Determinants of State Diesel Fuel Excise Tax Rates: The Political Economy of Fuel Taxation in the United States

by

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Abstract

Ever-escalating gasoline and diesel fuel prices are prompting some states to temporarily suspend the collections of gasoline, and in fewer instances, diesel fuel, taxes. With more attention being paid to the gas tax instead of diesel tax, the focus of this paper is on the determinants of State excise taxes levied specifically on diesel fuel. Among other things, we find the freight trucking industry's contribution to total state employment is a highly significant determinant of a state's diesel tax rate, consistently suggesting that the greater this contribution, the lower the tax rate, *ceteris paribus*. We find little evidence that the degree of freight transportation usage on state highways impacts diesel tax rates. These finding suggest that state legislators, when determining the diesel tax rate, exhibit behavior that is consistent with Stigler's (1971) economic or positive theory of regulation, sensitive to (indeed perhaps responsive to) the trucking industry's contribution to a state's economy. Moreover, state law makers appear less concerned over the impact that heavy freight transportation has on the highway infrastructure. Hence, our results seem contrary to the public interest or normative theory of regulation as articulated by Posner (1974) asserting that law makers act in a way consistent with social welfare maximization.

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1. Introduction

Since the summer of 2000, the United States (US), along with many other countries, have been experiencing escalating fuel prices, from motor gasoline to home heating fuel to natural gas with no apparent end in sight. This, combined with the current political environment, has substantially revitalized interest among economists and policy analysts on the economic impact of rising energy costs on the US economy. According to the US Department of Energy's Energy Information Administration (EIA), since reaching a low of about $0.96 per gallon in February 1999, average national retail gasoline prices increased to about $2.62 per gallon as of August 2005 and sky-rocketed further in early September 2005 as a consequence of the Hurricane Katrina's disruption of crude oil deliveries from the Gulf of Mexico and its devastating impact on oil refining and distribution in the Mississippi Delta region where a substantial amount of crude is refined and distributed to the nation's mid-west and east coast. Gasoline is not the only energy commodity experiencing substantial price increases. Home heating fuel and natural gas prices are rising as well. The price of diesel fuel, too, has increased dramatically. From a national-average low of $0.95 in late February 1999, Diesel prices increased to $2.59 by late August 2005. [1]

Fearing that high and escalating gas prices will disrupt economic growth, many states as well as the federal government are debating the merits of suspending gas tax collections for a period of time. According to a recent *Wall Street Journal* article by Robert Matthews (2005), the state of Georgia has suspended its 7.5 cent excise tax and its 4 percent sales tax on gasoline until October 1, 2005.[2] Massachusetts, Connecticut, and Oklahoma legislators are also considering similar action. This is not the first time states have suspended gas tax collections. Declaring an "energy emergency" in June of 2000, Indiana's late Governor Frank O'Bannon suspended that state's gasoline sales tax for a period of sixty days and later that summer extended the suspension an additional fifteen days, a move that was estimated

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[1] This data is available from the Energy Information Administration, US Department of Energy, at http://www.eia.doe.gov.

[2] See Matthews, Robert Guy, "Rising Gas Prices May Force States To Suspend Tax," *The Wall Street Journal*, September 6th, 2005, A2.

to have cost the state between $22 and $30 million in lost revenue collections.[3] After O'Bannon suspended the Indiana tax, Governor George Ryan of Illinois, observing Illinois residents crossing into Indiana to fill their gas tanks, followed suit and suspended that state's gas tax temporarily as well (Adhicary, 2000).

Whether or not such tax suspensions will have a substantive impact on a state's economic performance is subject to debate.[4] However, if the goal is to support the economic vitality of a state, it is somewhat perplexing why the focus is only on gasoline tax suspensions and not on, say, diesel tax suspensions. Indeed, according Matthews (2005), only California and Michigan have lifted taxes on dyed diesel and there is no indication that any other state is considering such actions. Yet, many major industries are heavy users of diesel fuel such as the mining and construction industries and the trucking services industries.[5] Taken together, these three industrial sectors alone account for 8 percent of total GDP in the United States, and in some states, this percentage is much higher. It is also important to keep in mind that the growth of these industries will have substantial "spillover" effects on the rest of the economy. According to the US Bureau of Economic Analysis, the Motor Freight Transportation and Warehousing multiplier is 2.3168. This implies, then, that a $1,000 increase in final demand in this industry alone will have ripple effects throughout the economy, ultimately resulting in a $2,317 increase in aggregate economic activity, more than double the initial effect.[6]

Moreover, there is evidence suggesting that the trucking industry in particular is suffering from these high diesel prices. Consider a 2001 Peterbilt model 379 semi truck that has two fuel tanks that can contain 135 gallons diesel fuel. To completely fill these tanks at current diesel prices would cost nearly

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[3]See Indianapolis Star, 2000: "Governor Suspends Gas Tax," taken from Indystar.com at http://www.indystart.com, accessed on line by authors on June 2002.

[4] Several studies exist, referenced below, that attempt to measure such impacts. Recent evidence strongly suggests that the efficacy of a tax suspension will have little impact on a state's economy (see, e.g. Decker and Wohar, 2005).

[5] Agricultural equipment is also generally fueled with diesel. However, most states exempt such equipment from taxation.

[6] This figure comes from the BEA's RIMS II Regional Input Output Multipliers User Handbook which can be found at http://www.bea.gov/bea/regional/rims/. Obtaining these multipliers is a fee services. However, the multiplier provided above is supplied free of charge in BEA's documentation but is specific to the Kansas City Missouri Metropolitan Statistical Area. While this multiplier is likely to vary from region to region, the figure provided above is certainly illustrative of the point that this sector is integrally linked with other sectors in the economy.

$350.[7] One year ago, this tank could have been filled at a cost of $252. It is true that for the major freight transportation companies, some of this additional cost can be recouped from consumers in the form of increased surcharges. However, it's unclear, and no studies to our knowledge have investigated this issue, as to how much of the surcharge covered this increased fuel costs. While such evidence is scant, some anecdotal information is available. For instance, according to a recent *Associated Press* article, for every five cent increase in fuel cost there is a one cent per mile fuel surcharge increase.[8] It is unlikely then that the full cost of the fuel price increase can be covered by an increase in surcharges. Even if freight companies can recoup some of this cost increase, most independent truckers, operating in much more competitive environments, do not have the luxury of assessing surcharges. These freight transporters are completely at the mercy of the diesel fuel market.

With the greater emphasis on the gas tax suspensions over the diesel tax suspensions by most states, it seems natural to postulate that the determinants of a state's gasoline tax differ from those of a diesel tax. That said, it should be pointed out that in a number of states the excise tax on gasoline and diesel are the same. However, there are a number of cases where the diesel tax exceeds the gas tax. Consider, for example, Arizona, where as of 2003, the tax on gasoline is 18 cents a gallon and the tax on diesel is 26.4 cents a gallon. There are also a number of cases where the diesel tax is less than the gasoline tax, such as Tennessee where the gasoline tax is 21.4 cents a gallon and the diesel tax is 18.4 cents a gallon.[9] A reasonable explanation for higher diesel fuel tax rates is that freight vehicle transportation creates a greater degree of wear and tear on highway and road infrastructure. This higher cost imposed on roads and highways may therefore justify a higher tax rate on fuels used by semi trucks and other heavier vehicles.[10] However, there are likely to be other rationales for higher rates and it's not clear how the

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[7] See http://www.asmusmotors.com for further specifications on this vehicle.

[8] See William Poovey, "Truckers hit with higher diesel costs," found at BusinessWeek Online, http://www.businessweek.com/ap, September 6th, 2005.

[9] This data comes from the publication *Highway Statistics (various years)*, Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation (DOT) Online issues are available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.

[10] Indeed, this explains why toll road rates are higher for heavier vehicles as well.

concern over state of road infrastructure would explain instances where the diesel tax is lower than the gasoline tax.

Research on the determinants of fuel taxation, whether it is gasoline or diesel, appears to be rather scant. Studies investigates the determinants of gasoline taxation have examined both the US and European countries. However, very few studies focus on diesel taxation, and those studies that do examine European countries, with none, to our knowledge investigating on the US experience. Building on this existing work, our focus is on the determinants of State excise taxes levied on diesel fuel. Among other variables, we find the freight trucking industry's contribution to total state employment has a highly significant and negative effect on a state's diesel tax rate, consistently suggesting that the greater this contribution, the lower the tax rate, *ceteris paribus*. We find little evidence that the degree of freight transportation usage on state highways impacts the diesel tax rates. These findings suggest that state legislators, when determining the diesel tax rate, exhibit behavior that is consistent Stigler's (1971) economic or positive theory of regulation, sensitive to (indeed perhaps responsive to) the trucking industry's contribution to a state's economy. Moreover, state law makers appear less concerned over the impact that heavy freight transportation has on the highway infrastructure. Hence, our results seem contrary to the public interest or normative theory of regulation as articulated by Posner (1974) asserting that law makers act in a way consistent with social welfare maximization.

The remainder of this paper is organized as follows. In section 2, we briefly review the relevant literature. In section 3 we develop our econometric model. In section 4 we discuss the data and various econometric methodology and issues. Section 5 contains a discussion of the estimation results and section 6 concludes.

2. Literature Review

Much of the literature on fuel taxation is primarily concerned with the impact such taxes have on general economic growth, tax incidence, or market efficiency.[11]. That said, there are a few studies that have looked at, either directly or indirectly, the determinants of gasoline taxes (see, e.g. Nelson, 2002, Goel and Morey, 1993, and Shmanske, 1990).[12] Building on this research, more recent studies have reported that tax levels to be sensitive to a variety of political and economic conditions. Hammar, Lofgren, and Sterner (2004) for instance, investigate the determinants of gasoline tax rates across a panel of Western European countries, the United States, and New Zealand and find that while low taxes encourage greater gasoline consumption, high levels of consumption lead to substantial pressure against tax rate increases. Additionally they find other governmental variables to influence tax rates, such as the level of government debt. This study is very compelling. However, Hammar, Lofgren, and Sterner (2004) focused exclusively on gasoline tax rates. In contrast, Rietveld, and van Woudenberg (2005) used a cross section of 100 countries to investigate fuel tax differentials between these countries and investigated both the gasoline and diesel tax question. They find that for both gasoline and diesel, smaller countries tend towards lower tax rates than larger countries. Moreover, fuel taxes tend to be higher in countries with proportionally larger government spending and greater degrees of income inequality. However, they find no evidence that fuel taxes tend to be higher

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[11] For fuel tax impacts on growth and employment, see Uri and Boyd (1998) and Decker and Wohar (2005). For the incidence of gasoline taxation, see Chauinard and Perloff (2004) and Chernick and Reschovsky (1997). Finally, Sipes and Mendlesohn (2001) research the effectiveness of gas taxes on air pollution.

[12] Nelson's (2002) study actually investigated a variety state excise taxes, including motor fuels, broadly defined, with specific attention paid to cross-border effects. That is, do state's set excise tax levels giving consideration to neighboring state's tax rate? This is an interesting question and, while we don't consider such effects here, we believe this would be a fruitful avenue for future research. Shmanske's study is of particular importance to our study because his study seems to be one of the few that considered the impact that specific industries, most notably trucking, has on fuel tax rates. While he finds that the trucking interest does not have a statistically significant impact on such taxes, it should be pointed out that his study focused exclusively on gasoline tax rates, not diesel tax rates.

in countries with automobile usage, calling into question the hypothesis that fuel taxes are set in part to curb certain external costs such as air pollution. Again, while this study offers important insights, it is important to note that Rietveld and van Woudenberg (2005) econometrically modeled gasoline and diesel prices as a function of various determinants and then made inferences as to tax rates based on those results, rather than directly modeling gasoline and diesel tax rates, as we do in this study.

With a different geographic and conceptual focus, and with direct attention on gasoline tax rates themselves, Goel and Nelson (1999), attempt to explain tax rate differentials between US States. To motivate their empirical analysis, the authors develop a theoretical model much in the spirit of Peltzman's (1976) extension of Stigler's capture theory that suggests that law makers and regulators are motivated to make decisions so as to maximize net positive feedback, in the form of political support, from a population of vested stakeholders. To this end, and guided by modeling conventions laid out by Hettich and Winer (1988), Goel and Nelson (1999) construct a model where a vote-maximizing legislator weighs the costs and benefits of imposing additional taxes. With voters exerting pressure on legislators to limit fuel prices and price increases, their model predicts that higher gasoline prices should be accompanied by lower tax rates. Indeed their empirical analysis confirms this result.

Political support, however, can take a variety of forms, particularly when considering industry's influence on candidates seeking political office. This can come in the form of a variety of sources, from campaign contributions to public endorsements, all of which should, in principle, increases votes. Hence, while voter maximization seems a reasonable objective, the model is ultimately silent as to the *source* of political support. While this may not be as significant an issue when considering the determinants of gasoline tax rates, as this tax impacts nearly every group in an economy, it is of importance when considering the determinants of diesel tax rates as the primary uses of diesel fuel are not end-user residential consumers but rather commercial interests.

3. The Empirical Model and Data

With our attention on diesel tax rates, our empirical model adopts the basic elements of Goel and Nelson's (1999), hereafter GN, but augment it in an attempt to identify where there might be similarities between the determinants of gasoline and diesel tax rates as well as to ferret out what political influences might be present through the pressure of diesel tax rates. To this end, we collected state-level data on a variety of variables from several different sources, constructed a panel dataset, and estimated the following model:

$$\begin{aligned}\ln(DTAX_{i,t}) = {} & \alpha_i + \beta_1 \ln(DPRICE\_AVG_{i,t}) + \beta_2 \ln(CPI\_AVG_{i,t}) \\ & + \beta_3 \ln(DTAXUS\_AVG_t) + \beta_4 \ln(TOTROAD_{i,t} / POP_{i,t}) \\ & + \beta_5 \ln(HFUNDS_{i,t} / POP_{i,t}) + \beta_6 \ln(HWAY_{i,t} / TOTROAD_{i,t} * 100) \\ & + \beta_7 \ln(EMPMIN \& CON_{i,t-1} / EMPTOT_{i,t-1} * 100) \\ & + \beta_8 \ln(EMPTR_{i,t-1} / EMPTOT_{i,t-1}) + \beta_9 \ln(NONATTAIN_{i,t} / POP_{i,t}) + e_{i,t}\end{aligned} \quad (1)$$

The dataset covers all 50 US states over the period 1992 to 2001.[13] Further definitions of each variable, their respective means and standard deviations, and their corresponding data sources can be found in Table 1. The dependent variable, DTAX, is the excise tax, measured in cents per gallon, levied on diesel purchases in state i, in year t. Note, following GN, we initially model the state diesel tax in nominal terms as this is the variable which state law makers have direct control over.[14] However, since it is also reasonable to presume legislative consideration of an inflation adjusted tax rate, we model the diesel tax in real terms as well.[15]

[13] Data prior to 1992 is difficult to obtain for a variety of variables, such as road and highway infrastructure miles. Moreover, price data more recent than 2001 at the state level for all 50 states is not yet available.
[14] While we tend to follow GN reasonably closely, our analysis also differs in a number of ways. For instance, GN estimate a linear model whereas we follow Hammar, Lofgren, and Sterner (2004) and estimate all of our models in

The variable DPRICE_AVG measures a two year moving average of the pre state and federal excise tax real diesel price in state i.[16] We introduce this variable as a moving average embodying both historical and contemporaneous movements in price recognizing that it takes time for legislators to react to price changes over time.[17] From GN's model, we would expect the coefficient associated with DPRICE_AVG to be negative indicating an inverse relation to the diesel tax. As prices increase, political pressure from state residents should prompt law makers to lower the tax rate. For the nominal equation we include CPI_AVG which measure the two year moving average of this price index. Again, following GN, we expect that sign of the coefficient associated with CPI_AVG to be positive reflecting the political difficulties associated with lowering tax rates in an inflationary environment.

The variable DTAXUS_AVG measures the two year moving average in the inflation adjusted federal diesel tax rate. This variable's expected impact on DTAXUS_AVG is unclear.

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log-linear form. What theory exists on this topic is largely silent as to functional form but with the log-linear form the resulting coefficients are conveniently interpreted as elasticities which facilitates a discussion of both absolute magnitudes of effect as well as allows for a comparison of magnitudes across independent variables. That said, we did estimate our model using a linear form and the signs and significance levels of all coefficients in the model were consistent with the log linear form.

[15] Lacking a reasonable state level price deflator, we follow conventional practice and deflate all nominal values the US All Urban Consumer Price Index (CPI). This series can be obtained from the US Bureau of Labor Statistics at www.bls.gov.

[16] Note here that our price variable is state specific, unlike GN. This seems reasonable since prices can vary significantly from state to state and it seems more likely that state legislators would be more inclined to consider local area price information when considering tax changes. That said, we also estimated (1) using a national diesel price level. The results were similar to the ones presented here but the overall fit of the equations, as measured by an adjusted R^2 were lower. It is important to note, however, that obtaining pre-tax state level data on fuel prices is rather difficult. Fortunately, the US Department of Energy's Energy Information Administration (EIA) does publish annual data on state level prices for a variety of fuels, including transportation sector distillate, which as EIA note, is essentially diesel fuel. This data, and the associated documentation detailing interpretation and conversion factors, can be found at http://www.eia.doe.gov/emeu/states/_price_multistate.html. This data is nominal, includes federal, state and local taxes, and is denominated in dollars per million British Thermal Units. Therefore, using standard conversion factors, we converted the data to dollars per gallon, subtracted state and federal excise tax, and deflated the series using the CPI. Further details on this conversion are available from the authors upon request.

[17] GN introduce their gas price variable with a two year lag, also arguing that it takes time for law makers to respond to market conditions. However, it does seem reasonable upon further reflection not to ignore the possibility that law makers, when debating the merits of a tax change, consider contemporaneous information on fuel price movements as these prices do tend to fluctuate significantly in a short period of time. That said, we also tried estimating (1) by explicitly including contemporaneous, one year and two year lagged real diesel price levels in our specification. The significance results were relatively poor for these three variables, largely due to some degree of collinearity between them. Hence, we opted for the moving average structure of this variable.

On the one hand, we might expect a positive effect in that state regulators may be able increase state taxes and not incur as much political damage if the federal government has raised taxes proportionately more. This may be a particular attractive strategy during periods of budget tightening. On the other hand, a negative effect would suggest that state legislators can significantly build political capital if the voting public recognizes the state's attempt to counter rising federal tax rates. The purpose of the moving average accounts for the state government's likely position of following federal action.[18]

Our regression model includes TOTROAD//POP which comes from the US Department of Transportation's *Highway Statistics* and measures for each state total state highway agency administered roads and highways on a per capita basis. We would expect that a greater volume of road infrastructure would prompt state law makers to levy a higher diesel tax to maintain these existing roads.

Most state earmark gasoline and diesel tax collections for the purposes of road construction and repair. However, there are other sources of funding available for this purpose such as road and crossing tolls and state bond proceeds. The Variable HFUNDS/POP measures for each state sources of inflation adjusted funding for highways other than tax collections on a per capita basis. The expected effect this variable is likely to have on the diesel tax rate would be negative if legislators view these sources as substitutes for diesel tax collections. Alternatively, if legislators view these funds as complementary sources of funding with diesel tax collections, we would expect a positive sign.[19]

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[18] Introducing this variable as a moving average or lagged one or two years does not qualitatively change the results

[19] We also included the motor gasoline tax in our estimation of (1) in an earlier specifications postulating that the gas tax may substitute for diesel. However, since gas and diesel taxes are so highly correlated and that a number of independent variables are correlated with the gas tax (not surprising since many of these variables were included in GN's model), we chose not to keep the gas tax as an independent variable.

While the precedes collected from the diesel tax itself are typically earmarked for road construction and repair, levying such a tax would in theory result in less diesel fuel consumption (at least to some degree) and therefore may be used to control pollution emissions (Sipes and Mendelsohn, 2001). To control for this potential, we include the proportion of a state's population living in counties that are not meeting US EPA ambient air quality standards (NONATTAIN/POP) as a determinant of the diesel fuel tax. We should expect then, a higher tax rate in those states with a greater proportion of the population living in these non-attainment counties.

Until now, we've essentially discussed variables believed to impact the diesel tax rate that were also, with some modification, determinants of GN's gas tax model. We now focus on determinants that may be considered more unique to diesel tax determination. Clearly one major issue that arises with the diesel tax rate specifically is the degree to which it could be used to cover costs of highway repair. Larger vehicles have a much larger impact on roads and highways than do cars and other smaller vehicles. It stands to reason that a state with substantially more trucking traffic would experience a greater wear and tear on that state's road infrastructure suggesting benefits to a higher diesel fuel tax. The US Department of Transportation (DOT) does generate some data on average annual daily truck traffic by state. However, this data appears to be only currently available for the year 1998.[20] However, one would expect that a measure of annual daily truck traffic to be highly correlated with the proportion of highway miles to total road miles (HWAY/TOTOAD) in a state. Such data is available over time and there does seem to be some variation in this ratio across states (see Table 1). We thus use this measure to proxy for trucking usage rates. Under the presumption that

[20] Apparently, according to the DOT, previous estimates were based on different statistical procedures and data measurements that make comparisons over time unreliable (personal correspondence between the DOT and the authors).

legislators behave in a way consistent with the normative theory of regulation (Posner, 1974) we would expect a positive coefficient associated with this variable. An increasing cost imposed on a social good such as roadway infrastructure, should be met with a higher tax placed on those considered responsible for the higher damage caused.

As discussed earlier, political influence can manifest itself in many ways. Commercial interests that are heavy users of diesel fuel may be in a position to pressure legislators to keep diesel taxes low in an effort to control operating costs and maintain higher profit margins. The ability of these interests to succeed in this effort may vary from state to state depending on the degree of "importance" state law-makers place on these commercial interests, or put differently, the degree to which these interests have convinced law makers of their relative importance.

In an attempt to capture some of these effects, we include two variables designed to proxy for political power or influence within a state. There are a number of industries that are heavy users of diesel fuel. Both the construction and mining sectors utilize very large trucking and other mobile equipment that are largely powered by diesel fuel. Moreover, the freight trucking transportation service sector also is a heavy consumer of diesel fuel. For these three sectors, we collected employment data by state and calculated the proportion of employment in construction and mining to total employment (EMPM&CON/EMPTOT) and the proportion of trucking to total employment (EMPTR/EMPTOT).[21] These commercial interests, it can be hypothesized, are likely to be in a position to exert more effective pressure on legislators if they

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[21] This data can be obtained form the Bureau of Economic Analysis, US Census Bureau at http://www.bea.gov/bea/regional/data.htm. The trucking sector is labeled "Trucking and Warehousing Services" but there is no further breakdown than this. We had also considered adding railroad freight service to the analysis but at the state level, we encountered numerous discloser instances where the data was suppressed from public access. We decided to consider mining and construction together largely because these two sectors are more similar to one another, in the sense that they both use a wide spectrum of very large mobile equipment for industrial development purposes within a state while trucking uses more a specialized diesel power vehicle and is largely a service oriented sector that may be more mobile in terms of fleet headquarters. Also, while not of major concern here, we do conserve on degrees of freedom in our regression analysis by doing this.

account for a larger proportion of economic activity in a state. Therefore, if the desire is for lower diesel fuel tax rates, we should expect, consistent with Stigler's (1971) economic theory of regulation, to see a negative impact of these variables on the tax rate.[22]

Note that we introduce these employment variables lagged one year. This is done in part to avoid potential issued related to endogeneity. For instance, it might be that such firms locate in certain states because the tax is low relative to other states. With the lagged variables included, it is less likely that a future diesel tax would prompt substantial industrial location.[23]

Finally, since it is highly likely that the above variables do not capture all state-specific factors that might influence the diesel tax policy. Such factors, which are difficult to quantify, might involve, as GN suggest, tradition, constitutional differences and so forth. Hence, our specification involves state specific dummy variables, α_i (as would be included in a standard fixed effects model (discussed below) to capture these effects.

4. Econometric Methodology and Issues

As a first glance as to the likely impact the three additional variables, (i.e. the proportion of highways in a state as well as the two employment variables discussed above), are likely to have on the diesel tax, consider the correlations presented in Table 2. This table presents simple correlations between the diesel tax (both real and nominal) across all states over the ten year

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[22] It should be emphasized that like so many empirical models, ours does not truly test Stigler's theory. This is a very difficult test to implement. We simply offer a suggestion as to what our results might imply about this theory. Note that a positive coefficient might also be consistent with Stigler's theory in that industry might demand higher diesel tax rates to inhibit entry. While this is a possibility, it's not very likely, in our judgment, as our focus in on a state's diesel tax and these, like many of markets, are largely regional or national in delineation and therefore preventing entry into a particular state does not seem to efficacious. Moreover, it's not clear to what degree industrial location is sensitive to diesel tax rates.

[23] While it does not seem likely that construction, mining or trucking firms would necessarily be apposed to locating in one state versus another state on the grounds that the diesel tax is lower, it should be noted that simply lagging dependent variables does not solve endogeneity problems. We therefore conducted a Hausman test following a procedure proposed by Davidson and MacKinnon (1989) and found no statistical support for endogeneity.

period 1992-2001 and our three additional variables. The results tend to support the hypotheses discussed above, particularly for the inflation adjusted diesel tax. The correlation between the proportions of highways and the real diesel tax is positive suggesting that diesel taxes are likely to be higher in states that have a high proportion of highway miles to total road miles. Moreover, both employment variables are negatively correlated with both the real and nominal diesel tax. While these results are suggestive, they do not constitute statistical evidence that each meaningfully impacts the diesel tax. For that, more standard regression analysis is in order.

To estimate our empirical model we first construct a fixed effects (FE) model, the standard form of which is:

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \varepsilon_{i,t} , \tag{2}$$

where $y_{i,t}$ is each state *i*'s DTAX for years *t* = 1992 through 2001, α_i are the time-invariant estimated state constant variables, and $X_{i,t}$ is the matrix of independent variables as discussed above.[24]

As is understood, FE is appropriate when we are confident that the cross section units can be viewed as parametric shifts in the regression. However, if the cross section and time series constant terms are random variables distributed across cross sectional and time series units, then the random effects (RE) model, $y_{i,t} = \alpha + u_i + \beta X_{i,t} + \varepsilon_{i,t}$, is appropriate. We test for the appropriateness of FE versus RE via a standard Hausman statistic.

One final econometric issue relates to cross-sectional heteroscedasticity. Analysis of the estimated regression residuals for each variation of our model (see below) suggested that the error variance differed substantially between states, thus violating standard assumptions

[24] We do not include in our estimation yearly dummy variables since we, following GN's specification, include the national diesel tax rates which only vary over time and is not specific to particular states. In a real sense, then, our model does control time-specific patterns.

necessary to insure reliable regression statistics. Therefore a correction is in order, in particular to avoid biases in our estimated standard errors. To do so we employed the White cross-section method that treats the pool regression as a multivariate regression with an equation for each cross-section, i.e. for each state. White-type robust standard errors are thus employed for the system of equations.[25]

5. Results

We estimate four variations of our basic empirical model. Our estimation results are presented in Table 3. Models 1 and 3 attempt to explain the variation in the nominal diesel tax rate and models 2 and 4 the real tax rate. As we indicated earlier, for each model we estimated both a FE and RE specification. While there is a fair degree of consistency in the sign, magnitude and statistical significance between these two specifications across our model variants, an analysis of the Hausman statistics strongly suggest that for all model variants except model 3, the FE is the preferred specification. Based on our adjusted R^2 statistics for the FE specifications, our models capture over 94 percent of the variation in state diesel tax rates, much in line with other studies in this literature. Moreover, based on our model's F-statistics, for all model variations we can safely reject the null hypothesis that estimated coefficients are jointly zero.

In terms of the point estimates, we find the trucking services sector's share of total state employment to have a negative impact on both the real and nominal tax rate and is statistically significant across all model variants. Moreover, the magnitudes of the estimated elasticities appear to be economically meaningful as well. Focusing on the real diesel tax rate (models 2 and 4) we find elasticities on the order of about 0.41, suggesting that a 10 percent increase in this sector's share of total employment would results in a 4.1 percent decline in the real diesel tax. It

[25] See Greene (1993, pp. 448-452) for a discussion of this issue.

does appear that trucking interests do have an impact on state legislature's diesel tax rate decisions in a way favorable to that sector, a result consistent with Stigler's positive theory of regulation. By contrast, however, we find little evidence that mining and construction interests impact such taxes. While the estimated coefficients on mining and construction's share of total employment are consistently negative, the magnitudes of these elasticities are relatively small and rarely does the variable achieve statistical significance, at conventional levels of significance.

The other variable that proves to be statistically significant across all model variants is HFUND/POP. Our results indicate that there is a positive relationship between diesel tax rates and the real per-capita level of highway funds generated from revenue sources other than tax receipts. This result, consistent with GN's findings, suggests that state legislators' view such alternative sources as complementary assets to diesel tax collections.

There is some, albeit weaker, evidence suggesting that diesel tax rates (in particular the real tax rates) are sensitive to air quality. Indeed, focusing on models 2 and 4 again, we find that a 10 percent increase the a state's share of residents located in EPA-designated non-attainment states results in roughly a 1.3 percent increase in the diesel tax rate. This effect, too, appears to be consistent to some degree with GN and other studies.

While the employment effects, at least with respect to trucking, are consistent with our a prior expectations, we find scant evidence that state legislatures are sensitive to trucking usage, as proxied by the share of a state's interstate highway miles to total road mileage (HWAY/TOTROAD) when setting the diesel tax. Indeed this variable is only statistically significant in the real diesel tax models (2 and 4), and only for the FE specification, and only at a 10 percent level of significance. Moreover, the estimated elasticities are relatively small. From model 2, for instance, we find the elasticity to be 0.07, suggesting a 10 percent increase in a state's share of highways to total roads will prompt a relatively small 0.7 percent increase in the diesel tax. This result would seem at odds with the normative theory of regulation, as articulated by Posner (1974), that would hypothesize that, as larger freight trucks cause greater wear and tear on a roadway system, this greater harm should prompt a higher diesel tax rate.

Finally, our results do not generally support GN's voter maximization model. Recall that there model predicted a negative relationship between the gasoline excise tax and gasoline price, for which they found empirical support. However, with respect to diesel, this relationship does not seem to hold. As discussed earlier, under a voter maximization model there may be some reason to suspect correlation between diesel prices and employment share data. Employees in the mining, construction, and trucking industries are as likely as any to vote, hence, the inclusion of both, as in model 1 and 2, may generate biases in our estimated coefficients. This concern about bias prompted estimation of model variations 3 and 4, where we omit DPRICE_AVG from the specification to see if this alters the estimated coefficients associated with the employment variables in the mining and construction industries, which had insignificant coefficients associated with them in models 1 and 2. We find that dropping this price variable has little impact on the overall results. Employment in mining and construction still appear not to impact the diesel tax whereas trucking employment does.[26]

[26] It is important to note two results at this point. First, because the insignificance of DPRICE_AVG is at odds with GN's results, we estimated all four models by dropping the employment variables and retaining DPRICE_AVG. In all cases, the variation in diesel prices did not prove to have a negative coefficient nor was it statistically significant. In short, our results suggest that the diesel tax is not influence by the diesel price. Second, we also collected data on the gasoline tax and gasoline prices by state. We then estimated four models that attempted to explain variations in the gasoline tax as a function of gasoline prices and all other explanatory variables defined in equation 1. When this was done, we did indeed find that the moving average of gasoline prices negatively impacted the gasoline tax, just as GN predict. Hence, GN's theoretical model is verified (with more recent data), with respect to the gasoline tax. Moreover, we should point out that the trucking sectors' state of total employment also negatively impacted the gasoline tax. This result suggests a number of issues. First, it may be that the trucking interests efforts to limit the diesel tax have a spill-over effect on gasoline. That is, perhaps users of gasoline increase pressure on state officials

6. Conclusion

The potential negative impact that ever-escalating gasoline and diesel fuel prices are likely to have on a state's economy are prompting some states to temporarily suspend their gasoline taxes, and to a lesser degree, their diesel fuel taxes. Georgia has already done so and others, such as Oklahoma, Connecticut and Massachusetts are debating it merits of such a policy. While it's not clear if such a policy will limit recessionary tendencies in a state's economy, it is perplexing why, if the fear is economic hardship, that the focus is mainly on gasoline tax suspensions and not so much on diesel tax suspensions. Many major industries are heavy users of diesel fuel such as the mining and construction industries and the trucking services industries which account for 8 percent of total GDP in the United States.

Previous studies that have focused on diesel taxation have investigated European countries, with none, to our knowledge investigating on the US experience. The purpose of this paper is to contribute to filling this gap. The focus of this paper is on the determinants of State excise taxes levied specifically on diesel fuel. We employ a fixed effect panel data set covering all 50 US states over the period 1992 to 2001. Our most prominent finding is that the proportion of freight trucking industry's employment to total state employment a highly significant determinant of a state's diesel tax rate. Specifically, our results are robust to model specification and indicate that the greater the contribution of freight trucking employment to total state employment, the lower the diesel tax rate, *ceteris paribus*. In contrast, we find little evidence that the degree of freight transportation usage on state highways impacts the diesel tax rates. These findings suggest state legislators, when determining the diesel tax rate, exhibit behavior that is consistent with Stigler's (1971) economic or positive theory of regulation, in which legislators are sensitive to (indeed perhaps responsive to) the trucking industry's contribution to a state's economy. On the other hand, our results indicate that state law makers appear less concerned over the impact heaving

to limit the gas tax if they observe these officials limiting the diesel tax for the trucking interests. It also might suggest that the trucking interests desire lower gasoline tax rates as well, particularly if a percentage of their fleets are smaller vehicles that run on gasoline. Irrespective of which of these hypotheses is true, we note that the estimated elasticity between trucking employment share and the gas tax is much less than that for diesel. From Table 3, recall our estimated elasticities are -0.25 for the nominal diesel tax rate and -.41 for the real tax rate. By contrast, the estimated elasticity between trucking employment share and the gas tax are -.16 for nominal tax rate and -.28 for the real tax rate.

freight transportation has on the highway infrastructure. Hence, our results seem contrary to the public interest or normative theory of regulation as articulated by Posner (1974) asserting that law makers act in a way consistent with social welfare maximization.

There are a number of potentially fruitful avenues for future research. For instance, similar to Rietveld and van Woudenberg's (2005) work, one might consider a cross-country comparison of diesel tax rates to test whether or not the basic results we find here generalize to other countries. It also would be of interest, following Nelson (2002), to test if there is a "border-tax" effect with respect to diesel specifically; that is, whether or not neighboring state's diesel tax rates influence a given state' diesel tax policy. We leave these consideration for future research.

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Table 1: Summary Statistics

	Data source	Mean	St. div.
DTAX (cents per gallon)	Highway Statistics (various years), Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation, available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.	19.72	4.74
CPI	US Bureau of Labor Statistics, available at www.bls.gov.	1.58	0.11
DPRICE (dollars per gallon)[1]	Energy Information Administration (EIA), US Department of Energy, available at http://www.eia.doe.gov/emeu/states/_price_multistate.html.	0.60	0.09
DTAXUS (cents per gallon)	Highway Statistics (various years), Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation, available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.	23.96	1.29
TOTROAD	Highway Statistics (various years), Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation, available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.	15,363.48	16,890.93
POP (1000 residents)	Bureau of Economic Analysis, US Census Bureau, available at http://www.bea.gov/bea/regional/data.htm.	5,408.58	5,896.12
HFUNDS[2]	Highway Statistics (various years), Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation, available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.	472,192.76	454,653.37
HWAY/TOTROAD*100	Highway Statistics (various years), Office of Highway Policy Information, Federal Highway Administration, US Department of Transportation, available at http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm.	8.50	4.72
EMPM&C/EMPTOT*100	Bureau of Economic Analysis, US Census Bureau, available at http://www.bea.gov/bea/regional/data.htm.	6.39	1.66
EMTR/EMPTOT*100	Bureau of Economic Analysis, US Census Bureau, available at http://www.bea.gov/bea/regional/data.htm.	1.54	0.49
NONATTAIN/POP*100	For counties in nonattainment: The Green Book Nonattainment Areas for Criteria Pollutants, US Environmental Protection agency, available at http://www.epa.gov/oar/oaqps/greenbk/. For the county and state population: Bureau of Economic Analysis, US Census Bureau, available at http://www.bea.gov/bea/regional/data.htm.	25.57	17.39

[1]Measured as the real price per gallon excluding the state and federal diesel tax rates.
[2]Measured as the real value of highway funds collected by each state which includes tolls, revenues from bond initiatives, and other minor sources. but excludes tax revenues collected

Table 2: Correlations between Diesel Price and other key variables

	DTAX	DTAX/CPI
HWAY/TOTROAD	-0.10	0.24
EMPM&C(-1)/EMPTOT(-1)	-0.16	-0.06
EMPTR(-1)/EMPTOTL(-1)	-0.07	-0.43

Table 3. Estimation Results

dependent variable:	Model 1 ln(DTAX)		Model 2 ln(DTAX/CPI)		Model 3 ln(DTAX)		Model 4 ln(DTAX/CPI)	
	f.e.	r.e.	f.e.	r.e.	f.e.	r.e.	f.e.	r.e.
Constant	2.5370 ***	2.7150 ***	1.6029 ***	2.0316 ***	2.4536 ***	2.6233 ***	1.5813 ***	2.0353 ***
	(0.1970)	(0.2172)	(0.2390)	(0.4813)	(0.1838)	(0.2188)	(0.2527)	(0.5208)
ln(DPRICE_AVG)	-0.0367 ***	-0.0366 ***	-0.0159	0.0020	--------	--------	--------	--------
	(0.0113)	(0.0104)	(0.0286)	(0.0321)	--------	--------	--------	--------
ln(CPI_AVG)	0.5481 ***	0.5153 ***	--------	--------	0.5649 ***	0.5329 ***	--------	--------
	(0.0487)	(0.0313)	--------	--------	(0.0429)	(0.0249)	--------	--------
ln(DTAXUS_AVG)	-0.0103	-0.0099	0.1246	0.1847 *	0.0305 *	0.0308 *	0.1405	0.1828
	(0.0290)	(0.0260)	(0.0786)	(0.1114)	(0.0175)	(0.0161)	(0.0917)	(0.1299)
ln(TOTROAD/POP)	0.0283	0.0010	0.3602 ***	0.1284 **	0.0228	-0.0008	0.3520 ***	0.1288 **
	(0.0840)	(0.0578)	(0.0544)	(0.0542)	(0.0813)	(0.0572)	(0.0543)	(0.0525)
ln(HFUNDS/POP)	0.0347 ***	0.0283 ***	0.0327 ***	0.0235 ***	0.0333 ***	0.0269 ***	0.0321 **	0.0236 ***
	(0.0091)	(0.0069)	(0.0100)	(0.0082)	(0.0096)	(0.0074)	(0.0107)	(0.0084)
ln((HWAY/TOTROAD)*100)	0.0233	-0.0111	0.0792 *	0.0420	0.0178	-0.0152	0.0757 *	0.0424
	(0.0358)	(0.0392)	(0.0443)	(0.0384)	(0.0362)	(0.0381)	(0.0472)	(0.0380)
ln((EMPM&C(-1)/EMPTOT(-1))*100)	0.0033	-0.0281	-0.0301	-0.1612 **	0.0077	-0.0234	-0.0276	-0.1618 **
	(0.0420)	(0.0608)	(0.0475)	(0.0707)	(0.0429)	(0.0623)	(0.0474)	(0.0733)
ln((EMPTR(-1)/EMPTOT(-1))*100)	-0.2485 ***	-0.1898 ***	-0.4146 ***	-0.3691 ***	-0.2506 ***	-0.1899 ***	-0.4128 ***	-0.3695 ***
	(0.0477)	(0.0548)	(0.0693)	(0.0885)	(0.0473)	(0.0544)	(0.0699)	(0.0937)
ln(NONATTAIN/POP)	0.0683	0.0619 *	0.1292 ***	0.1485 ***	0.0690	0.0621 *	0.1285 ***	0.1487 ***
	(0.0506)	(0.0384)	(0.0280)	(0.0137)	(0.0502)	(0.0380)	(0.0280)	(0.0152)
Adj. R^2	0.947	0.199	0.945	0.237	0.947	0.199	0.945	0.239
F-Statistic	154.761 ***	14.684 ***	148.894 ***	20.244 ***	157.406 ***	16.372 ***	151.824 ***	23.184 ***
Hausman Statistic[1]	27.156 ***		177.827 ***		0.531		80.053 ***	

standard errors reported in parentheses.

* - Significant at the 10 percent level.

** - Significant at the 5 percent level.

*** - Significant at the 1 percent level.

[1]Larger values favor FE over RE.