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The Determinants of Gasoline and Diesel Fuel Excise Tax Rates

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Abstract

As Goel and Nelson (1999) show, fluctuations in fuel prices prompt politicians to alter fuel taxation policies. The goal of this paper was to examine the determinants of both gasoline and diesel fuel excise taxes. The diesel model builds on the work of Decker and Wohar (2006) and is extended to construct a model for gasoline fuel excise taxes. In addition to replicating results of prior research, the results suggest that states with colder weather have higher fuel tax rates. Additionally, findings demonstrated that increased funding from the Highway Trust Fund is associated with lower fuel tax rates.

Introduction

Given the importance of energy commodities in today's economy, price fluctuations can have significant impacts on economic growth. Specifically, gasoline and diesel fuel prices are two such energy commodities that carry weight (Decker & Wohar, 2005). Although fuel taxation is a major source of funding for public infrastructure, a vital component of a successful economy, increasing fuel prices lead politicians fearful of economic decline to enact policies that provide relief from such taxation. With most voters viewing the economy's success as the responsibility of politicians, politicians have naturally sought out policies that will maximize votes (Hettich & Winer, 1988). If they wish to set fuel tax policy that is both efficient, in terms of financing for public infrastructure, and favorable for constituents, they must carefully consider several political and economic variables. The goal of this study is to examine these variables with respect to gasoline and diesel fuel excise tax rates. With the majority of the focus on this particular topic being about tax incidence and the impact on economic growth, this study will take a more fundamental perspective by asking what variables determine these tax rates across states.

In this study, two separate models are developed, one for gasoline and one for diesel excise taxes. Cross-sectional data collected for a number of variables was used to look at the differences in fuel excise taxes across states in the U.S. Excise taxes are taxes imposed on specific goods, such as gasoline or cigarettes and are often employed as an attempt to regulate behavior.[1] Among other significant variables in the gasoline model, the total highway use of gasoline per interstate length maintains an inverse relationship to gasoline excise tax rates. This result is consistent with Hammar, Lofgren, and Sterner (2004) that higher consumption of

[1] (n.d.). Retrieved November 14, 2014, from http://www.irs.gov/Businesses/Small-Businesses-&-Self-Employed/Excise-Tax

gasoline leads to reduced tax rates.[2] Additionally, according to Goel and Nelson's (1999) findings, vote-maximizing politicians alter tax structures to provide greater benefits to constituents via public goods. This makes it interesting that sales tax rates are statistically significance determinants of gasoline excise taxes but maintain a positive relationship. With the diesel model, the variable for mining industry employment in a state does not obtain statistical significance, which is consistent with the findings of Decker and Wohar (2006). However, a state's total capital outlay expenditures and tractor registrations do predict diesel excise tax rates. This suggests that diesel excise taxes are used to fund road construction and are more so employed in states that use more diesel fuel; for example, in states with a large amount of farming. Additionally, highway federal funding is a predictor of diesel excise tax rates and has a negative coefficient. This suggests that receiving increased federal funding motivates politicians to redirect this tax revenue elsewhere rather than replenish the account from which the funds were received.

Literature Review

Decker and Wohar (2006) examine the determinants of diesel excise taxes over a nine-year period (from 1992-2001) and focus on economic considerations unique to each state, such as fuel prices. They find that the number of workers that a state employs in the freight trucking industry is inversely related to diesel fuel tax rates. Additionally, they find that freight transportation on highways is not associated with diesel fuel tax rates. This suggests that policy makers do not consider this an important variable, as Posner's public interest theory of regulation, which states that policy makers focus on maximizing public well-being, would suggest.[3] Their results are important because they direct their focus to determinants of diesel fuel

[2] Hammar, H., Löfgren, Å., & Sterner, T. (2004). Political economy obstacles to fuel taxation. *The Energy Journal*, 1-17.
[3] Posner, R. A. (1974). Theories of economic regulation.

excise taxes and integrate their results with existing research on the political factors of fuel taxation.

This paper will extend the work of Decker and Wohar (2006) by building a model for diesel as well as gasoline excise tax rates. In addition, this paper will focus on determinants within one year. The data utilized is similar to that of Decker and Wohar (2006), however federal excise tax rate and fuel prices are excluded due to the cross-sectional nature of the data set. The gasoline model in this study will additionally include variables for highway gasoline usage and highway travel per capita. The diesel model will include, as was the case in Decker and Wohar's (2006) model, a variable for mining industry employment in each state in addition to a variable for total highway federal aid.

Goel and Nelson (1999) investigated the political economy of fuel taxation. They focused first on how politicians might adjust tax policy to respond to fluctuating fuel prices. They found that both economic and political factors must be investigated when examining the determinants of fuel tax rates. Moreover, their study confirms that in the presence of constituent pressure to provide relief from increasing fuel prices, politicians will lower fuel tax rates. This is further evidenced by past proposals to link fluctuations in the economy to state tax rates, thus a growth in the economy would prompt an increase in tax rates and vice versa. Based on these results, in the present study a variable for state sales tax rates in both gasoline and diesel models will be added. It is expected that politicians may use fuel excise tax rates to recover lost revenue from lower sales tax rates.

Hammar, Lofgren, and Sterner (2004) also investigated the political environment of fuel taxation however their focus is on altering fuel usage.[4] They showed that countries with high fuel

[4] Hammar, H., Löfgren, Å., & Sterner, T. (2004). Political economy obstacles to fuel taxation. *The Energy Journal*, 1-17.

demand, such as the U.S., present opposition to increases in fuel taxation. They found that higher levels of consumption lead to lower tax rates, allowing countries with large quantities of vehicles to enjoy lower tax rates. For this reason, gasoline usage is a variable included in the gasoline model. Additionally, their results are consistent with the aforementioned studies, which demonstrated that fiscal policy affects fuel tax rates. These findings suggest that federal funding for highways is an important variable that should be assessed when examining diesel fuel excise tax rates.

Economic Theory

The dependent variable in each model, gasoline and diesel fuel tax rates, is represented in nominal value rather than real value. The justification for this is that policy makers have control over the nominal fuel tax rates and are also what constituents are most familiar with. In the remainder of this section, the economic justification will be given for the independent variables in each model.

State Sales Tax Rate (stsaletxtr). Based upon the results of Goel and Nelson (1999), state sales tax rate was added to both regression models. One might expect politicians to use fuel excise taxes as a way to recover lost revenue from low, or non-existent, sales tax rates. Although this would predict a negative coefficient, Goel and Nelson (1999) find that politicians are likely to reduce fuel excise tax rates specifically to alleviate the economic burden of increasing fuel retail prices. Given this evidence, a positive coefficient is expected for sales tax rates. It may be the case that states with higher tax rates in general will have higher fuel excise tax rates.

Average Winter Temperature (winteravgtemp). The average winter temperature for each state is chosen as an independent variable because the weather can have enormous impacts on road quality. Severe winter weather can prevent states from practicing routine road construction and maintenance. Moreover, the cold weather causes roads to contract, which leads to fractures and potholes. States that suffer from such weather must devote more financial resources to repairing and maintaining acceptable road conditions. This variable is included in both models and is predicted that to have a negative coefficient.

Total Interstate, Freeway, and Expressway Travel (totintfreexptvl) and Total Arterial Road Travel (totartertvl). Decker and Wohar (2006) found freight transportation on highways is not a predictor of diesel fuel excise tax rates. While this means that policy makers may not consider this variable when deciding diesel fuel taxation rates, it is possible that they would consider highway and arterial road traffic when deciding gasoline taxation rates because this form of transportation is more frequent. States with a large amount of highway travel, thus having a large quantity of vehicles using gasoline, possess the potential to have large gains in total fuel tax revenue when fuel excise taxes increases even slightly. Due to these large potential gains, politicians may be more likely to increase fuel tax rates. In addition, states with more traffic will also require more road maintenance. Increases in fuel excise taxes may be needed to cover these costs. For these reasons, variables for total interstate, freeway, and expressway travel and total arterial road travel in each state are included in the gasoline model with the expectation of positive coefficients.

Total Highway Law Enforcement and Safety Expenditures (hiwaylawenf&sftexp). Because fuel excise taxes are also used to regulate highway safety, the amount of money a state spends on highway law enforcement and safety is likely to play a role in gasoline excise tax rates. Diesel vehicles are typically used more in commercial trucking and construction settings rather than everyday commutes. As such, these vehicles are relatively unaffected by highway law enforcement. Rather, highway law enforcement and safety spending is likely to be incurred for the purpose of keeping everyday commuters safe and in accord with the law. Therefore, a variable for highway law enforcement and safety expenditures is included in the gasoline model only and a positive coefficient is expected.

Total Highway Use of Gasoline (tothiwyusegas). The total amount of gasoline consumed for highway use is also a likely actor in gasoline excise tax rates. Hammar, Lofgren, and Sterner (2004) show that countries with high fuel demand present opposition to increases in fuel taxation and actually enjoy lower fuel tax rates. Therefore, the variable for highway gasoline usage is expected to take on a negative coefficient.

Total Highway Federal Aid (tothiwayfedaid). The Highway Trust Fund is a source of funding that is sustained by fuel tax revenue and is given to states for construction of highways. Since the introduction of the Mass Transit Account, gasoline excise tax revenue is used to sustain both accounts while diesel fuel excise taxes contribute solely to the Highway Trust Fund.[5] Thus, total federal aid received from the Highway Trust Account is included as a variable only for the diesel model. It is unclear what effect this variable will have. It seems reasonable to postulate that receiving more funding from the Highway Trust Fund would create the need to replenish the account by raising fuel tax rates. Alternatively, not all states contribute as much money to the trust fund as they receive, which would justify an expectation for a negative coefficient.

Total Capital Outlay Expenditures (totcpotlyexp). Capital outlay expenditures are costs that the Highway Trust Fund may not necessary cover. Due to the limitations placed on Highway Trust Fund awards, states will incur expenses for routine road maintenance in addition to road construction. Selecting total capital outlay expenditures as a variable is an attempt to capture those expenses not covered by Highway Trust funding. A positive coefficient is a reasonable prediction for this variable because road maintenance is funded by fuel taxation.

[5] Transportation FAQs. (n.d.). Retrieved November 16, 2014, from http://www.artba.org/about/transportation-faqs/

Total Mining and Construction Employment (totmin&conemply). Consideration of employment also presents variables unique to diesel excise taxes. As Decker and Wohar (2006) found, the number of workers that a state employs in the freight trucking industry is inversely related to diesel fuel tax rates. This study focuses on the mining and construction industry to examine whether employment in these industries will be significantly related to diesel tax rates within one year of data. Based upon the findings of Decker and Wohar (2006), it is expected that this variable will have a negative coefficient.

Total Tractor Registrations (tracreg). Last is the consideration of another variable specific to diesel excise tax rates, namely the number of tractor registrations in a state. Much like the mining and construction industry, it is expected that states with large farming industries will gain favor by policy makers and experience relief from high diesel fuel prices. A negative coefficient is predicted, which is consistent with the results of Decker and Wohar (2006), as well as Stigler's theory of economic regulation (Stigler, 1971).

Econometric Methodology

To model both gasoline and diesel excise tax rates, a cross-sectional data set was constructed for the year 2012. The majority of the data was collected from the U.S. Department of Transportation Federal Highway Administration's website.[6] From this website, the data for the gasoline and diesel tax rates; total interstate length; total arterial road length; total interstate, freeway, and expressway travel; total arterial road travel; total capital outlay expenditures; highway law enforcement and safety expenditures; number of tractor registrations; total highway federal aid; and total highway use of gasoline was collected for all 50 states. The data on mining and construction employment was collected from the Bureau of Economic Analysis.[7] The total

[6] Highway Statistics Series. (n.d.). Retrieved October 28, 2014, from https://www.fhwa.dot.gov/policyinformation/statistics/2012/
[7] Regional Economic Accounts. (n.d.). Retrieved November 4, 2014, from http://www.bea.gov/regional/index.htm

population of each state was collected from the American Community Survey for 2012, 1-year estimate.[8] The state sales tax rate data was collected from the Tax Foundation's website[9] and finally, the average winter temperatures, given for a 29-year period, for each state were collected from the National Oceanic and Atmospheric Administration.[10]

The mean gasoline tax rate across all 50 states was 22.67 cents per gallon with a standard deviation of 6.83 and the mean diesel tax rate was 23.12 cents per gallon with a standard deviation of 8.13. Additionally the range of gasoline tax rates was 30.45 percent while the range of diesel tax rates was 43.7 percent. This indicates that there is a reasonable amount of variation in fuel excise tax rates across the U.S. to be explained. The standard deviation in sales tax rates was 2 percent and the mean was 5 percent. The standard deviation of interstate miles is 3,062 and 8,163 for arterial road miles. This indicates how much different road infrastructure may be between states. Arterial road infrastructure is primarily needed in heavily populated areas, thus it is expected that the length of arterial roads in a state is correlated with the total population in that state. This correlation can be seen in Figure 1. Additionally, the standard deviation in capital outlay expenditures is $1,478,917 and is likely correlated with a state's total interstate length. This relationship is visualized in Figure 2.

[8] United States Census Bureau. (n.d.). Retrieved November 14, 2014, from http://www.census.gov/acs/www/
[9] State and Local Sales Taxes in 2012. (n.d.). Retrieved November 4, 2014, from http://taxfoundation.org/article/state-and-local-sales-taxes-2012
[10] (n.d.). Retrieved November 7, 2014, from http://www.esrl.noaa.gov/psd/data/usclimate/tmp.state.19712000.climo.

Figure 1. Total Population and Arterial Road Length[11]

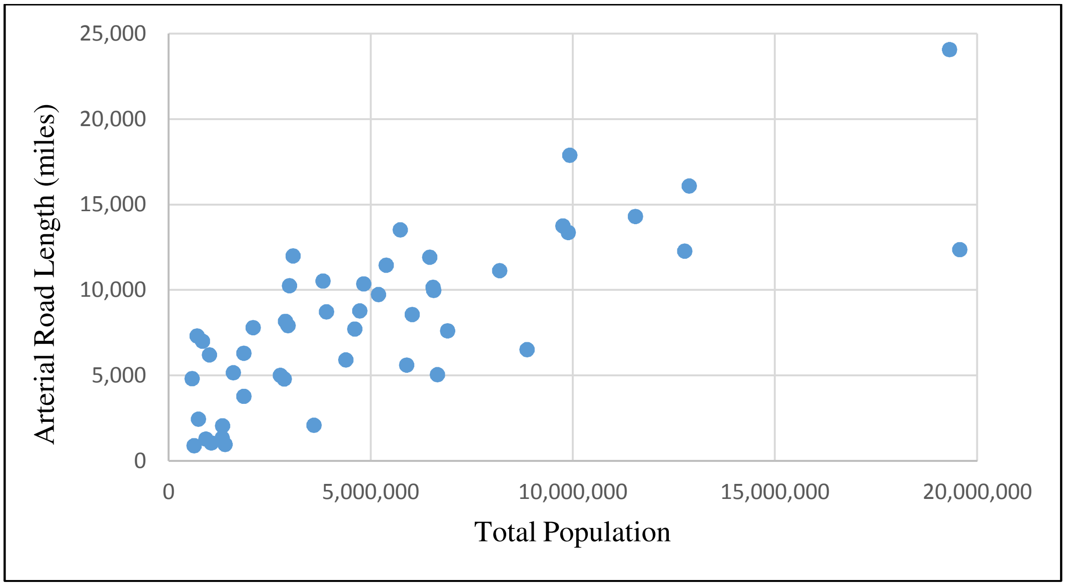
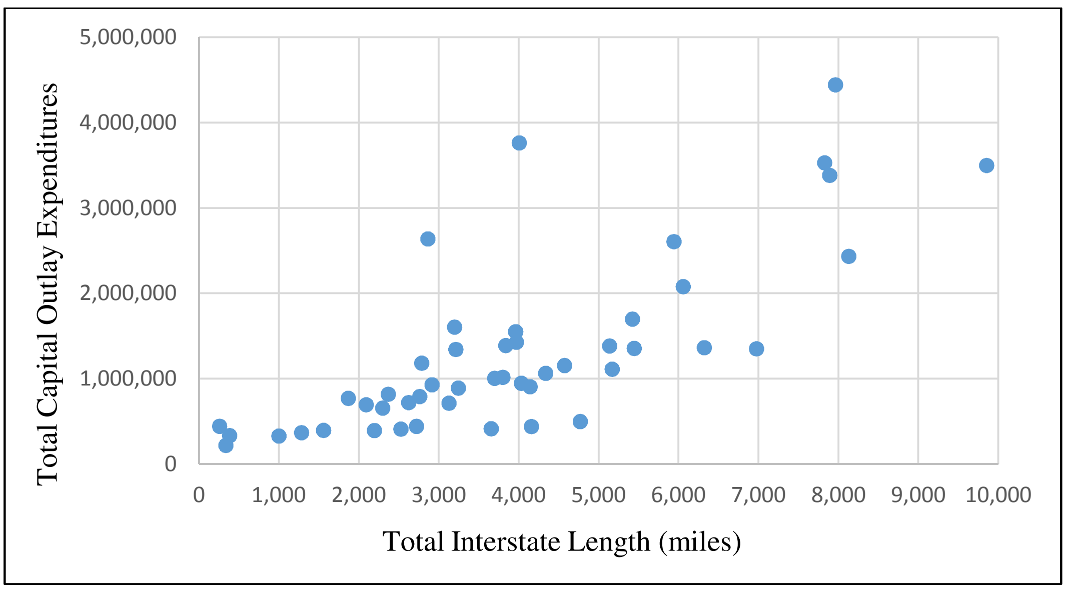


Figure 2. Total Interstate Length and Total Capital Outlay Expenditures[12]



The cross-sectional data set reflects 2012 data, with the exception of average winter temperature (winteravgtemp). For this variable, the mean temperatures of December, January, and February for a 29-year period were averaged together for each state to give a simple mean

[11] The outliers in this scatter plot are not shown.
[12] The outliers in this scatter plot are not shown.

winter temperature. However, the data on this variable excluded Alaska and Hawaii. In addition to the average winter temperature variable, there were several other computed variables. In order to measure the total interstate, freeway, and expressway and total arterial road travel as well as total highway use of gasoline, while controlling for population, each variable was divided by the total population in each state (totintfreeexptvl/totpop, totartertvl/totpop, and tothiwyusegas/totpop). These three computed variables provide a more accurate estimate of road traffic and gasoline usage per capita. Next, in order to measure highway law enforcement and safely expenditures, total capital outlay expenditures, and total highway federal aid while controlling for total interstate length, each variable was divided by total interstate length (hiwaylawenf&ampsftexp/totintleng, tothiwayfedaid/totintleng, and totcpotlyexp/totintleng). Finally, the total mining and construction in a state was measured, while controlling for total employment in that state (totmin&conemply/totemply). For a complete set of summary statistics, see Table 1.

Ordinary Least Squares (OLS) was used to estimate the regression model for the cross-sectional data set. The model for each dependent variable is as follows:

Gasoline Model

$$\begin{aligned}\ln(gtrate2012_i) &= \beta_1 \\ &+ \beta_2 \ln(Stsaletxtr_i) \\ &+ \beta_3 \ln(winteravgtemp_i) + \beta_4 \ln(totintfreeexptvl/totpop_i) \\ &+ \beta_5 \ln(totartertvl/totpop_i) \\ &+ \beta_6 \ln(hiwaylawenf\&sftexp/totintleng_i) + \beta_7 \ln(tothiwyusegas \\ &/totpop_i) + e_i\end{aligned}$$

Diesel Model

$$\begin{aligned}\ln(dtrate2012_i) \\ &= \beta_1 \\ &+ \beta_2 \ln(Stsaletxtr_i) \\ &+ \beta_3 \ln(winteravgtemp_i) + \beta_4 \ln(totcpotlyexp/totintleng_i) \\ &+ \beta_5 \ln(totmin\&conemply/totemply_i) \\ &+ \beta_6 \ln(tothiwayfedaid/totintleng_i) + \beta_7 \ln(tracreg_i) + e_i\end{aligned}$$

The MacKinnon-White-Davidson test was used for guidance between the linear and log-linear (also known as log-log) form. This test rendered inconclusive results. For both the gasoline and diesel regression models, both the linear (gasoline model: T_{36} = -1.10, p>.10, diesel model: T_{36} = -1.09, p>.10) and log-linear forms (gasoline model: T_{36} = -0.84, p>.10, diesel model: T_{36} = -1.28, p>.10) failed to be rejected. Rejecting both forms leaves little guidance from the test. Thus, the model selection was determined by previous literature. Log-linear from is the functional form adopted by Decker and Wohar's (2006) study of diesel excise tax rate determinants and Goel and Nelson's (1999) study that involved gasoline excise tax rate determinants.

Results

Each model is fairly successful in predicting its respective tax rate. The adjusted R^2 value for the gasoline model suggests that the model explains about 33 percent of the variation in gasoline excise tax rates across the U.S. Similarly, the adjusted R^2 for the diesel model suggests that the model explains about 32 percent of the variation in diesel excise tax rates across the U.S. Given the natural logarithm transformation, each coefficient should be interpreted as the percentage change in the dependent variable for every one percent increase in the corresponding independent variable. For a detailed list of results see Table *2*.

Gasoline Model

In the gasoline model, state sales tax rate only achieves statistical significance in the gasoline model and has a positive coefficient. The gasoline model results are expected based on the findings of Goel and Nelson (1999). This indicates that states with higher sales tax rates are likely to have higher gasoline excise taxes. However, state sales tax rate did not significantly predict diesel tax. With politicians focused on maximizing votes, it is in their best interest to mitigate economic hardships due to fuel prices and taxation. The positive coefficient could mean that these politicians do not consider the sales tax rate as a way to achieve such relief. The non-significant result of the diesel model suggests that diesel excise tax rates may be determined independent of other tax rates and more dependent on variables like industry employment, as Decker and Wohar (2006) show in their study of diesel excise tax rate determinants.

In both models, the average winter temperature obtained statistical significance and a negative coefficient. For the gasoline model, a 1 percent increase in the average winter temperature is associated with a 0.23 percent decrease in gasoline excise tax rates ($p<.05$). A reasonable speculation for this result is that colder weather equates to greater structural damage and a limitation on opportunities for road construction and maintenance. Both gasoline and diesel tax rates may be used to finance road repairs, but it may also require more diesel fuel vehicles, rather than gasoline vehicles, to maintain and repair buildings in cold areas.

The variable for total interstate, freeway, and expressway travel was not significantly related to gasoline fuel tax rates. It is possible that the Highway Trust Fund accounts for a large portion of interstate funding, and gasoline tax revenue is directed elsewhere, such as arterial roads not financed by the Highway Trust Fund. Indeed, given the significance of the arterial travel this seems very plausible. This would explain the lack of statistical significance of this variable.

The variable for total arterial travel, controlling for population, did obtain statistical significance. The positive coefficient suggests that greater quantities of traffic on arterial roads contribute to higher gasoline excise taxes. Specifically, a change of 1 percent in total arterial road travel results in 1.08 percent increase in gasoline excise tax rates ($p<.05$). This could be because arterial roads are largely funded via gasoline taxation, especially those roads that the Highway Trust Fund does not finance. This result is expected because gasoline vehicles primarily travel on arterial roads.

Highway law enforcement and safety was associated with gasoline fuel tax rates such that a 1 percent increase in highway law enforcement and safety expenditures will lead to a 0.11 percent change in gasoline tax rates ($p<.05$). This is expected because increased highway law enforcement and safety measures are directed primarily at everyday public commuters, which mostly drive gasoline vehicles.

The final variable in the gasoline model, total highway use of gasoline per capita, achieves statistical significance and possesses a negative coefficient. The negative coefficient suggests that a 1 percent increase in total highway use of gasoline is approximately associated with a 2.14 percent decrease in gasoline excise tax rates ($p<.01$) which is consistent with the results of Hammar, Lofgren, and Sterner (2004). Their study shows that areas with greater consumption of gasoline enjoy lower fuel tax rates. Such heavy dependence on an expensive commodity like gasoline means that states will be more resistant to increases in gasoline tax rates. In this situation, the same vote-maximizing politician will be likely to advocate for reductions in gasoline tax rates, as Goel and Nelson (1999) find.

Diesel Model

As mentioned in the gasoline section, state sales tax rate was not statistically significant in the diesel model. It is likely that variables such as industry employment, as Decker and Wohar (2006) found, are more important than state sales tax rate in determining diesel tax rates. Additionally, the average winter temperature is significant in the diesel model. Specifically for the diesel model, a 1 percent increase in the winter average temperature results in a decrease of 0.25 percent in diesel excise tax rates (p<.10). The negative coefficient is likely because of the destructive effects of cold weather on road surfaces and buildings.

Next, total capital outlay expenditures per interstate mile is another significant variable in the diesel model. The results suggest that a 1 percent increase in total capital outlay expenditures is associated with a 0.46 percent increase in diesel excise tax rates (p<.05). This result is expected given that diesel fuel tax revenue is a major contributor to the Highway Trust Fund account and is used to fund road construction and repair. Thus, given an increase in capital outlay expenditures, we would expect higher diesel fuel tax rates to fund them.

The variable for total mining and construction employment was not significant. This result replicates the findings Decker and Wohar (2006). However, Decker and Wohar (2006) find that the second industry employment variable that was used in their study, the freight trucking industry, is a significant and inversely related variable. This could be because the freight trucking industry depends directly on highway infrastructure, while mining and construction could be considered stationary activities and less dependent on highway infrastructure. As a result, they would not contribute to road congestion and depreciation.

Next, the total highway federal aid per interstate mile attains statistical significance. Unlike gasoline taxes, revenues generated from diesel taxes are only contributed to one highway account, the Highway Trust Fund. Interestingly, the coefficient for this variable is negative; suggesting that a 1 percent increase in funding received, per interstate mile, from the Highway Trust Fund account would lead a 0.43 decrease in diesel tax rates ($p<.10$). Perhaps politicians reallocate fuel tax revenue to other areas when they receiving external financing for road construction and maintenance. This would explain that fact that several states receive more funding from the Trust Fund account than they contribute.

The last variable in the diesel model is the number of tractor registrations in each state. This variable yields significant results and a negative coefficient. In tractor registrations, a 1 percent increase suggests a decrease in diesel excise tax rates of 0.15 percent ($p<.05$). The negative coefficient is to be expected given its similarity to the highway use of gasoline in the gasoline model and the results of Hammar, Lofgren, and Sterner (2004).

In order to ensure that the variable choices in each model are not creating imperfect multicollinearity, the variance inflation factor (VIF) was computed for each variable. Additionally, the computed variables in each model were carefully considered as to not further contribute to multicollinearity problems. Assuming that a VIF > 5 indicates severe multicollinearity problems, each variable is relatively safe from multicollinearity. However, it should be mentioned that the variables for total arterial travel per capita (totartertvl/totpop) and total highway use of gasoline per capita (tothiwyusegas/totpop), in the gasoline model, do possess VIFs greater than 4. This suggests that there could be some influence of imperfect multicollinearity on these parameter estimates.

Finally, White's General Heteroscedasicity Test (White test) was used to test for heteroscedasicity. Using an F-test of each model as a whole, the null hypothesis for both models, which states that the model is homoscedastic, failed to be rejected (gasoline model: $F_{7,37} = 0.83$, p>.10; diesel model: $F_{7,36} = 0.57$, p>.10). The results of this test suggest that there are no issues with heteroscedasticity in either model.

Conclusion

While previous research in fuel taxation focused on tax incidence and its impact on economic growth, the objective in this study was to identify the determinants of fuel excise tax rates. By constructing separate models for gasoline and diesel excise tax rates, variables with a significant relationship specific to each dependent variable were identified. State sales tax rate, average winter temperature, arterial road traveled per capita, highway law enforcement and safety expenditures, and highway use of gasoline all possessed a significant relationship with gasoline excise tax rates. Variables significantly related to diesel excise tax rates included average winter temperature, capital outlay expenditure per interstate mile, highway federal aid per interstate mile, and total tractor registrations in a state. Conversely, the model does not indicate that total employment in the mining and construction industry by a state has a significant relationship with diesel excise tax rates.

Results of previous studies of fuel excise tax determinants, (Decker & Wohar, 2006) and (Goel & Nelson, 1999), were replicated in this study. However, the results of this study provide particular insight into the effect of climate variations, highway use of gasoline, capital outlay expenditures and, most notably, highway federal aid. Climate variations across states, examined by observing the average winter temperature in each state, suggest that the destructive effects of cold weather are associated with higher fuel excise tax rates. States may be unable to practice routine maintenance procedures during the three winter months and may also incur damages from the harsh weather. In both cases, maintenance efforts must be increased during months with favorable weather conditions and more funds will be required to repair damages, thus requiring increased revenue.

With the U.S. being a major consumer of gasoline, Hammer, Lofgren, and Sterner's (2004) findings suggest that gasoline tax rates should be lower, which is indeed the result in this study. Such resolute dependence on gasoline fuel makes it exceptionally difficult for politicians to raise fuel tax rates while maintaining constituent support. Expenses incurred for road construction and expansion, not covered under the Highway Trust Fund, known as capital outlay expenditures, provide an antecedent for increases in diesel excise tax rates. Because diesel fuel tax revenue is used to replenish the Highway Trust Fund, given the negative coefficient on the highway federal aid variable, it is possible that receiving increased federal funding motivates politicians to redirect this tax revenue to expenditures outside the limits of the Highway Trust Fund. This fiscally irresponsible action by politicians could be motivated by their desire to maximize public goods, and could present one reason for the financial instability of many states, as well as the federal government.

Table 1. Descriptive Statistics

Variable	Description	Minimum	Maximum	Mean	Std. Deviation
gtrate2012 (cents per gallon)	Gasoline excise tax rate in state *i* in 2012.	7.50	37.95	22.67	6.83
dtrate2012 (cents per gallon)	Diesel excise tax rate in state *i* in 2012	7.50	51.20	23.12	8.13
Stsaletxtr	State sales tax rate in state *i*.	.00	.07	.05	.02
Totpop	Total population in state *i*.	576412.00	38041430.00	6265634.34	7000303.94
totinterstleng (miles)	Total interstate length in state *i*.	256.14	15519.27	4375.65	3061.81
totarterleng (miles)	Total arterial road length in state *i*.	909.93	46059.03	9596.21	8163.42
totintfreeexptvl (millions of miles)	Total interstate, freeway, and expressway travel in state *i*.	1552.93	140491.99	19477.47	23481.36
totartertvl (miles in millions)	Total arterial road travel in state *i*.	2701.13	165240.76	31723.29	31635.64
totcpotlyexp (thousands of dollars)	Total capital outlay expenditures in state *i*.	222624.00	8570373.00	1513617.26	1478916.63
hiwaylawenf&ampsftexp (thousands of dollars)	Highway law enforcement and safety expenditures in state *i*.	8576.00	1786612.00	185578.66	275383.12
totmin&conemply	Total mining and construction employment in state *i*.	27363.00	1455273.00	212438.46	243881.00
winteravgtemp[a]	Average winter (December, January, and February) temperature in state *i*.	12.11	59.36	32.039	10.64
Tracreg	Tractor registrations in state *i*.	2433.00	270595.00	51624.00	58190.50
tothiwayfedaid (thousands of dollars)	Total highway federal aid in state *i*.	129852.00	2493128.00	573834.66	485520.42
tothiwyusegas (thousands of gallons)	Total highway use of gasoline in state *i*.	267372.00	14204797.00	2613812.18	2737270.34

Note: sample size (n) = 50
[a] Sample size (n) = 48 (excludes Alaska and Hawaii)

Table 2. OLS Regression Results

Dependent Variable	Model 1. ln(gtrate2012)			Model 2. ln(dtrate2012)		
	Coefficients	Std. Error	Variance Inflation Factor (VIF)	Coefficients	Std. Error	Variance Inflation Factor (VIF)
Constant	3.48 ***	0.88	-	5.49 **	1.94	-
ln(Stsaletxtr) *Sales Tax Rate*	0.40 *	0.20	1.12	0.15	0.24	1.26
ln(winteravgtemp) *Average Winter Temperature*	-0.23 **	0.11	1.10	-0.25 *	0.12	1.20
ln(totintfreeexptvl/totpop) *Total Interstate, Freeway, and Expressway Travel per Capita*	0.37	0.27	1.41	-	-	-
ln(totartertvl/totpop) *Total Arterial Road Travel per Capita*	1.08 **	0.37	4.66[a]	-	-	-
ln((hiwaylawenf&sftexp/totintleng)x100) *Highway Law Enforcement and Safety Expenditure per Interstate Mile*	0.11 *	0.06	1.33	-	-	-
ln((tothiwyusegas/totpop)x100) *Total Highway Use of Gasoline per Capita*	-2.14 ***	0.55	4.30[a]	-	-	-
ln((totcpotlyexp/totintleng)x100) *Total Capital Outlay Expenditure per Interstate Mile*	-	-	-	0.46 **	0.19	2.77
ln((totmin&conemply/totemply)x100) *Total Mining and Construction Employment per Total Employment in State i*	-	-	-	-0.15	0.19	1.57
ln((tothiwayfedaid/totintleng)x100) *Total Highway Federal Aid per Interstate Mile*	-	-	-	-0.43 *	0.23	3.31
ln(tracreg) *Total Tractor Registrations in State i*	-	-	-	-0.15 **	0.05	1.20
Adjusted R^2	0.33			0.32		
F Statistic	4.56 **			4.29 **		
Std. Error of Estimate	0.259			0.299		

* Significant at the 10 percent level

** Significant at the 5 percent level

*** Significant at the 1 percent level

[a] Although the VIF is less than 5, risk of imperfect multicollinearity still exists. This may account for unexpected parameter estimates.

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