.279	0.482	0.275	0.281	0.378	0.348

* E-Difference = E(RECY|RESP=1) - E(RECY|RESP=0)

Appendix 1: Survey instrument

The survey was conducted by Statistics Norway in October/November 2004 as a part of their quarterly Omnibus survey. The questions and response alternatives are reported below (translated from Norwegian). Our questions were preceded by questions on living conditions and household characteristics, smoking, traveling, and consumer purchases in neighboring countries. Respondents were finally asked about work force participation and working conditions, political preferences and voting, membership in organizations and income. In addition, Statistics Norway provides information on respondents' education from their register database.

GLASS RECYCLING

We will now turn to a few questions about recycling of glass (excluding deposit-refund items).

I Some people dispose of glass with other household waste, while others sort their glass waste before disposal. How do you / your household usually dispose of glass waste? Do not count deposit-refund items.

1. Dispose of all glass with other waste
2. Sort some glass
3. Sort most glass
4. Sort all glass

II If you turn in glass for recycling, do you have to carry it farther than your usual household waste?

1. Yes
2. No

If II=Yes:

IIb How far do you have to carry it?

1. Less than 150 meters
2. Between 150 and 500 meters
3. More than 500 meters

III Can you/your household save money by recycling glass? We are thinking of, among other things, reduced waste treatment fees. Do not count income from collect-refund systems.

1. Yes
2. No

IIIb How much can you save per year?

1. Less than 100 NOK
2. 100-500 NOK
3. More than 500 NOK

IV How common du you think it is to recycle glass among households in your municipality [in Oslo: city area]? Would you say...

1. very common
2. rather common
3. rather uncommon
4. or very uncommon

IVb How sure are you about that? Are you...

1. very certain,
2. rather certain,
3. rather uncertain,
4. or very uncertain

V How common do you think it is to recycle glass among households in Norway? Would you say...

1. very common
2. rather common
3. rather uncommon
4. or very uncommon

Vb How sure are you about that? Are you...

1. very certain,
2. rather certain,
3. rather uncertain,
4. or very uncertain

VI How common do you think it is to recycle glass among your family and friends? Would you say...

1. very common
2. rather common
3. rather uncommon
4. or very uncommon

VIb How sure are you about that? Are you...

1. very certain,
2. rather certain,
3. rather uncertain,
4. or very uncertain

VIIa To what extent do you agree with the following statement? Sorting of glass waste does not contribute to improving the environment. Would you say that you...

1. fully agree,
2. partly agree,
3. partly disagree,
4. or fully disagree

VIIb To what extent do you agree with the following statement? I consider myself an environmentally conscious person. Would you say that you...

1. fully agree
2. partly agree,
3. partly disagree,
4. or fully disagree

VIIc To what extent do you agree with the following statement? If I do not recycle glass, I risk negative social sanctions from my peers. Would you say that you...

1. fully agree
2. partly agree,
3. partly disagree,
4. or fully disagree

VIId To what extent do you agree with the following statement? The authorities have mandated that I recycle. Would you say that you...

1. fully agree
2. partly agree,
3. partly disagree,
4. or fully disagree

VIIe To what extent do you agree with the following statement? I feel a responsibility to recycle glass. Would you say that you...

1. fully agree
2. partly agree,
3. partly disagree,
4. or fully disagree

[1] Glass is perhaps the *least* likely material to invoke environmental associations in people. In contrast to paper produced from scarce forest resources (at least in principle) and plastics derived from petroleum, glass is primarily made from abundant sand material. Hence, if we can find evidence of social interactions in responsibility ascription in the context of glass, similar mechanisms are likely to be at play broadly in people's recycling behaviors. In other words, we chose the material that was least likely to support our models and hypotheses. Furthermore, recycling of paper is sometimes easier and more convenient than not recycling, so paper recycling might be explained without resorting to any kind of altruism or moral preferences. For most households, glass recycling does require an extra effort.

[2] Note that while economists have usually treated positive and negative social sanctions symmetrically, this view is not always shared by psychologists.

[3] Typically, self-image or warm glow (S_i) in these models is specified as $S_i = -K(g_i - g^*)^2$, where K>0, g_i is *i*'s actual contribution, and g^* is the ideal contribution.

[4] Eq. (1) is consistent with the moral motivation model of Brekke et al. (2003) under the following assumptions: 1) the self-image function is modified from $S_i = -K(g_i - g^*)^2$ in the Brekke et al. paper (where g^* is the contribution maximizing social welfare if everybody provided it) to $S_i = -(RESP_i)K(g_i - g^*)^2$, and 2) glass recycling is considered morally superior to not recycling (g^*=1). Brekke et al. assumed, implicitly, that when (hypothetical) consequences imply g^*>1, responsibility is ascribed. Here, we allow $RESP_i$ =0 even if g^*=1. If the individual is of the opinion that the government, not households, should take care of glass sorting and recycling, if she has reciprocal preferences and is unwilling to act when others don't, or if she has never even consciously considered the issue of glass recycling, she may not feel responsible even if she would agree that full household recycling is socially better than no recycling.

[5] Consider two persons, A and B, for whom $T_A = T_B$, $\alpha_A = \alpha_B > ½$, and $P_A = P_B$, but where A is very confident about his assessment P_A while B is very uncertain. To conclude that recycling is a personal responsibility, both demands that $\Pr(P > T_i) > \alpha_i$. Now, if $P_i < T_i$, it follows that $\Pr(P_i > T_i) < ½$ and hence neither A nor B will conclude that recycling is a personal responsibility. However, if $P_i > T_i$, then $\Pr(P_i > T_i) > ½$, but the probability is higher the lower the variance of the subjective probability distribution. To see this, suppose $P_i = 0{,}4$, T_i=0,3, and α_i=70%. Since A is confident that $P_i = 0{,}4$, it is likely that he will conclude that $\Pr(P > 0{,}3) > 70\%$. B, on the other hand, who is very uncertain, may well think that $50\% < \Pr(P > 0{,}3) < 70\%$, which is insufficient to make him accept the responsibility.

[6] Statistics Norway's *Omnibus Survey* collects socioeconomic and demographic data on Norwegian households on a quarterly basis. Researchers can request additional questions at a piecemeal rate. The fourth survey of 2004 included, in addition to our questions on glass recycling, questions on family relations and cohabitation, smoking behavior, traveling and vacations, and households' shopping trips to neighboring countries. A total of 1347 households participated in this survey, yielding a response rate of 67%. In the econometric analysis, we drop respondents with missing information (item non-response) on key variables, which reduce the usable sample size to 1104 observations (leaving a response rate of usable responses of 50.2%). The recycling-related questions are translated in Appendix 1. Since these questions only comprised a small part of the overall survey, there is little reason to suspect so-called *avid recycler* bias, which might arise in surveys strictly focused on the recycling topic.

[7] We only report statistics for the variables we used in the final estimations. Several more background variables were available from the survey (including detailed information about the respondent's labor market situation). However, due to multi-collinearity issues discovered in preliminary analysis, we take a somewhat parsimonious approach here.

[8] Note that the statement is formulated specifically in terms of responsibility for glass recycling as opposed to in terms of a sense of general environmental responsibility. The reason for this is that according to most interpretations of the norm-activation theory, ascription of responsibility is context specific. An alternative, and potentially interesting, approach would be to use multiple statements to create a responsibility ascription index. Unfortunately, a limited survey budget made this approach infeasible in our case.

[9] Research on recycling behavior typically relies on self-reported data (Jenkins et al. 2003, Ferrera and Missios 2005, Kipperberg 2007). The reason for this is that direct observation is difficult. Moreover, getting permission from households to track and quantify their recycling efforts may cause them to alter their behavior.

[10] The question was not framed in terms of shares or percentages, however. Rather, we asked "how common do you think glass recycling is among your friends and family?" The response alternatives were very common, rather common, rather uncommon and very uncommon. We also asked how common the respondent believed glass recycling in their municipality and in the whole country. However, in our estimations we focus on beliefs about behavior in one's immediate peer group (family and friends).

[11] Preliminary statistical explorations of SOCGR1 and SOCGR2 revealed that that 84% of the respondents who were certain about their assessment of others' recycling behavior thought recycling is common in their immediate social group. In contrast, those who were uncertain about this assessment, were almost evenly split between assessing recycling as common versus uncommon (52% versus 48%), which is consistent with pure guessing. Ascription of responsibility (RESY = 1) is prevalent in both groups, however, the share of respondents ascribing responsibility is significantly higher in the certain group. This observation indicates that certainty may have an additional effect in ascribing responsibility, separate from perceived peer behavior, which is consistent with our reluctance hypothesis.

[12] The CURBGR variable is an auxiliary variable provided by Statistics Norway, whereas MSAVE is based on information provided by the respondents in the survey. The variable GLASSKG can be regarded as proxy for the overall importance of glass recycling in the municipalities, and, therefore, a type of *fixed effects* control variable.

[13] It should be noted that, to our knowledge, recycling is not mandatory in any Norwegian municipality.

[14] Note that ENVIRON and ENVAWARE could be regarded as awareness of consequences (AC) measures, a key concept in the norm activation theory.

[15] A different identification strategy for the social learning hypothesis is to use the responsibility measure (or its predicted value from a first-stage instrumental variable estimation) directly in the recycling equation. However, endogeneity concerns combined with lack of credible exclusion restrictions made us opt against pursuing this identification strategy. Moreover, separate estimation is statistically inefficient if common unobservable factors influence both data generating processes. Our FIML approach deals with both these issues. Nevertheless, exploratory data analysis (not reported in this paper) of this alternative approach yielded the same hypotheses inferences (qualitative results) as the ones based on joint model estimation.

[16] One may question whether SOCGR2 should enter linearly in equation (3) since, according to the theory, we expect that for reluctant (eager) individuals, the effect of certainty is stronger (weaker) if SOCGR1 takes a high (low) value. Ideally, we would like to estimate separately the effects of SOCGR2 when SOCGR1 is high or low, respectively, but given our data, this would create substantial multicollinearity problems. As an alternative specification, we have also performed estimations where SOCGR2 enters as an interaction variable with SOCGR1. Most results from these estimations (available upon request) were qualitatively similar to those reported below.

[17] By specifying the error terms (ε_1 and ε_2) as being correlated, $RECY_i$ becomes implicitly dependent on $RESP_i$. A different identification strategy for the social learning hypothesis would be to use the responsibility measure (or its predicted value from a first-stage instrumental variable estimation) directly in the recycling equation. However, endogeneity concerns combined with lack of credible exclusion restrictions made us opt against pursuing this identification strategy. Moreover, separate estimation is statistically inefficient if common unobservable factors influence both data generating processes. Our FIML approach deals with both these issues. Nevertheless, exploratory data analysis (not reported in this paper) of this alternative approach yielded the same hypotheses inferences (qualitative results) as the ones based on joint model estimation.

[18] The estimated correlation coefficient (ρ) for RESP and RECY is 0.42, suggesting a positive relationship between the two outcomes. The model's joint log-likelihood (-751.30) can be compared to the sum of the two log-likelihoods from estimating RESP and RECY separately (-768.95) with a likelihood ratio test. The test-statistic is 35.30, which exceeds the 0.01 significance level critical χ^2 value of 10.83. Hence, the estimated ρ is statistically significant, which means joint estimation is statistically more efficient. More importantly, we can use the estimated correlation coefficient or more specifically, the conditional mean functions in equations 10a and 10b, to quantify the effect of ascription of responsibility on recycling behavior.

[19] All models are found to be statistically significant vis-à-vis the intercept-only model, based on likelihood ratio tests. Furthermore, the restrictions imposed on the full model in the alternative specifications are rejected by similar tests. Hence, given our data, the joint model reported in Table 2 is the statistically superior specification.

[20] For example, the estimated parameter on CURBGR in the RECY equation is statistically significant at a 0.1 level under a 1-sided hypothesis (presence of a curbside recycling program can be argued from theory should have a positive effect on recycling behavior).

[21] When other categories of variables are removed, the statistical importance of these variable categories does not markedly change.

[22] The coefficient signs for several of these variables in the RECY equation are consistent with an *opportunity cost of time* hypothesis: individuals who live in larger households, allocate more time to household chores, and have lower household income, may have lower perceived time costs, and are therefore more likely to engage in recycling.