Do As You Believe
—— On the Behavioral Response to Environment Protection

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Abstract

This paper builds an environmental belief predictor using the households' socio-demographics to explore the relationship of environmental belief and residential energy expenditure using GSS and AHS data. The analysis starts by showing the stable and different environment perceptions across households' characteristics which may suggest different socio-demographics contribute to the various environmental beliefs. Then I use logit modeling strategy to select the predictors and match the availability in AHS data to predict the corresponding environmental belief of those households, and using the predicted probabilities to explore the cross-individual and cross-time variations in residential energy expenditure by using quantile regression and fixed effects model respectively. In order to cope with the discrepancies between two different datasets, Lewbel IV approach is implemented to mitigate the measurement error. The results from the analysis suggest that environmental belief affects the residential energy expenditure both in cross-individual and cross-time analyses, which implicate that people are more environmentally concerned reduce their own energy consumption to protect the environment.

Keywords: Environmental belief, residential energy expenditure, Lewbel IV

JEL: D19, Q40, Q50

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I. Introduction

"*For more than 30 years, the science has been crystal clear. How dare you continue to look away and come here saying that you're doing enough, when the politics and solutions needed are still nowhere in sight.*"

————Greta Thunberg, UN Climate Action Summit, 2019

Environment protection has drawn great attention from the public, thanks to the increase exposure of the social media, more and more people and activists across the world are calling for swift action either inside their own countries or a worldwide cooperation mainly focus on the deduction of carbon emission in the upcoming years and achieve carbon neutrality by 2050 to cope with the imminent environment threats. In the light of response to the threat of climate change, this paper takes a distinct perspective to investigate that whether people will behave like what they believe, namely, if a person is considering the public has done too little in terms of improving and protecting the environment, will he or she follow its own belief to take actions in their own way, such as reduce the carbon emission and usage of greener energy.

In order to answer this question, this paper use two publicly available datasets, GSS and AHS data to investigate the above correlation. Thus, the analyses start with a basic correlation analysis to have a closer picture of which socio-demographics could drive the variation of environmental perceptions, and later analyze the environmental perceptions in different groups of socio-demographics to support the important effect of respondents' characteristics on environmental perceptions. Then I use the non-linear logit model to explore the relationship and match the corresponding characteristics in the AHS data in order to predict the environmental beliefs of households.

The analysis then moves on to explore the cross-individual and cross-time variations in terms of residential energy expenditure, surprisingly, the results show that households with a higher probability in favoring a more environmentally friendly perceptions will take their own actions to reduce the expenditure of residential energy. The discrepancies between two survey data regarding the environmental beliefs is further resolved by the Lewbel IV approach, which mitigate the measure error of environmental beliefs since two sample of respondents may share the different beliefs, even they are representative compared to the population. Further, I introduce prices of all types of energy to compute the residential energy consumption, after Lewbel IV approach, the results show that households may in favor of reducing the consumption in fuel oil and natural gas, but increase electricity slightly due to the increasing low-carbon sources for those have a higher probability in favoring an environmentally concerned belief.

The existing literature has already taken a stand on this issue by exploring the voluntary constraint on energy consumption. Peck and Doering (1976) find no significant effect of energy conservation on consumption on natural gas using a three-year dataset, in contrast to their research, this paper uses a great length of data covering from 1985 to 2013 to explore the environmental beliefs on residential energy consumption and finds significant effects. Later, Kotchen and Moore (2008) shows the households are more likely to participate in voluntary constraint program for energy conservation, this result coincides the conclusion find in this paper, that households reduce their own residential energy consumption to protect the environment on their own.

The main contribution of this paper is twofold. The first and foremost contribution is to show persistent but various environmental perceptions across different groups of characteristics of households, and especially for the age group, the analyses later showcase an evolution of environmental beliefs over time, that is, the households care more and are more concerned about the environment protection, but as they grow older, they lose their concern in the environment protection.

The second contribution is to inform the policy makers and researchers that people will follow what they believe, namely will consume on more environmentally friendly energy in order to compensate their belief in too less of environment protection has been done by the public currently. The results from this paper show that we will benefit more by motivate consumers and they will adapt a greener life simply by their own belief.

The structure of the rest of the paper is as following, in Section 2, I introduce the datasets that I use throughout the analyses, then investigate the correlation between respondents' socio-demographics and environmental perceptions and match the similar characteristics available in the AHS data to predict the environmental beliefs in Section 3. Further, in Section 4, I explore the variations of environmental beliefs on various residential energy expenditure. Later, in Section 5, I implement Lewbel IV and introduce energy consumption to support the validity of the results. Last, the paper concludes in Section 6.

II. Data

This analysis uses datasets from General Social Survey (GSS), American Housing Survey (AHS) and U.S. Energy Information Administration (EIA). All three datasets are easily accessible for public use and cover extensive range of information that is needed for this paper. In below, I will outline the basic introduction of data that I extract from these datasets and provide corresponding summary statistics.

1. GSS data

The reason for choosing GSS data is that it is a representative survey of adults in U.S. and collects extensive information regarding the socio-demographics and behavioral questions, in this case, the public belief regarding improving and protecting the environment. It gives me the opportunity to run a yearly association analysis of public belief about the environment protection based on the basic socio-demographics.

At first, I select the socio-demographics, namely sex, race, age, marital status, educational background, working status, party affiliation, and personal income from the GSS dataset along with the "natenvir" (the public belief about environment protection). For comprehensive description of these variables, please see Appendix A.1. The time period that I use is from 1985 to 2012 in order to match the availability of AHS data to build a panel dataset later. Next, before heading to the correlation analyses, I drop the observations with the responses "Don't know", "No answer" and "Not applicable", only keep the ones with explicit answer that could provide real characteristics and true beliefs of the respondents.

Due to the limited access to geo-data of GSS, I cannot decode the information of respondents at ZIP code level, which could potentially dampen the validity of policy suggestion from the later results because of the heterogeneity across the country. And by evaluating it nationally without giving specific attention to some regions, the public belief could be dragged by the potential outliers and over-sampled representatives. However, I argue that GSS data is craftly designed to overcome this situation, both by excluding over-sampled representatives and applying survey weight every year. The later results may not show the heterogenous results across the states, but on average betray a nationally public belief regarding the environment protection, and it is informative to the public and policy makers about the corresponding question.

In the following Table 1, I present the descriptive statistics of GSS data, namely the number of observations, mean, standard deviation, minimum and maximum values to the variables. Given each year will be uniquely evaluated later, I use year 1985 as an example to showcase the information of respondents' socio-demographics and environmental belief. "age", "educ" and "conrinc" are continuous, and the rest are dummy variables that I created for race, sex, marital status, party affiliation, labor force status, and environmental belief respectively. "conrinc" is respondent income calculated in constant dollars, and "too little", "about right" and "too much" are the dummy variables that captures the respondents believing that the public has done too little, about right or too much towards improving and protecting environment. All variables are shown only when the response is applicable.

Table 1 Summary statistics

	N	Mean	Std. Dev.	min	max
age	1527	45.711	17.91	18	89
educ	1534	12.41	3.169	0	20
white	1534	.872	.334	0	1
black	1534	.1	.299	0	1
other	1534	.029	.167	0	1
male	1534	.449	.498	0	1
female	1534	.551	.498	0	1
marry	1534	.568	.496	0	1
widow	1534	.105	.307	0	1
divorce	1534	.11	.313	0	1
separated	1534	.042	.202	0	1
Never marry	1534	.175	.380	0	1
dem	1529	.389	.488	0	1
ind	1529	.313	.464	0	1

gop	1529	.298	.457	0	1
work	1534	.62	.486	0	1
unemployed	1534	.03	.169	0	1
Not labor	1534	.351	.477	0	1
conrinc	958	29997.25	26383.91	789	111181
Too little	717	.587	.493	0	1
About right	717	.329	.47	0	1
Too much	717	.083	.277	0	1

2. AHS data

The AHS national data is biennially conducted by the U.S. Census Bureau and it provides comprehensive details about representative households in housing characteristics, socio-demographics, housing costs, structure and other characteristics that could inform the up-to-date information about housing stocks across the country. Because the samples of AHS have been redrawn at 1985 and 2015, I use the time period from 1985-2013 to construct the panel data of residential energy expenditure. The survey provides unique identifiers (Control) to help me track the respondents throughout the time period I have chosen.

The reason for me to choose AHS data is that is also brilliantly designed to match the national population statistics in order to come out robust policy research. And by using the socio-demographics it provided, I can match those have the similar characteristics as GSS dataset to predict the belief towards environment protection of each respondent. This measure later helps me explore that whether those hold a more environmentally-friendly belief about environment protection could affect the behaviors of residential energy consumption.

The data I extract from AHS are corresponding statistic significant socio-demographics derived from the previous GSS data analyses in each year which are used to predict environmental perception for the AHS respondents, housing characteristics, housing energy efficiency, MSA (metropolitan statistical area) identifiers and housing structure. All of which are suggested by literature that is important when analyzing residential energy expenditure. The variables and description are provided in Appendix A.2.

In below, I use year 1985 as an example to provide the basic data statistics (See Table 2), in this table, I get rid of the “Not applicable” answer in order to showcase the true observations that has been used in this analysis. The number of observations, mean, standard deviation, minimum and maximum values are shown in the table. The definition of ZINC (household income), ROOMS (number of rooms in the unit) and PER (number of persons in the unit) is quite intuitive and is displayed in Appendix A.2. For the other variables, are all dummies that I create and will use in the later analyses. “msa” equals 1 if the household is in the metropolitan statistical area, “chdays” stands for cooling and heating degree days for the given region of households, “yh” is for the number of years since the units were built and lastly, “detach” stands for the detached building with respect to the attached building, which betray different pattern for energy consumption. AMTO, AMTE and AMTG are corresponding housing costs in fuel oil, electricity, and natural gas.

Table 2 Summary statistics

	N	Mean	Std. Dev.	min	max
ZINC	41076	28118.94	24083.98	-10001	264600
ROOMS	41076	5.58	1.851	1	21
PER	41076	2.672	1.487	1	15
msa	41076	.8	.4	0	1
chdays	41076	.471	.499	0	1
yh	41076	33.63	21.747	0	70
detach	41076	.66	.474	0	1
AMTO	5234	821.563	532.344	1	2601
AMTE	38614	66.84	47.356	1	261
AMTG	22667	52.6	38.436	1	196

3. EIA data

I use EIA data mainly for extracting prices of corresponding type of energy consumed, which are also important factors for the energy consumption demand, namely the final residential energy consumed by each household. Due to the partial availability of national prices of residential energies, I use the yearly average national prices to enhance the validity of the model from 1991-2013 for fuel oil expenditure, 2001-2013 for electricity expenditure, and 1985-2013 for natural gas. The time trends of average retail prices are shown in Figure 1. There are clear increasing patterns for all three types of energy, which may decrease the demand themselves apart from the potential effect of environmental belief on residential energy consumption.

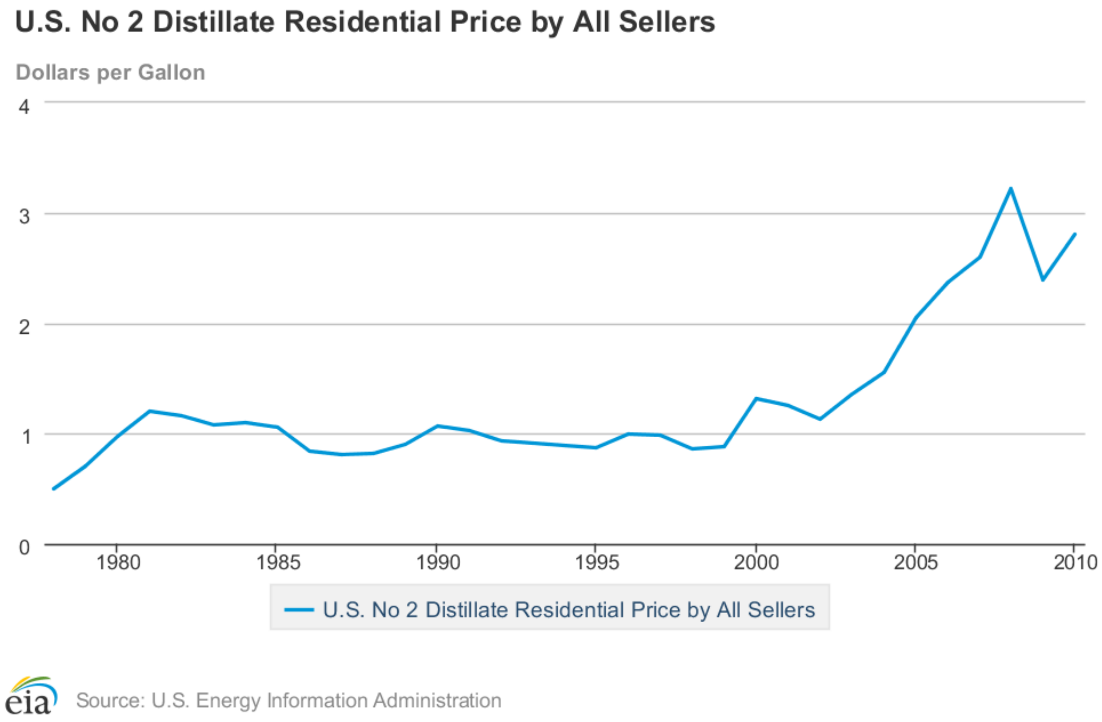

Figure 1.1 Residential Price for Fuel Oil

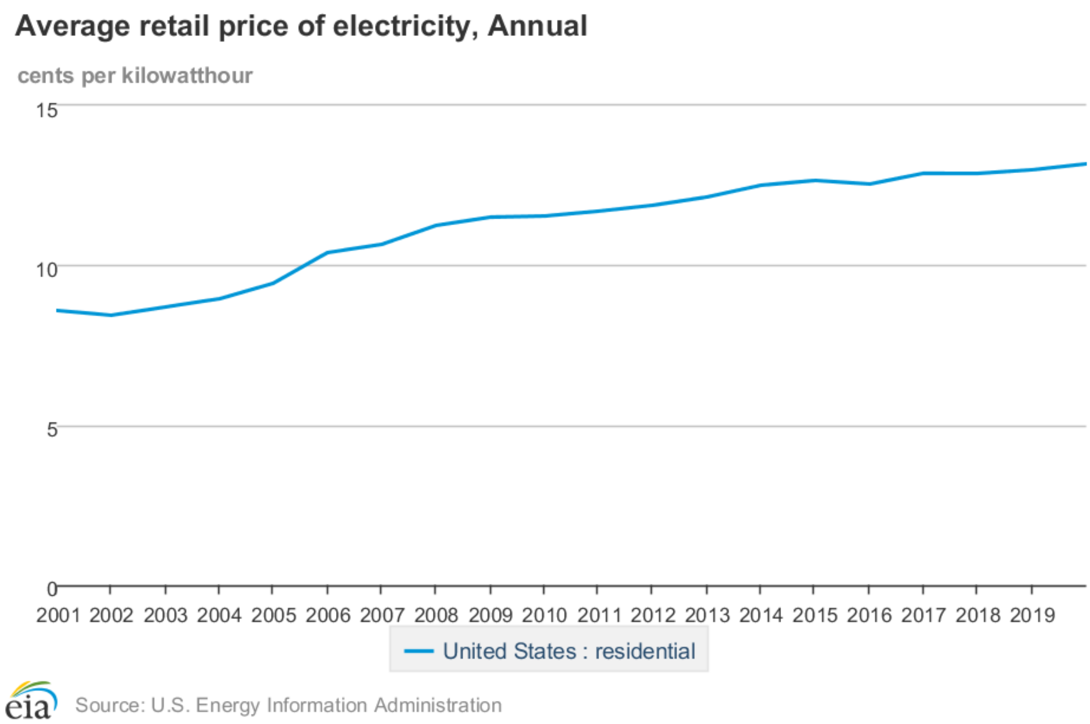

Figure 1.2 Residential Price for Electricity

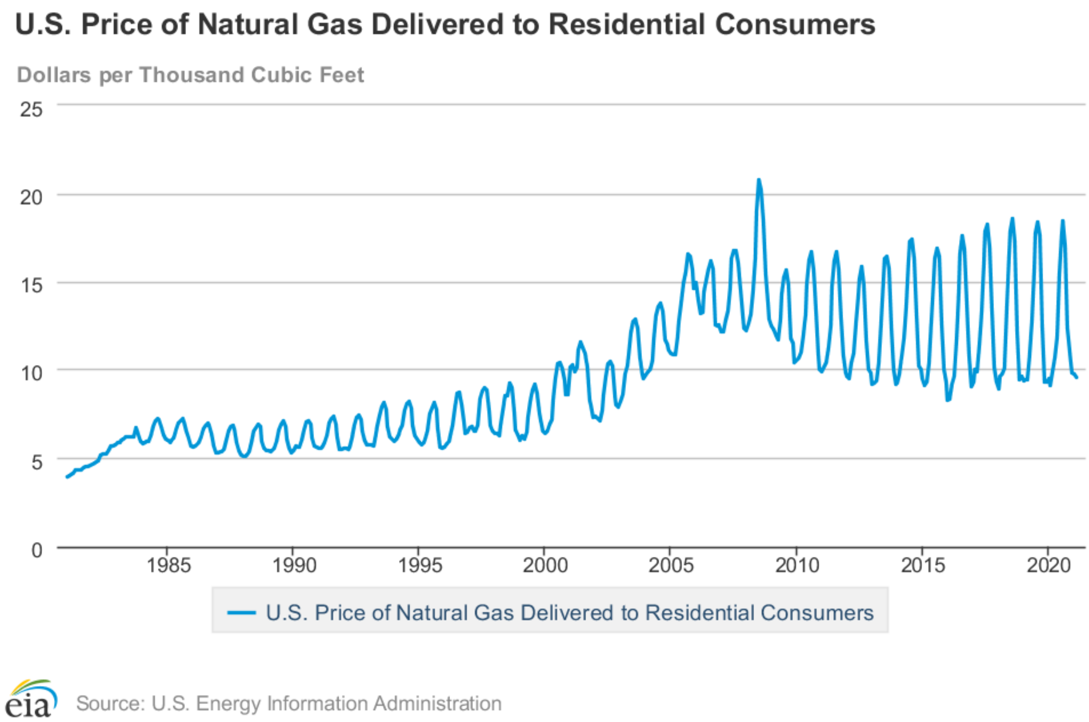

Figure 1.3 Residential Price for Gas

III. Breakdown of environmental perception

In this section, I will go in details to develop a model of public beliefs of environment protection. The purpose of this part is to investigate that which characteristic(s) could be accounted for the environmentally friendly belief in environment protection. The structure of this section is as following. At first, I will showcase the naïve correlation between environmental belief and respondents' characteristics through the time trend and present the evolution of corresponding effect over time using GSS data, then, I will introduce two non-linear models, namely Logit and Probit model to investigate the relationship behind beliefs and socio-demographics in each year. Finally, I use the logit estimates to match the characteristics in AHS dataset to predict the environment perception for the households in the later dataset.

1. Correlation analyses

Without any further processing of the data, I first regress on the original data to achieve the basic correlation between beliefs in environment protection and socio-demographics of the respondents, that is, age, sex, race, marital status, educational background, working status and household income. The purpose of these analyses is to have a fist glimpse of the correlation, to motivate that whether the change in belief could be explained by any of the potential explanatory variables.

As shown in the Appendix B, I present the basic correlation between environment perception and respondents' socio-demographics. Note that the environment perception is coded with "1" for believing that we have done too little to improve and protect the environment, "2" for believing we have done about right, and 3 for believing that we have done too much to environment protection in the GSS data. Thus, as the value increases, the respondent's belief shifts from environmentally concerned to not that much concerned. The time trends in the figures are volatile and unintuitive, but we can clearly see the differences across respondents with different socio-demographics, therefore, in the later part, I will separate respondents in different groups based on their characteristics and investigate the corresponding environment perception over the time period.

1.1. Across group differentials

I retrieve the following figure 3.1-3.2 by using the data from GSS, the purpose of these figures is to show that how many percentages of respondents have chosen that we have done too little to the environment protection in each group and plot them over the entire time period. The stable and various environment perceptions across different groups over time may suggest that these socio-demographics could contribute to the various perceptions among respondents.

As shown in the figures below, those respondents fall in the younger group have a much environmentally friendly belief compared to the older group and the pattern persists over the time. More specifically, on average 70% of the respondents from age 18-34 choose too little for the question asking about environment improvement and protection, in contrast to a roughly 40% of the 65+ respondents favor in this option. As to the educational background, those respondents with a college degree dominates the high school graduates and those without high school degree in terms of environmental belief. By exploiting the across group differentials, it gives us a better image that which characteristics could be accounted for the different belief, and in below, I will present the correlation analyses in the entire period to explore the evolution of these differentials across respondents.

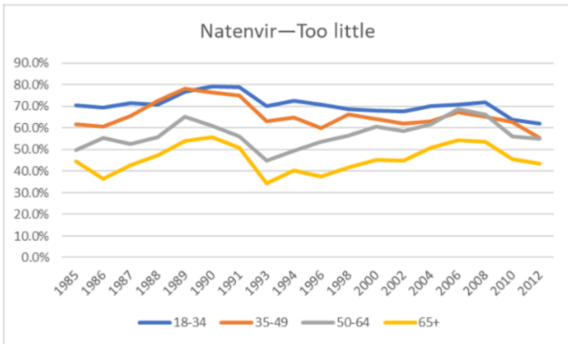

Figure 3.1 Environment Perception across age

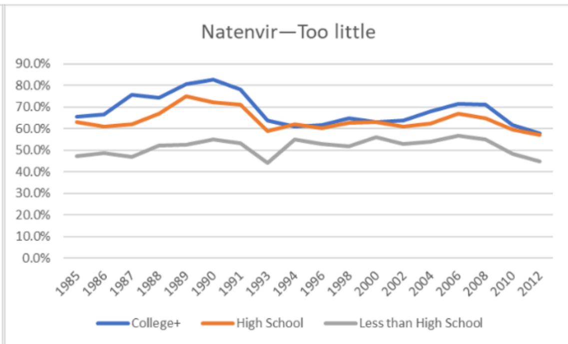

Figure 3.2 Environment Perception across education

1.2 Environment perception evolution over time

The environment belief in the GSS dataset is quite stable over time, which makes us wonder if the younger group today holds a similar environment belief comparing to the younger group 27 years ago and the same for older groups, which further suggests that people change their environment beliefs over time. To be specific, the respondents hold a much more environmentally friendly belief when they were young, as time goes by, their focus of life change from environment concern to their children, jobs etc., which makes them do not in favor of the same environment belief that they hold 20 years ago. Thus, after joining in an older group, they change their belief to a less environmental concerned one. The intuition behind this time trend may seem frustrating, that is, the younger generation may not hold their environmentally concerned belief for their entire life, and in contrast they might lose their interest as they grow older which is suggested by the previous generations. However, we do not know for sure that whether the current younger generation will fight for their greener earth forever or pass their porches to the next generations when they grow older as already shown in the previous record, but this evolution of environment belief over time is itself much concerned and should be paid extra attention.

In order to justify the time evolution of environment perception discussed in above, I introduce the following analysis to explore this time trend. The dependent variable, environment perception is coded as it is in the original dataset but without not applicable answers, and then I separate respondents into different groups with each characteristic available in the GSS data to explore the cross-group differentials, all variables are dummies except for the respondents' income. As shown in the Table 3, in the first column I present the pooled results over time, in the second column I introduce time dummies of each year besides year 1985 to incorporate the time fixed effects that may affect the respondents' perception, such as government change and policy shock in that specific year. And in the last column, I include the interactions between each socio-demographics and time trend to explore the evolution of different environment perception in each characteristic over time.

Table 3 Environment Perception over Time

	(1) perception	(2) perception	(3) perception	(3) cont	
age18	-.31***	-.298***	-.418***	.01	age18*t
	(.031)	(.031)	(.058)	(.008)	
age35	-.239***	-.233***	-.37***	.011	age35*t
	(.031)	(.03)	(.058)	(.008)	
age50	-.153***	-.151***	-.188***	.003	age50*t
	(.031)	(.031)	(.058)	(.008)	
college	-.065***	-.079***	-.049	0	age65*t
	(.021)	(.021)	(.037)	(.008)	
high	-.042**	-.051***	-.05	-.001	College*t
	(.018)	(.018)	(.032)	(.003)	
male	.046***	.049***	.049**	.001	High*t
	(.012)	(.012)	(.024)	(.002)	
white	-.038	-.031	-.093*	0	Male*t
	(.024)	(.024)	(.054)	(.002)	
black	-.018	-.015	-.096	.005	White*t
	(.028)	(.028)	(.061)	(.003)	
marry	.054***	.064***	.057*	.006*	Black*t
	(.015)	(.015)	(.03)	(.004)	
widow	.054	.066*	.007	.001	Marry*t
	(.036)	(.035)	(.067)	(.002)	
divorce	-.003	.002	.025	.004	Widow*t
	(.02)	(.02)	(.039)	(.005)	
sep	.028	.038	.036	-.001	Divorce*t
	(.033)	(.033)	(.063)	(.003)	
work	.017	.016	.05	0	Sep*t
	(.023)	(.023)	(.044)	(.004)	
unempl	.027	.019	.125	-.002	Work*t
	(.04)	(.04)	(.08)	(.003)	
lninc	-.001	-.002	.006	-.008	unempl_t
	(.006)	(.006)	(.012)	(.005)	
dem	-.075***	-.064***	-.034	-.001	Lninc*t
	(.017)	(.017)	(.034)	(.001)	
gop	.15***	.162***	.089**	-.003	Dem*t
	(.017)	(.017)	(.035)	(.002)	
				.006**	Gop*t
				(.002)	
_cons	1.626***	1.643***	1.616***		
	(.066)	(.071)	(.128)		
Observations	10769	10769	10769		

R-squared	.052	.067	.06

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

In the first column, the results clearly show a negative and statistic significant effect of younger age on environment perception. Recall that the environment perception is environmentally concerned which is the respondent believes that we have done too little to the environment protection. Thus, as suspected before, respondents lie in age 18-34 have a much environmentally concerned perception comparing to the other groups, and as age increases, the respondents may still concern but not as much as the younger groups, and this may suggest that age plays a major part in the environment perception of GSS respondents. The same situation applies to the educational background, people with at least college degrees concern more about what have done to improve the environment with respect to the high school graduates and those do not hold a high school degree. And for the other socio-demographics, the male respondents are less concerned, white and black respondent are slightly more concerned to the other race. The differentials also come from the various marital status, the married and widowed respondents are the least concerned group compared to the divorcee and single respondents, which makes sense since the married respondents must take more responsibilities in their children and the other ordinary stuff, while single and divorcee may focus their concern on the environment issue. Another stereotype may have been shown in the results is that the democrats are more environmentally friendly comparing to the baseline independent respondents, but republicans show less interest in the environment question. The respondents' income and work status are not statistic significant, but I keep them for the further analyses to see if there are differentials across groups in these characteristics.

There are a lot of other confounding factors may affect the environment perceptions of respondents, one may argue that the government change after each election, either nationally or locally could affect the corresponding environment or energy policy that may shape the different environment perceptions. I completely agree with this argument and in fact these factors should be considered and included in the future research in order to improve the precision of the further analyses and capture the true effects of socio-demographics on environment perception. However, due to the limited time of this research and datasets, I did not include such confounding factors, but I argue that even those factors matter, the persistent and different environment perceptions across different characteristics over time indeed suggest the significant impacts and respondents do not care that much about government change as their own demographics shift. Thus, in the second column, I introduce year fixed effects in the regression to get rid of these effects, the coefficients of interest sightly change but the patterns have shown before remain stable, this supports the discussion I argued above.

I also wonder how these effects evolve over time, then I interact each socio-demographic with time trend to see how the coefficients change over time. At year 1985, t=0, the coefficients are the ones present in column (3), then 27 years later, when t=27, the coefficients change to the value after subtracting the interaction. For example, the younger group age18-34 changes the coefficient from -0.418 to -0.148 which implicates that younger generation is not that much more concerned compared to the older groups than the younger respondents 27 years ago, but they are still more concerned than the older group age65+ in terms of environment protection. Surprisingly, respondents age from 50-64 today hold a similar perception as the age 18-34 group, which may suggest that either we have improved the environment over the last 27 years, so younger people may not be that much more concerned, or the younger generation does not hold a much strongly environmentally concerned perception as the respondents 27 years ago. Regardlessly, the various environment perceptions across age remain. Another striking intuition behinds the results is that for the age 50-64 today are the respondents lie in age 18-34 for 27 years ago, hence, when they were the younger group, on average they hold a much environmentally concerned perception back then but the magnitude decreases over time as they grow older, which coincides with the previous discussion that I addressed before. The combined results make me suspect that the characteristics may have an impact on environment belief and further I will use them to predict respondents' environment perceptions.

In the educational background, the college graduates do not show much difference to the high school graduates, but both are environmentally concerned than the ones do not hold a high school degree. And the gender differentials persist over time, but for race, working status, they tend to converge to a similar perception. Another interesting result is that the environment perceptions slightly widen across marital status and party affiliation, this result may suggest the substantial impacts of these demographics on environment perception.

2. Predict environment belief

In the previous part, I use separate groups of respondents' characteristics to show the very different environment perceptions over time, which makes me suspect the important impact of socio-demographics on environment belief, thus in this part of analysis, I recode the environment perception in the original data and run a logit model which is used later to predict the environment belief of households in AHS data.

2.1 Variables

The dependent variable is the environment perception that I extract from the GSS data, for the description of the variable and summary statistics, please see Appendix A.1 and Table 1. Furthermore, I recode the value of the environment perception with 1 for choosing we have done too little to the environment protection and improvement, and with 0 for the other two options. The reason for recoding the dependent variable is to serve the analyses in the further sections, that is, for those respondents choosing too little in the GSS interviews, they may have a potential motivation to protect the environment in their own way. That said, those believe they need further actions towards environment improvement may thus decrease their consumption on the residential energy, in order to either save more energy for the future generations without being depleted too early, or saving the energy from being exploited from the earth and use energy that is greener and can be regenerated.

The explanatory variables that I use are the socio-demographics that I introduced in the section 2, namely age, sex, race, educational background, marital status, labor force status, and income of the respondents. All the respondents with no answer and not applicable are dropped from the analyses. And I recode sex, race, marital status, and labor force status as dummy variables in order to capture the different effect on environmental perception in terms of male vs. female, white vs. black and others, married vs. unmarried, working vs. being unemployed or out of labor market, and assign value 1 for all the first cases in these characteristics and 0 otherwise. As for age and education are measured in years and income is the respondents' income calculated in constant dollars to avoid inflation being accounted in the income variable, comprehensive description is introduced in Appendix A.1.

2.2 Methodology

The model of the analyses is shown in equation (1), environment perception is discussed as above, the environmental belief for each respondent in every year, and X_i is a full set of socio-demographics correspond to every respondent in the GSS data. The aim of this analysis is to investigate in every survey year separately, which socio-demographics could be accounted for the variation of environmental perceptions and use these characteristics later to predict the environmental beliefs for the households in the AHS data that share the similar socio-demographics.

$$Perception_i = \beta X_i + \varepsilon_i\,, \quad i = 1, \ldots, N \tag{1}$$

The analyses start with basic ordinary least square (OLS) analyses in each year. However, as suggested in the previous literature, the OLS approach does not consider the discreteness of the outcomes of dependent variable, and it may be inconsistent since the dependent variable, environment perception now is being coded as binary outcomes, that is, the respondent either reply the question with we have done too little to the environment protection, or other cases. Because the outcome of choosing too little is our interest since the respondent may change their behavior to correspond their responses. Thus, for a binary outcome as a dependent variable, I present the following two non-linear models to investigate the relationship of socio-demographics on environmental perception.

For the logit model as presented in equation (2), the probability of choosing too little for their environmental perception is being specified as the right-hand side of the equation, and the coefficient of interest of the logit model will be estimated by the maximum likelihood estimation (MLE) and the corresponding log-likelihood function is presented in equation (3) with y_i stands for environment perception of each respondent. The MLE method is more appropriate for this case since we do not need to specify the underlying distribution. And another approach I present in equation (4) is probit model, which also uses the MLE method mentioned earlier.

$$\Pr(Perception_i = 1|x_i) = \frac{\exp\,(x_i{'}\beta)}{1+\exp\,(x_i{'}\beta)} \tag{2}$$

$$L_N(\beta) = \sum_{i=1}^{N}\{y_i \ln \Pr(y_i = 1) + (1 - y_i) \ln\,[1 - \Pr(y_i = 1)]\} \tag{3}$$

$$\Pr(Perception_i = 1|x_i) = \int_{-\infty}^{x_i'\beta} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{z^2}{2}\right) dz \quad (4)$$

2.3 Results

I separately run the regressions of OLS, logit and probit for each GSS interview year lies in the chosen time period, and I present year 1985 as an example to interpret the results, the comprehensive results of regressions are introduced in Appendix C. First, as shown in the Table 4, I report the variables that are also available in the AHS data which estimates are used for later matching and all the variables included in the GSS data. In this special case, three socio-demographics are statistic significant at 5% level, and age is also statistic significant at 1% level, due to the limitation that I mentioned earlier, the OLS estimates may not be consistent, but nonetheless provides intuition behind the relationship between respondents' characteristics and environmental belief.

In column (2) and (3), the table showcases the logit and probit estimates respectively, and throughout of this paper I will not discriminate the estimates between logit and probit, rather simply present the results as a comparison, since the predictability of logit and probit estimates are quite identical, hence, there is no point of favoring one to another and both estimates will give back the similar prediction of environment perceptions in the later analyses. For this reason, I use logit estimates throughout the paper to predict the environmental beliefs of households in AHS data.

The results present in Table 4 clearly show that age and being married or widowed status have a negative effect on the environmental perception of the respondents, that is, for being 1 year older the respondents have a 0.021 less of log-odds ratio of choosing too little as their response to the question regarding environmental perception, and for being married the negative impact on log-odds ratio is much stronger and the magnitude is 0.646. Also, white and black respondents may more in favor of environmentally concerned perception in contrast to the other races. Furthermore, by checking all the results presented in Appendix C, one interesting thing need be mentioned is that age is statistic significant at every year throughout the time period. However, sex, gender and education partially play an important part on environmental perception, let alone labor force status and income of the respondents are never significant in the logit or probit estimates.

Table 4 Regression Results

Year=1985	(1) perception	(2) perception	(3) perception	(1) perception
age	-.005***	-.021***	-.013***	-.008***
	(.001)	(.006)	(.003)	(.002)
educ	.005	.021	.012	.001
	(.006)	(.027)	(.017)	(.008)
male	.049	.223	.136	.037
	(.041)	(.18)	(.111)	(.051)
white	-.288**	-1.636**	-.945**	-.197

	(.122)	(.768)	(.409)	(.124)
black	-.336**	-1.849**	-1.081**	-.295**
	(.134)	(.805)	(.436)	(.142)
marry	-.136**	-.646**	-.394***	-.136**
	(.055)	(.254)	(.153)	(.062)
widow	-.082	-.39	-.237	-.2
	(.086)	(.377)	(.232)	(.137)
divorce	-.083	-.423	-.253	-.063
	(.068)	(.309)	(.187)	(.076)
sep	.032	.113	.079	.072
	(.103)	(.486)	(.292)	(.129)
lninc				.008
				(.024)
dem				.079
				(.071)
gop				-.119*
				(.072)
work				-.202**
				(.091)
unempl				-.176
				(.162)
_cons	1.108***	3.065***	1.831***	1.338***
	(.163)	(.912)	(.509)	(.246)
Observations				491
R-squared				.116

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

This striking result is against the time persistent pattern of various characteristics that I showed earlier, however, given the limited sample in each year the final logit estimates may not be that accurate. Because I drop out all the not applicable respondents from the dataset, the remaining respondents may not well represent the entire population even after applying survey weight every year. Thus, in the future research, the analyses should pay attention this issue and introduce a large number dataset to confirm the corresponding correlation I present in Table 4. And another explanation is that those characteristics may play a part on the environmental perception, but not strong enough to capture the cross-individual variations, this suggests the magnitude of variation in these socio-demographics is not as large as the differentials of age has shown in the entire sample and population. Thus, the future analyses should focus on decoding the significant effect of age on environmental belief.

Another issue in this analysis is that even after include all the available characteristics of the respondents in the GSS data, the R squared remains a very low level, only 11% variation can be explained by the corresponding socio-demographics, this may jeopardize the precision of further prediction and should be resolved by the further improvement. However, as mentioned by the literature, behavioral analyses may systematically have a low level of R squared, since every person is unique and the corresponding behavior may seem like unpredictable but this does not weaken the correlation found in the analyses.

One approach could help improve the predictability is to implement the least absolute shrinkage and selection operation (LASSO). It not only selects the true significant predictors given a finite sample when facing too much predictors and bring the subsets of predictors that have the lowest prediction error. It may seem not necessary to the case that I am facing, however, for the future research including more variables and require higher predictability, the LASSO approach could be essential. As suggested by the literature, a simple LASSO selection method could be inconsistent, thus, I suggest the adaptive LASSO suggested by Zou (2006) and the estimates is derived from equation (5)

$$\widehat{\beta^{*(n)}} = arg \min_{\beta} ||y - \sum_{j=1}^{p} x_j \beta_j||^2 + \lambda_n \sum_{j=1}^{p} \frac{1}{|\hat{\beta}|^{\gamma}} |\beta_j| \quad (5)$$

I did not report the pseudo-R squared values for the logit and probit models, since the pseudo-R squared is not as accurate as the one in the linear regression, and by simply comparing the magnitude could lead us to a wrong direction. Thus, in order to show the validity of the model, I use the Hosmer-Lemeshow (HL) test to assess the goodness of fit of the logit model and group them in 10 cases as suggested by Hosmer and Lemeshow (1982), the corresponding p-value of chi-squared is larger than 0.05, thus, I conclude that the model prediction is a good fit of real data. This does not solve the potential problem of predictability, but do suggest the logit predictions is similar to the true results.

Finally, I match the corresponding socio-demographics in GSS with the available characteristics in the AHS data, due to the limitation of the dataset, I cannot match all the socio-demographics which could generate precision error in the application, nonetheless, I use the logit estimates each year to predict the environmental beliefs of households may hold based on their socio-demographics and later, I check whether the difference in predicted environmental belief lead to a different behavior. One more thing need to be mentioned is that the predicted environmental belief in the AHS data is the probabilities of the households choosing the environmentally friendly perception which is believing that we have done too little to environment protection and improvement.

IV. Environmental belief on residential energy expenditure

As discussed in the previous section, I estimate the logit models between respondents' socio-demographics and environmental perceptions in each year from 1985-2012. And in this section, I use the prediction of the logit estimates as a behavioral indicator to the regression to investigate that whether the differences of environmental beliefs across the households result in the final variations of residential energy consumption.

The structure of this section is as following, first, I analyze the cross-section variation of residential energy expenditure in every year, to investigate that whether the differentials of environmental beliefs, namely the probability choosing environmentally concerned perceptions using logit estimates derived from the previous section can be accounted for the different costs of energy across households. Then I move on to build a panel dataset that capture the change of residential energy expenditure in the last 27 years and explore whether this change could be explained by the change of environmental beliefs.

1. Cross-section variation

1.1 Variables

The dependent variables that I use in this section are AMTO, AMTE and AMTG from AHS data, which are annual cost of fuel oil, average monthly cost of electricity and average monthly cost of gas in the households respectively. The different length of residential energy expenditure will not affect the validity of the results, since in the initial survey, the questions regarding housing costs were conducted by asking the annual costs of all three types of energy, and then transform the costs of electricity and gas in monthly costs. Thus, all three costs were estimated by the households on a yearly basis and there is no measurement error in terms of using the different time length to measure the final energy costs. Furthermore, in order to smooth the data, I specifically take the natural log of all three costs, which is also commonly used in the previous literature and all the not applicable answers are automatically removed from the final dataset.

The explanatory variables fall in four categories, namely household characteristics, housing characteristics, MSA (metropolitan statistical area) and region identifier, and housing energy efficiency. The first and foremost is the environmental beliefs that I predict with the logit estimates on the household demographics, and the form of belief is the probability of choosing that we have done too little to environmental protection. And I also include household income into the regression, since previous literature has proved that household income affects the behavior of energy expenditure.

The second category for the predictors is housing characteristics, which include the number of rooms in the housing unit, whether the housing unit is detached or attached to another building. The existing evidence has shown for households with more rooms in their units, will lead to a higher consumption demand in order to match the increase of square feet of the units. And a detach building will also cost more on the energy consumption compared to the buildings that are attached together. Another thread of predictors are the dummies for MSA and regions, note that for households living in a cold or hot area will consume more energy since the essential demand of heating and cooling increase in the housing units, and a housing unit lie in MSA may have a efficient electricity system to reduce the cost but inefficient supply for fuel oil and thus a higher cost in the corresponding energy expenditure. Those dummies are, “ch” stands for the cooling and heating degree days of the unit, “msa” for whether the unit is in the metropolitan statistical area. I also include “yh” the number of years since the unit was built to measure the housing energy efficiency, the intuition behind this is that for those units were built a long time ago may not have an efficient energy system in the unit and results in more energy expenditure.

And the number of persons living in the unit is also included in the predictors, because more persons living in the housing unit may imply a higher residential energy demand.

1.2 Methodology

This part of analysis is to investigate that whether the variation of environmental beliefs across households has an impact on the residential energy expenditure. I use OLS and quantile regression methods to evaluate the effects of interest in every year. The model is presented in equation (6)

$$Exp_i = \beta Natenvir_i + \gamma X_i + \varepsilon_i \tag{6}$$

The dependent variables are residential energy expenditure introduced earlier and β is the coefficient of interest, X_i is a set of predictors explained before. The intuition behind this model is that whether for those households with a higher probability of choosing that we have done too little in environmental protection will result in a decrease in the residential energy consumption. If so, this may inform the behavioral response to the environmental protection.

Furthermore, the reason for choosing the quantile regression is that the results from this analysis is the mean regression estimator and it can resist the effect of potential outliers in the sample, it minimizes the objective function presented in equation (7), unlike OLS estimator will be dragged by the extreme outliers. And by extending results of quantile regression. I also present the results of 10th, 25th, 75th, and 90th percentile results to showcase the heterogenous effects of environmental belief on energy expenditure, and the very different results across different percentiles further justify the choice of quantile regression, and the different percentile results could also be informative when it comes to policy design regarding environment protection.

$$Q_N(\beta_q) = \sum_{i:y_i \geq x_i'\beta}^{N} q\left|y_i - x_i'\beta_q\right| + \sum_{i:y_i < x_i'\beta}^{N} (1-q)\left|y_i - x_i'\beta_q\right| \tag{7}$$

1.3 Results

As presented in Table 5, the first columns give the univariate coefficients, and the second columns present the multivariate OLS results, and the third columns present the quantile regression results. The results below are the estimation of year 1985, for the comprehensive estimations, please see Appendix D.

In year 1985, all the coefficients of interest are negative and statistic significant at 1% level and the magnitude of quantile estimators are a bit less than the result in OLS estimators, however, all of them remain stable. For the other coefficients, each predictor behaves differently. A detached building decreases the cost in fuel oil but increase the energy cost of electricity and natural gas. The other results are, the lower efficiency of energy system, the housing unit lies in higher cooling and heating degree days area and locate in the metropolitan statistical are increase the housing costs in fuel oil and gas, but somewhat decreases the cost for electricity. This coincides the reality of our daily life, since living in MSA area, it is easier to have access to electricity and the price is lower in contrast with fuel and gas which may be limited by the city regulation and results in a higher cost to access them. And the effects of energy system efficiency could be explained that a very old housing unit may not support an efficient energy system, thus, then reduce the appliances that using electricity and use more fuel oil and gas. As for income and number of rooms in the unit, they betray the same sign as explored by the previous literature, that is, more rooms and more income, more energy expenditure.

For our primary predictor, environmental belief, the negative sign justifies the previous discussion, which is a higher probability of choosing too little in environmental belief question may lead to a decrease in the residential energy expenditure, since the households take their own action to fight against the climate change or save the energy to improve the condition of environment. This striking result is also found in the other 12 out 14 interview years of AHS data in the chosen time period and is at least statistic significant at 5% level. However, in some years, the environmentally friendly beliefs result in higher expenditure in electricity, this result will be evaluated in the robustness check section in order to figure out the valid relationship between environmental belief and energy expenditure.

Additionally, in Table 6, I present the heterogenous results of different percentiles, as shown in the table, the first quantile of the households has much stronger effects of environmental beliefs on residential energy expenditure, these households almost double the negative behavioral response in the consumption of fuel oil and gas, however this heterogenous effect shrinks when comparing the difference of electricity expenditure. This interesting result can be explained by the formality of sources and potential threat that different types of energy pose on the environment. First, the electricity may be generated by the greener energy, such as solar, wind, etc., this formality difference compared to the fuel oil and gas exploited from earth boost the households' confidence and assurance when consuming electricity. Another explanation is that consuming electricity does not generate those environment-concerned byproducts, for those households believe we have done too little may shift their daily consumption of fuel oil and gas to electricity. These mixed effects could be used to explain the small difference of electricity expenditure across different percentiles.

Another important implication comes out of the results is the heterogenous results across different percentiles may inform the policy designers for the heterogenous environmental policy in terms of residential energy consumption. One issue should be paid extra attention is that for those households in favor of environmentally friendly beliefs may already use less energy compared to the others and they are the least affected ones for the potential energy regulation. But the "nonchalant" households may consume the same amount of energy regardless the further tax or regulation about energy consumption. And the key point of regulation is to reduce the energy consumption to fight against the climate change, if those households consume the same anyway, the reduction of higher-carbon energy policy may not be effective despite the heterogenous results shown in the results.

Table 5 Environment Belief on Energy Expenditure

Year 1985	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
belief	-.643***	-.623***	-.489***	-.557***	-.45***	-.413***	-1.061***	-.791***	-.758***
	(.128)	(.131)	(.108)	(.034)	(.032)	(.036)	(.053)	(.052)	(.054)
ROOMS		.068***	.064***		.091***	.083***		.098***	.105***
		(.008)	(.008)		(.002)	(.003)		(.004)	(.004)
PER		-.018*	-.004		.086***	.089***		.053***	.045***
		(.01)	(.009)		(.003)	(.003)		(.004)	(.004)
lninc		.031***	.036***		.021***	.027***		.01**	.012***
		(.01)	(.011)		(.003)	(.003)		(.004)	(.004)
msa		.334***	.278***		-.015*	-.013		.079***	.055***
		(.032)	(.028)		(.008)	(.009)		(.014)	(.013)
yh		.003***	.003***		-.005***	-.006***		.002***	.003***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.246***	.231***		-.133***	-.164***		.309***	.36***
		(.027)	(.023)		(.007)	(.008)		(.011)	(.011)
detach		-.109***	-.137***		.186***	.181***		.166***	.2***
		(.037)	(.028)		(.009)	(.01)		(.016)	(.017)
_cons	6.761***	5.649***	5.767***	4.303***	3.412***	3.403***	4.273***	2.883***	2.86***
	(.071)	(.132)	(.118)	(.02)	(.034)	(.038)	(.03)	(.053)	(.055)
Observations	4733	4733	4733	33412	33412	33412	19557	19557	19557

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Column (1) report OLS results for univariate, Column (2) report OLS results for multivariate
Column (3) report Quantile regression results

Table 6 Heterogenous Quantile Results

Year 1985	(1) lamto	(2) lamto	(3) lamto	(4) lamto	(1) lamte	(2) lamte	(3) lamte	(4) lamte	(1) lamtg	(2) lamtg	(3) lamtg	(4) lamtg
belief	-1.245***	-1.217***	-.455***	-.408***	-.506***	-.446***	-.424***	-.447***	-.927***	-.879***	-.635***	-.592***
	(.343)	(.188)	(.09)	(.113)	(.059)	(.041)	(.039)	(.052)	(.11)	(.079)	(.05)	(.069)
ROOMS	.035	.053***	.078***	.081***	.092***	.081***	.091***	.101***	.084***	.108***	.098***	.091***
	(.026)	(.012)	(.006)	(.008)	(.004)	(.003)	(.003)	(.004)	(.008)	(.006)	(.003)	(.005)
PER	-.066**	-.03**	0	.005	.089***	.092***	.083***	.074***	.065***	.058***	.045***	.05***
	(.029)	(.015)	(.008)	(.009)	(.005)	(.003)	(.003)	(.004)	(.009)	(.006)	(.004)	(.005)
lninc	.086***	.06***	.009	.011	.052***	.033***	.018***	.008	.02***	.013**	.009**	.002
	(.028)	(.012)	(.007)	(.007)	(.006)	(.003)	(.003)	(.005)	(.007)	(.006)	(.004)	(.008)
msa	.642***	.395***	.249***	.224***	-.061***	-.032***	.006	.018	.133***	.094***	.057***	.071***
	(.09)	(.046)	(.022)	(.027)	(.015)	(.01)	(.011)	(.013)	(.036)	(.022)	(.013)	(.016)
yh	.007***	.004***	.002***	.002***	-.005***	-.005***	-.006***	-.005***	-.001**	.001*	.004***	.005***
	(.002)	(.001)	(0)	(.001)	(0)	(0)	(0)	(0)	(.001)	(0)	(0)	(0)
ch	.619***	.36***	.097***	.06**	-.112***	-.16***	-.141***	-.113***	.299***	.402***	.267***	.173***
	(.08)	(.041)	(.021)	(.025)	(.012)	(.009)	(.009)	(.012)	(.026)	(.017)	(.011)	(.014)
detach	-.033	-.111**	-.151***	-.239***	.26***	.227***	.149***	.131***	.322***	.343***	.032*	-.084***
	(.117)	(.055)	(.028)	(.036)	(.017)	(.012)	(.012)	(.015)	(.032)	(.024)	(.019)	(.021)
_cons	4.078***	5.323***	6.428***	6.74***	2.335***	2.95***	3.849***	4.241***	1.891***	2.272***	3.388***	3.907***
	(.365)	(.168)	(.088)	(.104)	(.067)	(.043)	(.042)	(.06)	(.11)	(.081)	(.052)	(.085)
Observations	4733	4733	4733	4733	33412	33412	33412	33412	19557	19557	19557	19557

Standard errors are in parentheses
*** *p*<.01, ** *p*<.05, * *p*<.1

Fortunately, this is not the case. By separating the households into different groups based on their probabilities of choosing environmentally friendly beliefs, below 0.5 vs. above 0.5, and I evaluate the average environmental beliefs and all three types of residential energy expenditure of each group over the years and deflate the energy costs using consumer price index (CPI), I find that for the groups with probability in favoring environmentally friendly beliefs in 1985 shift their environmental beliefs to a more environmentally friendly one, the probability increase and is above 0.5 and also converge to the ones of higher probability group, which may due to the increase of age and shift of marital status etc., and by deflating the cost, I find the decease of energy costs in all three types of energy for both groups, which in the later sections will be examined that whether this is generated by the prices of energy. By doing this simple analysis, I show that the environmental beliefs do change over time and less concerned group may grow concern in the environment protection. Thus, the heterogenous policy design may be effective if less concerned group will eventually decrease their energy consumption. However, due to the precision of predicted probabilities of environmental beliefs, the results may marry if include more predictors, therefore, the future research should tackle the prediction error and further justify the effectivity of heterogenous policy implementation.

2. Panel variation

In the previous part of this section, I use quantile regression results to conclude that for those individuals have a higher probability choosing an environmentally concerned belief will take actions themselves, namely cut their own residential energy expenditure. However, the results vary across the types of energy and percentiles of the sample, in some cases, households may even in favor of electricity in terms of a greener energy. While the interesting results occur in each year of the regression, one may wonder whether the change of energy expenditure across time could be explained by the change of environmental belief of the households.

In order investigate this relationship, I present a fixed effect model to explore the potential correlation. The fixed effect model used throughout the analyses is presented in equation (8). The dependent variables are energy expenditure of three types of energy in each household from 1985-2013, and belief is the environmental belief of the corresponding households in each year, β is the coefficient of interest. X_{it} is a full set of time-variant predictors, such as households' income, number of years since the units were built, $MSA \times \theta_t$ is the MSA by year fixed effects to incorporate the specific characteristics of MSA and year that may affect the final residential energy expenditure and δ_i is the time-invariant household and housing fixed effects. In equation (9) I also include the socio-demographics that is time-variant for the households to capture whether they have an impact on energy expenditure and further improve the causal relationship between environmental belief and residential energy expenditure.

$$Exp_{it} = \beta Belief_{it} + \gamma X_{it} + MSA \times \theta_t + \delta_i + \varepsilon_{it} \quad (8)$$

$$Exp_{it} = \beta Belief_{it} + \gamma X_{it} + Age_{it} + Educ_{it} + Marital_{it} + MSA \times \theta_t + \delta_i + \varepsilon_{it} \quad (9)$$

Table 7 Panel Results

	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
belief	-.551***	-.562***	.18	.049**	-.029	-.047**	-.015	-.059*	.099**
	(.089)	(.096)	(.153)	(.019)	(.019)	(.024)	(.035)	(.035)	(.045)
PER		-.001	.043***		.074***	.069***		.029***	.034***
		(.007)	(.009)		(.001)	(.002)		(.003)	(.003)
lninc		.031***	.034***		.007***	.006***		.005**	.006***
		(.009)	(.009)		(.001)	(.001)		(.002)	(.002)
yh		.003***	.003***		.015***	.015***		.013***	.013***
		(0)	(0)		(0)	(0)		(.001)	(.001)
age			.009***			0			.003***
			(.001)			(0)			(0)
marry			-.009			.049***			-.015
			(.047)			(.008)			(.015)
widow			.071			-.026***			-.044***
			(.049)			(.01)			(.017)
divorce			.069			.032***			-.009
			(.054)			(.009)			(.017)
sep			.134			.064***			-.009
			(.095)			(.014)			(.028)
educ			.025***			.005***			.002
			(.003)			(.001)			(.002)
_cons	7.212***	6.719***	5.279***	.011***	.005***	.005***	.016***	.011***	.011***
	(.051)	(.102)	(.197)	(.001)	(.001)	(.001)	(.002)	(.002)	(.002)
Observations	7078	7078	7078	100904	100904	100904	40709	40709	40709
R-squared	.201	.211	.233	.165	.217	.219	.208	.23	.231

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Column (1) report univariate results, Column (2) report multivariate results, Column (3) include socio-demographics

The results of the analyses are presented in Table 7. The first columns give a first glimpse of corresponding relationship of environmental beliefs on residential energy expenditure and by including the other predictors into the regression in the second column, the R squared slightly increased to 0.2 on average, and the results showcase a negative relationship. This result may suggest that the increase of probability of households in favor a more environmentally concerned beliefs will take actions on their own, reduce the residential energy expenditure, the foremost and reachable way to protect the environment without pulling too much of effort.

In the third columns I include the socio-demographics to capture the impact of age, marital status and educational background on residential energy expenditure, in order to enhance the causality of the correlation of interest, as shown in the table, after including these variables, the sign and the significance change of all three types of energy and I can not conclude the relationship just based on the above results, since energy price play a great part on energy expenditure, without controlling it could lead to the omitted variable bias (OVB). Thus, in the later section, I will introduce the prices as control and then formally conclude the relationship of environmental belief and residential energy expenditure.

V. Robustness check

In the previous sections, I use GSS data to investigate the relationship between respondents' socio-demographics and environmental perceptions, and later use the logit estimates to predict the environmental beliefs of those households who share the similar characteristics in AHS data, and then investigate that whether the difference of environmental beliefs across individuals and time could explain the change of residential energy expenditure across households and time respectively.

Despite of interesting cross-section results and contradictory results across time after controlling for socio-demographics, two major problems of the analyses arise from the methodology I implemented before. The first one is measurement error, even though the GSS and AHS data are representative towards the true population in U.S., the environmental belief of GSS respondents may still differ from the beliefs hold for the households, either because the lack of information for those respondents with no response or the lack of enough matching characteristics in the AHS data, thus, the predicted environmental beliefs may not be as accurate as the true beliefs hold by the households from the AHS sample. Another potential problem is omitted variable bias in the panel data analysis, as discussed earlier, without including the price of energy dampen the results that I present in the panel analysis. Thus, in order to overcome these two problems that may challenge the relationship between environmental belief of residential energy expenditure that I build in this paper, I introduce Lewbel (2012) instrument variable (IV) method which is useful when no external IV is available and use residential energy consumption (amount consumed by dividing the prices of residential energy) to improve the previous results.

1. Measurement error

I followed Arthur Lewbel's method of constructing instrument variable when no external instrument is available, since environmental beliefs predicted from the logit estimates could be inconsistent, I apply the above method to get the estimators as presented in Table 8. In the first columns present the Lewbel IV estimates to improve the previous panel data analysis, and in the second columns, I include the socio-demographics of the households and implement the instrumentation as well.

Table 8 Lewbel IV Approach

	(1) lamto	(2) lamto	(1) lamte	(2) lamte	(1) lamtg	(2) lamtg
belief	-.928**	-1.184***	-1.236***	-.824***	-2.072***	-1.782***
	(.415)	(.32)	(.088)	(.063)	(.156)	(.113)
PER	.019*	.033***	.088***	.071***	.052***	.036***
	(.011)	(.01)	(.002)	(.002)	(.004)	(.003)
lninc	.009	.011	.01***	.006***	.013***	.01***
	(.009)	(.009)	(.001)	(.001)	(.003)	(.003)
yh	.036***	.035***	.018***	.019***	.017***	.019***
	(.001)	(.001)	(0)	(0)	(0)	(0)
age		0		-.003***		-.006***
		(.002)		(0)		(.001)
marry		-.048		.002		-.102***
		(.074)		(.009)		(.018)
widow		.057		-.043***		-.069***
		(.079)		(.011)		(.02)
divorce		.054		.024**		-.013
		(.084)		(.01)		(.02)
sep		.043		.052***		-.035
		(.105)		(.016)		(.032)
educ		.011		.012***		.016***
		(.007)		(.001)		(.002)
Observations	7080	7080	100905	100905	40710	40710

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

The Lewbel instruments are generated by the auxiliary equations' residuals and mean-centered included exogenous variables as presented in equation (9). The results of generated IV reinforce the previous panel results when no socio-demographics is included, that for those who have a higher probability of choosing we have done too little to the environment protection lead to a decrease in all three types of residential energy expenditure. The coefficients of interest are all negative and statistic significant, however, I still could not conclude the relationship without introducing the energy prices into the regression.

$$Z_j = \left(X_j - \bar{X}\right) * \varepsilon \tag{10}$$

2. Energy demand

As discussed earlier, without controlling for energy prices could cause the OVB, thus, in this part of analysis, I introduce the prices of all three types of energy, however due to the available prices in EIA data, I have to drop several years from the panel in order to perform the analysis. This strategy is better than simply controlling for the energy prices, because in this paper I want to analyze that whether those more environmentally concerned households will reduce their energy consumption, not the expenditure. Thus, I divide the energy costs by prices of energy in each year and retrieve the demand of residential energy and then take the natural log of it. After that, I implement the Lewbel IV approach again to overcome the mismeasurement discussed above and I present both results in Table 9 and Table 10. And I further argue there is no reverse causality in this relationship, since I use the predicted environmental beliefs, not the actual beliefs, the energy demand does not affect the predicted beliefs.

As shown in the table, we can see that if the household increase their probabilities in favoring more environmentally friendly beliefs, they may reduce their demand in fuel oil and natural gas, but increase their consumption in electricity. This may because that electricity is a greener energy comparing to the other two types of energy, and as time goes by, households maybe more convinced as more share of electricity comes from low-carbon resources. Though only 4% more of electricity comes from low-carbon resources throughout the time period according to Our World in Data (OWID), I argue that it is the belief matters, that is, households may not know the exact value of share of electricity comes from low-carbon resources, but their perception from the news media and social media, may somewhat exaggerate the true value of increase and potential benefit, then the households behave on their "biased" beliefs to shift the energy consumption over three types of energy according over time.

After including the socio-demographics of the households, the results further support the discussion on electricity consumption, however, the sign of fuel oil and natural gas change. Then I implement Lewbel IV approach in order to mitigate the measurement error problem and the coefficients of interest shift back to negative. Therefore, I use the results after Lewbel instrumentation to conclude the corresponding relationship, which are the increase of probabilities for households in favoring environmentally friendly beliefs motivate the households to reduce their consumption in fuel oil and natural gas in order to save the environment by their own. Though I lost the statistical significance of beliefs in electricity consumption, but the correlation remains positive, which coincides the previous discussion that they may in favor electricity since it is a greener energy comparing to the other two types of energy.

Table 9 Environment Belief on Energy Demand

	(1) ldamto	(2) ldamto	(3) ldamto	(1) ldamte	(2) ldamte	(3) ldamte	(1) ldamtg	(2) ldamtg	(3) ldamtg
natenvir	-.13 (.108)	-.264** (.111)	.32** (.138)	.113*** (.036)	.087** (.035)	.153*** (.042)	-.009 (.034)	-.099*** (.034)	.007 (.044)
PER		.019** (.009)	.031*** (.011)		.069*** (.003)	.064*** (.003)		.034*** (.002)	.036*** (.003)
lninc		.008 (.009)	.01 (.009)		.004** (.001)	.003* (.001)		.002 (.002)	.003 (.002)
yh		-.007*** (.002)	-.009*** (.002)		.011*** (.001)	.011*** (.001)		-.008*** (0)	-.008*** (0)
age			.006*** (.002)			.001** (0)			.001*** (0)
marry			.15 (.094)			.056*** (.013)			.004 (.015)
widow			.187* (.098)			-.028* (.016)			-.019 (.017)
divorce			.11 (.099)			.033** (.015)			.008 (.017)
sep			.22* (.119)			.055** (.024)			.015 (.028)
educ			-.001 (.008)			.002 (.002)			-.001 (.002)
_cons	-.008 (.007)	-.004 (.007)	-.004 (.007)	.003 (.002)	.003 (.002)	.003 (.002)	-.004 (.002)	0 (.002)	0 (.002)
Observations	5662	5662	5662	47087	47087	47087	40709	40709	40709

*Standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1*

Table 10 Lewbel IV

	(1) ldamto	(2) ldamto	(1) ldamte	(2) ldamte	(1) ldamtg	(2) ldamtg
natenvir	-.158 (1.375)	-2.276* (1.371)	-.616* (.357)	.334 (.216)	-.186 (.129)	-.282*** (.096)
PER	.019 (.023)	.039*** (.013)	.07*** (.003)	.063*** (.003)	.036*** (.003)	.037*** (.003)
lninc	.006 (.01)	.01 (.01)	.006*** (.002)	.004** (.002)	.002 (.002)	.002 (.002)
yh	-.008*** (.002)	-.005** (.002)	.013*** (.001)	.014*** (.001)	-.009*** (0)	-.01*** (0)
age		-.007 (.007)		.002** (.001)		0 (.001)
marry		.01 (.098)		.06*** (.018)		-.007 (.016)
widow		.171 (.105)		-.033* (.018)		-.021 (.018)
divorce		.105 (.107)		.028* (.017)		.01 (.018)
sep		.145 (.123)		.051* (.027)		.012 (.029)
educ		.008 (.011)		.002 (.003)		.001 (.002)
Observations	5664	5664	47089	47089	40710	40710

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

3. Further improvement

Due to the limited time of finishing this paper, I cannot implement further analyses to support the validity of the results that I just concluded above. Thus, I leave this to the future research. First and foremost, the energy consumption is highly relevant and dependent on the energy consumption in the previous years, because people cannot change their demand that easily and swiftly, thus, a dynamic panel data approach which is suggested by Arellano and Bond (1991) should be implemented to explore the correlation between environmental belief and residential energy consumption. Further, a more comprehensive analysis of cross-individual variations should be carried out by introducing the households' socio-demographics, in order to check that whether these characteristics have an impact on the residential energy expenditure. Moreover, more time-variant predictor of residential energy expenditure suggested by the existing literature should be included and adaptive LASSO could be carried out for selection. Last but least, a more comprehensive analysis about the relationship of socio-demographics and environmental beliefs should be explored in order to advance the predictability of environmental beliefs.

VI. Conclusion

This paper mainly extracts data from the two publicly used datasets, namely GSS and AHS data in order to investigate the relationship of environmental belief on the households' energy consumption. The analyses begin with a basic correlation analysis of respondents' characteristics on environment perceptions over the entire time period. Surprisingly, the various effects across different groups of characteristics persist over time, and this paper shows an interesting result which is the younger group tends to have a more environmentally concerned perception, but they lose their concern over time, which is worth extra attention for the public and policy designers.

This persistent differentials across groups in different socio-demographics make me suspect the important effects of respondents' characteristics on environmental perceptions. Therefore, I use logit model to estimate the corresponding relationship in each year and match the available characteristics in the AHS data to predict the environmental beliefs, which is the probability of in favoring an environmentally concerned perception. And use the predicted beliefs to explore the variations of residential energy expenditure across individual and time.

Interestingly, I found that for households with a higher probability in favoring a more environmentally concerned belief, they cut their own residential energy expenditure in three types of energy to improve the environment on their own. After implementing the different percentiles of quantile regression, I show the heterogenous effects of environmental beliefs on residential energy expenditure, which may further inform the policy designers for a heterogenous environment policy to cope with the imminent environment threat.

Later, in the panel analysis, I found the negative effects of environmental beliefs on residential energy expenditure as well, however, after including the time-variant characteristics of households, the sign change and lost the corresponding significance, this is mainly due to the measurement error and omitted variable bias. Thus, in order to overcome these problems, I implement the Lewbel IV approach and introduce residential energy consumption by diving the energy costs by prices of energy. The further results support the previous theory by showing a negative effect of environmental belief on consumption of fuel oil and natural gas, but positive and nonsignificant effect on electricity consumption, this is because the households consider electricity as a greener energy since increasing share of electricity comes from low-carbon sources.

Therefore, this paper concludes that for those households hold a more environmentally concerned belief, may reduce the residential energy consumption on their own in order to improve and protect the environment. That is, the households perceive the environment threats and act based on their perception in terms of energy consumption.

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Appendix

Appendix A.1 GSS Data

Variable	Description	Response
Natenvir	Improving and protecting the environment	a) Too little b) About right c) Too much
Age	Respondent's age	From 18-89
Sex	Respondent's sex	a) Male b) Female
Race	Race respondent consider itself as	a) White b) Black c) Other
Marital	Currently marital status	a) Married b) Widowed c) Divorced d) Separated e) Never married
Educ	Highest year of school completed	From 0-20
Wrkstat	Labor force status	a) Working fulltime b) Working parttime c) Temp not working d) Unempl, laid off e) Retired f) School g) Keeping house h) Other
Rincome	Respondent's income	a) Less than $1000 b) $1000-2999 c) $3000-3999 d) $4000-4999 e) $5000-5999 f) $6000-6999 g) $7000-7999 h) $8000-9999 i) $10000-14999 j) $15000-19999 k) $20000-24999 l) $25000 or more

Appendix A.2 AHS Data

Variable	Description	Response
ZINC	Total household income	From -10000 loss to $10000 or more
ROOMS	Number of rooms in the unit	From 1-21
PER	Number of persons in the household	From 1-98
METRO	Central city/ suburban status	a) Central city b) Suburb c) Other urban suburb d) Rural suburb e) Urbanized area, non-metro f) Other urban, non-metro g) Rural, non-metro
METRO3	Central city/ suburban status	a) Central city of MSA b) Inside MSA, but not in central city-urban c) Inside MSA, but not in central city-rural d) Outside MSA, urban e) Outside MSA, rural
Built	Year unit was built	a) 1979 b) 1975-1978 c) 1970-1974 d) 1960-1969 e) 1950-1959 f) 1940-1949 g) 1930-1939 h) 1920-1929 i) 1919 or earlier j) 1980-YYYY
Degree	Average heating/cooling degree days	a) Coldest b) Cold c) Cool d) Mild e) Mixed f) Hot
NUNIT2	Structure type	a) 1 unit building, detached b) 1 unit building, attached c) Two or more units

		building d) Mobile home, 1 unit e) Mobile home, 2 or more units
AMTO	Annual cost of oil, coal, kerosene, etc.	From $1-9997
AMTE	Average monthly cost of electricity	From $1-261
AMTG	Average monthly cost of gas	From $1-196

Appendix B Basic Correlation in GSS over Time

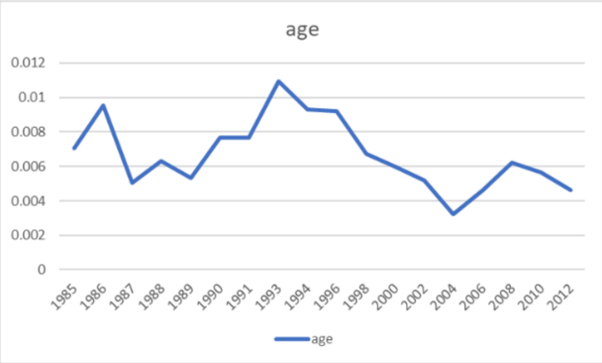

Figure 1.1 Age and Environment Perception

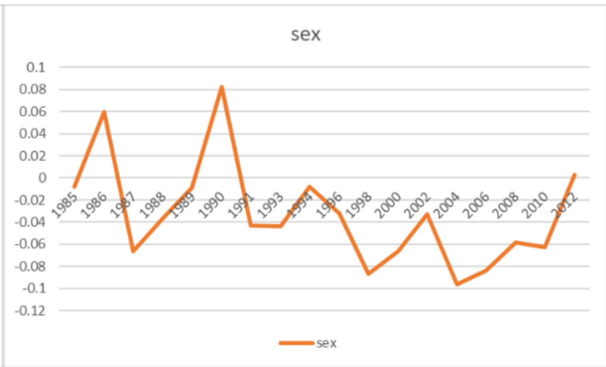

Figure 1.2 Sex and Environment Perception

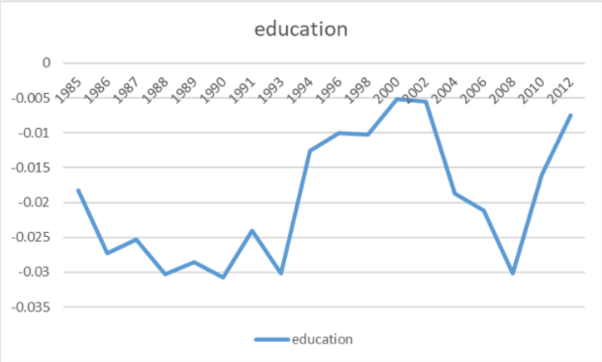

Figure 1.3 Education and Environment Perception

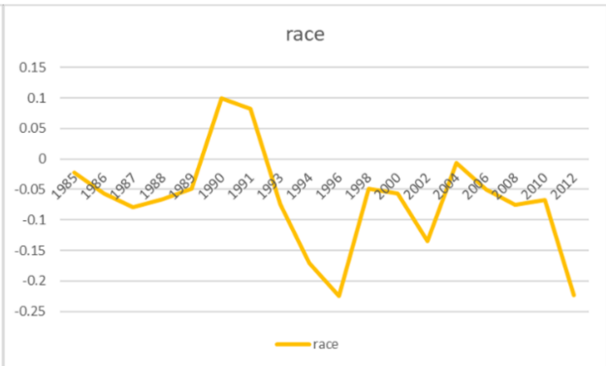

Figure 1.4 Race and Environment Perception

Figure 1.5 Labor Force Status and Environment Perception

Figure 1.6 Income and Environment Perception

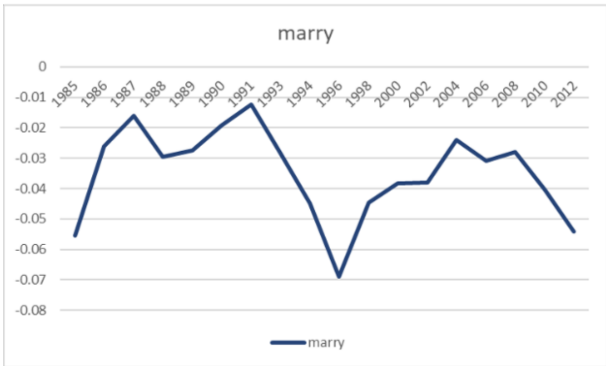

Figure 1.7 Marital Status and Environment Perception

Appendix C Regression Results of Environment Perception

Column (1) reports OLS results, Column (2) reports Logit results

Appendix C.1

Year=1987	(1) little	(2) little
age	-.003**	-.013**
	(.001)	(.006)
educ	.021***	.099***
	(.006)	(.031)
_cons	.558***	.176
	(.107)	(.524)
Observations	563	563

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.2

Year=1989	(1) little	(2) little
age	-.004***	-.02***
	(.001)	(.005)
educ	.02***	.107***
	(.006)	(.033)
white	.172**	.85**
	(.082)	(.423)
black	.209**	1.085**
	(.095)	(.512)
_cons	.503***	-.12
	(.118)	(.64)
Observations	729	729

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.3

Year=1991	(1) little	(2) little
age	-.007*** (.001)	-.035*** (.006)
marry	.06 (.047)	.273 (.248)
widow	.147* (.076)	.667* (.371)
divorce	.006 (.061)	-.007 (.308)
sep	.05 (.106)	.208 (.562)
_cons	.989*** (.051)	2.278*** (.276)
Observations	725	725

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.4

Year=1993	(1) little	(2) little
age	-.008*** (.001)	-.036*** (.005)
_cons	.964*** (.048)	1.997*** (.228)
Observations	754	754

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.5

Year=1994	(1) little	(2) little
age	-.007*** (.001)	-.031*** (.004)
marry	-.032 (.035)	-.17 (.16)
widow	.038 (.06)	.144 (.263)
divorce	-.033 (.045)	-.178 (.205)
sep	.124* (.069)	.572* (.342)
_cons	.953*** (.04)	1.966*** (.188)

Observations	1450	1450

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.6

Year=1996	(1) little	(2) little
age	-.005***	-.024***
	(.001)	(.004)
white	.106*	.459*
	(.057)	(.247)
black	.22***	1.024***
	(.065)	(.294)
marry	-.08**	-.375**
	(.035)	(.163)
widow	-.12*	-.521*
	(.062)	(.275)
divorce	.05	.199
	(.044)	(.208)
sep	.032	.118
	(.068)	(.323)
_cons	.776***	1.212***
	(.065)	(.289)
Observations	1369	1369

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.7

Year=1998	(1) little	(2) little
age	-.005***	-.022***
	(.001)	(.003)
male	-.061**	-.27**
	(.027)	(.117)
_cons	.89***	1.672***
	(.04)	(.184)
Observations	1309	1309

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.8

Year=2000	(1) little	(2) little
age	-.004***	-.018***
	(.001)	(.004)
white	.098*	.43*
	(.057)	(.248)

black	.119*	.523*
	(.065)	(.284)
marry	-.03	-.137
	(.034)	(.152)
widow	-.037	-.142
	(.06)	(.261)
divorce	.107**	.489**
	(.044)	(.209)
sep	-.056	-.254
	(.076)	(.331)
_cons	.734***	.994***
	(.062)	(.271)
Observations	1345	1345

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.9

Year=2002	(1) little	(2) little
age	-.004***	-.017***
	(.001)	(.004)
marry	-.07**	-.307**
	(.035)	(.153)
widow	-.048	-.202
	(.062)	(.261)
divorce	.029	.113
	(.045)	(.198)
sep	-.011	-.061
	(.08)	(.345)
_cons	.816***	1.336***
	(.042)	(.184)
Observations	1314	1314

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.10

Year=2004	(1) little	(2) little
age	-.002*	-.008*
	(.001)	(.004)
educ	.014***	.061***
	(.005)	(.02)
male	-.079***	-.349***
	(.026)	(.116)

marry	-.078**	-.36**
	(.035)	(.16)
widow	-.084	-.381
	(.065)	(.283)
divorce	-.043	-.207
	(.046)	(.206)
sep	-.066	-.306
	(.081)	(.354)
_cons	.615***	.496
	(.078)	(.344)
Observations	1357	1357

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.11

Year=2006	(1) little	(2) little
age	-.003***	-.012***
	(.001)	(.004)
educ	.015***	.07***
	(.004)	(.019)
white	.065*	.3*
	(.038)	(.177)
black	.101**	.483**
	(.048)	(.23)
male	-.05**	-.241**
	(.025)	(.118)
marry	-.068**	-.356**
	(.033)	(.164)
widow	-.068	-.346
	(.058)	(.273)
divorce	-.026	-.16
	(.04)	(.197)
sep	-.065	-.343
	(.075)	(.353)
_cons	.608***	.483
	(.071)	(.334)
Observations	1440	1440

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.12

Year=2008	(1) little	(2) little
age	-.004***	-.021***

	(.001)	(.004)
educ	.019***	.089***
	(.005)	(.023)
_cons	.627***	.541
	(.081)	(.384)
Observations	968	968

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.13

Year=2010	(1) little	(2) little
age	-.004***	-.015***
	(.001)	(.004)
educ	.01*	.04*
	(.005)	(.021)
_cons	.619***	.486
	(.085)	(.355)
Observations	974	974

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix C.14

Year=2012	(1) little	(2) little
age	-.002*	-.009*
	(.001)	(.005)
marry	-.098**	-.411**
	(.041)	(.172)
widow	.001	-.006
	(.08)	(.331)
divorce	0	-.01
	(.054)	(.227)
sep	-.059	-.25
	(.098)	(.404)
_cons	.724***	.925***
	(.047)	(.199)
Observations	967	967

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D Results of Environmental Belief on Energy Expenditure

Column (1) report basic OLS results, Column (2) include controls for OLS, Column (3) report Quantile regression results

Appendix D.1

Year=1987	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.207 (.14)	-.691*** (.154)	-.533*** (.113)	.549*** (.037)	-.072* (.037)	.004 (.041)	-.198*** (.059)	-.465*** (.063)	-.545*** (.062)
ROOMS		.096*** (.008)	.078*** (.007)		.091*** (.002)	.087*** (.003)		.103*** (.004)	.11*** (.004)
PER		-.014 (.011)	-.006 (.008)		.077*** (.002)	.077*** (.003)		.038*** (.004)	.032*** (.004)
lninc		.03*** (.011)	.037*** (.01)		.024*** (.003)	.03*** (.004)		.007* (.004)	.011* (.006)
msa		.275*** (.027)	.258*** (.022)		-.042*** (.007)	-.036*** (.008)		.071*** (.013)	.059*** (.012)
yh		.003*** (.001)	.004*** (0)		-.005*** (0)	-.006*** (0)		.003*** (0)	.004*** (0)
ch		.259*** (.028)	.228*** (.021)		-.14*** (.006)	-.183*** (.007)		.275*** (.01)	.331*** (.011)
detach		-.009 (.043)	-.044 (.029)		.217*** (.009)	.222*** (.01)		.215*** (.015)	.236*** (.018)
_cons	6.408*** (.093)	5.415*** (.136)	5.536*** (.107)	3.638*** (.025)	3.207*** (.034)	3.185*** (.042)	3.744*** (.04)	2.677*** (.054)	2.69*** (.06)
Observations	5698	5698	5698	38503	38503	38503	22367	22367	22367

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.2

Year=1989	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.03	-.38***	-.38***	.751***	.286***	.361***	.152***	0	-.009
	(.104)	(.114)	(.097)	(.032)	(.031)	(.036)	(.046)	(.047)	(.051)
ROOMS		.081***	.069***		.085***	.082***		.088***	.093***
		(.008)	(.007)		(.002)	(.003)		(.003)	(.004)
PER		.003	.004		.061***	.064***		.027***	.024***
		(.009)	(.008)		(.002)	(.003)		(.003)	(.004)
lninc		.023**	.023***		.027***	.03***		.006*	.011***
		(.009)	(.006)		(.003)	(.003)		(.004)	(.004)
msa		.266***	.25***		-.023***	-.019**		.022*	.039***
		(.025)	(.022)		(.008)	(.009)		(.012)	(.012)
yh		.003***	.003***		-.004***	-.005***		.003***	.003***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.235***	.198***		-.114***	-.148***		.224***	.275***
		(.024)	(.022)		(.006)	(.008)		(.009)	(.011)
detach		-.192***	-.183***		.206***	.218***		.205***	.212***
		(.031)	(.033)		(.008)	(.01)		(.013)	(.016)
_cons	6.424***	5.628***	5.853***	3.362***	2.872***	2.846***	3.384***	2.462***	2.383***
	(.076)	(.112)	(.09)	(.024)	(.031)	(.038)	(.034)	(.046)	(.051)
Observations	4718	4718	4718	35220	35220	35220	21868	21868	21868

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.3

Year=1991	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.599***	-.863***	-.786***	.343***	-.001	.012	-.264***	-.273***	-.272***
	(.113)	(.117)	(.098)	(.029)	(.029)	(.036)	(.042)	(.043)	(.05)
ROOMS		.079***	.081***		.088***	.088***		.089***	.094***
		(.008)	(.007)		(.002)	(.003)		(.003)	(.003)
PER		.035***	.031***		.068***	.072***		.033***	.035***
		(.01)	(.009)		(.003)	(.003)		(.004)	(.004)
lninc		.046***	.039***		.021***	.024***		.004	.005
		(.011)	(.01)		(.002)	(.004)		(.003)	(.003)
msa		.224***	.216***		.001	.022**		.012	.021*
		(.027)	(.022)		(.007)	(.009)		(.011)	(.012)
yh		.004***	.002***		-.004***	-.005***		.003***	.003***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.206***	.237***		-.111***	-.145***		.253***	.296***
		(.026)	(.023)		(.006)	(.008)		(.009)	(.01)
detach		.063	-.014		.194***	.196***		.208***	.232***
		(.04)	(.033)		(.008)	(.01)		(.013)	(.016)
_cons	6.819***	5.441***	5.681***	3.75***	3.158***	3.148***	3.714***	2.676***	2.62***
	(.074)	(.134)	(.113)	(.02)	(.03)	(.042)	(.029)	(.043)	(.048)
Observations	5284	5284	5284	39921	39921	39921	24244	24244	24244

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.4

Year=1993	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.338***	-.52***	-.523***	.094***	-.043*	-.05*	-.357***	-.278***	-.311***

	(.088)	(.096)	(.078)	(.024)	(.024)	(.028)	(.034)	(.035)	(.042)
ROOMS		.074***	.073***		.087***	.089***		.095***	.104***
		(.007)	(.007)		(.002)	(.002)		(.003)	(.004)
PER		.023**	.026***		.075***	.079***		.034***	.031***
		(.01)	(.009)		(.002)	(.003)		(.003)	(.004)
lninc		.013	.018**		.01***	.011***		-.001	0
		(.008)	(.008)		(.002)	(.002)		(.003)	(.004)
msa		.193***	.193***		-.01	-.004		.015	.019
		(.025)	(.023)		(.007)	(.009)		(.011)	(.014)
yh		.001**	.001***		-.004***	-.005***		.003***	.004***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.26***	.22***		-.168***	-.203***		.268***	.308***
		(.024)	(.022)		(.006)	(.007)		(.009)	(.011)
detach		.005	-.05		.205***	.204***		.16***	.17***
		(.036)	(.034)		(.008)	(.01)		(.013)	(.018)
_cons	6.601***	5.697***	5.826***	4.062***	3.428***	3.448***	3.784***	2.689***	2.653***
	(.047)	(.103)	(.089)	(.014)	(.026)	(.029)	(.019)	(.038)	(.048)
Observations	4456	4456	4456	36593	36593	36593	22872	22872	22872

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.5

Year=1995	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.324***	-.44***	-.467***	-.206***	-.164***	-.142***	-.598***	-.397***	-.431***
	(.111)	(.117)	(.09)	(.027)	(.026)	(.031)	(.038)	(.038)	(.044)
ROOMS		.07***	.062***		.08***	.083***		.081***	.089***

		(.009)	(.005)		(.002)	(.002)		(.003)	(.003)
PER		.021*	.031***		.074***	.078***		.031***	.028***
		(.011)	(.009)		(.002)	(.003)		(.003)	(.004)
lninc		.029***	.019***		.013***	.011***		.008***	.009**
		(.01)	(.007)		(.002)	(.002)		(.003)	(.003)
msa		.147***	.169***		-.001	-.012		.001	.008
		(.028)	(.021)		(.007)	(.009)		(.011)	(.011)
yh		.002***	.002***		-.004***	-.004***		.003***	.003***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.171***	.171***		-.161***	-.203***		.26***	.296***
		(.027)	(.023)		(.006)	(.007)		(.009)	(.01)
detach		-.046	-.116***		.197***	.2***		.156***	.148***
		(.038)	(.033)		(.008)	(.01)		(.012)	(.016)
_cons	6.562***	5.559***	5.872***	4.224***	3.482***	3.523***	3.923***	2.792***	2.768***
	(.062)	(.12)	(.093)	(.016)	(.026)	(.03)	(.022)	(.038)	(.046)
Observations	4549	4549	4549	41236	41236	41236	27018	27018	27018

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.6

Year=1997	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.683***	-.653***	-.371***	-.368***	-.058**	-.035	-.57***	-.24***	-.229***
	(.143)	(.148)	(.091)	(.027)	(.025)	(.03)	(.04)	(.039)	(.043)
ROOMS		.097***	.081***		.086***	.087***		.101***	.11***
		(.011)	(.007)		(.002)	(.002)		(.003)	(.003)
PER		.021*	.027***		.073***	.075***		.031***	.021***

		(.013)	(.008)		(.002)	(.003)		(.003)	(.004)
lninc		.017*	.015**		.006***	.009***		.006**	.011***
		(.01)	(.008)		(.002)	(.002)		(.003)	(.004)
msa		.175***	.171***		-.016**	-.004		-.03**	-.028**
		(.033)	(.024)		(.007)	(.009)		(.012)	(.013)
yh		.005***	.003***		-.004***	-.004***		.003***	.004***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.269***	.213***		-.172***	-.208***		.285***	.318***
		(.036)	(.025)		(.006)	(.008)		(.01)	(.011)
detach		.203***	.011		.235***	.248***		.161***	.167***
		(.063)	(.041)		(.009)	(.01)		(.014)	(.016)
_cons	6.738***	5.14***	5.642***	4.292***	3.419***	3.402***	3.998***	2.669***	2.579***
	(.075)	(.148)	(.103)	(.016)	(.027)	(.03)	(.023)	(.04)	(.05)
Observations	3564	3564	3564	35161	35161	35161	22170	22170	22170

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.7

Year=1999	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.409**	-.461**	-.353**	-.358***	-.219***	-.202***	-.748***	-.476***	-.506***
	(.18)	(.182)	(.149)	(.036)	(.034)	(.041)	(.053)	(.055)	(.057)
ROOMS		.109***	.084***		.09***	.089***		.103***	.106***
		(.009)	(.008)		(.002)	(.002)		(.003)	(.003)
PER		.019	.02*		.07***	.071***		.034***	.03***
		(.013)	(.011)		(.002)	(.003)		(.003)	(.004)
lninc		.006	.013		.011***	.011***		-.003	-.002

		(.008)	(.008)		(.002)	(.002)		(.003)	(.003)
msa		.178***	.198***		-.005	0		-.001	-.008
		(.035)	(.028)		(.007)	(.009)		(.012)	(.012)
yh		.005***	.002***		-.003***	-.003***		.003***	.003***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.217***	.149***		-.173***	-.202***		.225***	.252***
		(.033)	(.027)		(.006)	(.007)		(.009)	(.01)
detach		.248***	.121***		.22***	.226***		.138***	.182***
		(.057)	(.047)		(.008)	(.01)		(.013)	(.014)
_cons	6.548***	5.042***	5.486***	4.277***	3.436***	3.452***	4.089***	2.902***	2.866***
	(.102)	(.148)	(.129)	(.022)	(.029)	(.033)	(.032)	(.045)	(.047)
Observations	3722	3722	3722	41472	41472	41472	27281	27281	27281

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.8

Year=2001	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.372**	-.516***	-.226*	-.368***	-.105***	-.111**	-.603***	-.271***	-.316***
	(.188)	(.19)	(.132)	(.04)	(.037)	(.045)	(.06)	(.058)	(.06)
ROOMS		.1***	.082***		.075***	.073***		.094***	.098***
		(.009)	(.007)		(.002)	(.002)		(.003)	(.003)
PER		.017	.01		.08***	.08***		.036***	.026***
		(.012)	(.009)		(.003)	(.003)		(.004)	(.004)
lninc		.024***	.02***		.008***	.009***		0	.009***
		(.009)	(.007)		(.002)	(.002)		(.003)	(.003)
msa		.233***	.203***		.006	.014		-.026**	-.023*

		(.033)	(.026)		(.008)	(.011)		(.013)	(.013)
yh		.002***	.002***		-.003***	-.004***		.003***	.004***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.269***	.199***		-.164***	-.188***		.203***	.252***
		(.033)	(.026)		(.007)	(.008)		(.01)	(.011)
detach		.072	.071*		.254***	.249***		.266***	.291***
		(.055)	(.039)		(.009)	(.011)		(.015)	(.016)
_cons	6.88***	5.517***	5.703***	4.277***	3.413***	3.44***	4.351***	3.05***	2.953***
	(.11)	(.165)	(.115)	(.025)	(.031)	(.039)	(.037)	(.05)	(.053)
Observations	3319	3319	3319	37765	37765	37765	24267	24267	24267

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.9

Year=2003	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.498**	-.591***	-.434***	-.759***	-.271***	-.268***	-.93***	-.502***	-.524***
	(.215)	(.216)	(.155)	(.036)	(.034)	(.041)	(.054)	(.053)	(.058)
ROOMS		.07***	.065***		.07***	.067***		.077***	.086***
		(.01)	(.006)		(.002)	(.002)		(.002)	(.003)
PER		.035***	.032***		.065***	.068***		.021***	.013***
		(.012)	(.008)		(.002)	(.002)		(.003)	(.003)
lninc		.049***	.035***		.008***	.007***		.007***	.008***
		(.011)	(.009)		(.001)	(.001)		(.002)	(.002)
msa		.174***	.166***		-.007	-.015*		.085***	.04***
		(.034)	(.024)		(.007)	(.008)		(.012)	(.012)
yh		.004***	.002***		-.003***	-.003***		.004***	.004***

		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.238***	.179***		-.124***	-.149***		.255***	.303***
		(.034)	(.028)		(.005)	(.006)		(.008)	(.009)
detach		.193***	.017		.162***	.152***		.142***	.146***
		(.063)	(.044)		(.007)	(.009)		(.012)	(.013)
_cons	6.948***	5.279***	5.831***	4.561***	3.66***	3.711***	4.401***	3.078***	3.05***
	(.119)	(.187)	(.135)	(.021)	(.027)	(.032)	(.031)	(.043)	(.046)
Observations	3413	3413	3413	43284	43284	43284	27128	27128	27128

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.10

Year=2005	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	.66***	.298	.265	-.47***	-.046	-.12***	-.325***	-.112**	-.091
	(.236)	(.223)	(.167)	(.039)	(.036)	(.041)	(.06)	(.057)	(.066)
ROOMS		.077***	.058***		.063***	.059***		.079***	.082***
		(.008)	(.007)		(.002)	(.002)		(.002)	(.002)
PER		.016	.021**		.066***	.07***		.014***	.007**
		(.013)	(.009)		(.002)	(.002)		(.003)	(.004)
lninc		.038***	.038***		.01***	.012***		.004	.011***
		(.013)	(.014)		(.002)	(.002)		(.003)	(.003)
msa		.308***	.235***		-.014**	-.013		.122***	.092***
		(.038)	(.026)		(.007)	(.008)		(.012)	(.012)
yh		.005***	.002***		-.002***	-.003***		.004***	.004***
		(.001)	(0)		(0)	(0)		(0)	(0)
ch		.34***	.212***		-.115***	-.143***		.253***	.308***

		(.038)	(.027)		(.006)	(.007)		(.009)	(.01)
detach		.136**	.076		.194***	.193***		.139***	.158***
		(.062)	(.051)		(.008)	(.009)		(.012)	(.015)
_cons	6.501***	4.962***	5.539***	4.465***	3.563***	3.614***	4.325***	3.118***	3.016***
	(.141)	(.194)	(.165)	(.024)	(.03)	(.035)	(.036)	(.048)	(.055)
Observations	3113	3113	3113	38519	38519	38519	23809	23809	23809

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.11

Year=2007	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	.365*	.032	.315*	-.184***	.163***	.101**	.097	.263***	.241***
	(.211)	(.211)	(.17)	(.041)	(.037)	(.044)	(.062)	(.059)	(.068)
ROOMS		.1***	.11***		.093***	.087***		.117***	.124***
		(.012)	(.01)		(.002)	(.003)		(.004)	(.004)
PER		-.006	.002		.077***	.083***		.005	0
		(.012)	(.011)		(.002)	(.003)		(.004)	(.004)
lninc		.027*	.014		.009***	.012***		.009***	.015***
		(.014)	(.014)		(.002)	(.002)		(.003)	(.004)
msa		.211***	.164***		-.017**	-.023***		.103***	.08***
		(.037)	(.031)		(.007)	(.009)		(.013)	(.014)
yh		.001*	0		-.002***	-.002***		.003***	.004***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.246***	.247***		-.122***	-.156***		.222***	.226***
		(.036)	(.033)		(.006)	(.007)		(.01)	(.011)
detach		.097	0		.198***	.193***		.122***	.106***

		(.06)	(.047)		(.009)	(.01)		(.014)	(.017)
_cons	6.974***	5.812***	5.945***	4.673***	3.615***	3.703***	4.07***	2.701***	2.663***
	(.136)	(.2)	(.169)	(.028)	(.034)	(.039)	(.041)	(.053)	(.064)
Observations	2340	2340	2340	34784	34784	34784	22566	22566	22566

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.12

Year=2009	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	.163	-.486**	.081	.316***	.014	0	.038	-.077*	-.016
	(.176)	(.196)	(.189)	(.034)	(.032)	(.037)	(.046)	(.043)	(.053)
ROOMS		.089***	.102***		.092***	.081***		.131***	.135***
		(.016)	(.012)		(.002)	(.002)		(.003)	(.003)
PER		.014	.001		.083***	.088***		.017***	.007**
		(.013)	(.013)		(.002)	(.003)		(.003)	(.003)
lninc		.037**	.025*		.01***	.012***		.007***	.012***
		(.015)	(.015)		(.002)	(.002)		(.003)	(.003)
msa		.204***	.099**		-.042***	-.043***		.059***	.053***
		(.045)	(.043)		(.007)	(.009)		(.011)	(.013)
yh		.001	0		-.002***	-.003***		.004***	.005***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.236***	.203***		-.167***	-.208***		.187***	.186***
		(.037)	(.035)		(.006)	(.007)		(.008)	(.01)
detach		.1*	.018		.22***	.221***		.148***	.124***
		(.061)	(.059)		(.008)	(.01)		(.012)	(.015)
_cons	7.198***	6.178***	6.204***	4.437***	3.826***	3.907***	4.237***	2.938***	2.865***

	(.113)	(.177)	(.177)	(.023)	(.027)	(.033)	(.031)	(.041)	(.048)
Observations	2670	2670	2670	40599	40599	40599	27237	27237	27237

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Appendix D.13

Year=2011	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-.389	-.941**	-.755***	.198***	-.038	.01	-.096	-.088	-.041
	(.322)	(.391)	(.253)	(.044)	(.041)	(.046)	(.064)	(.062)	(.063)
ROOMS		.1***	.094***		.092***	.082***		.122***	.122***
		(.016)	(.011)		(.002)	(.002)		(.003)	(.003)
PER		-.018	.018		.09***	.092***		.024***	.019***
		(.025)	(.014)		(.002)	(.002)		(.003)	(.003)
lninc		.046***	.028**		.005***	.005***		.013***	.013***
		(.016)	(.011)		(.001)	(.001)		(.002)	(.002)
msa		.32***	.281***		-.058***	-.045***		.077***	.09***
		(.065)	(.043)		(.006)	(.007)		(.011)	(.011)
yh		-.001	.001		-.002***	-.002***		.004***	.005***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.143**	.131***		-.195***	-.226***		.224***	.172***
		(.056)	(.033)		(.005)	(.006)		(.008)	(.008)
detach		.113	.067		.194***	.175***		.113***	.068***
		(.1)	(.061)		(.007)	(.008)		(.012)	(.012)
_cons	7.484***	6.295***	6.549***	4.552***	3.968***	4.041***	4.252***	2.866***	2.872***
	(.173)	(.272)	(.174)	(.025)	(.028)	(.031)	(.036)	(.043)	(.043)
Observations	2505	2505	2505	46057	46057	46057	29156	29156	29156

Standard errors are in parentheses
***** p<.01, ** p<.05, * p<.1**

Appendix D.14

Year=2013	(1) lamto	(2) lamto	(3) lamto	(1) lamte	(2) lamte	(3) lamte	(1) lamtg	(2) lamtg	(3) lamtg
natenvir	-2.074***	-1.677***	-1.109***	-2.286***	-.383***	-.323***	-1.947***	-.567***	-.761***
	(.553)	(.584)	(.322)	(.05)	(.049)	(.049)	(.079)	(.078)	(.093)
ROOMS		.081***	.089***		.086***	.077***		.125***	.121***
		(.013)	(.011)		(.002)	(.002)		(.003)	(.003)
PER		-.006	.008		.078***	.086***		.011***	.009***
		(.024)	(.012)		(.002)	(.002)		(.003)	(.003)
lninc		.048***	.022**		.003**	.002		.014***	.016***
		(.014)	(.01)		(.001)	(.001)		(.002)	(.002)
msa		.308***	.216***		-.078***	-.09***		.172***	.198***
		(.064)	(.045)		(.006)	(.007)		(.012)	(.013)
yh		.001	.001		-.002***	-.003***		.005***	.005***
		(.001)	(.001)		(0)	(0)		(0)	(0)
ch		.177***	.144***		-.152***	-.198***		.252***	.282***
		(.052)	(.034)		(.005)	(.005)		(.009)	(.01)
detach		-.121*	.003		.222***	.18***		.103***	.045***
		(.067)	(.065)		(.007)	(.007)		(.012)	(.015)
_cons	8.458***	6.922***	7.002***	5.854***	4.126***	4.216***	4.811***	2.524***	2.603***
	(.292)	(.397)	(.246)	(.028)	(.036)	(.035)	(.044)	(.058)	(.068)
Observations	2963	2963	2963	53616	53616	53616	35019	35019	35019

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*