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Panel data analysis of fuel price elasticities to vehicle-miles traveled for first year participants of the national evaluation of a mileage-based road user charge study

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PANEL DATA ANALYSIS OF FUEL PRICE ELASTICITIES TO VEHICLE-MILES TRAVELED FOR FIRST YEAR PARTICIPANTS OF THE NATIONAL EVALUATION OF A MILEAGE-BASED ROAD USER CHARGE STUDY

by

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CERTIFICATE OF APPROVAL

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MASTER'S THESIS

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This is to certify that the Master's thesis of

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has been approved by the Examining Committee
for the thesis requirement for the Master of Science
degree in Civil and Environmental Engineering at the July 2011 graduation.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The impact of fuel price changes can be seen in practically all sectors of the United States economy. Fuel prices directly and indirectly influence the daily life of most Americans. The national economy as well as the high standard of living we have come to enjoy in the United States is run on gasoline. Since the late 1990's the days of cheap oil and $1.00 gallons of gas are clearly over, understanding the influences of fuel price is more important now than ever. Since 1998 regular gasoline prices have increased $0.22 per gallon per year on average through the present with little evidence suggesting this trend will slow down or reverse substantially. The drastic and permanent change to the status quo of fuel prices has potentially rendered traditional knowledge of fuel price elasticities inapplicable to current analysis. Obtaining accurate measures of fuel price elasticities is important as it is used as a measure of personal mobility and can be related to the quality of life the public is experiencing. Price elasticities are also used in determining the future revenue available for surface transportation projects. Traditionally, short-run fuel price elasticities are thought to be inelastic allowing transportation agencies to ignore short-run fuel price changes to some degree when creating future projects and evaluating its economic feasibility. By using driving data collected from *The National Evaluation of a Mileage-based Road User Study* the fuel price elasticity of vehicle-miles traveled (VMT), as well as the sensitivity of gas prices relative to a historical high price, were estimated for the first year study participants using a panel data set approach with linear regression. The short-run fuel price elasticity of VMT was determined to be -1.71 with a range of -1.93 and -1.48. The elasticities found were significantly higher than the average short-run fuel price elasticity of -0.45 but can be rationalized by the impact poor economic conditions as well as the historically high fuel prices experienced prior to the researches time table had on the individuals driving behavior. The results suggest current short-run elasticities are not inelastic, if this trend continues transportation agencies must re-evaluate how they predict the future funding available for surface transportation projects.

BACKGROUND

The influence of fuel price on VMT is the primary goal of the analysis. However, there are many ways to interpret these influences. The fuel price changes over a given time period could be taken as a single independent change and evaluated as such to create a fuel price elasticity. While fuel price elasticities can be determined for long, medium and short-run periods the focus of this analysis deals only with short-run elasticities. Numerous studies have been conducted through the years to determine fuel price elasticities with varying results. Studies concluded by Dahl and Sterner (1991) found typical short-run fuel price elasticities of VMT to be -0.26. These elasticities relate that a 10% increase in fuel prices will most likely reduce VMT 2.6% in the short term. Additionally, Small and Van Dender (2007) found a short-run fuel price elasticity of VMT to be -0.45 on average from 1966-2001. Small and Van Dender's research used aggregated macro data from pooled cross-sectional time-series data at the U.S. State level for their elasticity analysis. By using aggregated data the potential to lose some information and relationships along the way becomes more likely.

Issues arising from consumer choice and behavior, such as how the individual perceives the price and how that affects their driving behaviors, allow for variations of analysis of fuel price changes. Does the individual consumer consciously perceive the price in relation to an all-time high price or rather a short-run comparison of what the gas price was? One such study conducted by Willenborg and Pitts (1977) of consumer behavior with relation to fuel price changes in the long-run and short-run in the mid-1970s suggested that when analyzing consumer behavior it is considerably more beneficial to view their perception of price and subsequent behavior in the short-run. The authors theorized that consumers will in some ways change their driving behavior during the short run but tend to be unaffected by increasing prices over the long-run as they grow comfortable with new peaks and lows. Overall, consumers in general refuse to change their driving behavior in the short-run and would adapt to most changes except in drastic episodes of price change. As illustrated in Figure 1, since the late 1990's fuel prices have stayed relatively low and stable. However, recent trends of the 2000-2009 decade have completely changed the fuel price landscape, most notably in the summer of 2008 when the all-time historic fuel price at that time was experienced. This episode of drastic change occurred just prior to the driving data's time table.

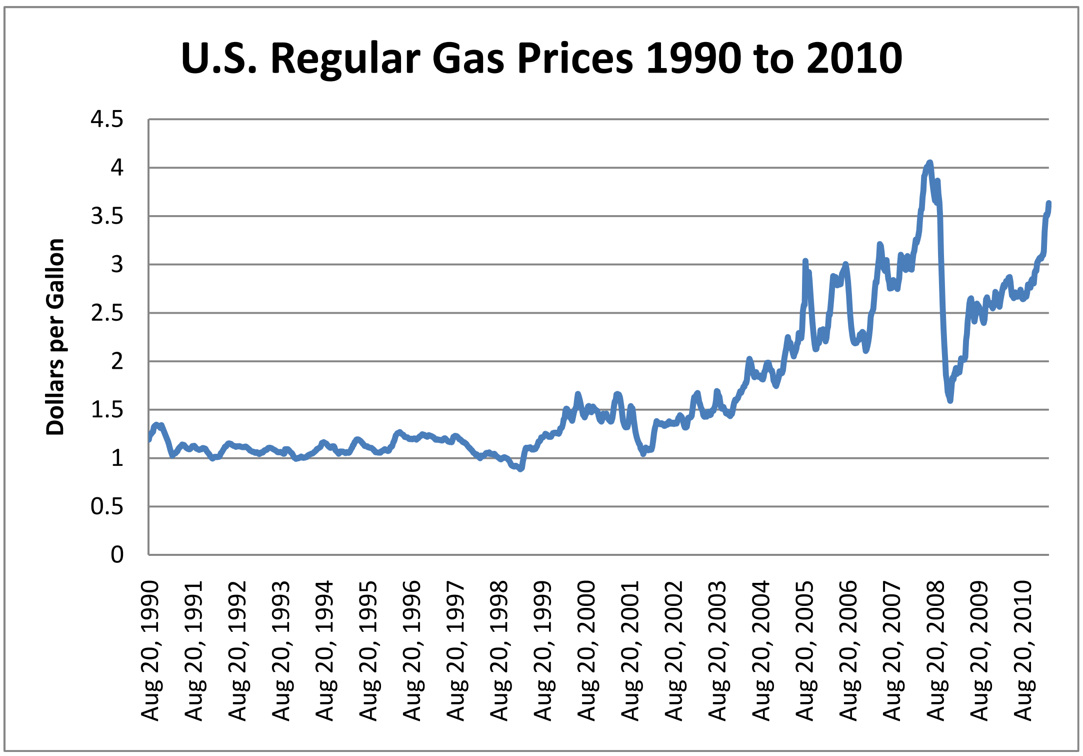

Figure 1. U.S. Regular Gas Prices 1990 to 2010

"U.S. Retail Gasoline Historical Prices." Www.eia.doe.gov. Web. 12 Apr. 2011.

Transportation agencies and Civil Engineering firms need to have a good understanding of the impacts of fuel price changes as it directly affects their ability to predict the available funding in the future for projects. Fuel price elasticities are an important factor in estimating future VMT and thus the amount of money that will be generated by the gas tax. Typically, short-run fuel price elasticities are considered to be inelastic allowing agencies to disregard the impact of short-run price changes when estimating future VMT and funding. However, given the recent fuel price trends it is important that fuel price elasticities are re-evaluated.

METHODOLOGY

A panel data analysis model will be applied to estimate the fuel price elasticity of VMT. There are various types of analysis available with panel data sets such as: fixed effects (FE) models, random effects (RE) models and others. Within these models there are dynamic, robust and covariance panel structure models. For this research the FE and RE linear regression models were the primary candidates for the analysis. A FE model is used whenever you are only interested in analyzing the impact of variables that do not change over time. In this case if a FE model would be appropriate it would limit the analysis of VMT to the price related variables while holding all the other socio-demographic variables constant. A FE model will attempt to control the biasing effects of time-invariant variables in order to better assess the impact of the changing variables. The general equation for the FE model is displayed below.

$$y_{it} = \beta X_{it} + \alpha_i + u_{it}$$

'y' is the dependent variable with 'i' individuals and 't' time periods, 'X_{it}' is an independent variable which varies over time. 'α' is the unknown intercept for each individual, this term will absorb the impacts of the time-invariant variables in the equation as well as any heterogeneity in the data. Finally, 'u_{it}' is the error term associated with the model. For example, when analyzing the differences in driving behavior between individuals using a FE model would be beneficial if the impact of time independent individual-specific characteristics were not relevant to the relationship in question, i.e. the impact of fuel price on VMT.

The RE model differs from the FE model in that the differences between individuals are assumed to be random and uncorrelated rather that fixed. This distinction allows the time-invariant socio-demographic variables to be included and analyzed rather than be absorbed by the intercept as in the FE model, depending on what the particular aim of the research is this can be both a positive or negative.

$$y_{it} = \beta X_{it} + \alpha_i + u_{it} + \varepsilon_{it}$$

The key difference in the equation for the RE model is the inclusion of 'ε_{it}' which is the error term associated with the variables within each individual, such as socio-demographic time-invariant variables. The other distinction between the models is the error term 'u_{it}' only represents the errors associated with variables that occur between the individuals, such as price related variables which will change with time and do not depend on the individual's characteristics. When analyzing the effect of fuel prices on individuals driving behaviors a RE model would allow all of the variables relationships to be determined providing additional insight from the model.

Panel dataset analysis is a form of longitudinal data analysis which contains a two dimensional cross-section of data where individuals are observed over multiple time periods. For the panel data analysis the individuals' data were observed in monthly time increments. By using panel data analysis the repeated observations of the individuals in the study allows the analysis to determine what, if any, changes occurred throughout the time period. If the panel data set contains no missing values, all individuals are observed an equal number of times, the panel is considered to be a balanced panel. However, if there are missing values it is considered to be an unbalanced panel. The data set used in the analysis was an unbalanced panel, most of the missing values can be attributed to some participants either entering the study late or exiting the study early. If a panel data set is unbalanced mathematical adjustments are made to the models. This is handled automatically by the statistical software packages used for the analysis.

Panel data analysis was used to estimate the impacts of price and demographic variables on vehicle miles traveled. Panel data increases the possibility of violating the statistical assumptions need to provide reliable inferences. The most common violations are heteroskedasticity and autocorrelation with the error terms. Heteroskedasticity occurs when the standard deviations of a variable vary over a specific amount of time. While using panel data regression it is assumed that the error terms for a given individual will be uncorrelated over time and the standard deviations of the error terms will be consistent over time. However, this may not be the case. To control for it robust standard errors will be used to calculate heteroskedasticity and autocorrelation consistent standard errors. Additionally, a time-lagged variable will be included to address any autocorrelation issues. For further statistical detail and background on the panel data analysis regression models please refer to *Introduction to Econometrics* by Stock and Watson (2007).

DATA

The data used in the following research was taken from *The National Evaluation of a Mileage-based Road User Charge Study*. Although, the study was preformed for two sets of participants over two years only data collected from year one was used in this research. The study involved approximately 1,200 volunteer participants throughout the United States whose vehicles were outfitted with an on-board computer unit with Global Positioning Systems (GPS) to obtain total vehicle miles traveled data on a daily basis. The fuel price information used in the research was obtained from purchasing city specific average daily fuel prices from the website 'www.GasBuddy.com'. By using self-reported micro data instead of aggregated macro data the analysis will have a higher resolution that allows the investigation of individually revealed behavior.

The socio-demographic information was obtained from the participants through pre-study screening questionnaires as well as surveys completed throughout the participant's time in the study. A breakdown of the participants' socio-demographic distribution can be seen in Tables A1 through A9 in the attached Appendix covering age, gender, miles-per gallon rating, a comparison of vehicle type with VMT and MPG, student status, employment status, education level, income and political scale respectively. The socio-demographic distribution of the group is an acceptable match to the population of the United States as a whole allowing any conclusions found to be extrapolated to the larger population. For specific information on *The National Evaluation of a Mileage-based Road User Charge Study* or further documentation of the participants' match to the general population please contact to refer to *The National Evaluation of a Mileage-Based Road User Charge Final Report* which is currently not released to the public.

The model's data includes 1,193 individuals with 8,509 total observations. The maximum and minimum observations per individual were ten and one respectively with an average of 7.2. The individuals and fuel prices spanned across six cities: Austin, Texas, Baltimore, Maryland, Eastern Iowa, The Research Triangle in North Carolina, Boise, Idaho, and San Diego, California. Monthly VMT was used for the time period of November 2008 to August 2009.

VARIABLES

In addition to evaluating how the price of fuel affected the amount of driving done by the individuals it is also important to compare the results of how the individuals' socio-demographic data affected the amount of driving to conventional knowledge on the interactions when creating the base model. The variables included in the base model were chosen for a variety of reasons. A summary of the currently accepted relationships between the different socio-demographic variables and VMT as well as the justification of the variables for being included in the base model will be explained below.

Age

The age of the vehicles primary driver was included in the base model to assess how the data set fits within general knowledge on the influence of age on VMT. It is generally accepted that older drivers, after age 49 and on, will drive fewer miles than younger primary drivers, with the exception of 16 and 17 year-old primary drivers. Individuals' ages 18 through 49 drive significantly more miles while the differences in VMT within their age ranges were statistically insignificant as illustrated in Figure 2. Another way to interpret the impacts associated with age is to classify the individual based on where in their life cycle they are. Much of the VMT-age groupings can be attributed to this form of classification. Although, the individuals' life cycle classification was not explicitly available from the Road User Study's data the age variable and additional variables can be an indirect measure of this impact.

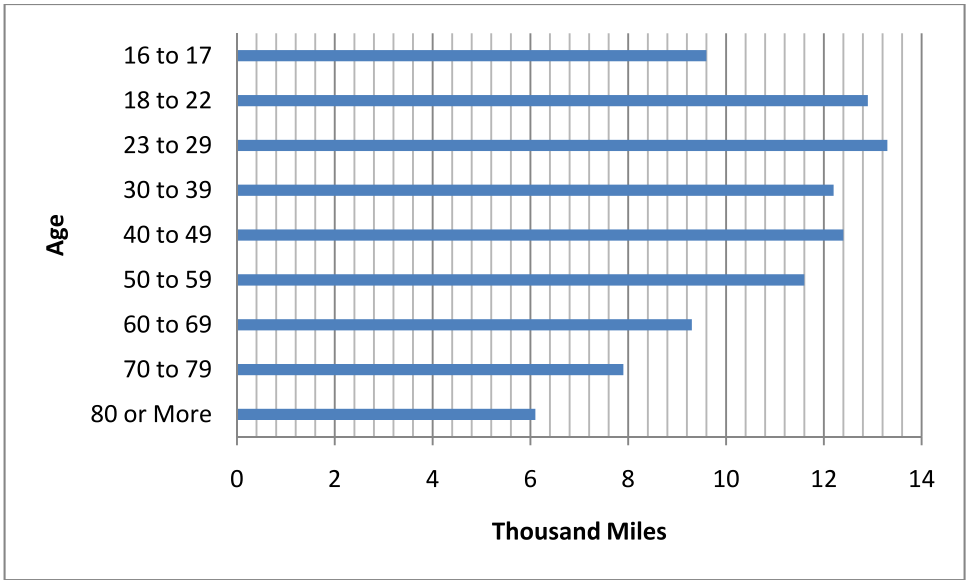

Figure 2. Age Versus VMT Trends

Dahl, C. and Sterner, T., 1991. Analyzing gasoline demand elasticities: a survey, Energy Econ. 13, 3, pp. 203–210.

Student Status

Whether or not the individual was a student was included in the base model and is an indirect measure of life cycle classification. It is expected that students on average will drive less than a non-student individual. This coincides with the decline in VMT associated with the 16 and 17 year-old individuals.

Gender

Gender was included in the base model to capture the differences in the travel patterns of men and women. In general men drive significantly more miles per year then women. However, the nature of their travel is considerably different. Women will tend to make more trips, but of smaller distances, than men. Although, current VMT trends suggest that the gap in VMT and travel behavior between men and women is closing as societal trends driving the difference change according to Sloboda and Yao (2005).

Income

The reported income of the primary driver can be used to estimate the VMT of the vehicle. Typically VMT increases with income as shown in Figure 3, although the relationship changes significantly when combined with the composition of the household. Income was included in the base model, however, because income is highly correlated with education level only one of the two variables will be included in later models.

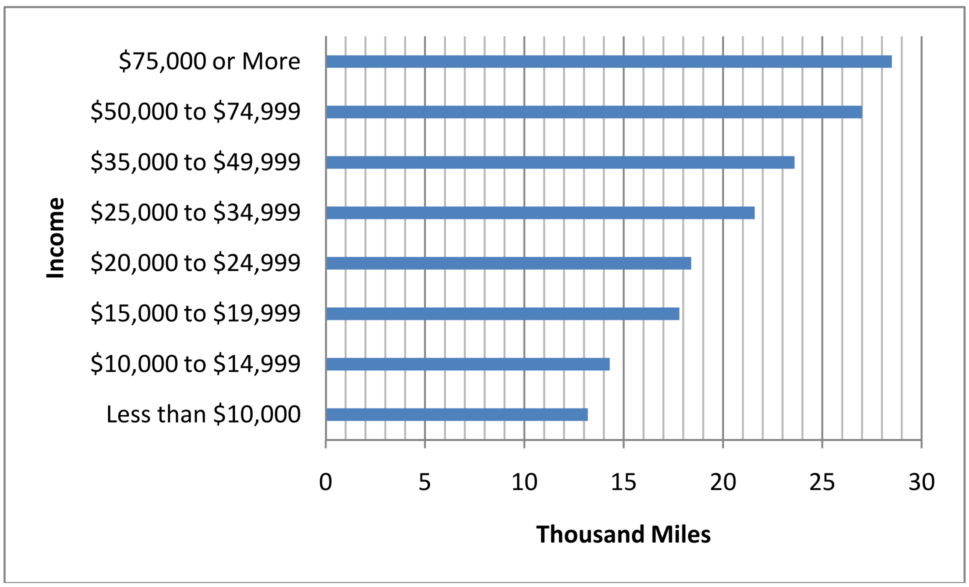

Figure 3. Income Versus VMT Trends

Dahl, C. and Sterner, T., 1991. Analyzing gasoline demand elasticities: a survey, Energy Econ. 13, 3, pp. 203–210.

Education

Education level was chosen ahead of income because the validity of the income values associated with the individuals is more likely to be incorrect because they were self-reported by the individual who is more likely to provide inaccurate information regarding income than education level.

Employment Status

Whether or not the individual was employed can also have a significant influence on the individual's VMT as individuals who are employed will make significantly more trips and have a much higher VMT. Because of its predictive qualities the individual's employment status was included in the base model.

Month

The time influences on VMT are captured by including monthly dummy variables in the base model. The average VMT per vehicle will on average fluctuate throughout the year; this is summarized in Figure 4. Generally speaking it can be seen that average monthly VMT will be highest during the summer months while being lowest during the coldest months such as December through February. The causes of the variation occur for a variety of reasons such as inclement weather, vacation times, school and work schedule changes etc.

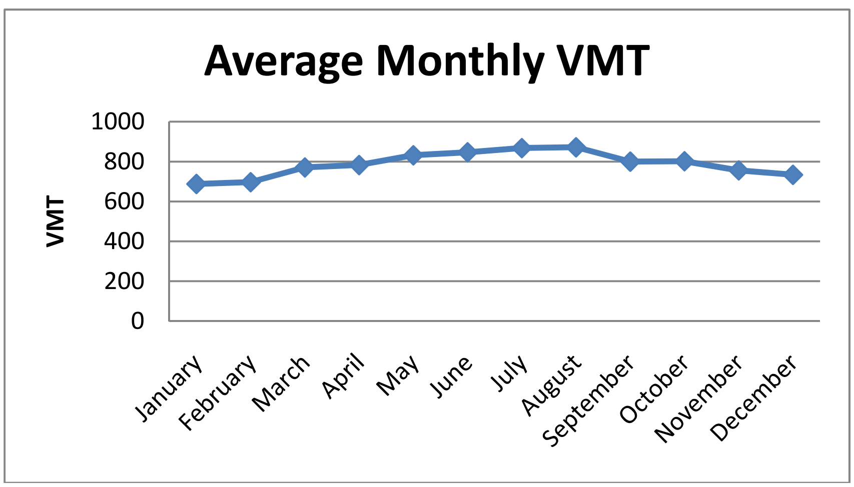

Figure 4. Monthly VMT Trends

Dahl, C. and Sterner, T., 1991. Analyzing gasoline demand elasticities: a survey, Energy Econ. 13, 3, pp. 203–210.

Geographic Site

The site the individual was selected from was brought into the analysis using dummy variables. The sites can be generally differentiated into rural and urban sites. Rural roads make up an overwhelming majority of the roads in the United States. As of 1996 there was 3,092,773 miles of rural road compared to only 826,677 miles of urban road. However, despite the considerable difference in miles of road associated with rural and urban roads, urban roads experienced considerably more VMT than rural roads, 1,522,139 million VMT urban to 960,063 million VMT rural. Individuals from states and sites that are characterized as more urban than rural should have higher VMT Avgoustis (1999).

Miles Per-Gallon Rating

The MPG rating used in the research is based off the type of vehicle the participant had outfitted with the OBU for the RUS study. Research by the Federal Highway Administration using 2001 National Household Travel Survey data found a general pattern that the average MPG rating of the vehicle type was inversely related to the annual miles driven for that vehicle type according to.

With reference to Table A7 comparing the average car with the average Van, SUV or Pickup cars, all of which had a lower MPG rating, the lower MPG rating had significantly fewer annual miles.

Self-reported Political Scale

The effects of a drivers self-reported political scale on the drivers VMT, if any, has not been significantly researched. Consequently, the inclusion of a political scale variable in the analysis will not serve as an additional check for the models validity. Any significant relationships found will be purely for secondary investigation.

RESULTS

The research's final model utilized a RE model with a robust panel structure. The RE model was chosen over the FE model primarily because the analysis of the impacts of the participants' socio-demographic variables was of great interest and value. How the participants' socio-demographic variables affected the model and how the results coincide with generally accepted patterns was important. The FE and RE models were both statistically appropriate to use given the data used. A robust standard errors method was used to control for any heteroskedasticity and autocorrelation that may occur.

The impact of fuel prices on VMT was primarily analyzed using SPSS, STATA and Microsoft Office. The analysis of fuel price was interpreted in two different ways. The first and primary method was analyzing the relationship using an average monthly unleaded fuel price while the second method evaluated the fuel price as the difference between the fuel price and the historical high, which was $4.28 in July 2008. By incorporating the two different fuel price variables it is possible to better comment on the drivers behavior based on the differences in the results.

From the creation of the base model, subsequent model were also made by stripping away any statistical insignificant variables to arrive at a final model. This process was completed for both average monthly unleaded fuel price as well as for the difference between the fuel price and the historic high price for coefficient relationships as well as fuel price elasticities. In Appendix B the results for the RE models with robust standard errors for the different stages of the coefficient analysis can be seen. For all of the models the socio-demographic variables were all converted and calculated as dummy variables. Only the individual's age and the associated fuel prices were imported as continuous variables.

Model 1

The base model RE analysis with robust standard errors of the average monthly unleaded fuel price shows a moderately strong R squared value of 0.512 for social science data analysis. For the base model all potentially relevant variables were included. Variables that either did not satisfy the 95% confidence interval of significance or were thought to be too highly correlated with other variables were eliminated. In Table B1 the base model for the average monthly unleaded fuel price analysis can be seen.

As mentioned in the previous section the income variable was eliminated from the model because it both did not meet the significance requirements for any of its options and was thought to be too correlated and derivative of the education variable which is also more likely to be accurate. Interestingly, the rated miles-per gallon fuel economy of the vehicle was found to have an insignificant relationship with VMT this would seem to be counter-intuitive. The February 2009 dummy variable was eliminated because it was too correlated with the driving behavior of January 2009 which was the default dummy variable for the set. Additionally, whether or not the individual was a student was found to be insignificant. A one month time lagged variable of the total miles traveled variable was included in the model to account for autocorrelation in the model.

Model 2

After eliminating the statistically insignificant variables the final model, see Table B2, was developed and will be used for further commenting. The average monthly price was found to be significant with a -3.84 coefficient. This means that for every one cent increase in the average monthly unleaded fuel price the driver will most likely decrease his/her traveling by 3.84 miles per month. The continuous age variable was found to be significant with a -0.839 coefficient, meaning for every one year older the individual is they will drive 0.839 miles less per month. The individuals' gender was significant at the 90% confidence interval and indicated that men will drive 21.73 miles more per month than women. Employed individuals will most likely drive 47.12 miles more than an unemployed individual. The relationships found with the aforementioned socio-demographic variables adhere to conventional wisdom.

The relationships found from the site's dummy variables, using California as the default, were all found to be significant with the general relationship showing that the more populous or urban the city and state was the more the individual drove. The time related variables, in monthly format, were consistently significant while displaying driving behaviors that match up with conventional wisdom of seasonal VMT changes. The education dummy variables showed that, in relation to individuals with a high school degree set as the default, persons with no high school and some college drove 51.2 and 41.4 miles less respectively than an individual with a high school degree. Finally, the individuals self-identified political scale affiliation showed that a self-identified liberal individual will most likely drive 34.7 miles less per month than a self-identified moderate individual. Little research has been concluded on the different driving behaviors between people of different self-identified political affiliations making this finding interesting but difficult to comment on the relationship.

By changing the fuel price variable to represent the difference between the regional fuel prices and the national historical high for fuel prices the model does not change significantly. The different measurement of fuel price does not alter the magnitude of the relationship, only the sign is changed. However, the same conclusion is observed. The final model's socio-demographic and time variables are the same up to the third decimal place. Because of these results this form of analysis is derivative of the previous analysis. Because of the lack of a difference in the models the final model which used average monthly unleaded fuel price will be the primary model used for interpretations and conclusions.

Model 3

Finally, the dependent variables as well as all other continuous variables were converted to their natural log so their regression coefficients can be interpreted as elasticities in order to determine the fuel price elasticities for VMT. The results of the final model, using the average monthly unleaded fuel price as the fuel price variable, can be seen in Table B3.

DISCUSSION

The analysis of the impact of fuel price changes to an individual's VMT yielded significant intriguing results. The results of a panel data set linear regression, with socio-demographic variables included, determined the short-run fuel price elasticity of VMT -1.71 valid at the 95% confidence interval with lower and upper bounds of -1.93 and -1.48 respectively. The results for the fuel price elasticities shows that a 1% increase in fuel price will result in the individual decreasing their VMT by 1.71%. The fuel prices during the driving data's collection period ranged dramatically from $1.44 to $3.91 per gallon. For example, if the gas price were to rise from $3.00 per gallon to $3.50 the short-run change would cause the individual to most likely decrease their VMT by 28.5%.

The fuel price elasticity found is fairly extreme, but can be explained. As mentioned in the background section typical short-run fuel price elasticities of VMT averaged -0.45 for the 1966-2001 time frame. The elasticity results of this research were substantially higher but should not be immediately discredited for a variety of reasons. Firstly, the integrity of the model and the data is sound. Secondly, with the inclusion of the individuals' socio-demographic characteristics in the model to what degree the research's population fits with the general population can be reinforced by the analysis of the VMT relationships found. As shown through the results section, the relationships found between practically all of the socio-demographic variables and VMT adhered to conventional knowledge showing the research's population's driving behavior is representative of the overall population. Finally, individuals typically do not alter their driving behavior in the short-run due to changes in fuel prices, except in periods of drastic price increases or shortages. The changes in fuel price leading up to the studies VMT data can easily be described as a period of drastic change, as fuel prices rose to an all-time high of $4.28 in July 2008. I believe that the significantly higher elasticity found can be attributed to the volatile fuel prices the drivers experienced prior to when the

VMT data was collected. Additionally, the impact of the historically high fuel prices was most likely compounded by the continued economic downturn that has characterized much of the 2000-2010 decade limiting the individual's ability to absorb additional costs. Therefore, the research's individuals were reacting to the historical high fuel prices and making substantial changes to their short-run driving behavior to adapt.

CONCLUSION

The focus of this research was to determine the short-run fuel price elasticity of VMT using the first study year participants of The National Road User Study. The analysis utilized a linear regression analysis with a panel dataset with the STATA statistical software analysis package. The short-run fuel price elasticity of VMT was determined to be -1.71 with a range of -1.93 and -1.48. The elasticity found was significantly higher than the average short-run fuel price elasticity of -0.45 but can be justified by the impact poor economic conditions as well as the historically high fuel prices experienced prior to the researches time table had on the individuals driving behavior. The results suggest current short-run elasticities are not inelastic as previously thought. If this trend continues transportation agencies must re-evaluate how they predict the future funding availability for surface transportation projects. Further research should be conducted by analyzing the short-run fuel price elasticity for the second study year Road User Study participants to add additional empirical evidence to support the short-run elasticities found for year one.

APPENDIX A. VARIABLE INFORMATION

Table A 1. Age

	Frequency	Percent
18-24	78	6.5
25-44	505	42.4
45-64	424	35.6
65+	184	15.4
Total	1191	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 2. Gender

	Frequency	Percent
Female	621	52.1
Male	572	47.9
Total	1193	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 3. Education Level

	Frequency	Percent
No High School	60	5.0
High School or GED	394	33.1
Some College	361	30.3
Bachlor Degree or Higher	375	31.5
Total	1190	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 4. Income

	Frequency	Percent
<$4,999	20	1.7
$5,000 to $24,999	150	12.6
$25,000 to $74,999	649	54.5
>$75,000	371	31.2
Total	1190	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 5. Self-reported Political Scale

	Frequency	Percent
Liberal	326	27.4
Moderate	381	32.0
Conservative	414	34.8
Don't Know/No Response	69	5.8
Total	1190	100

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 6. MPG Rating

	Frequency	Percent
<20	534	44.8
21-25	526	44.1
>26	133	11.1
Total	1193.0	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 7. Comparison of Vehicle Type with VMT and MPG

	Percent of Household Vehicles	Annual Miles	Average MPG
Car	59.90%	11,678	22.4
Van	9.40%	13,417	18.4
SUV	12.50%	13,941	16.7
Pickup	18.20%	12,552	16.9
Overall	100%	12,291	20.3

Source: *2008 Status of the Nation's Highways, Bridges, and Transit: Conditions & Performance Report to Congress*. Rep. U.S. Department of Transportation, Federal Highway Administration &Federal Transit Administration. Web. 18 Apr. 2011.

Table A 8. Student Status

	Frequency	Percent
Non-student	1040	87.4
Student	150	12.6
Total	1190	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

Table A 9. Employment Status

	Frequency	Percent
Unemployed	269	22.6
Employed	921	77.4
Total	1190	100.0

Source: National Evaluation of a Mileage-Based Road User Charge. Unpublished. Iowa City: Public Policy Center, 2010. Print.

APPENDIX B. STATISTICAL MODELS

Table B 1. Regression Coefficients for Average Monthly Unleaded Fuel Prices Base Model

Totalmiles	Coef.	Robust Std. Err.	Z	P>Z	[95% Conf. Interval]	
Age	-1.106	0.465	-2.38	0.017	-2.017	-0.194
Gender	21.748	11.575	1.88	0.060	-0.938	44.433
RatedMPG	0.575	1.063	0.54	0.589	-1.508	2.658
Student	-10.895	19.058	-0.57	0.568	-48.248	26.457
Employment	41.971	14.733	2.85	0.004	13.095	70.847
Education: No High School	-46.029	23.914	-1.92	0.054	-92.900	0.841
Education: Some College	-40.361	14.428	-2.80	0.005	-68.639	-12.082
Education: Bachelor or Higher	-27.151	15.422	-1.76	0.078	-57.377	3.076
Income: <$4,999	-77.068	42.328	-1.82	0.069	-160.030	5.893
Income: $5,000-$24,999	-10.759	17.427	-0.62	0.537	-44.915	23.396
Income: >$75,000	9.712	13.592	0.71	0.475	-16.928	36.352
Political Scale: Liberal	-54.187	26.041	-2.08	0.037	-105.226	-3.148
Political Scale: Conservative	-18.753	26.114	-0.72	0.473	-69.935	32.428
Political Scale: Don't Know	-11.161	26.043	-0.43	0.668	-62.204	39.882
Totalmiles lag 1	0.704	0.017	40.74	0.000	0.671	0.738
Nov_08	-357.388	27.505	-12.99	0.000	-411.298	-303.479
Dec_08	368.263	32.166	11.45	0.000	305.218	431.308
Feb_09	19.677	18.624	1.06	0.291	-16.825	56.178

Table B 1. Continued

Mar_09	159.151	19.663	8.09	0.000	120.611	197.690
Apr_09	100.892	18.895	5.34	0.000	63.859	137.925
May_09	225.575	19.820	11.38	0.000	186.727	264.422
Jun_09	270.561	25.022	10.81	0.000	221.517	319.603
Texas	-127.601	24.534	-5.20	0.000	-175.687	-79.516
Idaho	-227.755	21.769	-10.46	0.000	-270.422	-185.088
Maryland	-140.041	21.108	-6.63	0.000	-181.412	-98.671
Iowa	-187.357	21.037	-8.91	0.000	-228.590	-146.123
North Carolina	-114.824	21.615	-5.31	0.000	-157.190	-72.459
AvgMonPrice	-3.742	0.302	-12.38	0.000	-4.335	-3.150
Constant	1199.637	88.008	13.63	0.000	1027.145	1372.128
Sigma_u	0					
Sigma_e	437.561					
rho	0					

Table B 2. Regression Coefficients for Average Monthly Unleaded Fuel Prices Final Model

Totalmiles	Coef.	Robust Std. Err.	Z	P>Z	[95% Conf. Interval]	
Age	-0.839	0.417	-2.01	0.044	-1.656	-0.022
Gender	21.729	11.401	1.91	0.057	-0.617	44.075
Employment	47.127	14.479	3.25	0.001	18.748	75.506
Education: No High School	-51.205	23.883	-2.14	0.032	-98.014	-4.396
Education: Some College	-41.363	14.145	-2.92	0.003	-69.087	-13.638
Education: Bachelor or Higher	-22.064	14.644	-1.51	0.132	-50.767	6.639
Political Scale: Liberal	-34.745	14.187	-2.45	0.014	-62.551	-6.939
Political Scale: Conservative	10.743	14.207	0.76	0.450	-17.103	38.589
Political Scale: Don't Know	19.764	25.992	0.76	0.447	-31.180	70.708
Totalmiles lag 1	0.705	0.017	40.93	0.000	0.671	0.739
Nov_08	-359.742	25.273	-14.23	0.000	-409.276	-310.209
Dec_08	358.271	30.150	11.88	0.000	299.178	417.364
Mar_09	151.127	17.350	8.71	0.000	117.123	185.132
Apr_09	93.916	17.013	5.52	0.000	60.571	127.261
May_09	221.008	18.959	11.66	0.000	183.850	258.167
Jun_09	269.429	24.932	10.81	0.000	220.563	318.294
Texas	-130.957	24.261	-5.40	0.000	-178.508	-83.406
Idaho	-232.644	21.438	-10.85	0.000	-274.661	-190.627
Maryland	-141.579	20.836	-6.80	0.000	-182.416	-100.742
Iowa	-194.043	20.811	-9.32	0.000	-234.832	-153.253
North Carolina	-117.872	21.472	-5.49	0.000	-159.957	-75.787
AvgMonPrice	-3.845	0.285	-13.48	0.000	-4.403	-3.286
Constant	1203.099	75.366	15.96	0.000	1055.385	1350.813

Table B 2. Continued

Sigma_u	0
Sigma_e	437.599
rho	0

Table B 3. Fuel Price Elasticities Using Average Monthly Unleaded Fuel Price Final Model

Ln(Totalmiles)	Coef.	Robust Std. Err.	Z	P>Z	[95% Conf. Interval]	
Ln(Age)	-0.063	0.030	-2.08	0.038	-0.122	-0.004
Employment	0.095	0.025	3.79	0.000	0.046	0.143
Education: No High School	-0.092	0.047	-1.94	0.052	-0.185	0.001
Education: Some College	-0.044	0.025	-1.73	0.083	-0.093	0.006
Education: Bachelor or Higher	-0.018	0.025	-0.71	0.478	-0.067	0.031
Political Scale: Liberal	-0.064	0.026	-2.47	0.013	-0.115	-0.013
Political Scale: Conservative	0.016	0.024	0.66	0.511	-0.031	0.063
Political Scale: Don't Know	0.039	0.039	1.00	0.316	-0.037	0.115
Ln(Totalmiles lag 1)	0.463	0.016	28.54	0.000	0.431	0.494
Nov_08	-1.443	0.119	-12.14	0.000	-1.676	-1.210
Dec_08	0.412	0.039	10.44	0.000	0.335	0.490
Mar_09	0.203	0.018	11.02	0.000	0.167	0.239
Apr_09	0.236	0.021	11.18	0.000	0.195	0.278
May_09	0.464	0.029	15.91	0.000	0.407	0.521
Jun_09	0.618	0.042	14.72	0.000	0.535	0.700
Texas	-0.270	0.043	-6.25	0.000	-0.354	-0.185
Idaho	-0.439	0.039	-11.28	0.000	-0.515	-0.363
Maryland	-0.286	0.041	-7.05	0.000	-0.366	-0.207
Iowa	-0.308	0.036	-8.61	0.000	-0.378	-0.238
North Carolina	-0.212	0.038	-5.53	0.000	-0.287	-0.137
Ln(AvgMonPrice)	-1.705	0.113	-15.09	0.000	-1.927	-1.484
Constant	12.979	0.619	20.97	0.000	11.766	14.192
Sigma_u	0.198					
Sigma_e	0.656					
Rho	0.084					

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