An Investigation into Environmentally Friendly Consumer Behavior: The Case of Household Recycling

Dissertation Prospectus

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INTRODUCTION

The topic of my dissertation is *environmentally friendly consumer behavior*. Particularly, I am interested in voluntary choices that appear to be made at a cost premium, either in terms of extra money or extra time spent. The broad question is, why are some individuals willing to incur additional expenditures when cheaper alternatives are available to them? At the surface, it seems that these consumers are making economic sacrifices, perhaps on behalf of the common good, that make them worse off. However, this idea cannot be accepted within the neoclassical paradigm of consumer choice. The rationality assumption commands that consumers maximize utility subject to resource constraints. The obvious economic answer to this question is that there must be additional benefits from these choices, which offer sufficient compensation for any additional costs. There are many examples of choice situations in which segments of consumers appear to be making such trade-offs: Transportation mode choices such as carpooling, ownership of fuel efficient vehicles such as e-vehicles, everyday shopping of eco-products such as organic produce, subscription to *green* energy alternatives, and installation of efficient water usage equipment such as low-flow showerheads.

The specific choice situation that I have selected for my research is *household recycling behavior*. Recycling fits into such choice situations as discussed above because the vast majority of consumers who recycle do so in the absence of any direct economic incentives. This is difficult to explain given the extra household resources required to engage in recycling. While it is true that there is rarely a monetary price on recycling, it is nevertheless not a "free lunch". If consumers are constrained on time, that is, if they have binding time budgets, then there is an implied own-cost, or price, of recycling. Hence, it appears that consumers are making economic sacrifices. This paradox can be resolved by consideration of the fact that recycling has both private and public good dimensions or attributes. In the less common case, when waste disposal services are provided at a marginal monetary fee, consumers can recycle to lower their waste disposal bills. This constitutes a private economic benefit of recycling. The public good benefits from recycling are the reduced need for landfill space and environmental conservation. First, landfills are generally considered public “bads” as such. In addition, landfills are often associated with secondary or external effects, such as air and water pollution and emission of greenhouse gasses that contribute to global climate changes. Secondly, recycling is a form of environmental conservation in that it saves scarce natural resources. Additionally, it is well known that most secondary-material production pollutes less than virgin material extraction and processing. For these reasons, consumers could consider their own recycling as a contribution to a public good. This contribution may have private complementary benefits, which compensate them for the extra resource commitment, and hence rationalize their behavior.

The broad objectives of my research are to both *explain* and *value* household recycling. To do so, I will adopt analytical methods developed within environmental economics. The reason for this lies partly in the notion of recycling as a non-market good. Most recycling takes place outside formal markets. Local agencies invariably provide recycling programs to households at zero marginal monetary fees. The absence of observable prices, which generally motivate demand estimation and welfare analysis, makes recycling a *de facto* non-market good. Non-market valuation methods provide a way to infer or derive the own-price of recycling, which in turn allows for estimation of demand functions and the concomitant welfare analysis. A key element to *revealing* the price of recycling is to investigate its time cost. This requires analysis of the consumers’ marginal money values of time, or the opportunity cost of time. A second reason for using methods from environmental economics is that the public good benefits discussed above are inherently passive-use or non-use values. Capturing these values is necessary for a full valuation of the benefits of recycling. Since these values arise independently of behavior, this cannot generally be accomplished via observing market or non-market transactions.

Recycling has been a popular area of research among economists, particularly after the so-called landfill crisis of the 1980's, as noted by Kinnaman and Fullerton (1999). Virtually all production and consumption activities generate physical by-products that must be handled some way or another (e.g., through recycling). Handling these by-products is necessary in order to support human production and consumption activities. Such handling is not *gratis*, however. Consumers have to give up money and time to get rid of by-products from their consumption activities. Society at large designates scarce economic resources, such as land space, to manage wastes. This unbreakable connection between human consumption and production activities and waste by-products is almost certain to secure its continued relevance. Four 'fresh-off the press' publications lend support to this claim: Porter (2002), Jenkins et al. (2003), Aadland and Caplan (2003), and Shinkuma (2003). Moreover, while the institution of recycling programs is taking place at a seemingly relentless pace, both in the United States and Europe, several politicians, policymakers, and economists have started questioning their economic rationale. This is evidenced most clearly by City of New York's recent moratorium on all its recycling programs [ABC News (2002)]. As with most publicly provided goods and services, it is fairly straightforward to document the costs of the provision of recycling. The quantification of its benefits on the other hand, is much more elusive. I propose that because of the multiple public-private goods dimensions of recycling, to correctly measuring its benefits, one must first understand consumers' recycling behavior. These are the goals of my research.

RESEARCH OBJECTIVES

The two main objectives of my research are to explain recycling behavior and to value the benefits of recycling to consumers. These objectives are discussed in separate subsections below. I am also interested in the role of consumers' time valuation and consumer heterogeneity. The value of time is often treated in a casual manner in empirical analysis. However, the accuracy of both demand estimation and welfare analysis hinges on a careful utility-theoretic treatment of this subject, particularly when time is a central element in the decision-making. The assumption of consumer homogeneity is very often made in economic analyses. Increasing availability of micro level data, along with recent advances in applied economics allow this assumption to be relaxed. For example, in random utility models heterogeneity can be incorporated both implicitly (e.g., random parameter models) and explicitly (e.g., latent class analysis), resulting in a more realistic and satisfactory representation of consumers, thereby often resulting in improved statistical properties of estimated models. I believe that the time and heterogeneity aspects are central to consumers' behavior and valuation in the recycling context.

Before going into my main objectives, I would like to narrow the scope of my research by explicitly stating that I do *not* intend to analyze the producer side of recycling. Nor will I seek to answer questions of the sort: What is the socially optimal level of recycling? What are the best or optimal solid waste management policies? My research will focus strictly on the consumer or household side of recycling. Based on my review of the existing literature, consumer's recycling choices are not well understood, and the valuation of consumer benefits of recycling has gone largely ignored.[1]

[1] See Kipperberg (2002b) for a literature review.

1. Explaining Recycling Behavior

What are the determinants of recycling behavior? The recycling demand literature focuses on the effects of solid waste policies, such as disposal fees and convenient recycling programs, and the role of socioeconomic variables. Kinnaman (1999), and Kinnaman and Fullerton (1999) provide overviews of the literature. To mention a few: Jenkins et al. (2003) provide a nation-wide, micro-level analysis of material-specific recycling. Jakus et al. (1996), Reschowsky and Stone (1994), and Saltzman et al. (1993) study material-specific household recycling at the regional level. Van Houtven and Morris (1999), Hong and Adams (1999), and Nestor and Podolsky (1998) study the household's total recycling level while Kinnaman and Fullerton (2000) and Callan and Thomas (1997) analyze total recycling across municipalities.

Recycling is often narrowly conceptualized, either implicitly or explicitly, as an alternative to waste disposal. In explaining recycling behavior I will focus on two additional aspects. First, such behavior may come at a significant cost, particularly in terms of the time it requires. Secondly, recycling activities may provide utility, or value, which sufficiently compensates for any extra costs. I discuss these two aspects below.

With the exception of a few empirical studies, namely Jakus et al. (1996) and Hong and Adams (1993), the *own-price* of recycling has generally been ignored. One explanation for this could be that the substitute price, the price of waste disposal, is under the policymaker's control, and hence constitutes an important policy tool for achieving recycling goals. Nevertheless, this is odd, given that most studies conceptualize recycling as a household production activity. If recycling, as an activity, requires non-trivial time effort, then there *is* a relevant own-price of recycling, unless consumers have a non-binding time-constraint. Moreover, in empirical estimation, ignoring this price amounts to omitted-variable bias, rendering any inferences questionable or even invalid.

In my research I will carefully incorporate the role of time into the analysis. In doing so, I intend to rely on recent work on utility-theoretic specification and estimation of demands with endogenous latent shadow values of time, as in Larson and Shaikh (2001).

If recycling activities were merely substitutes for waste disposal, then economic theory would predict that consumers would not recycle when waste disposal services are provided for free or at a fixed fee. However, this prediction is inconsistent with empirically observed widespread consumer recycling. The following quote by economists Kinnaman and Fullerton (1999) illustrates this fact: *73% of households recycled even in the absence of any legal or economic incentives. Why do these households recycle? Even if households value the quality of the environment (a public good) and their recycling effort improves the quality of the environment, households cannot be expected to provide this public good at their own cost. Perhaps households simply enjoy recycling or feel a civic duty to participate in recycling programs. Understanding why households have been willing to participate in municipal recycling programs remains an interesting question to economists and policy makers*.[2]

In contrast to economists, researchers in other social sciences, such as sociology and psychology, have long recognized that consumers are motivated to recycle for a variety of reasons aside from purely economic ones, see, e.g., Hornik et al. (1995), Gamba and Oskamp (1994), Oskamp (1991), Hopper and Nielsen (1991), Vinning and Ebreo (1990), and De Young (1986, 1988). One finding of these researchers is that many consumers have a desire or preferences for behaving in an *environmentally friendly manner*.

[2] Page 23, Kinnaman and Fullerton (1999).

Economist Ackerman (1997) also alludes to this idea: *Why do we recycle? Rarely is there a monetary reward. The increasingly common recycling boxes in public places rely on social pressure rather than financial incentives. Recycling is an impressive pure form of altruism, a widespread commitment to the greater good.*[3]

In my research I will conceptualize this type of preference as a desire to voluntarily contribute to a public good. Contrary to the prediction of standard economic models of voluntary public good contributions, several recent advances in economic theory have demonstrated that such contributions can be substantial. Furthermore, this theoretical outcome is consistent with empirical observations on many types of human behavior (e.g., charitable giving). Non-trivial voluntary public good contributions are rational within a neoclassical choice framework when there are private complementary benefits associated with these contributions. Andreoni (1990) presents the now famous theory of *warm-glow giving*. This theory is extended to an economic model of *moral motivation* in Brekke et al. (2003). Nyborg and Rege (2003) explain so-called considerate smoking behavior (a public good) within a *social norm* model. Preferences for particular *identities* are explored within a variety of economic choice contexts in Akerlof and Kranton (2000). I intend to incorporate the notion of such motivations or incentives either implicitly or explicitly into my analysis.

2. Valuation of Household Recycling

There are two important sources of values from recycling. First, consumers may obtain utility or value from engaging in recycling activities or from participating in recycling programs. These values can be called use-values. A second source of values arises from the public good

[3] Page 8, Ackerman (1997).

dimensions of recycling. For example, environmental conservation benefits from recycling are non-excludable and non-rival. These values can also be called passive-use values because they arise independently of any individual consumer's recycling behavior.

Existing assessments of recycling programs generally find them to be marginally efficient or not efficient from the point of view of society [Kinnaman (1999)]. The basis for this conclusion is often benefit-cost analyses, which take the benefits from recycling to be the avoided garbage disposal costs plus net revenues from the sale of recycled materials to secondary markets.

There are several problems with this approach. For one, this approach ignores the direct utility or values (the use-values) consumers may obtain from recycling. One reason for this omission lies as mentioned, in the narrow view of recycling as merely a substitute waste handling option to disposal. As discussed, this view is inconsistent with the absence of direct economic incentives for the majority of consumers. Another reason for ignoring potentially significant direct consumer benefits lies in the fact that consumers do not 'trade' their recycling activities in formal markets with observable market prices. This makes demand estimation, and subsequently valuation, difficult.

Another problem with existing benefit-cost assessments is that they inadequately deal with the public good or passive-use values of recycling. It is assumed that the social costs of waste disposal are accurately reflected in landfill charges. This is likely to be untrue for at least two reasons. Landfill investments are often subsidized causing lower than efficient tip fees. Also, landfills are associated with several negative externalities. While modern technology has reduced pollutant run-offs into surrounding land and water bodies, landfills still produce significant greenhouse gases that contribute to global climate change. These externalities are not reflected in landfill charges. In addition, it is assumed that natural resource prices reflect economic scarcity. This is very unlikely because virgin material extraction and processing industries enjoy subsidies and are not penalized for negative externalities. Public good benefits from reducing the need for landfills, conserving scarce resources, and indirectly reducing pollution effects are arguably relevant benefits from recycling.

Some existing studies in the literature have taken the consumer benefit side serious. Jakus et al. (1996) study the use-value of drop-off recycling programs through a revealed preferences approach. Aadland and Caplan (2003), Kinnaman (1998), Lake et al. (1996) Tiller et al. (1997) and Stock (1997) estimate willingness to pay for recycling programs, through the CVM stated preference approach. These estimates are likely to reflect total consumer benefits.

For my research I intend to estimate the total consumer value of recycling. However, I am also interested in the relative importance of use- versus non-use values.

A GENERAL BEHAVIORAL FRAMEWORK

For the purposes of exposition and to bring focus on the role of time in the context of recycling, I will first outline a continuous decision model. This assumes that the consumer or household makes decisions on the “intensive margin” (how much to recycle). Even though the discussion focuses on interior solutions, an empirical implementation of this framework would have to account for corner-solution cases. An alternative theoretical framework is to think of recycling as *fundamentally* a discrete choice in for example in a random utility framework. I.e., the consumer or household may think of recycling, of say a particular material, as an “either/or” choice, contingent on a subjectively formed expectation of a quasi-fixed price associated with the recycling alternative.

A Continuous Decision Framework for Consumer Recycling:

I motivate the household's recycling choices from a canonical two-constraint utility maximization model. In addition to being constrained by money, the household is also constrained on time.

Let $\mathbf{x}$ be a vector of N household activities with associated money prices $\mathbf{p}$ and time prices $\mathbf{t}$. The household can recycle J different materials, which is denoted by the vector $\mathbf{r}$. Recycling is a subset of all the possible household activities, hence $J < N$. The corresponding money and time prices of recycling are $\mathbf{p_r}$ and $\mathbf{t_r}$ respectively. The household chooses activity levels subject to strictly binding money budget $M = \mathbf{px}$ and time budget $T = \mathbf{tx}$. Both budgets are assumed to be the exogenously determined, e.g., through a first-stage labor market participation decision.

Utility is a function of activity levels $\mathbf{x}$ and a vector of exogenous utility shifters $\mathbf{s}$. Thus, we can write the value of the direct utility function as $u(\mathbf{x},\mathbf{s})$, which we assume to take on all the usual properties of a well-behaved utility function. The utility shifters consist of variables describing the household, such as socioeconomic characteristics. The utility shifters could also include subjective quality attributes, or perceived complementary benefits, potentially associated with some activities. This subset of utility shifters will be denoted by $\mathbf{q}$.

The indirect utility function $V(\mathbf{p},\mathbf{t},T,M,\mathbf{s})$ implied by utility maximization subject to the money and time budgets is defined as

(1) $$V(\mathbf{p}, \mathbf{t}, T, M, \mathbf{s}) \equiv \underset{\mathbf{x}}{Max}\,\{u(\mathbf{x},\mathbf{s}) \text{ s.t. } M - \mathbf{px} = 0,\ T - \mathbf{tx} = 0\}\ .$$

The Lagrangian is defined as

$$L(\mathbf{p}, \mathbf{t}, T, M, \mathbf{s}) \equiv u(\mathbf{x},\mathbf{s}) + \lambda[M - \mathbf{px}] + \mu[T - \mathbf{tx}],$$

where λ is the marginal utility of money and μ is the marginal utility of time.

The vector form of the first-order necessary conditions is

$$\begin{aligned} &\mathbf{x} : u_{\mathbf{x}} \leq \lambda\mathbf{p} + \mu\mathbf{t}, \quad [u_{\mathbf{x}} - \lambda\mathbf{p} - \mu\mathbf{t}]\mathbf{x} = \mathbf{0} \\ (2) \qquad &\lambda : M - \mathbf{px} = 0 \\ &\mu : T - \mathbf{tx} = 0 \end{aligned}$$

For interior activity choices we obtain the usual result that marginal benefits are equal to marginal costs, that is $u_{\mathbf{x}} / \lambda = \mathbf{p} + (\mu / \lambda)\mathbf{t}$. This condition differs from the single-constraint framework in that the marginal time cost is included on the cost side. The ratio of the marginal utility of money to the marginal utility of time μ / λ converts the time prices $\mathbf{t}$ into monetary terms. It will be convenient to denote this ratio by ρ, that is $\rho \equiv \mu / \lambda$. This ratio is the marginal money value of time, or the opportunity cost of time, where we note that by the envelope theorem, we have the equivalent expression $\rho = V_T / V_M$, where $V_T \equiv \partial V / \partial T$ and $V_M \equiv \partial V / \partial M$.

In principle, the solution of the first-order necessary conditions yield Marshallian demands as a function of money prices, time prices, money budget, and time budget, namely $\mathbf{x} = \mathbf{x}^*(\mathbf{p},\mathbf{t},M,T,\mathbf{s})$, as well as the corresponding values of the Lagrange multipliers $\mu = \mu^*(\mathbf{p},\mathbf{t},M,T,\mathbf{s})$ and $\lambda = \lambda^*(\mathbf{p},\mathbf{t},M,T,\mathbf{s})$. Thus, the marginal money value of time can be expressed as

(3) $\rho(\mathbf{p},\mathbf{t},M,T,\mathbf{s}) \equiv \mu(\mathbf{p},\mathbf{t},M,T,\mathbf{s}) / \lambda(\mathbf{p},\mathbf{t},M,T,\mathbf{s})$.

Because explicit solutions are difficult to derive, even for the simplest utility functions, an alternative representation of the optimal solution is useful for empirical implementation of two-constraint models. It can be shown that demand functions consistent with this framework are functions of full prices and full income, where time prices and the time budget are converted into monetary terms by the marginal money value of time ρ [Larson and Shaikh (2001)]. This implies that we can express the Marshallian demands as

(4) $\mathbf{x} = \mathbf{x}^*(\mathbf{p},\mathbf{t},M,T,\mathbf{s}) = \mathbf{x}^{**}(\mathbf{p}^{\mathbf{F}},M^F,\mathbf{s})$,

which for the recycling activity vector can be written as

(4') $\mathbf{r} = \mathbf{r}^*(\mathbf{p},\mathbf{t},M,T,\mathbf{s}) = \mathbf{r}^{**}(\mathbf{p}^{\mathbf{F}},M^F,\mathbf{s})$,

where the full price vector is defined as $\mathbf{p}^{\mathbf{F}} \equiv \mathbf{p} + \rho\mathbf{t}$ and full income is defined as $M^F \equiv M + \rho T$.

In general, estimation of the demand functions requires simultaneous specification and estimation of the latent endogenous marginal money value of time in equation (3). In analyzing recycling, I am going to maintain weak separability and subsequently estimate an incomplete demand system for the recycling activities. The above framework will be implemented by selecting a utility-theoretic functional form specification, which allows for testing or imposing the homogeneity, symmetry, and adding-up conditions, which must hold in two-constraint contexts.[4] I will also consider the possibility that the use of household time for recycling activities could be taken out of a specific time budget, such as a time budget for household work. Larson and Lew (2002) have shown how a model with a single time constraint generalizes straightforwardly to models with multiple time constraints.

By a utility-theoretic specification of demands, it is straightforward to derive Hicksian welfare measures for use values. An implicit expression for willingness to pay for recycling can be formulated from the indirect utility function

$$V^1(\mathbf{p^F}, M^F - \mathbf{p_r^F r} - WTP_{\mathbf{r}}^M, \mathbf{q}^1) \equiv V^0(\mathbf{p^F}, M^F, \mathbf{q}^0).$$

Non-use values cannot generally be inferred from observed behavior [Freeman (1999)]. Instead, hypothetical or stated preference data must be relied upon. Let us recognize that the total recycling from all consumers **R** is a measure of the public good. Then the welfare theoretic non-use values of recycling can be defined by the following implicit willingness to pay expression

$$V^1(\mathbf{p^F}, M^F - WTP_{\mathbf{R}}^M, \mathbf{R}^1) \equiv V^0(\mathbf{p^F}, M^F, \mathbf{R}^0).$$

Since it is the same underlying preferences that give rise to both sources of value, I would like to combine revealed preference and stated preference methods to estimate both sources of values simultaneously.

[4] See Larson and Shaikh (2001) for empirical specification requirements for models with two linear constraints. Partovi and

A Binomial Discrete Choice Model of Recycling

Suppose that the consumer makes a decision of whether or not to recycle J different materials. The pay-off or utility from recycling the jth material is denoted U_{ij}^{1} and the pay-off from not recycling is denoted U_{ij}^{0}, where $j = 1,..,J$ and i index the consumer. Then, the consumer will recycle only if $U_{ij}^{1} > U_{ij}^{0}$.

A common way to model such a decision is through a random utility model (RUM) framework. This framework recognizes that not all factors affecting utility can be observed by the researcher. Hence, utility is decomposed into an observable component V_{ij} and an unobservable (stochastic) component ε_{ij} such that $U_{ij} = V_{ij} + \varepsilon_{ij}$. Since the choice is binomial, the utility from not recycling can be normalized to zero without loss of generality. Thus, a consumer recycles if $V_{ij} + \varepsilon_{ij} > 0$.

The observable component of the indirect utility function can be modeled as a function of prices, income, and a vector of other covariates that affect utility. Following the notation from the previous section, $V_j = V_j(M^F - P_{r_j}^F, \mathbf{S})$, where subscript i is left out for notational convenience. Here $P_{r_j}^F$ denotes full cost of recycling the jth material, hence $M^F - P_{r_j}^F$ is the full income available to be used for all other activity expenditures. It is natural to think of $V_{ij}(\cdot)$ as increasing in M^F, decreasing in $P_{r_j}^F$, and thus increasing in $M^F - P_{r_j}^F$.

Let us pause for a moment and revisit with the full price or full cost of recycling. Recall from previously that $P_{r_j}^F = P_{r_j} + \rho t_{r_j}$. In the continuous activity demand framework, it is possible to define r_j in terms of time, such that the time prices t_{r_j} by construction are unity, *i.e. one hour of recycling "costs" one hour of time*. This simplification would not easily carry over to the discrete choice framework. Here, t_{r_j} is more appropriately thought of as the individual's (ex-ante) expectation of how much time it would require to recycle material j. Hence, it would seem appropriate to replace t_{r_j} with $E(t_{r_j})$, where $E(\cdot)$ indicates an expected value. These time price expectations may depend on the amount of waste materials produced (which in turn depends on a

Caputo (1998) derive the complete set of empirically testable properties for the general multiple-constraint case.

household's purchasing pattern, and variables such as household size, and household members' age distribution), the types of recycling systems available (e.g. curbside pick-up services versus drop-off recycling centers), the consumers' experience or familiarly with recycling (or similar activities), and so on. Hence, in implementing the binomial discrete choice model empirically, care must be taken to either collect data explicitly on the $E(t_{r_j})$'s or to model these expectations structurally.

Now let us return to the RUM framework. Based on the above discussion, we can now formulate the choice as follows. The consumer will recycle if and only if

$$V_{ij}(M_i^F - [P_{ir_j} + \rho_i E(t_{ir_j})], \mathbf{S}) + \varepsilon_{ij} > 0 .$$

A distributional assumption on the unobserved component of the indirect utility function leads to an econometric estimation model. For example, if ε_j is distributed logistically, we have a standard logit model. However, in the framework described above, we are looking at *J* discrete decisions. The required iid assumption of the standard logit is likely to be violated for two reasons. Firstly, the "unobservables" for a particular consumer are likely to be correlated across the *J* choices, meaning that $Cov(\varepsilon_{ij}, \varepsilon_{ik}) \neq 0$. Secondly, there could be pay-off complementarities or substitutability between recycling of the different materials. These aspects of the consumer choice can be addressed via the mixed logit model [see Train, 2001].

IMPLEMENTATION

The feasibility and scope of my research depend on the availability of existing data and/or the availability of funding for collecting original data. Below, I discuss progress made in these regards since my oral qualifying examination in the summer of 2002. I also outline a tentative timeline for the implementation of my research.

Data Sources

I spent three months working for Statistics Norway in the summer of 2002. Through this research, I gained access to Norwegian data on household recycling. This data has two components. The main component is data from a national household survey. This survey collected information on the household's extent of recycling of various materials, time usage, willingness to pay to avoid the time cost, and other motivations and attitude variables related to recycling. In addition, the survey collected standard socioeconomic information, including detailed information on labor market situation. The data links the survey data with information on solid waste policies instituted in Norwegian municipalities. The strength of this data is that it has detailed information on recycling of different materials and time usage information that has the potential for allowing me to estimate the households' marginal money values of time and to derive the full prices and full income. Two limitations of the data are that recycling activities were self-reported and discrete (ordered categories). The former introduces potential measurement error while the latter complicates the issue of implementing demand estimation. Another problem is that the labor market information does not distinguish between people working fixed versus flexible hours. Such distinction could be critical in determining the marginal money values of time.

I am also pursuing data from my previous employer, City of Seattle. Currently available data are mostly of the aggregate time-series variety. One source of micro-level data is self-haul data to the City's drop-off centers. This data source is interesting in that the households who choose this recycling option incur a substantial travel cost that can be used to generate demand functions. A challenge with this data source is that it contains both residential and commercial (business) users. It is unclear, at this point, whether information is available to distinguish these two classes of customers. A second potential source of micro data is a new survey of households in Seattle. I recently submitted a research proposal to the City of Seattle that would involve such original data collection [Kipperberg (2003c)]. A major advantage of collecting new data is that it allows construction of a survey instrument that could capture both use-values and passive-use values. The Norwegian data described above can likely only reveal values associated with behavior, not those values that are disjoint from the households' recycling activities.

Funding Sources

Last year I submitted a grant proposal to the Norwegian Research Council via the *Center for Development and the Environment* of the University of Oslo [Kipperberg (2002a)]. This application was accepted in January 2003. As a result, I currently hold a doctoral fellowship position at the aforementioned research center. This fellowship provides me with a full-time salary accompanied by an annual discretionary budget of $10,000, which can be used for further data collection and other research-related activities. This fellowship lasts until June 2005. In addition, the research proposal submitted to the City of Seattle budgeted $30,000 for conducting a comprehensive household survey.[5]

Tentative Timeline

Due to the length of duration of the aforementioned fellowship, I have set the summer of 2005 as the final deadline for completing my dissertation research. I have already completed the majority of the necessary literature review [Kipperberg (2002b)]. Furthermore, I have conducted several exploratory analyses of the Norwegian data, which I describe in the below section. The next goal is to address further data issues by the end of this year. I anticipate that collection of data through a new survey would be carried out between the end of this year and the first half of

[5] I expect to know the outcome of this proposal by July 2003. However, even if I do not receive this research money, I nevertheless intend to pursue a household survey, potentially via the fellowship research budget.

2004. As data issues are settled, I will be able to flesh out details of my theoretical approach and formulate empirical models and specific statistical hypotheses.

WORKS IN PROGRESS

I have several work products in progress, including theoretical analyses and empirical explorations. For example, Kipperberg (2003a) explores the relationship between certain stated preference questions and the opportunity cost of time. This discussion note also begins to explore the implications of the presence of multiple time constraints. Kipperberg (2003b) explores the possibility of modeling private complementary benefits associated with public good contributions via the notion of minimum or subsistence expenditure models.

The most complete products are Kipperberg (2003d) and Halvorsen and Kipperberg (2003). The former offers a comparison of the determinants of household recycling between Norway and the United States. In this paper I specify and estimate an empirical model for the Norwegian data, which is closely comparable to the analysis of U.S. households in Jenkins et al. (2003). The major finding of this analysis is that Norwegian consumers are more responsive to a direct economic incentive, in the form of waste disposal fees, while U.S. households are more responsive to convenience, in the form of curbside and drop-off recycling programs. The latter paper extends this analysis to incorporate the marginal money value of time and factors measuring households' preferences for contributing to a public good. Including a full price and a full income variable, appropriately reflecting the marginal money value of time, improves the statistical properties of estimated models. Moreover, the full price of recycling is significant in the regressions for three materials. Variables measuring the strength of households' motivations to contribute to a public good are jointly significant in all regressions and individually significant in several cases. In addition to improving the overall predictive power of the models, including this aspect of recycling improves statistical efficiency of other parameter estimates. Preliminary results for one material (glass recycling) are provided in the appendix; see Halvorsen and Kipperberg (2003) for details.

These two analyses estimate ordered models separately for each recycled material. Additionally, a first-order approximation is used to specify demands for recycling activities. The second analysis estimates the marginal money value in a first-stage analysis, which is subsequently used to construct full price and full income for the second-stage demand estimation. Further improvements that I intend to implement are as follows: First I would like to relax the assumption that the error terms are independent across materials. This implies that a recycling demand system should be estimated. Secondly, I want to adopt a utility-theoretic functional form specification that would allow the testing or imposition of homogeneity, symmetry, adding-up and curvature conditions. Thirdly, I would like the marginal money value of time to be estimated simultaneously with the demand functions in a *full-information* approach. I believe these improvements would yield one chapter of my dissertation and go a long way in addressing my first research objective.

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APPENDIX

First-Stage: Ordinary Least Square Regression for Log Marginal Money Value of Time

Variable	Coefficient	Standard Error	P-Values
Constant	2.8081	0.2717	0.0000
Earnings Rate	0.0004	0.0005	0.3317
Age of Respondent	-0.0145	0.0056	0.0093
Household Size	-0.1174	0.0422	0.0057
(0,1) Indicator for College Degree or Above	0.0399	0.1359	0.7690
(0,1) Indicator for Management Position	0.4069	0.1529	0.0081
(0,1) Indicator for Private Sector	0.0617	0.1403	0.6603
(0,1) Indicator for Unemployed	0.1241	0.5042	0.8057
(0,1) Indicator for Staying at Home	-0.6442	0.4151	0.1214
(0,1) Indicator for Retired and Living off Pension	-0.2775	0.2468	0.2614
(0,1) Indicator for Student	0.5238	0.2050	0.0109
(0,1) Indicator for Unskilled	-0.4550	0.2285	0.0471
(0,1) Indicator for Male Respondent	0.1632	0.1211	0.1785

N=441. Adjusted R-Squared=0.11, F-Stat=5.34, P-Value=0.0000. Mean predicted marginal money value of time is 9NOK ($1.3). Mean earnings rate is 116NOK ($16.6).

Second-Stage: Ordered Logit Model Estimation for Glass Recycling

Variable Name	Coefficient	Standard Error
Constant	0.2351	0.3129
Full Price and Full Income:+		
Full Price of Recycling	** -0.0302	0.0107
Full Income	0.0003	0.0002
Policy Variables:		
Voluntary Fee Differentiation	0.0543	0.1069
Mandatory Fee Differentiation	* 0.2665	0.1588
Curbside Recycling Program	** 0.5716	0.2839
Drop-Off Recycling Program	*** 0.3951	0.1286
Demograhic Variables:		
Household Size	-0.0109	0.0311
Single or Detached House	-0.0808	0.0945
College Degree or Above	0.0380	0.1009
Live in City	* -0.2928	0.1728
Recycling Motivations Questions:		
1. I think recycling is a pleasant activity in itself	*** 0.1328	0.0417
2. I consider it to be a mandate from the government	** -0.0821	0.0369
3. I want to think of myself as a responsible person	0.0390	0.0462
4. I want other people to think of me as a responsible person	0.0453	0.0437
5. I would like to contribute to a better environment	*** 0.2605	0.0854
6. I should do what I would like other people to do	-0.0113	0.0544
Model Performance:		
Ordered Logit Threshold Parameter	*** 0.7681	0.0506
Unrestricted Log-Likelihood	-747.566	
Restricted Log-Likelihood	-786.990	
Chi Square Statistic	*** 78.848	
Correct Predictions	568/876	

Standard errors are reported in parentheses. *,**,*** indicate significance at the 90%, 95%, 99% level of confidence respectively. +Variables derived from first-stage estimation of the marginal money value of time.