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THE IMPACT OF ECONOMIC POLICY UNCERTAINTY ON THE VEHICLE MILES TRAVELED (VMT) IN THE U.S.

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Abstract

This paper examines the impact of the economic policy uncertainty (EPU) on the vehicle miles traveled (VMT) in the United States (U.S.) over the period of January 1978 to October 2014. We estimate an empirical model based on a travel demand-analysis. It is found that an increase in economic policy uncertainty leads to a decrease in vehicle miles traveled. This negative relationship is also observed when different model types, various control variables, and the sub-indexes of the EPU are considered in the model.

Keywords: Vehicle Miles Traveled, Travel Demand; U.S. Economy, Economic Policy Uncertainty

1. Introduction

There is a growing literature on the determinants of travel demand, especially in the last decade. While the literature mainly considers demographic, social, and macroeconomic variables; extraordinary events such as financial crisis, turmoil in energy markets, and changes in fiscal policy are also considered as possible determinants of travel demand (Hymel, 2014). The findings of studies would help policy-makers to develop and update their transportation policies.

In one of the earliest studies, Goffey and Worthington (2003) uses a Multinomial Ordered Probit model to examine the determinants of motor vehicle usage in Australia. Vehicles for passenger, age of the principal driver, number of drivers at home, engine characteristics, amount of travel outside of capital cities, and interstate and the level of business-related travel significantly affect the motor vehicle usage. Zhang *et al.* (2009) model annual household Vehicle Miles Traveled (henceforth VMT) in Oregon and six states similar to Oregon. Fuel cost and living in an urban area decrease the VMT while the number of vehicles, income, and being a male lead to an increase in the VMT. Using cross-sectional time series data for the U.S. states from 1966 through 2004, Hymel *et al.* (2010) show that the effect of travel delay per adult is statistically negatively related with income implying that congestion has a larger negative impact on vehicle usage. Road miles, population per adult, living in urban areas, fuel prices, and

vehicle stock also significantly affect the VMT. Akar and Guldmann (2012) uses the 2009 National Household Travel Survey (covers 150,147 households involving 308,901 individuals and 309,163 vehicles) and explores the determinants of the VMT. It is shown that increases in household income and number of vehicles, workers, adults, and children positively affect the VMT; while there is a negative relationship between the VMT and population density, public transportation trips, and gasoline prices. McMullen and Eckstein (2013) focus on the determinants of the VMT by using data from a cross section of 87 U.S. urban areas over the period of 1982 to 2009. The per capita demand for the VMT in urban areas is positively associated with lane miles, personal income, and the percentage of employment in the construction and public sectors. On the contrary, fuel price, transit pass, and the percentage of employment in manufacturing, retail, and wholesale sectors are negatively related with the VMT per capita. The evidence for the effect of urban population density on the VMT is not robust. Woldeamanuel and Kent (2014) analyze the determinants of per capita VMT in California by using the National Household Travel Survey (NHTS), and they identified structural change from 2001 to 2009 versions of the NHTS. It is shown that the number of statistically significant variables increases in 2009 compared to 2001; however, distance to work, population density, travel day trips, gender, works at part time, and the number of vehicles in household are consistent in time. Hymel (2014) shows that economic factors such as income per adult, fuel prices, and unemployment significantly affected the VMT. It is also documented that the Californians are more responsive to fuel price changes compared to the rest of the nation which leads them to purchase more fuel-efficient vehicles. In addition, an increase in the availability of public transit decreases the VMT, but only by a minuscule amount. Based on these empirical findings, Hymel (2014) provided important policy recommendations for controlling the VMT, such as increasing the gasoline tax, implementing congestion pricing, and investing in public transportation system.

In this paper, in addition to the aforementioned traditional variables of the transportation economics literature, we introduce Economic Policy Uncertainty (henceforth EPU) index as a potential determinant of the VMT, and examine how uncertainty affects the VMT in the U.S. Travel decisions are easily postponed due to uncertainties in the economies. Indeed, traveling expenditures can make a considerable economic contribution to the domestic economy, but people can more easily cancel or postpone their travel plans than forgo their more basic needs under uncertainty. This study investigates the effects of uncertainty on *vehicles miles travelled* in the U.S.by using monthly data from the 1970s to 2014.EPU index developed by Baker *et al.* (2015) reflects information about the media coverage of political uncertainty, tax expiration codes, and disagreement among economic forecasters. EPU has recently received increasing attention and it is used to assess the impact of policy uncertainty on various variables, such as the firm-level decisions (Francis *et al.* 2014; Gulen and Ion, 2016; Kang *et al*, 2014; Wang *et al.* 2014), the oil price (Bekiros *et al.* 2015), the gold price (Aye *et al.* 2015), macroeconomic indicators (Bhagat and Ghosh, 2014), and the stock prices (Antonakakis *et al.* 2013; Ko and Lee, 2015; Demir and Oguz, 2015; Sum, 2013). To the best of our knowledge, there is no study that uses the EPU indexes to analyze the effects of policy uncertainty on the travel demand. Moreover, while the literature analyzes the determinants of the VMT by using survey data, we use the aggregated macroeconomic data in the empirical analysis. We expect that rising uncertainty will force some people to behave deliberately by postponing their travel plans to a less uncertain period or canceling them completely.

The remaining parts of the paper proceeds as follows: Section 2 explains the data and the empirical model. Section 3 describes and discusses the empirical results. Section 4 implements the robustness checks, and Section 5 concludes.

2. Data and Empirical Model

2.1. Data

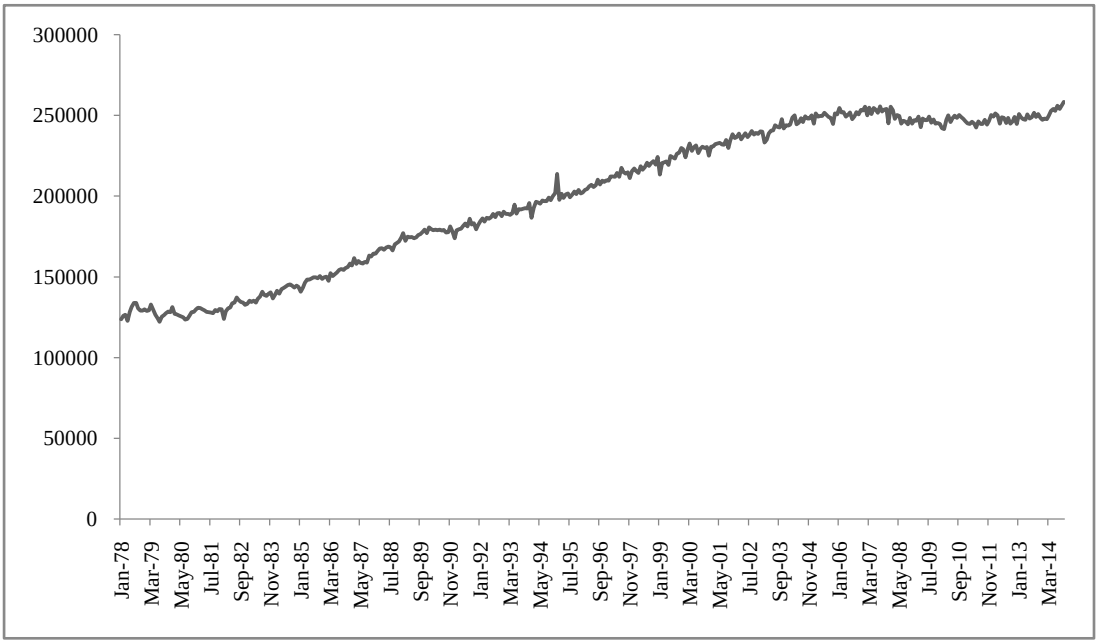
We analyze how uncertainty affects the VMT by introducing a variety of control variables. Variables, data sources, and a summary of the descriptive statistics are presented in Table 1. The VMT (seasonally adjusted) is the dependent variable, which is used as a primary indicator

of travel for policymakers and transportation professionals (e.g., Sacramento Area Council of Governments, 2015). Figure 1 represents the VMT over the period of January 1978 to October 2014.

Table 1. Data sources and descriptive summary statistics

Variables	Definition	Data Source	Mean	Standard Deviation	Minimum	Maximum	Observations
Vehicle Miles Traveled	Seasonally Adjusted, Logarithmic Form	U.S. Federal Highway Administration	12.17	0.241	11.71	12.46	442
Economic Policy Uncertainty (Historical)	Logarithmic Form	Baker *et al.* (2015)	4.938	0.240	4.412	5.860	442
Economic Policy Uncertainty (News–based)	Logarithmic Form	Baker *et al.* (2015)	4.624	0.334	3.802	5.648	358
Federal, State, and Local Purchases Disagreement	Logarithmic Form	Baker *et al.* (2015)	4.519	0.440	3.500	5.859	358
Consumer Price Index Forecaster Disagreement	Logarithmic Form	Baker *et al.* (2015)	4.561	0.290	3.708	5.138	358
Federal Tax Code Expiration	Logarithmic Form	Baker *et al.* (2015)	3.978	1.710	1.579	7.376	358
Real Disposable Income per Capita (Chained 2009$)	Seasonally Adjusted, Logarithmic Form	U.S. Bureau of Economic Analysis	10.24	0.205	9.893	10.56	442
Gasoline Price (U.S., $ per Gallon)	Logarithmic Form	U.S. Energy Information Administration	0.426	0.461	–0.463	1.421	442
Total Population	Logarithmic Form	U.S. Bureau of Census	12.49	0.111	12.31	12.67	442
Urban Consumers' Inflation (CPI–All) (1982–1984=100)	Seasonally Adjusted, Ratio	U.S. Bureau of Labor Statistics	0.302	0.325	–1.786	1.420	441
Urban Consumers' Inflation (CPI–Transportation) (1982–1984=100)	Seasonally Adjusted, Ratio	U.S. Bureau of Labor Statistics	0.289	1.187	–1.084	5.700	441
Civilian Unemployment Rate	Seasonally Adjusted, Ratio	U.S. Bureau of Labor Statistics	6.341	1.597	3.800	10.80	442
Total Vehicle Sales (Millions of Units)	Seasonally Adjusted, Logarithmic Form	U.S. Bureau of Economic Analysis	7.104	0.189	6.508	7.520	442
New Passenger Car Registrations (Thousands of Cars)	Logarithmic Form	National Bureau of Economic Research	4.999	0.185	4.372	5.587	442

Figure 1. VMT (in Miles) (January 1978–October 2014)



To measure policy uncertainty, we use the EPU index developed by Baker *et al.* (2015). This index calculated as the "news-based policy uncertainty" and the "(historical) overall baseline policy uncertainty" for the U.S. (see Baker *et al.* 2015) for the calculation methods and the details of the EPU indexes). On the basis of the baseline index, Baker *et al.* (2015) develop the components, i.e., the "Federal, State, and Local Purchases Disagreement", the "Consumer Price Index Forecaster Disagreement", and the "Federal Tax Code Expiration". We also use these sub-indexes in the empirical analysis.

2.2. Empirical Model

This paper considers a standard travel demand-analysis of transportation based on the literature and considers the income and the price effects as main determinants of the VMT. The income effect is measured by the real disposable income and the price effect is proxied by the gasoline price. This paper suggests that the EPU indexes can be a significant determinant of the VMT. Therefore, the following empirical model is developed:

$$VMT_t = f(RDI_t^{\delta_1}, GSP_t^{\delta_2}, EPU_t^{\delta_3}) \quad (1)$$

The empirical model in Equation (1) can be expressed in logarithmic form as such:

$$\log VMT_t = \delta_0 + \delta_1 \log RDI_t + \delta_1 \log GSP_t + \delta_3 \log EPU_t + \varepsilon_t \quad (2)$$

In Equations (1) and (2), $\log VMT_t$ is the vehicle miles traveled in logarithmic form at time *t*; $\log RDI_t$ is the real disposable income in logarithmic form at time *t*; $\log GSP_t$ is the gasoline price in logarithmic form at time *t*; $\log EPU_t$ is the economic policy uncertainty index in logarithmic format time *t*. The error term is denoted by ε_t. We expect that $\delta_3<0$; and this is the main hypothesis of the paper.

3. Empirical Results

Table 2 represents the estimations of Equation (2) by using the historical EPU index in logarithmic. In Column (I), the results of the estimations of the benchmark model for Equation (2) are reported. Moreover, we report the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors and the Variance Inflation Factors (VIF) statistics for multi collinearity. As expected, the average coefficient of the log real disposable income is positive and elastic (1.04), and the average coefficient of the log gasoline price is negative and inelastic (–0.12). The estimated coefficients of both variables are statistically significant at the 1% level. We then add several control variables to the benchmark regression. In Column II, it is shown that the log total population has a positive effect on the log VMT. In Columns III and IV, we control for the consumer price index (CPI) of all commodities and services and the CPI of transportation. The coefficients of CPI variables are not statistically significant. In Column V, we consider the Civilian Unemployment Rate, and observe that the unemployment rate is negatively related with the VMT. In Columns VI and VII, the log Total Vehicle Sales and the log New Passenger Car Registrations in the regressions negatively affect the log VMT. Finally, in Column VIII, we consider all control variables in the regression, and obtain the similar results with the previous empirical findings from Column I to Column VII.

Table 2. Results of the main regressions: January 1978–October 2014

Regressors	I	II	III	IV	V	VI	VII	VIII
Log Economic Policy Uncertainty (Historical)	–0.034 (0.006)***	–0.037 (0.006)***	–0.034 (0.006)***	–0.032 (0.006)***	–0.026 (0.007)***	–0.038 (0.007)***	–0.039 (0.007)***	–0.015 (0.006)**
Log Real Disposable Income per Capita	1.374 (0.010)***	0.846 (0.055)***	1.367 (0.012)***	1.377 (0.010)***	1.345 (0.014)***	1.391 (0.017)***	1.359 (0.010)***	0.609 (0.061)***
Log Gasoline Price	–0.117 (0.005)***	–0.148 (0.006)***	–0.116 (0.005)***	–0.118 (0.005)***	–0.105 (0.006)***	–0.122 (0.006)***	–0.125 (0.006)***	–0.108 (0.008)***
Log Total Population	–	1.092 (0.117)***	–	–	–	–	–	1.209 (0.116)***
Urban Consumers' Inflation (CPI–All)	–	–	–0.005 (0.006)	–	–	–	–	–7.154 (1.141)***
Urban Consumers' Inflation (CPI–Trans.)	–	–	–	0.002 (0.0013)	–	–	–	1.703 (0.260)***
Civilian Unemployment Rate	–	–	–	–	–0.003 (0.001)***	–	–	–0.016 (0.001)***
Log Total Vehicle Sales	–	–	–	–	–	–0.021 (0.012)*	–	–0.012 (0.010)
Log New Passenger Car Registrations	–	–	–	–	–	–	–0.049 (0.016)***	–0.064 (0.016)***
Constant Term	–1.681 (0.111)***	–9.899 (0.909)***	–1.611 (0.124)***	–1.722 (0.109)***	–1.408 (0.142)***	–1.680 (0.114)***	–1.253 (0.141)***	–8.482 (0.954)***
Observations	442	442	441	441	442	442	442	441
Adjusted R-squared	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Variance Inflation Factors	2.31	3.67	3.49	3.95	3.77	3.44	4.02	8.62

Notes: The dependent variable is the log vehicle miles traveled. We report the Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors. The standard errors are in parentheses. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

We observe that the effects of the log EPU indexes on the log VMT are always negative in all model frameworks, and the average coefficient is inelastic (–0.03). We also find the coefficient of the log EPU as statistically significant. In other words, the results in Table 2 indicate that one standard deviation increases in the economic policy uncertainty index yield to 0.77% decline (approximately annually 750 miles per capita) in the VMT.

The results of the sub-indexes of the EPU are presented in Table 3.The results are now based on the period from January 1985 to October 2014. We merely use the benchmark model in the regressions. Again, as expected, the average effects of the log real disposable income, and the log gasoline price on the log VMT are positive and elastic (1.28), and negative and inelastic (–0.1), respectively.

Table 3. Results of the sub–indexes of the economic policy uncertainty: January 1985–October 2014

Regressors	I	II	III	IV	V
Log Economic Policy Uncertainty (Historical)	–0.037 (0.006)***	–	–	–	–
Log Economic Policy Uncertainty (News–based)	–	–0.028 (0.005)***	–	–	–
Log Federal, State, and Local Purchases Disagreement	–	–	–0.043 (0.005)***	–	–
Log Consumer Price Index Forecaster Disagreement	–	–	–	–0.048 (0.006)***	–
Log Federal Tax Code Expiration	–	–	–	–	–0.011 (0.002)***
Log Real Disposable Income per Capita	1.318 (0.025)***	1.321 (0.025)***	1.179 (0.033)***	1.236 (0.025)***	1.358 (0.024)***
Log Gasoline Price	–0.112 (0.007)***	–0.113 (0.007)***	–0.085 (0.008)***	–0.094 (0.007)***	–0.094 (0.009)***
Constant Term	–1.084 (0.259)***	–1.164 (0.257)***	0.340 (0.345)	–0.221 (0.272)	–1.646 (0.249)***
Observations	358	358	358	358	358
Adjusted R-squared	0.96	0.96	0.96	0.96	0.96
Variance Inflation Factors	2.43	2.62	3.02	2.54	2.69

Notes: The dependent variable is the log vehicle miles traveled. We report the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors. The standard errors are in parentheses. *** indicates statistical significance at the 1% level.

We find that the impacts of the log historical EPU and the log news-based EPU indexes on the log VMT as –0.037 and –0.028, respectively. Three sub-indexes of the EPU are also considered in the regressions and all coefficients for the EPU indexes are statistically significant at the 1% level. The effect of the log Federal, State, and Local Purchases Disagreement on the log VMT is –0.043, and it is almost four times bigger than the effect of the log Federal Tax Code Expiration (–0.011). However, the greatest suppressing effect of the EPU on the VMT is substantiated through the log Consumer Price Index Forecaster Disagreement (–0.048).

4. Robustness Checks

In this section, we consider various different model definitions for the EPU, and re-estimate the benchmark model in Equation (2). Since the benchmark model in Equation (2) is defined in logarithmic form, we consider the EPU index in logarithmic form in the benchmark model. Initially, the current levels of the EPU indexes are considered instead of current logarithmic form. The estimations are reported in Table 4.We observe that the impacts of the historical EPU and the news-based EPU indexes on the log VMT are almost the same, and their coefficients

are –0.022. All coefficients for the log EPU and the sub-indexes are found as statistically significant at the 1% level. The lowest and the greatest suppressing effects on the log VMT are coming from the Federal Tax Code Expiration index (–0.003) and the Consumer Price Index Forecaster Disagreement index (–0.052), respectively.

Table 4. Results of the main regressions and sub–indices with alternative model I: January 1985–October 2014

Regressors	**I**	**II**	**III**	**IV**	**V**
Economic Policy Uncertainty (Historical)	–0.022 (0.004)***	–	–	–	–
Economic Policy Uncertainty (News–based)	–	–0.022 (0.004)***	–	–	–
Federal, State, and Local Purchases Disagreement	–	–	–0.040 (0.004)***	–	–
Consumer Price Index Forecaster Disagreement	–	–	–	–0.052 (0.006)***	–
Federal Tax Code Expiration	–	–	–	–	–0.003 (0.0004)***
Log Real Disposable Income per Capita	1.321 (0.025)***	1.324 (0.025)***	1.180 (0.033)***	1.222 (0.024)***	1.319 (0.025)***
Log Gasoline Price	–0.112 (0.007)***	–0.113 (0.007)***	–0.087 (0.008)***	–0.090 (0.007)***	–0.097 (0.008)***
Constant Term	–1.268 (0.256)***	–1.305 (0.256)***	0.176 (0.347)	–0.242 (0.254)	–1.278 (0.255)***
Observations	358	358	358	358	358
Adjusted R-squared	0.96	0.96	0.96	0.96	0.96
Variance Inflation Factors	2.24	2.12	2.40	2.26	2.30

Notes: The dependent variable is the log vehicle miles traveled. We report the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors and x100 values for the coefficients of policy uncertainty indices. The standard errors are in parentheses. *** indicates statistical significance at the 1% level.

Second, we consider the lagged EPU indexes in logarithmic instead of current logarithmic form, and report the results in Table 5.The coefficients of the historical EPU and the news-based EPU indexes are –0.043 and –0.031, respectively. All coefficients for the log EPU and the sub-indexes are once more found as statistically significant at the 1% level. It is again documented that the lowest and the greatest suppressing effects on the log VMT are taking shape from the Federal Tax Code Expiration (–0.012) and the Consumer Price Index Forecaster Disagreement (–0.047), respectively.

Third, we consider the lagged EPU indexes instead of current logarithmic form, and report the results in Table 6. The effects of the historical EPU and the news-based EPU indexes on the log VMT are almost the same, and their coefficients are –0.025. Again, all coefficients for the EPU indexes as well as the sub-indexes are found as statistically significant at the 1% level. The findings indicate that the lowest and the greatest suppressing effects on the VMT are actualized by the Federal Tax Code Expiration (–0.003) and the Consumer Price Index Forecaster Disagreement (–0.052), respectively. In addition, all coefficients of the log real disposable income are positive and elastic (1.04) on average, and the all coefficients for the log gasoline price are negative and inelastic on average in the results in Tables 4, 5, and 6. The estimated coefficients of both variables are also statistically significant at the 1% level.

Table 5. Results of the main regressions and sub–indices with alternative model II: January 1985–October 2014

Regressors	I	II	III	IV	V
Lagged Log Economic Policy Uncertainty (Historical)	–0.043 (0.006)***	–	–	–	–
Lagged Log Economic Policy Uncertainty (News–based)	–	–0.031 (0.005)***	–	–	–
Lagged Log Federal, State, and Local Purchases Disagreement	–	–	–0.043 (0.005)***	–	–
Lagged Log Consumer Price Index Forecaster Disagreement	–	–	–	–0.047 (0.006)***	–
Lagged Log Federal Tax Code Expiration	–	–	–	–	–0.012 (0.002)***
Log Real Disposable Income per Capita	1.316 (0.024)***	1.317 (0.024)***	1.170 (0.031)***	1.228 (0.025)***	1.347 (0.024)***
Log Gasoline Price	–0.111 (0.006)***	–0.113 (0.007)***	–0.083 (0.008)***	–0.091 (0.007)***	–0.090 (0.008)***
Constant Term	–1.035 (0.245)***	–1.118 (0.246)***	0.433 (0.332)	–0.142 (0.273)	–1.534 (0.243)***
Observations	357	357	357	357	357
Adjusted R-squared	0.96	0.96	0.96	0.96	0.96
Variance Inflation Factors	2.32	2.47	2.73	2.56	2.87

Notes: The dependent variable is the log vehicle miles traveled. We report the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors. The standard errors are in parentheses. *** indicates statistical significance at the 1% level.

Table 6. Results of the main regressions and sub–indices with alternative model III: January 1985–October 2014

Regressors	I	II	III	IV	V
Lagged Economic Policy Uncertainty (Historical)	–0.025 (0.004)***	–	–	–	–
Lagged Economic Policy Uncertainty (News–based)	–	–0.025 (0.004)***	–	–	–
Lagged Federal, State, and Local Purchases Disagreement	–	–	–0.041 (0.004)***	–	–
Lagged Consumer Price Index Forecaster Disagreement	–	–	–	–0.052 (0.006)***	–
Lagged Federal Tax Code Expiration	–	–	–	–	–0.003 (0.0004)***
Log Real Disposable Income per Capita	1.319 (0.024)***	1.321 (0.024)***	1.171 (0.032)***	1.214 (0.025)***	1.308 (0.024)***
Log Gasoline Price	–0.112 (0.006)***	–0.113 (0.007)***	–0.085 (0.008)***	–0.088 (0.007)***	–0.094 (0.007)***
Constant Term	–1.247 (0.245)***	–1.280 (0.247)***	0.272 (0.329)	–0.157 (0.255)	–1.169 (0.250)***
Observations	357	357	357	357	357
Adjusted R-squared	0.96	0.96	0.96	0.96	0.96
Variance Inflation Factors	2.68	2.84	2.45	2.39	2.71

Notes: The dependent variable is the log vehicle miles traveled. We report the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors and x100 values for the coefficients of policy uncertainty indices. The standard errors are in parentheses. *** indicates statistical significance at the 1% level.

In short, all findings in Tables 4, 5, and 6 are in line with the benchmark results. Therefore, the empirical results are robust when the different definitions of the EPU indexes (historical versus news-based), sub-indexes of the EPU, various model types of the EPU (lagged or current, level or logarithmic forms), and various control variables are considered.

5. Conclusion

This paper analyzes the impacts of the EPU and its sub-indexes on the VMT in the U.S. over the period of January 1978 to October 2014. We consider a travel demand-based analysis and controlled for various variables in the regressions. We also use several model types of the EPU in the model, i.e., the lagged/current and log/level forms, and find that the EPU is negatively related with the VMT. One standard deviation increases in the EPU index leads to 0.77% decline (annually 750 miles per capita) in the VMT.

When the importance of vehicle transportation is considered with the increasing vehicle numbers in the U.S. in the last decade, we can suggest that the empirical results in the paper are not only statistically, but also economically robust. Our results suggest that government regulatory policies are necessary regarding the effects of economic policy uncertainty in private vehicle transportation in the U.S.

Future papers on this subject can examine the effects of the EPU indexes on the VMT in other countries; particularly in countries which the VMT have significance for their macroeconomic activity (e.g., China and the United Kingdom).

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