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Abstract

Information programs to promote cellulosic biofuels may not achieve their objectives unless consumers can be induced to care about the information presented to them. The social psychology literature highlights two commonly used models to link psychological variables to environmentally related behaviors: the Theory of Planned Behavior (TPB) and the Norm Activation Theory (NAT). Other studies have compared the strength of these models or have adapted these models by adding additional variables, but few have compared across the alternative variable combinations noted in the literature. That is, most studies have added one or two psychological variables to the NAT or TPB models and have found that the additional variable is a significant factor influencing behavior. However, we are unfamiliar with any study that has included the full suite of examined variables within one model. This could be a problem in that the psychological variables are likely to be correlated. In turn, the output of these models may suffer from omitted variable bias; which could lead to erroneous conclusions about the importance of any specific variable. Previous findings that individual variables are significant in influencing behaviors may be incorrect. One objective here then is to start examining whether these 'significant findings' are robust, and if not, whether we can be more parsimonious in future modeling efforts. Economists often assume preferences are adequately proxied by the person's socioeconomic characteristics or by the person's participation in some environmental behavior. Recently, economists have begun to recognize that these characteristics are poor proxies especially since the proxies commonly used are binary (0/1) variables that provide relatively little detail, are usually not policy or program relevant and lack a theoretical justification. Thus, another objective is to compare the performance of models that incorporate these proxy variables with models incorporating psychological variables. Our results suggest: that a combined TPB and NAT model may be more effective than either model alone; that many variables seen as important in the literature may be less important than previously thought (allowing for more parsimonious models - resulting in less costly data collection); and that common proxy variables like membership in an environmental group may not work that well.

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1. Introduction

The Energy Independence and Security Act of 2007 requires the sale of specified quantities of renewable and advanced biofuels. The Northeast region of the US is heavily endowed with forests and thus has the potential for high yields of forest bioproducts - one of which is cellulosic ethanol. The use of ethanol in gasoline reduces greenhouse gas emissions, energy dependence from oil and, financial payments to petroleum exporting countries. Cellulosic ethanol has several advantages over corn-based ethanol production: cellulosic ethanol does not directly impact food supply or prices; can be produced from products traditionally thought of as waste (i.e. forest biomass left over after logging, domestic yard waste, cardboard), and has potentially greater reduction in greenhouse gas (GHG) emissions.

Understanding how information can impact consumer demand for cellulosic biofuels is of critical importance given the speed at which the US is moving towards programs to support biofuels. The level of consumer knowledge, and acceptance, of biofuel **attributes**[1] is an important precursor to understanding their potential to impact market demand, yet there is no literature documenting these issues. Indeed, because the environmental impacts of biofuels differ across source material, consumers may be quite sensitive to differences across biofuel types (Walsh 2007; Wegener and Kelly 2008). As consumers become more aware that ethanol is not all the same, we expect that product differentiation will be the norm. This is borne out in other consumer markets such as coffee where the 'fair trade' label is proudly displayed (Loureiro and Lotade 2005).

Information programs (e.g., ecolabeling) to promote cellulosic biofuels may not achieve their objectives unless consumers can be induced to care about the information presented to them. The social psychology literature has several models to link psychological variables to environmentally related behaviors; however, two are commonly used (Wall et al. 2008): Ajzen's Theory of Planned Behavior (TPB) and Schwartz's Norm Activation Theory (NAT). Our ultimate purpose is to design a behavioral model that provides clear links between various factors (be they economic, technology adoption or psychological) and environmentally related behaviors. However, as a first step this paper will examine and test the links between behavior and the various psychological constructs and models.

Other studies (e.g. Wall et al. 2008) have compared the strength of the above two models or have adapted these models by adding additional variables,

[1] Throughout the paper **attributes** can designate environmental impacts (e.g., forestry and landscape impacts; green house gas emissions), national security impacts (e.g., imported fuels displaced), consumer cost and convenience (e.g., frequency of refueling) and local economic impacts (e.g., improved employment and income in rural areas).

but few have compared across environmentally related behaviors or with the alternative variable combinations noted in the literature. That is, most previous examinations have added one or two psychological variables to the NAT or TPB models and have found that the additional variable is a significant factor influencing behavior. However, we are unfamiliar with any study that has included the full suite of examined variables within one model (nor are we aware of any comparisons between 'expanded' NAT and TPB models). This could be a problem in that the psychological variables are likely to be correlated. In turn, the output of these models may suffer from omitted variable bias; leading to biased parameter estimates (Barreto and Howland 2006) which could lead to erroneous conclusions about the importance of any specific variable. Quite simply, previous findings that individual variables are significant in influencing behaviors may be incorrect. Our objective here then is to start examining whether these 'significant findings' are robust, and if not, whether we can be more parsimonious in future modeling efforts.

One likely reason driving researchers to only include a few variables when testing a model is that collecting the required data is difficult within the context of a survey (the large number of questions that need to be asked would severely reduce response rates). For example, for each construct the researcher would commonly include five or more questions; thus, each additional variable adds a significant cost in terms of potential loss in survey or item non-response. Here we examine data we collected from a convenience sample of university students as part of the pretesting of our survey instrument. Although the results are limited in terms of being able to be externalized to other populations, it does provide a rich set of variables to test the various models and variable combinations.

2. Literature Review

Economic theory suggests demand for a product or service is a function of a number of factors; one of these being the tastes and preferences of consumers. Traditionally, economists (such as the current authors) have been rather ill-equipped at incorporating tastes and preferences in their models. Economists have often assumed these preferences are adequately proxied by the person's socioeconomic characteristics or by the person's participation in some environmental behavior (e.g. being a member of an environmental group). Recently, economists have begun to recognize that socioeconomic characteristics are poor proxies (Fraj and Martinez 2007). Especially since the proxies commonly used (gender, membership in an environmental organization) are binary (0/1) variables that provide relatively little detail, are usually not policy or program relevant (e.g., an eco-marketing campaign cannot change one's gender) and lack a theoretical justification.

In the TPB, behaviors[2] are a function of three main arguments, the individual's attitudes toward the behavior, their perceptions of their control over the behavior and their perceptions of social norms. In contrast, the NAT assumes that behavior[3] is a function of an individual's personal norms, their perceptions of the consequences of the behavior and the degree they feel personally responsible. These two models differ not just in terms of their variables but in their motivations; NAT assumes behaviors are socially motivated while the TPB is motivated in terms of rational self interest (Bamberg and Möser 2007).

Attitude towards a behavior is defined by Ajzen as "the degree to which performance of the behavior is positively or negatively valued" (http://people.umass.edu/aizen/tpb.diag.html). Fraj and Martinez (2007) indicate that environmental psychologists have indicated two sets of environmental attitudes: one based on the actual eco-behavior under study, the other being a more general eco-attitude (i.e., an attitude toward the environment not at a particular behavior). Attitudes have often been found to be a precursor to environmental behavior (e.g., Birgelen et al. 2009; Fraj and Martinez 2007; Kaiser et al 1999; Chan 2001); although often the effect is relatively weak (Fraj and Martinez 2007).

Norms are shared beliefs about how people should act (Schwartz and Howard 1982); social norms are generally defined as what the individual perceives as expectations on their behavior held by social groups important to the individual (e.g. peers, family or colleagues). These social expectations are assumed to be supported by real or perceived sanctions so that the individual has an incentive to adhere to the social norms (Ajzen 1988). At the other extreme are personal norms that are internal expectations held by the individual; e.g., a sense of obligation (Schwartz 1977).[4] These norms have also been found to positively influence a person's eco-related behaviors (Stern 2005; Ajzen et al. 2004; Ek and Söderholm 2008; Hunecke et al 2001; Thøgersen 1999; Birgelen et al. 2009).

Perceived control, behavioral consequences and responsibilities reflect how a person views themselves as being able to perform a specific behavior, what the consequences of acting (or not acting) would be and the degree they feel personally responsible to perform the behavior. Perceived behavioral control (Wall et al 2008; Ajzen 2002; Birgelen et al 2009) is indicated to be a significant precursor to environmentally related behaviors, although sometimes there is no link found (Birgelen et al. 2009).

With time researchers have combined the constructs of the two models (Wall et al. 2008), added new variables and have included interactive affects (e.g.

[2] The TPB is formulated to examine behavioral intentions as opposed to actual behavior.
[3] Although the NAT is constructed to examine behaviors, many study use the model to examine behavioral intentions (Wall et al.2008).
[4] This is a common simply dichotomy; see Thøgersen (2006) for a rigorous taxonomy of norms.

Umeh and Patel, 2004; Godin, Conner, & Sheeran, 2005; Kaiser et al., 2005). This literature suggests a person's eco-behavior is positively influenced by their level of environmental involvement[5] (Kokkinaki 1997; Thøgersen 2002), level of environmental concern (Bamberg 2003), level of environmental awareness (van Birgelen et al.2009), or their membership in an environmental group (Fielding et al.2008).

Several recent studies (Kaiser 2006; Bamberg et al.2007; Fraj and Martinez 2007; Carrus, Passafaro and Bonnes 2008) find that eco-behaviors are positively impacted by ecological affect (affects are emotional responses toward an action or object). One affective response would be guilt (Weiner, 2000), which is a feeling of regret aroused when a person "causes, anticipates causing, or is associated with an aversive event.'' (Ferguson & Stegge, 1998, p. 20). Guilt is both seen as a possible factor that interacts with both personal and social norms (Baumeister, 1998; Bamberg and Moser 2007). Other positive influences include the consumer's perceived behavioral effectiveness (Thøgersen 1999, 2000, 2002; Lee and Holden 1999), and when examining eco-purchasing behavior, trust in the information presented (Thøgersen 2002).

The role of socioeconomics characteristics is somewhat less consistent in determining eco-attitudes and behaviors. In general, women are found to be more eco-conscious than men (Zelezny et al. 2000; Johnston et al. 2001; Loureiro et al. 2001) possibly because females are more socialized to help others (Eagly 1987; Wilkson and Kitzinger 1996). Education has been found to have positive (Blend and van Ravenswaay 1999) negative (Johnston et al. 2001) or no (Moon et al. 2002) impact. Age has also shown positive (Rice 2006; Clark et al.2003; Roberts 1996), negative (Moon et al. 2002) or no (Loureiro et al. 2001) impact. Income has little impact (Moon et al. 2002; Blend and van Ravenswaay 1999; Loureiro et al. 2001).

One other item of interest is the degree that environmental behaviors are related. On one hand individuals who are environmentally sensitive should be positively inclined toward multiple environmentally preferred behaviors. For example, Birgelen et al. (2009) find that people who are more likely to buy environmentally friendly products are also likely to perform environmentally preferred disposal (e.g. recycling). However, some individuals may act as if they allocate their total environmental support decisions across behaviors; these latter individuals may choose to increase one environmental behavior but at the expense of another; i.e., an environmental substitution or rebound effect (Kotchen and Moore 2008; de Haan et al. 2006). For example, individuals who buy environmentally friendly products may choose to be less concerned with the

[5] The construct of involvement can be understood as personal relevance or importance (Park and Young 1986; Celsi and Olson 1988).

disposal of those products; e.g., the correlation in the Birgelen et al. study was only 0.58, suggesting the likelihood of such an effect.

3. Theoretical Model

We want to provide a modeling framework that would allow the measurement of changes in two related eco-behaviors of consumers due to changes in the availability of cellulosic transportation fuels. In this longer-term study we will examine how the availability of these biofuels could affect a consumer's choice of fuel while also allowing the consumer to change the amount of driving they do. Similar to Kotchen and Moore (2008), we are interested in this application as it could provide evidence of consumer eco-substitution behaviors (i.e., do people who choose environmentally better fuel also choose to drive more?), and if so, what factors induce this type of behavior (i.e., are eco-substitution behaviors related to specific types of consumers?). For example, after given information about the environmental tradeoffs related to gasoline use, higher income individuals might prefer to spend more per gallon to achieve a given amount of environmental benefits, while lower income individuals might choose instead to reduce their fuel consumption by driving less. Finally, we want to examine how the factors related to eco-behaviors that are illuminated in the social psychology literature should be brought into an economic choice framework.

We begin by adapting the indirect utility function of Kotchen and Moore where the individual's utility is a function of the following exogenous parameters: prices (P), income (M), and perceived private (g) and two types of public quality attributes of the fuel choices: (e) environmentally related attributes and (o) other attributes (e.g., improved national security). Our adaptation allows utility to vary across individuals according to a vector of variables assumed to be related to the individual's acceptability of new technologies (TPSY) and their environmental and other proclivities (EPSY; OPSY).[6] Combining TPSY and EPSY into the same model allows us to incorporate a technology adoption model into our environmental behavior model.[7] We examine this issue because some environmentally preferred products or processes (e.g., cellulosic biofuels) could be developed through, or will be perceived as, novel technologies. Previous research indicates that some consumers react negatively to new technologies and

[6] Kotchen and Moore recognize heterogeneity across EPSY but do not include nor test specific constructs, instead using a dummy variable denoting whether or not the individual belonged to an environmental group.

[7] Using or adapting the TPB to model technology adoption has been done (e.g., Workman 2005; Smarkola 2008; Crespo and del Bosque 2008: Wu and Chen 2005) but only in the context of adopting computer technologies. We are not aware of anyone combining technology adoption models into an eco-behavioral model.

products (e.g., Cox et al. 2007), and that some consumers already hold negative perceptions of ethanol (e.g., Wegener and Kelly 2008) which could be related to perceived risks related to its use (Teisl et al 2009). Combining OPSY and EPSY allows us to examine how people may make tradeoffs across various types of public goods (e.g., global warming gas reductions; improvements in fuel security).

Assuming two behaviors (choice of fuel type and choice of miles driven)

$$V(P, M, e, g, o) = \max_F \{l(M - PF^t) + g(F^t; TPSY) - e(F^t: EPSY) + o(F^t; OPSY)\}$$

where $l(\cdot)$ is the component of utility related to the numeraire good, $g(\cdot)$ is the component of utility related to the private benefits of fuel use, $e(\cdot)$ is the environmentally related disutility associated with fuel use and $o(\cdot)$ is the utility associated with other public good aspects of fuel use (e.g., fuel security); t denotes the fuel type (e.g., gasoline or ethanol). In Kotchen and Moore, the function $e(\cdot)$ is assumed to only apply to individuals who have environmental proclivities (i.e., the function is multiplied by a dummy variable which is equal to one if the person is a conservationist; zero otherwise) and is only a function of fuel use. We dispense with these assumptions since our interest is ultimately in determining how information can change people's evaluation of $e(\cdot)$, how individuals' psychological characteristics can affect $e(\cdot)$, and how both of these arguments can ultimately affect the choice of type and quantity of fuel used. That behavior may be related to technology adoption and the presence of other public goods is not in the Kotchen and Moore framework

Our ultimate purpose is to examine the behavioral model above to provide clear links between the economic, technology adoption and the psychological models and constructs. However given the data currently available, the focus of this paper is to more closely examine the links between behavior and the various psychological constructs and models. Other studies (e.g. Wall et al 2007) have compared the strength of the TPB and NAT models but not many have does so in: comparing across various environmentally related behaviors or with the alternative variable combinations as noted in the literature. That is, most previous examinations have entered one or two psychological variables to the NAT or TPB models at a time; we are unfamiliar with anyone who has included the full suite of 'significant' variables within one model.

4. Methods

The analysis is based upon a 23-page survey used to pretest an upcoming mail survey designed to examine people's reactions to alternative biofuels. The survey was administered to a convenience sample of 175 students in two different

introductory microeconomics courses. Although the sample is limited[8] the pretest allowed us to ask the almost 100 questions needed to construct our various psychological and behavioral measures. This section clarifies the methods employed in collecting the data.

4.1 Sampling and Survey Administration

In March of 2004, students in one introductory microeconomic course and one introductory macroeconomic course were offered the opportunity to obtain a few extra-credit points to pretest the survey instrument. Out of a total of 495 enrolled students, 175 completed the pretest survey. Our respondents seem like typical college students but are more likely to be males (Table 1). The percent belonging to environmental organizations is slightly lower than the national average of 13 percent.

Table 1. Characteristics of pretest respondents

Percent male	65
Average age (years)	20
Average education	1-3 years college
Percent belonging to an environmental organization	9
Average annual household income ($)	73,800

4.2 Survey Design

The survey instrument consisted of seven sections with 144 questions. The survey included questions to measure a respondent's: level of various environmental and economic concerns (5 questions), their knowledge, perceptions and use of biofuels, information they would like to know about biofuels, driving and fuel buying habits, their motivations for conserving transportation fuel, a fuel choice experiment, various environmental psychology constructs (94 questions), participation in various environmentally related behaviors (10 questions) and their socio-economic characteristics.

All EPSY, OPSY and TPSY questions used Likert-type ratings scales and most were asked toward the end of the survey. For the environmental concern questions, the scale runs from 1, 'not at all concerned', to 5, 'very concerned'. For the importance questions the scale runs from 1, 'not at all important', to 5, 'very important'. The other psychological questions were phrased as a series of statements meant to measure specific constructs; individuals were asked to indicate their level of agreement with the statements using a scale from 1,

[8] Although our sample is similar to other published studies; e.g., a 169 respondents for Fielding, McDonald and Louis (2008) and 176 respondents for Birgelen et al. (2009).

'strongly disagree', to 5, 'strongly agree'. Included is an appendix that lists, by construct, the framing of all questions ultimately used in this paper (some questions were dropped as part of the data construction – explained in the next section).

Most of the environmental participation questions used a scale from 1, 'never', to 5, 'always'. The two exceptions were for participation in an environmental organization and the degree that the person reduced their driving behavior. In the former, people were asked to indicate whether they belonged, worked for, or contributed to an environmental organization (1 indicates 'yes'; 0 denotes no). For the latter we asked two questions, in the first we asked respondents to indicate whether they ever try to reduce the amount of driving they do (1 indicates 'yes'; 0 denotes no). For those answering yes, we then asked them to indicate the importance of four alternative reasons why they try to reduce the amount of driving they do: 'to reduce global warming', 'to save money', 'to reduce air pollution' or 'to reduce oil imports'. The importance scale is the same as described above.

4.3 Data Analysis

Before discussing the analysis procedures or the models and variables tested we first present an overview of the data construction and validity testing. The survey specifically included adaptations of question wordings used in the environmental psychology literature to measure specific psychological constructs (see the appendix). We began the data construction by performing various rounds of factor analyses[9] to help confirm whether the variables we used to represent various constructs were adequately capturing these constructs. That is, we confirmed that the variables we meant to represent specific construct all loaded highly on a factor that seemed to capture that specific construct. We also did not want to include variables that may have loaded significantly high on a number of factors as that would indicate that those questions may have been worded such that more than one construct was being measured by the response.

We will not present all of the results here but briefly outline the procedures used. As an extraction method we used principal components analysis followed by Varimax rotation. Factors with Eigen values less than one are dropped from further analysis and items with factor loadings of 0.6 or higher are considered statistically significant for interpretation purposes. To further verify the reliability of the factor analysis we compute Cronbach's alpha on the original responses; aiming to have alphas greater than the minimum value of 0.70

[9] Factor analysis is a data reduction technique used to investigate whether a group of variables have common underlying dimensions and thus can be considered to measure a common factor.

(Nunnally and Bernstein 1994; Cortina, 1993). We dropped variables from a construct measure if this latter analysis indicated that a higher alpha could be obtained by dropping a question. Finally, we then created indices for each measure by summing the responses across variables included in the measure, and then dividing by the number of variables in the measure – in fact, constructing an average variable for each construct being measured. The end result of these data manipulations are 16 independent variables to measure our psychological constructs (Table 2) and two behavioral variables, DRIVE-LESS ('reduced driving for environmental reasons'), and ECO-BUY ('frequency of buying eco-labeled products'). These will be the set of variables that will be used in the regression analysis with the last two being our dependent variables. The regression technique used is ordered-logit analysis because of the ordered nature of the two dependent variables. Note that for all but one variable (Perceived control - Ecobuy) our Cronbach alphas are relatively high indicating relatively strong internal consistency in our measures.

Table 2. Summary of data construction

Variable description	Cronbach's alpha
Perceived control - Drive less	0.74
Perceived control - Ecobuy	0.64
Social norm - Drive less	0.85
Social norm - Ecobuy	0.90
Personal norm - Ecobehavior	0.90
Attitude – Drive less	0.83
Attitude – Ecobuy	0.90
Consequenses – Drive less	0.91
Consequenses – Ecobuy	0.82
Ecoawareness	0.80
Ecoaffect (eco-guilt)	0.92
Perceived consumer effectiveness	0.80
Environmental concern	0.87
Environmental importance	0.89
Trust	0.78
Male	-na-
Reduced driving for environmental reasons (DRIVE-LESS)	0.85
Frequency of buying ecolabeled products (ECO-BUY)	-na-

-na- denotes not applicable since the variable is not an index of other variables

Our first piece of analysis is to determine whether the traditional procedure used by economists to identify individuals with environmental

proclivities is adequate. That is, we want to determine whether a respondent belonging to an environmental organization ('environmentalist) is an adequate determinant of environmental sensitivity. We also would like to determine if standard socio-economic characteristics (gender, age, education etc) are adequate proxies to do the same. Unfortunately, the nature of our sample limits most of this socio-economic analysis (e.g. age and education ranges are relatively limited in the sample); however, we can examine whether gender acts as a suitable environmental proxy variable. Fortunately, gender is probably the most important socio-economic variable to test since the literature indicates it's the one socio-economic variable that is consistent in its effects – i.e., females are more environmentally sensitive than males.

For this part of the analysis we use multivariate analysis of variance (MANOVA) on all of the psychological variables and on all of our potential eco-behavioral variables; crossing these variables with the 'environmentalist' variable and the gender variable. If the MANOVA analysis indicates a significant difference (at the 10 percent significance level) across the suite of variables under study, then we follow with ANOVAs for each of the individual variables. There are a potentially large number of follow-up ANOVA tests required to determine the full set of differences (15 tests across all of the psychological variables and 9 for the behavioral variables). A problem with performing such a large number of tests at a specific significance level is that the overall likelihood of inappropriately rejecting a null hypothesis is greater than the specified significance level (called alpha inflation). To reduce the likelihood of committing such a Type I error, for the follow-up ANOVAS we calculated the significance level for each follow-up test that would retain an overall 10 percent significance level. The significance for these latter pair-wise tests (α^p) is set by using the formula: $1 - (1 - \alpha^p)^n = 0.10$; this procedure maintains the overall probability of committing a Type I error to 10 percent (Hand and Taylor 1987). For the ANOVA tests of the 15 psychological variables we set the $\alpha^p = 0.007$; to test the nine behavioral variables we sent the $\alpha^p = 0.011$

For the regression analysis we will start by examining the quality of the models in terms of fit. We do this by comparing the basic TPB and the NAT models. We then examine the fits of the TPB and NAT models when adding variables found in the literature to be significant – we do this two ways, one by adding each variable individually (as is common in the literature) and then adding them as a group. This is done to determine whether the variables found in the literature to be significant predictors of eco-behavior are robust when included in a more extensive formulation or may suffer from omitted variable bias (Barreto and Howland 2006) - the ultimate goal being an ability to reduce the number of variables needed for future study. Final comparisons are made with a presentation of the final parameter estimates. To examine model performance, we

use likelihood ratio tests and compare the model's Akaike's information criterion (AIC) and the pseudo-R^2. The AIC balances goodness-of-fit with parsimony in the number of predictors (Enders, 2004) and can be used to compare logistic regression models. The AIC is chosen over the similar Schwartz criterion as the AIC works better with smaller samples (Enders, 2004).

5. Results

The MANOVA analysis (Table 3) indicates that, at least for this sample, being a member of an environmental group is not a good predictor of a person's environmental proclivities (Wilks' lambda = 0.93; p = 0.79) or their eco-behaviors (Wilks' lambda = 0.90 p = 0.20). Consistent with most of the literature, gender seems to be a better predictor of a person's environmental proclivities (Wilks' lambda = 0.80; p = 0.00) or eco-behaviors (Wilks' lambda = 0.79; p = 0.00). However, follow-up ANOVAs on each variable indicate that the association may not be very strong. In total, only three of 15 eco-psychological variables show significant differences (women have higher environmentally related personal norms, have higher levels of environmental concern and find environmental issues more important) and only four of nine eco-behaviors indicate gender differences (women are more likely to buy eco-labeled and organic products, more likely to recycle and more likely to state they reduce their consumption for environmental reasons). These results at least suggest that previous literature that used participation in an environmental group as a proxy for differences in respondents' environmental proclivities may be wanting.

Likelihood ratio testing that compares the TPB and NAT models with a model that combines the variables from both theories indicates that for both the drive-less ($\chi^2_{(4)} = 29.0$; $p < 0.001$) and eco-buy ($\chi^2_{(4)} = 17.8$; $p < 0.001$) models, the combined (TPB + NAT) model is better than the TPB alone (Tables 4 and 5). For the drive-less model, the combined (TPB + NAT) model is not different than the NAT model ($\chi^2_{(6)} = 8.8$; $p = 0.188$) but for the eco-buy model, the combined (TPB + NAT) model is better than the NAT alone ($\chi^2_{(6)} = 14.2$; $p = 0.028$). In addition, the combined TPB + NAT models have the lowest (best) AIC result and the highest pseudo-R^2; combined these results suggest that the combined models perform better than either of the models by themselves. That the combined model is better than each individual model is consistent with the underlying justifications of the models. The TPB is supposed to be better at modeling purely self-interested behavior while the NAT should be better at modeling socially motivated behaviors; it is likely that our behaviors here entail both motivations.

Table 3. Mean responses split by whether the respondent was an environmentalist, and by gender (bolded results indicate significant differences at the 10 percent level)

	Environmentalist[a]		Male	
	No	Yes	No	Yes
Psychological variables				
Perceived control - Drive less	3.1	2.9	2.9	2.9
Perceived control - Ecobuy	3.3	3.1	3.2	3.1
Social norm - Drive less	2.5	2.3	2.3	2.5
Social norm - Ecobuy	2.3	2.4	2.4	2.2
Personal norm - Ecobehavior	2.8	3.2	3.3	**2.6**
Attitude – Drive less	3.6	3.6	3.9	3.4
Attitude – Ecobuy	3.6	3.7	3.8	3.5
Consequenses – Drive less	3.4	3.4	3.6	3.2
Consequenses – Ecobuy	3.5	3.5	3.8	3.3
Ecoawareness	3.6	3.8	3.7	3.6
Ecoaffect (eco-guilt)	2.0	2.3	2.2	1.9
Perceived behavior effectiveness	3.1	2.9	3.2	3.0
Environmental concern	3.1	3.1	3.4	**2.9**
Environmental importance	3.9	3.9	4.3	**3.7**
Trust	3.1	3.2	3.2	3.0
Behavioral variables				
Reduced driving (DRIVE-LESS)	3.2	3.7	3.5	3.0
Buy eco-labeled products (ECO-BUY)	2.8	2.9	3.0	**2.6**
Recycle	3.9	4.4	4.5	**3.7**
Buy organic	2.8	3.1	3.3	**2.5**
Carpool	3.2	2.9	3.3	3.0
Use public transportation	1.9	1.5	1.8	1.9
Turn off lights	4.1	4.0	4.2	4.1
Keep heat low in winter	3.2	3.6	3.2	3.2
Reduce overall consumption	2.8	2.6	3.1	**2.5**

a Environmentalist is defined as respondents who belong to, work for, or contribute to an environmental group.

Table 4. Model fit characteristics for various empirical versions of the hypothesized DRIVE-LESS models (bolding indicate the model is significantly different that the relevant base model at the 10 percent level)

	SI[a]	SJ[b]	Log likelihood	AIC[c]	pseudo-R^{2d}
Theory of Planned Behavior (TPB)			-185	385	0.18
Norm Activation Theory (NAM)			-175	363	0.32
TAM + NAM			-171	360	0.37
TPB +					
Ecoawareness			-185	386	0.19
Ecoaffect (eco-guilt)	*	*	**-176**	369	0.30
Environmental concern	*	*	**-168**	353	0.40
Environmental importance	*		**-179**	375	0.27
Environmentalist	*	*	**-183**	382	0.19
Perceived behavior effectiveness	*		**-181**	379	0.22
Trust	*		**-179**	375	0.26
Male	*		**-183**	382	0.19
Joint			**-159**	349	0.49
Joint - nonsignificant variables			**-161**	342	0.46
NAM +					
Ecoawareness			-175	364	0.32
Ecoaffect (eco-guilt)	*	*	**-172**	358	0.36
Environmental concern	*	*	**-166**	347	0.43
Environmental importance			-175	365	0.32
Environmentalist			-174	362	0.31
Perceived behavior effectiveness		*	-174	362	0.31
Trust	*		-173	360	0.35
Male			-174	363	0.31
Joint			**-161**	351	0.46
Joint - nonsignificant variables			**-163**	345	0.43

a SI denotes the variable is significant if added into the respective base models as a single variable
b SJ denotes the variable is significant as part of the suit of variable in the full (joint) model
c Akaike's Information Criterion
d based on the McKelvey-Zavoina formulation

Table 5. Model fit characteristics for various empirical versions of the hypothesized ECO-BUY models (bolding indicate the model is significantly different that the relevant base model at the 10 percent level)

	SI[a]	SJ[b]	Log likelihood	AIC[c]	pseudo-R^{2d}
Theory of Planned Behavior (TPB)			-181	377	0.36
Norm Activation Theory (NAM)			-180	371	0.37
TAM + NAM			-172	363	0.43
TPB +					
Ecoawareness			-181	379	0.36
Ecoaffect (eco-guilt)	*		-180	376	0.37
Environmental concern	*	*	**-176**	360	0.41
Environmental importance			-181	378	0.36
Environmentalist			-181	378	0.36
Perceived behavior effectiveness			-181	378	0.36
Trust	*	*	**-177**	371	0.40
Male	*		**-179**	374	0.38
Joint			-173	373	0.43
Joint - nonsignificant variables			**-174**	367	0.42
NAM +					
Ecoawareness			-179	373	0.37
Ecoaffect (eco-guilt)			-179	373	0.37
Environmental concern	*	*	**-175**	365	0.41
Environmental importance			-179	373	0.38
Environmentalist			-179	373	0.37
Perceived behavior effectiveness			-179	373	0.37
Trust	*	*	**-176**	366	0.40
Male			-179	373	0.37
Joint			-173	371	0.42
Joint - nonsignificant variables			**-174**	363	0.42

a SI denotes the variable is significant if added into the respective base models as a single variable
b SJ denotes the variable is significant as part of the suit of variable in the full (joint) model
c Akaike's Information Criterion
d based on the McKelvey-Zavoina formulation

Our next comparisons are to determine whether variables found in the literature to be significant predictors of eco-behavior are robust when included in a more extensive formulation. With the drive-less TPB models we find that seven of the nine potential eco-variables are significant when entered individually and provide models that are significantly different than the base TPB model. However, when all of these variables are entered together into a joint (full) model we find that only three of the variables are significant. Note also that dropping the non-significant variables from this joint model does not affect the model's fit (as measured by a likelihood ratio test); that is, the joint model and the joint model minus the non-significant variables are not different. This indicates that not only are these variables not significant individually but that they are non-significant factors when taken as a whole. We find a similar effect in the eco-buy TPB models. Here four of the nine potential eco-variables are significant when entered individually and three of those four provide models significantly different than the base TPB model. However, when all of the variables are entered together into a joint (full) model we find that only two of the variables are significant. Dropping the non-significant variables from this joint model does not affect the model's fit.

Making similar comparisons with the NAT versions of the models we find weaker effects, mostly because fewer of the variables that are entered individually are found to be significant. For example, in the drive-less model there are only three significant variables whereas the TPB version of the model had nine and in the eco-buy model there are only two significant variables whereas the TPB version of the model had four. Again, the fewer significant variables in the NAT (relative the TPB) models may be due to the fact that the NAT already adequately incorporates socially motivated variables. In addition the list of significant variables is relatively consistent between the 'entered individually' versus 'entered jointly' NAT models. Again, dropping the non-significant variables from both joint NAT models does not affect model fit. In all cases, the more parsimonious models (i.e., the 'joint models minus non-significant variables') perform best; likelihood ratio tests indicate they are all significantly different than the base models and they all have the lowest[10] AIC scores.

One reason many of the psychological variables may have become non-significant in the joint models is due to multicollinearity. To help rule out this potential explanation, we performed two levels of analysis. First we examined cross-correlations for all of the independent variables; in all cases the correlations were less than 0.80, most being less than 0.40. The only correlations in the LESS-DRIVE model that approach 0.80 were between 'Consequences-drive less'

[10] When comparing models with different numbers of parameters the model with the lowest AIC is considered best (SAS 2003)

and 'Environmental importance' (0.74), and between 'Consequences-drive less' and 'Perceived behavior effectiveness' (0.74). The only correlations in the ECO-BUY model that approached 0.80 were between 'Attitude-ecobuy' and 'Consequences-ecobuy' (0.73), and between 'Attitude-ecobuy' and 'Environmental importance' (0.75).

For the second level of analysis we estimated the models using ordinary least squares and examined the multicollinearity diagnostics (e.g., Variance Inflation Factor - VIF) as multicollinearity is not affected by functional form (Menard 2002). A VIF greater than 10 indicates multicollinearity although a VIF greater than 2.5 could be a concern in weaker models (Allison 1999). The analysis indicates that of all the variables under study (i.e., the variables that were 'added' to the base models to form the 'joint' models), only 'Environmental importance' had a VIF above 2.5, but only in the joint NAM LESS-DRIVE model (VIF = 2.7), and in the joint TPB (VIF = 2.8) and NAM (VIF = 2.6) ECO-BUY models. Noteably, in these three models 'Environmental importance' is not significant even when it is entered singly. Follow-up testing with 'Environmental importance' added singly to the base models indicates no multicollinearity. In total, these results would strongly suggest that multicollinearity is not likely to be the driving factor in explaining the lack of significance of the various psychological variables when estimating the joint models.

In terms of variables, the most important variable across all models is environmental concern; when entered individually, environmental concern provides the smallest AIC, provides models that are significantly different from either base model (NAT, TPB), and is always significant, even in the joint models. The second most important variables differs across the behavior being modeled; in the drive-less models, eco-affect is the second most important while in the eco-buy model the second most important is trust. Gender is unimportant in the final models; this is likely due to the fact that gender and environmental concern are highly correlated.

As with our initial comparisons of the models, we use likelihood ratio testing to compare the 'joint' TPB and NAT models with a similar model that combines the variables from both theories. These tests indicate that the drive-less TPB ($\chi^2_{(4)} = 5.2$; $p < 0.267$) and NAT ($\chi^2_{(6)} = 9.9$; $p < 0.125$) models are not different than the combined (TPB + NAT) model (Tables 6). For the eco-buy model, the combined (TPB + NAT) model is not different than the NAT model ($\chi^2_{(6)} = 10.2$; $p = 0.105$) but different from the TPB alone ($\chi^2_{(4)} = 9.5$; $p = 0.050$). The combined TPB + NAT models have the best AIC results (drive-less: 347; eco-buy: 370) and the highest pseudo-R^2 (drive-less: 0.51; eco-buy: 0.47). Comparing these results to the earlier NAT/TPB model comparisons suggests that adding the additional variables to the TPB helps incorporate some of the social motivations not included in the base TPB.

Almost all of the significant parameter estimates of the various joint but parsimonious models (Table 6) meet expectations in terms of sign. The only counterintuitive estimate is the negative sign on the perceived effectiveness variable in the NAT version of the drive-less equation. Given that the two eco-behaviors are different in nature it is not surprising the suite of significant variables are different across the TPB + NAT models. For example, personal norms are not important in the drive-less model but are significant in the eco-buy model. That perceived control is important in the drive-less equation but not in the eco-buy equation may be an artifact of the quality of the two variables (the Cronbach's alpha on the perceived control variable in the eco-buy equation was relatively low).

Table 6 Parameter estimates for the parsimonious, joint models

	Theory of planned behavior (TPB)	Norm activation theory (NAT)	TPB+NAT
Dependent = DRIVE-LESS			
Social norms	0.27**		0.25**
	(0.11)		(0.11)
Attitudes	0.09		-0.03
	(0.09)		(0.11)
Perceived control	0.31***		0.30***
	(0.10)		(0.10)
Personal norms		0.21*	0.16
		(0.12)	(0.14)
Perceived consequences		0.26**	0.29**
		(0.13)	(0.13)
Ecoaffect (eco-guilt)	0.42***	0.35***	0.40***
	(0.11)	(0.11)	(0.11)
Environmental concern	0.60***	0.47***	0.50***
	(0.13)	(0.14)	(0.14)
Environmentalist	0.77**	0.37	0.69*
	(0.38)	(0.37)	(0.39)
Perceived behavior effectiveness	0.01	-0.23*	-0.21
	(0.10)	(0.13)	(0.13)
Goodness-of-fit statistics			
Log likelihood	-158	**-162**[a]	-155
AIC	339	343	336
pseudo-R^2	0.50	0.46	0.53

Table 6 Parameter estimates for the parsimonious, joint models (Continued)

Dependent = ECO-BUY			
Social norms	0.32***		0.25**
	(0.09)		(0.10)
Attitudes	0.29***		0.21*
	(0.09)		(0.12)
Perceived control	0.01		0.04
	(0.08)		(0.08)
Personal norms		0.50***	0.39***
		(0.11)	(0.12)
Perceived consequences		-0.01	-0.12
		(0.09)	(0.12)
Environmental concern	0.29*	0.26**	0.20*
	(0.12)	(0.12)	(0.12)
Trust	0.25*	0.24**	0.21*
	(0.12)	(0.12)	(0.13)
Goodness-of-fit statistics			
Log likelihood	**-174**	-173	-169
AIC	367	363	360
pseudo-R^2	0.42	0.42	0.46

* denotes significant at the 10% level; ** denotes significant at the 5% level; *** denotes significant at the 1% level

a Bolding indicates that the single (TPB or NAT) is significantly different than the joint (TPB + NAT) model.

Note that the traditional proxy of gender does not survive in any of the models, suggesting the model variables are already explaining any 'gender' effect. Given the MANOVA results, the variables most likely to be implicated are: personal norms and environmental concern; which are significantly different across gender. The other traditional proxy (environmentalist) does survive in some of the drive-less models, suggesting this variable is explaining some construct other than those already in the model. Further analysis with the full data set may shed light on what this proxy is measuring.

6. Discussion and Conclusions

To our knowledge, this is the first attempt at a more complete testing of the various psychological factors that seem to be important in eco-behaviors. However, the results of this study should also be reviewed with some caution. First, the sample is one of convenience and relatively small, potentially hurting the external validity of the results. In addition, our behavioural measures are

stated behaviors, not observed behaviors[11] and our models only examine main effects; i.e. we did not include interaction terms although these may be important. A few other missing, but potentially important, considerations are that some behaviors are influenced by habit and the perceived benefits of the choice, items we will be able to test with the final data but were unable to test here.

Although cognizant of the above caveats, the results suggest: that a combined TPB and NAT model may be more effective than either model alone (especially when the behavior entails both private and public benefits); that many variables seen as important may be less important than previously thought (potentially allowing for more parsimonious models - resulting in less costly data collection); and that common proxy variables like membership in an environmental group may not work that well. The first point would be consistent with the idea that each model is designed to capture different aspects of a person's choice decision – the TPB is meant to capture motivations due to private benefits whereas the NAT focuses more on public (social) motivations. For example, personal norms seem relatively more important to eco-buying as opposed to driving-less behavior; this makes sense as the most important reason given by our respondents for driving less is to save money. Further, other studies have shown that people assume greener products are more expensive and may entail some quality sacrifices (Teisl et al 2008). The second and third points above have some implications in eco-behavioral research; that is, commonly used or previously identified variables may need to be reconsidered.

The importance of the underlying psychological factors in influencing eco-behavior suggests a strong role for the long-run provision of information through eco-marketing or eco-education programs as such programs may help to alter these perceptions thus making eco-labeling programs potentially more effective. If tastes and preferences are partially endogenous, then changing preferences can be a policy objective. Further, if our results withstand scrutiny, then economic researchers of eco-choice behavior have an added incentive to study and incorporate these psychological variables more completely into an economic framework.

[11] Note however, that the TPB and NAT models are meant to predict behavioral intentions, not actual behaviors. In this light, stated behaviors might be better than intended behaviors.

APPENDIX:

QUESTIONS USED TO CONSTRUCT THE ENVIRONMENTAL CONCERN MEASURE

How concerned are you about … (PLEASE CIRCLE **ONE** NUMBER)

	NOT AT ALL CONCERNED		SOMEWHAT CONCERNED		VERY CONCERNED
THE AMOUNT OF AIR POLLUTION IN THE REGION	1	2	3	4	5
HOW FORESTS ARE MANAGED IN THE REGION	1	2	3	4	5
THE EFFFECT OF GLOBAL WARMING ON THE REGION	1	2	3	4	5

QUESTIONS USED TO CONSTRUCT THE ENVIRONMENTAL TRUST MEASURE

There are different pieces of information that could be part of a fuel label. Please review the following list and rate how important each piece of information is to you. (PLEASE CIRCLE **ONE** NUMBER FOR **EACH** ITEM)

	NOT AT ALL IMPORTANT		SOMEWHAT IMPORTANT		VERY IMPORTANT
WHO CERTIFYS THE LABEL	1	2	3	4	5
AMOUNT OF GLOBAL WARMING GASES MADE WHEN THE FUEL IS USED	1	2	3	4	5
WHETHER THE FUEL CONTAINS ETHANOL MADE FROM CORN	1	2	3	4	5
WHETHER THE FUEL CONTAINS ETHANOL MADE FROM TREES	1	2	3	4	5
CONCERNS ASSOCIATED WITH USING THE FUEL	1	2	3	4	5
BENEFITS ASSOCIATED WITH USING THE FUEL	1	2	3	4	5
A PHONE NUMBER OR WEBSITE SO YOU COULD GET MORE INFORMATION	1	2	3	4	5

ALL OTHER MEASURES USED THIS FORMAT (QUESTION WORDING FOLLOWS)

Please read the following statements. Please express **your opinion** by circling the answer that matches how you feel about the statement. (CIRCLE **ONE** NUMBER FOR **EACH** ITEM)

	STRONGLY DISAGREE		NEUTRAL		STRONGLY AGREE
IT'S HARD FOR ME TO REDUCE HOW MUCH I DRIVE	1	2	3	4	5

CONTROL - DRIVE LESS
IT'S HARD FOR ME TO REDUCE HOW MUCH I DRIVE
I HAVE LITTLE CONTROL OVER HOW MUCH I DRIVE

CONTROL - ECOBUY
ITS HARD FOR ME TO BUY ECO-FRIENDLY FUEL
IT IS IMPOSSIBLE FOR ME TO TELL IF MY FUEL IS ECO-FREINDLY

SOCIAL NORMS - DRIVE LESS
MOST PEOPLE I KNOW TRY TO DRIVE LESS
MOST OF MY FRIENDS TRY TO DRIVE LESS
PEOPLE WHO ARE IMPORTANT TO ME TRY TO DRIVE LESS

SOCIAL NORMS- ECOBUY
MOST PEOPLE I KNOW TRY TO BUY ECO-FRIENDLY PRODUCTS
MOST OF MY FRIENDS BUY ECO-FRIENDLY PRODUCTS
PEOPLE WHO ARE IMPORTANT TO ME BUY ECO-FRIENDLY PRODUCTS

PERSONAL NORMS – ECOBEHAVIOR
I FEEL THAT I SHOULD DRIVE LESS FOR THE SAKE OF THE ENVIRONMENT
I FEEL PERSONALLY RESPONSIBLE TO HELP SOLVE ENVIRONMENTAL PROBLEMS
I FEEL THAT I SHOULD BUY ECO-FRIENDLY PRODUCTS FOR THE SAKE OF THE ENVIRONMENT

ATTITUDES – DRIVE LESS
IT'S GOOD TO REDUCE THE AMOUNT OF MILES I DRIVE
IT'S WORTHWHILE TO REDUCE THE AMOUNT OF MILES I DRIVE

ATTITUDES – ECOBUY
IT'S GOOD TO BUY ECO-FRIENDLY PRODUCTS
IT'S WORTHWHILE BUYING ECO-FRIENDLY PRODUCTS

AFFECT
I FEEL GUILTY WHEN I DRIVE BECAUSE IT'S BAD FOR THE ENVIRONMENT
I FEEL GUILTY WHEN I DRIVE BECAUSE IT INCREASES GLOBAL WARMING
I FEEL GUILTY WHEN I DRIVE BECAUSE IT INCREASES AIR POLLUTION

ENVIRONMENTAL AWARENESS
I AM AWARE OF CURRENT ENVIRONMENTAL PROBLEMS
I AM WELL INFORMED ABOUT ENVIRONMENTAL PROBLEMS

PERCEIVED EFFECTIVENESS
WHEN I REDUCE MY DRIVING I IMPROVE THE ENVIRONMENT
I DECREASE FUEL IMPORTS WHEN I REDUCE MY DRIVING
I IMPROVE THE ENVIRONMENT WHEN I BUY ECO-FRIENDLY PRODUCTS

CONSEQUNCES –DRIVE LESS
REDUCING THE AMOUNT OF MILES DRIVEN DECREASES OIL IMPORTS
REDUCING THE AMOUNT OF MILES DRIVEN DECREASES GLOBAL WARMING
REDUCING THE AMOUNT OF MILES DRIVEN DECREASES AIR POLLUTION

CONSEQUNCES –ECOBUY
BUYING ECO-FRIENDLY PRODUCTS IMPROVES OUR ECONOMY
BUYING ECO-FRIENDLY PRODUCTS IMPROVES THE ENVIRONMENT

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