

Robert M.

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## Cost-Benefit Analysis of Implementing a Sales Tax on Motor Fuels in Wisconsin

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and Peter Whalen**

Cost-Benefit Analysis Course, La Follette School of Public Affairs, University of Wisconsin-Madison

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## Glossary

- *Ad valorem* sales tax: A tax whose value is a percentage of the price of the good. In other words, a sales tax.
- Deadweight loss: The net reduction in overall social welfare from a loss of surplus from one group not offset by gains to another group from a policy that alters the market's equilibrium. In the case of a tax, there are transactions that would have occurred in an undistorted market that are no longer taking place. This loss of social welfare is not offset by a gain anywhere else.
- Excise tax: A per-unit tax levied on a good. In our model, the tax of 32.9 cents per gallon is an excise tax.
- Heavy-duty vehicles: All freight trucks in Wisconsin. This analysis assumes that these trucks all consume diesel.
- Light-duty vehicles: All passenger cars (compact, midsize, and large), and light-duty trucks such as sport utility vehicles, vans, and pickup trucks.
- Marginal excess tax burden (METB): The change in deadweight loss resulting from raising an additional dollar of government revenue. These values vary by the tax policy in question.
- Monte Carlo simulation: Refers to a technique in which uncertain parameters used to determine net benefits and revenue are allowed to vary in a range. It is typically executed thousands of times by a computer program to simulate a large number of potential outcomes of the policy.
- Negative externality: A negative externality exists when the actions of an individual or firm impose costs that are not borne solely by the person or firm in question. Pollution,

congestion, and noise that result from fuel consumption impose costs on all residents of Wisconsin yet these costs are not reflected in the price of fuel.

- Nominal: Fixed, not adjusted for inflation.
- Price elasticity of demand: The percentage change in quantity demanded for a percentage change in price. It is negative for motor fuels because a price increase will result in a smaller quantity consumed. A number very close to zero means that there is very little demand response for a change in price. A number close to 1 means that a 1 percent increase in price will result in a 1 percent decrease in quantity demanded.
- Price shock: This analysis incorporates the possibility of a sharp increase or decrease in the price of fuel, the change is referred to as a price shock.
- Social welfare: See welfare
- Standing: Refers to whose costs and benefits are considered. This analysis estimates the costs and benefits for the state of Wisconsin and the nation.
- Ton mile: one ton of freight moved one mile.
- Welfare: From the consumer's point of view, welfare is the benefit from consuming a good minus monetary cost. From the producer's perspective, welfare is the price of the producer's good sold in the marketplace less the costs to produce the good in aggregate. Consumer surplus, producer surplus, and government revenue together represent social welfare.

## **Executive Summary**

In Wisconsin, the excise tax on gasoline and diesel fuel makes up three-fifths of the state's Transportation Fund that pays for road construction and repair. Revenue from the excise tax is steadily declining in real terms, partly because the tax rate is not keeping pace with inflation. In Wisconsin, motor fuel tax is fixed at 32.9 cents per gallon. In this analysis we examine the impact of changing Wisconsin's fixed tax on motor fuels to a mixed-tax alternative. The mixed-tax alternative would align the fuel tax to inflation and the price of motor fuel and initially impose no additional tax burden on consumers.

The mixed-tax alternative would work in this way: A 5 percent sales tax would be levied on motor fuel and the excise tax would be reduced by a corresponding amount. For example, if the price of a gallon of gasoline was \$1.00, the 5 percent sales tax would be 5 cents, the reduced excise tax would be 27.9 cents, and the total would still be 32.9 cents. The total tax on fuel would not change on the day the policy was implemented. One year later, the fixed excise tax would still be 27.9 cents if the cost of fuel was the same. However, if a gallon of gas cost \$2.00, the 5 percent sales tax would be 10 cents. The reduced excise tax would still be 27.9 cents, for a total of 37.9 cents. In this manner, the mixed-tax alternative would link part of the tax rate to the price of fuel. The motor fuel tax would increase when fuel prices rise and decline when fuel prices drop.

We estimate impacts for state revenue and net societal benefits (government savings and noneconomic benefits to society after accounting for any government costs incurred). We compare the fixed excise tax of 32.9 cents under four scenarios to the mixed-tax alternative. Two of the base case scenarios include the possibility of fuel price shocks, similar to the rapid price



spikes that occurred in 1979 and 2008. Two additional scenarios include an excise tax that is fixed or rises with inflation. The four base case scenarios are:

**Fixed Excise Tax**

Scenario 1: Fixed excise tax with motor fuel price shocks accounted for

Scenario 2: Fixed excise tax with no motor fuel price shocks

**Excise Tax Changes with Inflation**

Scenario 3: Excise tax rising with inflation and accounting for motor fuel price shocks

Scenario 4: Excise tax rising with inflation with no motor fuel price shocks

*The Impact of a Mixed-Tax Alternative on Wisconsin Revenue*

First, our statistical analysis estimates differences in Wisconsin state revenue. As shown in the table below, we compare the mixed-tax alternative to four scenarios derived from the base case of Wisconsin's 32.9-cent excise tax on fuel. Based on national projections, we estimate that inflation would vary between 1.4 and 2.7 percent annually from 2011 to 2020 and that motor fuel costs would increase. Compared to each of the four base case scenarios, the mixed-tax alternative would yield additional revenue. With price shocks in the analysis, the mixed-tax alternative would bring the state an additional \$939 million to \$1.71 billion in revenue over the nine-year period. Without price shocks, the additional revenue would range from \$803 million to \$1.58 billion.

**Average difference in Wisconsin state revenue between mixed-tax alternative and each base case scenario (millions of 2010 dollars)**

<b>Year</b>	<b>With Price Shocks</b>		<b>Without Price Shocks</b>	
	<b>Fixed Excise Tax</b>	<b>Excise Tax Rising with Inflation</b>	<b>Fixed Excise Tax</b>	<b>Excise Tax Rising with Inflation</b>
2012	72	38	60	24
2013	130	75	110	62
2014	160	96	150	81
2015	180	110	170	89
2016	200	110	190	97
2017	220	120	210	110
2018	240	130	220	110
2019	250	130	230	110
2020	260	130	240	120
<b>Total</b>	<b>1,712</b>	<b>939</b>	<b>1,580</b>	<b>803</b>

Source: Authors

*The Impact of a Mixed-Tax Alternative on Net Societal Benefits in Wisconsin*

Second, we estimate in dollars the net societal benefits from changes in the motor fuel tax policy. We determine values for benefits that occur outside the market, including the resulting reductions in accidents, congestion, local pollution, and road noise. We also calculate costs for road maintenance and the marginal excess tax burden. Marginal excess tax burden is an estimate that accounts for the cost of raising government revenue through a given tax policy. If revenue can be raised from a second source such as the sales tax, this money can be used to lower other taxes and reduce the excess tax burden on consumers.

The two overall marginal excess tax burden costs we consider for Wisconsin are the explicit deadweight loss of the tax and the federal marginal excess tax burden. Deadweight loss refers to taxes that are less economically efficient. Some taxes are more expensive to implement than others and, as a result, they incur a larger “cost” to government.

The table below compares the net societal benefits of the mixed-tax alternative to each of the four base case scenarios. For example, if no price shocks occur and the excise tax remains

fixed, we expect that the mixed-tax alternative would yield net societal benefits of \$101 million at minimum and \$783 million at maximum. If price shocks occur and the excise tax remains fixed, we forecast the minimum benefit of the mixed-tax alternative to be \$4 million and the maximum to be \$12 billion.

**Net societal benefits of the mixed-tax alternative compared to each of the four base case scenarios**  
**(millions of 2010 dollars)**

<b>Scenario</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Average</b>
(1) Excise tax fixed, price shocks	4.08	12,000	1,910
(2) Excise fixed, no price shocks	101	783	268
(3) Excise rising with inflation, price shocks	26	14,200	1,810
(4) Excise rising with inflation, no price shocks	77	865	227

Source: Authors

Compared to current tax policy, revenue would be the same if fuel costs were the same and if no inflation occurred. However, if inflation or motor fuel costs rise (as predicted), the mixed-tax alternative would yield greater government revenue and higher net benefits for society compared to each of the four scenarios. The revenue enhancements occur because inflation and rising fuel costs are accounted for. The societal benefits occur because of a reduction in nonmarket costs associated with driving, such as accidents, congestion, pollution and road noise.

## Introduction

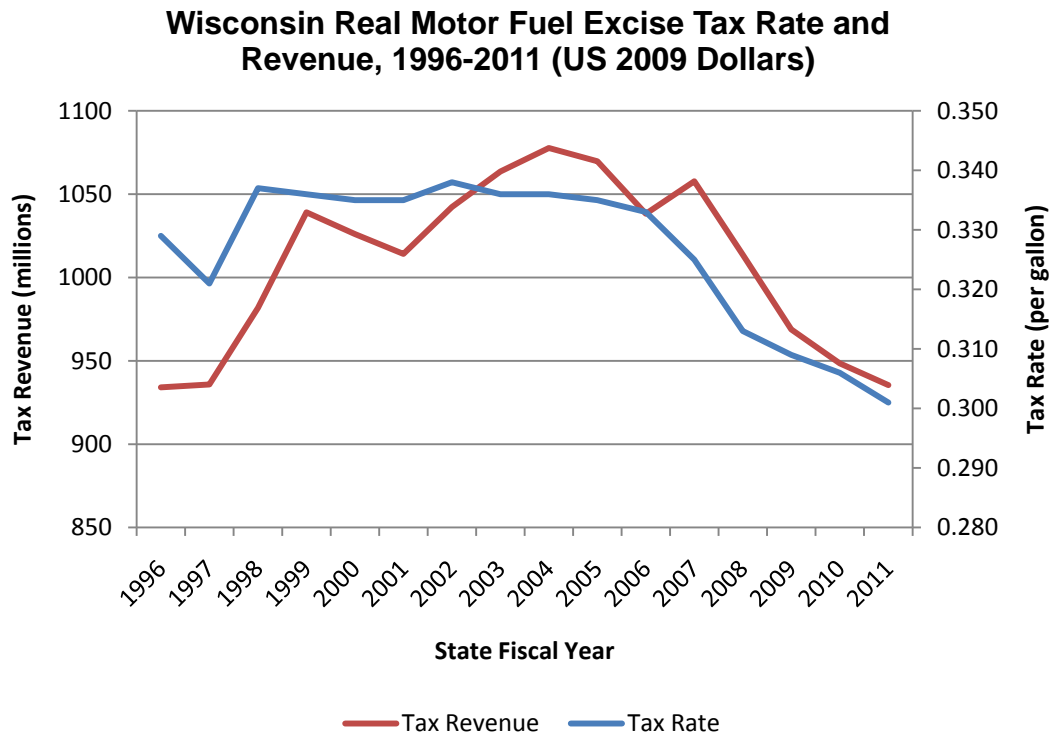
In Wisconsin, most consumers of gasoline and diesel fuel pay a state excise tax at the pump that funds most of the state's Transportation Fund. The Transportation Fund provides the means for road and infrastructure construction as well as repair. In fiscal year 2007-2008, these fuel taxes accounted for 59.5 percent of the state's Transportation Fund, with vehicle registration fees accounting for an additional 32 percent. Of the tax revenue collected from fuel, 76.5 percent was collected from the purchase of gasoline, while 23.3 percent was collected from the purchase of diesel fuel (Wisconsin Department of Revenue, 2010).

Wisconsin's fuel tax originated in 1925 when the legislature passed a measure to allocate a fuel tax of 2 cents per gallon to the state's General Fund. At the time of its creation, the tax was viewed as a way of shifting the burden of maintaining the state's highways to those individuals who used them, the motorists. In 1945, the state created the Transportation Fund so that fuel tax revenue would be separate from general revenue. Between 1925 and 1980 the state's fuel tax changed five times and never increased more than 2 cents at a time. Beginning in 1985 the state began to index the fuel tax according to a formula the legislature created. Indexing ended in 2006 with the passage of Act 85, which decoupled the tax rate from inflation. The fuel tax has not changed since and sits at 32.9 cents per gallon, 2 cents of which goes directly toward reclaiming old fuel tank sites. There are several exemptions to paying the state fuel tax. Most notably, fuel sold for use in mass transit and fuel purchased for non-highway use is exempted as long as it is purchased in amounts exceeding 100 gallons (Wisconsin Legislative Fiscal Bureau, 2009).

The status quo excise tax of 32.9 cents serves as our base case. However, in real terms, the fuel tax rate has declined in recent years due to inflation, and so we take inflation into account. For a depiction of the historical trajectory of real fuel tax rate levels and real fuel tax revenue in Wisconsin, see Figure 1. For a comparison of Wisconsin's tax policy to other states'

tax rates, see Appendix A. In addition, fuel prices can change suddenly, such as the rapid price spikes that occurred in 1979 and 2008. Thus we consider price shocks as well as inflation to create base case scenarios.

**Figure 1**



Source: Authors, adapted from Wisconsin Department of Transportation (2010)

#### *Alternative Policy: Mixed-Tax Approach*

The mixed-tax approach under consideration here features a reduced fuel excise tax offset by the application of the state sales tax to fuel. This change would result in no initial net burden for consumers. The excise tax reduction would be equal to the initial sales tax revenue from a gallon of gas, meaning that price of fuel at the pump would not change initially. We calculated the costs and benefits associated with this potential shift in Wisconsin's motor fuel tax formula

to include an *ad valorem* sales tax. Additionally, we determined the impact of the mixed-tax approach on state Transportation Fund revenue in the face of price and consumption uncertainty.

To assess this alternative, we made several assumptions. First, we assumed other fuel tax regulations would remain the same. “Motor fuel” would retain the same definition, and the same tax exemptions for specific buyers and certain fuels types would persist. Second, the state sales tax would remain at 5 percent and would be applied at the point of purchase.

To create a tax that would initially impose no additional net burden on consumers, we merged the extant 5 percent sales tax with a new excise tax. On the day the new policy took effect, consumers would pay the same nominal tax rate per gallon that they would have paid under the current policy. For example, consumers now pay 32.9 cents per gallon in taxes. If we predict that gasoline would cost \$3 per gallon (before tax) on the policy’s first day, the new motor fuel tax would comprise the 5 percent sales tax plus an excise tax of 17.9 cents per gallon, thus ensuring that the state would continue to collect 32.9 cents per gallon. Following this initial tax setting, consumers’ net burden would vary with the price of motor fuel.

As we assumed that driving patterns would not change on the initial day of policy implementation, the numerous externalities associated with auto use would not be immediately altered. However, over time, if we predict fuel taxes to increase based upon the increases in the price of fuel, the tax could potentially mitigate a number of important negative externalities, including traffic congestion and air pollution. The benefits associated with the reduction of negative externalities should be considered and monetized. To predict costs and benefits after that initial day, we used fuel price forecasts and studies of gasoline demand elasticity to estimate how much motor fuel consumers will buy. Using forecasts of fuel prices, we then compared the net social benefits of the mixed-tax policy to those of the base case.

## Methodology

The objective of this project was to apply a sales tax to motor fuels in Wisconsin that imposed no initial net burden on consumers. Consumers, producers, and the state government bear the benefits and costs of altering the motor fuel tax. We calculated net benefits (NB) for state and national standing. Our base case model simply retains the status quo excise tax; we imposed a new 5 percent *ad valorem* sales tax with an offsetting reduction in the existing excise tax in the mixed-tax alternative. The net benefit of the alternative policy is the difference between the net benefits under the mixed-tax alternative and the base case scenarios. Under the assumption that fuel prices will rise, imposing a sales tax on motor fuels reduces fuel consumption, which, in turn, decreases negative externalities and reduces consumer surplus. Depending on elasticity and marginal excess tax burden (METB) estimates, the sales tax also increases government revenue and produces deadweight loss in the motor fuels market. We used the following equations to calculate net benefits for state and national standing:

Wisconsin:

$$\text{NB} = \Delta \text{Deadweight Loss of Mixed Tax Alternative} + \text{reduced METB of } \Delta \text{WI Revenue} + \text{Reduction in Negative Externalities (local air pollution, congestion, accidents/fatalities, noise, and road maintenance)}$$

Nation:

$$\text{NB} = \Delta \text{Deadweight Loss of Mixed Tax Alternative} + \text{reduced METB of } \Delta \text{WI Revenue} - \text{increased METB of } \Delta \text{Federal Revenue} + \text{Reduction in Negative Externalities (local air pollution, congestion, accidents/fatalities, noise, and road maintenance)}$$

For each standing, we calculated net benefits on an annual basis from the beginning of 2011 through the end of 2020 per the client's request. Implicit in the calculation, we determined the change in the stream of revenue for the state Transportation Fund over this time horizon. We assumed that the imposition of a sales tax does not increase administrative costs at the state level.

Further, we assumed (for the sake of simplicity) that light-duty vehicles consume all gasoline and heavy-duty vehicles consume all diesel (see Appendix B).

### *Tax Adjustment*

The imposition of a 5 percent *ad valorem* sales tax would normally decrease consumer surplus. To keep the initial consumer burden the same, the state excise tax of 32.9 cents on motor fuels was decreased by the exact amount of the new 5 percent sales tax.

### *Price and Quantity Forecast*

We calculated the initial price per gallon of diesel and gasoline in Wisconsin (\$2.70 and \$3.01, respectively) by starting with the Energy Information Administration's (EIA) 2011 U.S. national average price forecast and multiplying it by the ratio of the average Wisconsin to U.S. fuel prices in 2010. This price forecast accounts for expected improvements in fuel economy and technology, increased use of alternative fuels, projected economic conditions, and projected demand for freight (EIA, 2010a). For the base case, we forecasted changes to the initial Wisconsin motor fuels price by using the annual percentage changes predicted by the EIA for U.S. national gasoline and diesel prices (EIA, 2010a). For the alternative case, the year-on-year annual change in retail prices paid by the consumer was 5 percent greater than the year-on-year price change in the base case to account for the new sales tax. We incorporated a probability of a price shock in any given year—see Appendix C for a more detailed explanation of our approach.

We calculated base case forecast changes in quantity of Wisconsin motor fuel consumed in the same way we calculated price changes, by taking forecasted annual percent changes in U.S. gasoline and diesel consumption from the EIA's national projection and applying them to the trailing 12-month average consumption ending November 30, 2010, of both fuels in Wisconsin (Wisconsin Department of Revenue, 2010). For the mixed-tax alternative, we used



meta-analysis estimates of long-term price elasticities of demand (-0.45 for gasoline and -0.24 for diesel) to calculate the decrease in quantity of fuel consumed due to the 5 percent greater price change. See Appendix D for a more detailed discussion of elasticity estimates.

### *State and Federal Revenue Forecast*

For the base case, we calculated Wisconsin revenue in each year by multiplying the volumes of gasoline and diesel consumed by the real excise tax. In 2010, this is 32.9 cents per gallon. Because the current excise tax is in nominal terms, in the future it will fall in real terms because of inflation. We used the Congressional Budget Office's (2010) and the market's expectation of inflation to reduce the excise tax by the appropriate amount (see Appendix E). We also compared the mixed-tax alternative to scenarios in which the base case excise tax was adjusted to inflation. For the mixed-tax alternative case, we multiplied the alternative volumes of gasoline and diesel fuel in each year by the combination of the excise tax and *ad valorem* sales tax in that year. We calculated the difference in federal revenue between the base and alternative cases as the difference in volume of gasoline and diesel consumed multiplied by the federal excise taxes of 18.4 cents and 24.4 cents respectively.

### *Benefits*

Benefits of altering the motor fuel tax include the avoided METB; reduced negative externalities such as air pollution, traffic congestion, and injuries and fatalities from collisions; and tax revenue from non-Wisconsin residents purchasing fuel in Wisconsin.

### Avoided METB

We assumed that the additional state revenue from the imposition of the motor fuel tax displaces funds that would otherwise come from Wisconsin's general fund. Therefore, we count

the METB of raising the revenue through other taxes (state sales and income tax) as a benefit. Finding a proper METB for the state is challenging as there is not a large amount of relevant literature. We estimated the Wisconsin METB for the income tax as varying from 0.01 to 0.07 (Parry, 1999 and Wisconsin Legislative Fiscal Bureau, 2009). We estimated the U.S. METB for the U.S. income tax to range from 0.06 to 0.57 (Parry, 1999). Appendix F contains a more detailed discussion of these calculations. We estimated avoided METB as 1 to 7 percent times the additional revenue from the imposition of the sales tax, relative to revenue in the base case. Please note that the directly implied deadweight loss from the imposition of our motor fuel tax was also considered and calculated in the cost section below to determine the overall deadweight loss of modifying the fuel tax regime.

### Negative Externalities

We drew estimates of the following negative externalities from meta-analyses in the literature: local air pollution, traffic congestion, and injuries and fatalities from car accidents (for values used in estimation see Appendix B and road maintenance noise for heavy-duty vehicles. For discussion of omitted externalities, see Appendix G. For light-duty vehicles, these externalities were presented in dollars per mile driven, and for heavy-duty vehicles, they were presented in dollars per ton-mile. For each externality category, we converted the units on the externalities into a dollars per gallon figure using fuel economy (miles or ton-miles per gallon) forecasts from the EIA (2005 and 2010a) and ICF International (2009) and then multiplied the externality cost by the volume of motor fuels consumed. Because forecast consumption in the alternative case was universally lower than in the base case, all of these externalities increased the net benefits of the alternative case, relative to that of the base case.

### Out-of-State Consumption

In calculating Wisconsin's standing, we must consider that not all of the fuel in Wisconsin is purchased by Wisconsin residents. The data do not allow a reasonably accurate way to estimate the amount of tax paid by non-residents purchasing fuel because there is no comprehensive monitoring system that tracks whether fuel purchases are made by Wisconsin residents or by individuals visiting or passing through the state. When considering Wisconsin standing we expect that the tax revenue paid by non-residents has a positive but negligible impact on state government revenue. We consider the externalities from driving when determining consumption's effects on Wisconsinites, but we believe that reduced accidents, pollution, congestion, and noise would have very little cumulative effect on other states' residents. Therefore, we only use externalities when calculating Wisconsinites' welfare.

### *Costs*

We measure costs of altering the motor fuel tax in three ways, by determining the deadweight loss and by discounting future revenue and benefits.

The net decrease in social surplus (net change in producer surplus, consumer surplus, and government revenue) from this particular new sales tax on motor fuels was calculated through the derivation of the demand curve and direction determination of the resulting deadweight loss. Annual price, quantity, and elasticity estimates with an assumption of demand linearity, allowed us to derive the demand curve for motor fuels in each individual year (for a more detailed explanation of the mathematics of this process see Appendix H). As Wisconsin represents a small portion of the national motor fuels market (Wisconsin Department of Revenue, 2010; EIA, 2010a), the supply curve was assumed to be flat at the prevailing price. We directly determined the deadweight loss as the net change in social surplus due to the shift in demand from

imposition of the *ad valorem* sales tax, after we considered changes in consumer surplus, producer surplus, and government revenue. As indicated, the cost of this directly determined deadweight loss was subtracted from the avoided METB if the revenue was raised through the state's other general revenue channels to determine the net deadweight loss of revenue raised through the new sales tax.

To discount future revenue and benefits, we discounted net benefits at the mid-point of each year using the social discount rate of 3.5 percent. We chose this figure based on the optimal growth rate model developed by Richard Newell and William Pizer. As our time horizon of 10 years fell into the 0 to 50 year period, we used the pertinent rate for that time period (Newell and Pizer, 2000). Our project is not front-loaded or back-loaded in terms of benefits and costs. In other words, neither benefits nor costs accrue more heavily at the beginning or end of the project; they are spread evenly throughout. Therefore, the choice of discount rate does not have a substantial impact on the magnitude of net benefits.

## **Results**

To run our Monte Carlo sensitivity statistical analysis, we established ranges for the following constants: motor fuel elasticity, price forecasts, and negative externality costs. These ranges and their sources may be found in Appendix I. Appendix J contains the STATA code used to perform the statistical analysis found in the report.

### *Net Benefits*

We ran separate Monte Carlo simulations for the alternative mixed-tax policy versus five base case excise tax scenarios to include consideration of inflation and price shocks: (1) motor fuel excise tax in nominal dollars (unadjusted for inflation) with price shocks included, (2) motor fuel excise tax in nominal dollars with price shocks excluded, (3) motor fuel excise tax indexed

to inflation with price shocks included, (4) motor fuel excise tax indexed to inflation with price shocks excluded, and (5) motor fuel excise tax in nominal dollars with price shocks included and METB of income tax set to zero. The highest mean net benefits of \$1.91 billion were found for the scenario with price shocks and a nominal excise tax, while the lowest mean net benefits of \$268 million were found for the scenario with price shocks and an excise tax tied to inflation.

Table 1 shows additional details.

**Table 1: Present value of Wisconsin net benefits due to replacement of 32.9 cent excise tax on motor fuels with a mixed-tax alternative compared to each of five base case scenarios (billions of 2010 dollars)**

Scenario	Minimum	Maximum	Mean	Standard Deviation
(1) Excise tax fixed, with price shocks	0.00408	12.0	1.91	2.19
(2) Excise tax fixed, no price shocks	0.101	0.783	0.268	0.127
(3) Excise tax indexed to inflation, with price shocks	0.026	14.2	1.81	2.18
(4) Excise tax tied to inflation, no price shocks	0.077	0.865	0.227	0.121
(5) Excise tax fixed, no METB, with price shocks	-0.110	11.5	1.64	2.06

Source: Authors

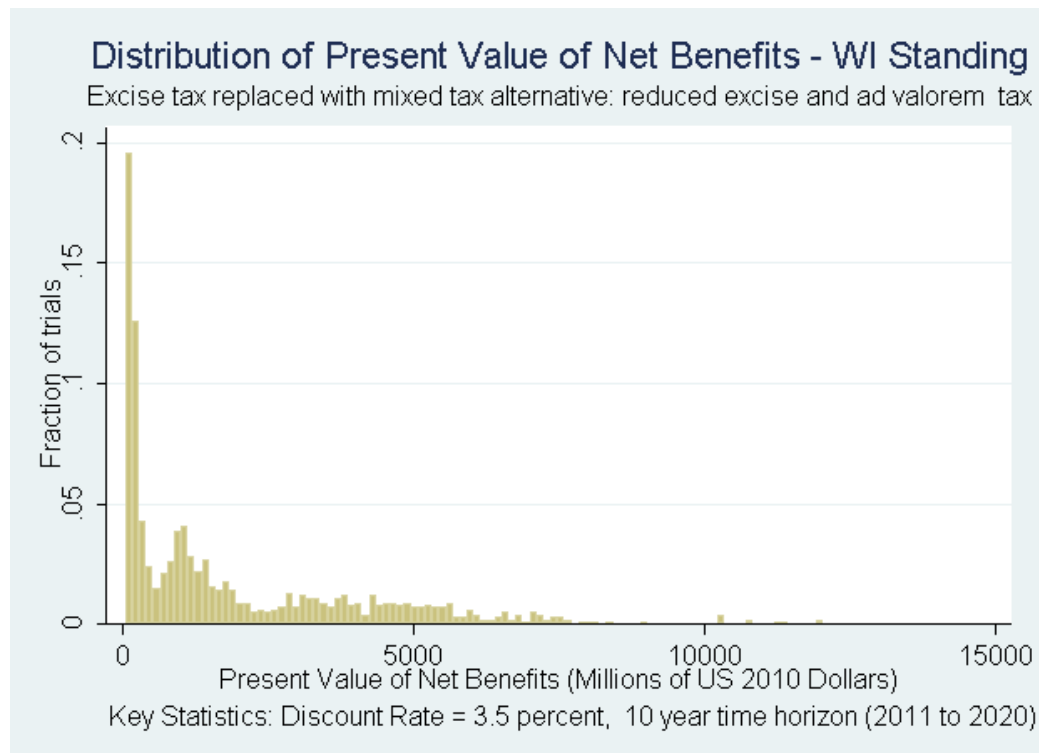
Focusing on Scenario 1, we found the replacement of the 32.9 cent excise motor fuel tax with the mixed-tax alternative results in mean positive net benefits of \$1.91 billion for Wisconsinites and \$1.89 billion for Americans as a whole from 2011 through 2020 when price shocks are considered. The range of net benefits for Wisconsin standing runs from \$4.08 million to \$12 billion, while the range of net benefits for national standing runs from \$4.04 million to \$11.9 billion (see Table 2 for additional statistics). Despite this wide range in net benefits of nearly \$12 billion, 100 percent of estimates result in a positive outcome (see Figures 2 and 3 for histograms of net benefits estimates). For additional histograms and tables of statistics on the net benefits of scenarios 2-5, see Appendix K.

**Table 2: Present value of net benefits due to replacement of nominal 32.9 cent excise tax on motor fuels with a mixed-tax alternative (billions of 2010 dollars) – risk of price shock included**

Standing	Minimum	Maximum	Mean	Standard Deviation	Number of Estimates
Wisconsin	0.00408	12.0	1.91	2.19	1000
National	0.00404	11.9	1.89	2.17	1000

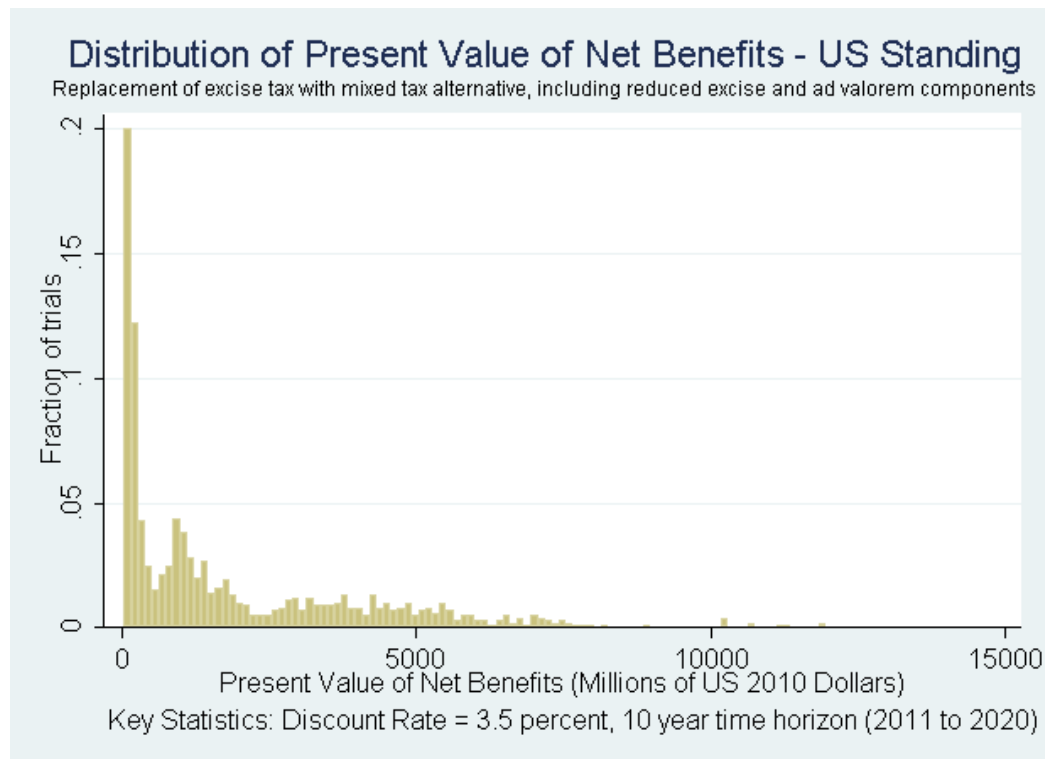
Source: Authors

**Figure 2: Price shocks included and base case excise tax simulated in nominal terms**



Source: Authors

**Figure 3: Price shocks included and base case excise tax simulated in nominal terms**



Source: Authors

### Wisconsin Revenue

We forecast Wisconsin government revenue under four Monte Carlo simulations as previously summarized for net benefits, with and without price shocks and with an excise tax base case in nominal and real dollar terms. We omit a scenario in which METB is excluded because it has conceptually no impact upon revenue. Under each scenario, switching from a pure excise tax to a mixed-tax alternative increases state revenue. The greatest mean increase in revenue of \$1.712 billion occurred when price shocks were included and the base case excise tax was considered in nominal terms – not increased in pace with inflation. The smallest mean increase in revenue of \$803 million occurred when price shocks were not included and the base case excise tax was considered in real terms – increased in value to keep pace with inflation (see Table 3 and Appendix K for additional details).

**Table 3: Mean Wisconsin state revenue under each of the four possible simulations where the 32.9 cent excise tax is replaced with a mixed-tax alternative (millions of 2010 dollars)**

<b>Year</b>	<b>Price Shock</b>		<b>No Price Shock</b>	
	<b>Excise Nominal</b>	<b>Excise Real</b>	<b>Excise Nominal</b>	<b>Excise Real</b>
2012	72	38	60	24
2013	130	75	110	62
2014	160	96	150	81
2015	180	110	170	89
2016	200	110	190	97
2017	220	120	210	110
2018	240	130	220	110
2019	250	130	230	110
2020	260	130	240	120
Total	1,712	939	1,580	803

Source: Authors

## **Discussion of Results, Limitations & Distributional Impacts**

As Figures 2 and 3 show, the distribution of net benefits is heavily skewed to the right. This finding is theoretically consistent with the model used for estimating net benefits because, in the event of a high price shock, the impact of the shock is amplified by 5 percent in the alternative case relative to the base case. Large price shocks (defined for the purposes of this discussion as those increasing the fuel price by 50 percent or more) occur in only 3.7 percent of all estimates. This additional 5 percent price boost of the impact of the original shock drives a larger decline in the alternative consumption than in the base consumption. The larger decline in consumption results in substantially lower negative externality costs, which ultimately increases net benefits. The preceding analysis does not factor in the consumer cost of the decline in consumption; however some of this cost is picked up by our calculation of the direct deadweight loss of the tax policy. Price shocks in our model last for one year, after which prices resume their original trajectory.



This chain of events reveals a structural limitation of our model. In an empirical study, transitional costs in the aftermath of large price changes might be revealed that would fundamentally alter consumer behavior and associated consumer welfare. Consumers would be forced to pay substantially more for fuel or alter their habits to use much less of it. Our model, as written, is not able to capture these transitional costs. We were not able to build an estimate of these transitional costs into the model because of a lack of credible and current information about the magnitude or frequency of their impacts on social welfare impacts (Harrington et al., 2000). See Appendix L for a more detailed, qualitative treatment of transition costs.

### *Impact of Standing*

Mean net benefits differ between Wisconsin and national standings by \$20 million in the model that includes price shocks and uses the base case with a nominal 32.9 excise tax. In this model, the federal government would suffer mean total losses of \$125 million over the 10-year horizon of the project, due to decreased fuel consumption and the resulting drop in federal excise tax collected. Wisconsin consumers save this same \$125 million, so only the METB (which we estimate to be between 0.06 and 0.57) of that amount is relevant in terms of an impact on net benefits. Relative to the massive federal budget of \$3.5 trillion in 2009 and \$2.97 trillion in 2008, this \$125 million impact should not be significant. In other words, standing does not have a substantial impact upon the determination of net benefits or stability of federal government funding.

### *Distribution of Impacts and Perception*

In terms of distributional impacts, Wisconsin consumers would stand to reap the primary benefits of the proposed mixed-tax policy, in terms of fewer negative externalities and reduced METB compared with other forms of state revenue raising, e.g., income or sales taxes. The state

would also gain via the projected increase in government revenue, a direct transfer from consumers. However, many state residents might not perceive the impacts of this policy in the manner just described. Assuming prices rise during the next decade, the increase in retail price at the pump from the sales tax would be obvious to all observant consumers. However, the benefits might be far more diffuse and less apparent. A consumer can count how many dollars she has spent on gasoline in a month but cannot perceive how much local air pollution or traffic congestion she has experienced. On account of this inequality in perception of costs and benefits, the average consumer might not regard the sales tax imposition to have the same benefits that it does on paper and in comprehensive models.

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## Appendix A: Comparison of State Tax Regimes

One of this project's consultants, John B. Koskinen, Chief Economist at the Wisconsin Department of Revenue, requested comparative analysis of the motor fuel tax regimes in states adjacent to Wisconsin: Illinois, Michigan, Iowa, and Minnesota. We summarized each state's motor fuel tax structure and gross nominal incidence at the point of purchase.

Illinois and Michigan apply their *ad valorem* retail sales and use tax of 6.25 percent and 6 percent respectively to motor fuels, in addition to imposing excise taxes and other storage or environmental fees. In contrast, Minnesota and Wisconsin exempt motor fuel from the *ad valorem* sales and use tax, but impose comparatively higher excise taxes, in addition to storage and inspection fees. Based on prevailing retail gasoline prices in July 2010, the total nominal state motor fuel taxes and fees for each of the four states in descending order was: Illinois, 40 cents; Michigan, 36 cents; Wisconsin, 33 cents; and Minnesota, 27 cents. Total nominal taxes and fees on diesel fuel exhibited the same descending trend: Illinois, 68 cents; Michigan, 57 cents; Wisconsin, 57 cents; and Minnesota, 52 cents (American Petroleum Institute, 2010a).

If excise taxes and fees are held constant, changes in the price of gasoline and diesel could substantially alter the relative motor fuel tax rates among states. Notably, an increase in the price of fuel would lift the nominal tax rate of Illinois and Michigan, relative to Wisconsin and Minnesota. Wisconsin's excise tax of 32.9 cents per gallon was permanently set as of April 1, 2006, officially ending the policy of indexing the excise tax to the price of gasoline effective April 1, 2007. Looking forward, Michigan and Illinois have no high profile changes to the gasoline tax pending. Minnesota's excise tax of 27 cents per gallon was set on July 1, 2010, and remains in effect until June 30, 2011, when it may be reset at another level (American Petroleum Institute, 2010a).

Table A1 compares fuel taxes in Wisconsin and its neighboring states as well as the U.S. average.

**Table A1: Comparison of Regional Fuel Taxes**

<b>State</b>	<b>Fuel</b>	<b>State Excise Tax</b>	<b>Other State Taxes &amp; Fees</b>	<b>Total State Taxes &amp; Fees</b>	<b>Total State &amp; Federal Taxes</b>
Illinois	Gasoline	\$0.19	\$0.21	\$0.40	\$0.58
	Diesel	\$0.22	\$0.22	\$0.43	\$0.68
Iowa	Gasoline	\$0.21	\$0.01	\$0.22	\$0.40
	Diesel	\$0.23	\$0.01	\$0.24	\$0.48
Michigan	Gasoline	\$0.19	\$0.17	\$0.36	\$0.54
	Diesel	\$0.15	\$0.18	\$0.33	\$0.57
Minnesota	Gasoline	\$0.27	\$0.00	\$0.27	\$0.46
	Diesel	\$0.28	\$0.00	\$0.28	\$0.52
Wisconsin	Gasoline	\$0.31	\$0.02	\$0.33	\$0.51
	Diesel	\$0.31	\$0.02	\$0.33	\$0.57
U.S. Average	Gasoline	\$0.19	\$0.11	\$0.29	\$0.48
	Diesel	\$0.19	\$0.09	\$0.28	\$0.53

Source: Authors adapted material from the American Petroleum Institute, 2010a

## **Appendix B: Externalities Explicitly Considered**

This appendix describes the expected reduction in negative externalities. These social costs include local pollution, congestion, and vehicle collisions.

### *Vehicle Miles Traveled and Projected Fuel Economies*

We measure social costs according to vehicle miles traveled (VMT). The more vehicle miles traveled, the greater the social cost — the greater the negative externalities of pollution, traffic congestion, and vehicle collisions that cause personal injury and property damage.

Tailpipe emissions vary by VMT rather than gasoline consumed (Parry et al., 2007). New technology ensures that emission control systems function consistently throughout a vehicle's life. Thus, local pollution varies by VMT. Congestion and collisions also vary by VMT. To estimate these costs, then, we had to project Wisconsin's expected VMT for each year.

We used fuel consumption projections and fuel economy projections. To project fuel economy for light-duty vehicles, we used the Energy Information Administration's (EIA) annual energy outlook 2010. The EIA considered project changes in corporate average fuel economy standards, rising fuel prices, the increased use of hybrids and unconventionally fueled cars, and other factors that contribute to a steady improvement in the fleet's average miles per gallon. However, vehicles are usually driven for many years after their initial purchase, meaning that new standards and innovations affecting new cars only change the entire fleet's average miles per gallon very slowly. The average light-duty vehicle in use is about 10.2 years old (Oak Ridge National Laboratory, 2010). Thus the EIA predicts that the fuel economy of the entire stock will rise from 21 miles per gallon in 2010 to 24.3 miles per gallon in 2020. We assume that Wisconsin fuel economies will mirror national trends.



We made similar forecasts for heavy-duty vehicles and diesel consumption. Freight trucks, however, are not expected to improve efficiency dramatically in the coming decade (Parry, 2006). The EIA predicts that truck miles per gallon averages will rise from 6.1 in 2010 to 6.6 in 2020. We use ton-miles to assess freights' social costs in accordance with the literature. In a report for the U.S. Federal Railroad Administration, ICF International (2009) concluded that freight trucks get 68 to 133 ton-miles per gallon, the range we incorporate in our model.

We assume that all freight trucks use diesel and all light-duty vehicles use gasoline. We predict the social costs of each using the respective consumption estimates of diesel and gasoline. In fact, some cars and light trucks use diesel. We therefore took the percentages of new cars and new light trucks sold in the past 20 years that use diesel and concluded that 2.3 percent of light-duty vehicles on the road use diesel. As the percentage of light-duty vehicles using diesel is expected to rise, we used the EIA's 2009 prediction – 10 percent of new light-duty vehicles will take diesel by 2030 – to get a rough measure of how many new light-duty vehicles will use diesel in the future. Finally, we used these estimates to project that about 3.8 percent of the light-duty vehicles on the road will take diesel over the next decade. Without data on what percentage the nation's diesel fuel these light-duty vehicles will consume, we assume that it will be small compared to consumption by freight trucks. Therefore, we assumed that light-duty vehicles and the social costs they incur will vary by gasoline consumption, while freight costs vary by diesel consumption.

### *Accidents*

Vehicle accidents cause injuries and fatalities (or quality-adjusted life years lost), property damage to automobiles, travel delays, medical costs, lost productivity, insurance expenses and legal expenses (Parry et al., 2007). These costs average about 15.8 cents per VMT.

We sought only to measure the externalities accidents impose. Drivers may internalize the risk of injury to themselves and their passengers when they choose to drive (Parry et al., 2007). Moreover, they may compensate for additional vehicles by driving more carefully and this compensation (slowing down, for instance) is itself costly. Though inter-driver costs remain unclear, pedestrian and cyclist injuries account for 13 percent of fatalities caused by light-duty vehicles. Property damage and medical costs, paid for by third parties such as insurance agencies and the clients that support them through premiums, also contribute to external social costs. People hurt in motor vehicle collisions bear the risk of their own lost productivity, but another externality surfaces when the government loses the taxes individuals would have paid.

Ian Parry, Margaret Walls, and Winston Harrington (2007) considered these externalities when reviewing several studies of the marginal external costs of accidents. They concluded that costs ranged between 2 and 7 cents per vehicle mile, with a point estimate at 3 cents per mile, 3.17 cents in 2010 dollars. We then used the yearly average fuel economies for light-duty vehicles to derive the number of vehicle miles Wisconsinites will drive from the amount of gasoline they are projected to consume in the base and mixed-tax cases. Finally, multiplying VMT by the 2010 social costs per mile, we arrived at the external costs of accidents Wisconsin may expect each year.

David Forkenbrock (1999) also considered fatalities, injuries, and property damage when reviewing several studies of the costs of accidents involving freight trucks, as well as the compensations trucking companies pay and potential victims' willingness to pay to avoid accidents. Large trucks are involved in 2.7 fatalities per 100 million miles traveled, while light-duty vehicles are involved in 2.1 fatalities per 100 million miles traveled. However, truck driving costs substantially less per mile in terms of property damage and injuries. At an average

of 14.8 tons per truck load, Forkenbrock (1999) concludes that accidents cost 0.871 cents per ton-mile (converted to 2010 dollars). Studies estimating the accident costs of freight trucks reviewed by Todd Litman (2009) put this value at 0.718 cents per ton-mile. Thus, we allowed the cost of accidents to vary in our analysis, with a uniform probability of using any value between 0.718 and 0.871 cents per ton-mile.

### *Congestion*

According to the literature, roadway congestion is highly variable over time and space, and congestion at one point does not necessarily imply that the roadway is over capacity at that point because congestion can be caused by a delay at some other point. A change in fuel taxes would have a larger impact on non-congested roads and a comparatively smaller impact on heavily congested roads. In this analysis, we use the national estimates for congestion costs from a meta-analysis that puts it at 3.5 cents per mile for light-duty vehicles (Parry et al., 2007).

For heavy-duty trucks, estimates vary considerably. Forkenbrock (1999) assumed no cost of congestion, as freight trucks travel mostly through rural areas. Litman (2009), in a review of freight externality estimates, takes a different approach, finding a cost of 1.148 cents per ton-mile. This significant divergence is likely due to the assumptions regarding the degree to which trucks operate in urban areas during peak travel times.

### *Local Air Pollutants*

Vehicles that burn motor fuels release pollutants such as nitrogen oxide, carbon monoxide, and various hydrocarbons also known as volatile organic compounds (Parry et al., 2007). Fine particulate matter is created indirectly by chemical reactions of sulfur dioxide, nitrogen oxide, and hydrocarbons (Parry et al., 2007). Unlike greenhouse gases such as carbon dioxide, these pollutants generally operate at a local rather than global scale thereby causing

local residents to bear the majority of these costs. The pollutants can cause a number of adverse health effects. Experts put the cost at approximately 2.9 cents per mile (in 2010 dollars) for light-duty vehicles (Parry et al., 2007). There is a fairly wide range of 1.8 to 21 cents per mile according to a U.S. Federal Highway Administration (2000). The same study concludes that a value of 2.5 cents per mile is appropriate.

In our sensitivity analysis, we allow the cost of pollution per light-duty vehicle's VMT to range between 1 cent and 21 cents per mile with a distribution heavily favoring the lower values because most studies estimate approximately 2 cents per mile driven.

Freight trucks emit the same pollutants, causing fatal and nonfatal health problems and some agricultural problems. Forkenbrock (1999), assuming 14.8 tons per load, an average speed of 55 miles per hour, and mostly rural driving, concluded that pollution costs about 0.08 cents per ton-mile. Litman's (2009) sources provide an estimate of 0.89 cents. Converting to 2010 dollars, we set the cost of local pollution by freight trucks to range between 0.118 and 1.277 cents per ton-mile in our model.

### *Noise*

We opted to include noise as an externality for heavy-duty vehicles but concluded that the cost was minimal, uncertain, and unimportant in calculating the net effects of light-duty vehicles. For freight, Forkenbrock (1999) again noted that most truck driving occurs far from population centers but, using studies that measure lowered property values, arrived at a cost of 0.04 cents per ton-mile. Litman's (2009) review finds a similar estimate. In 2010 dollars, we vary this parameter between 0.057 and 0.059 cents per ton-mile.

### *Road Maintenance*

Perhaps the most obvious cost associated with transportation is that of highway system construction and maintenance. While highway users internalize some of these costs through user fees (like the fuel tax in question), evidence suggests that not all of these costs are completely covered by these mechanisms (U.S. Federal Highway Administration, 2000). This observation is particularly important for heavy-duty vehicles, whose damage to roadways is far greater than those of light-duty vehicles, which have negligible impacts upon the quality of the highway system (Small et al., 1989). Based upon estimates by the U.S. Federal Highway Administration (2000) and Litman (2009), we employ a range of 0.105 to 0.37 cents per ton-mile to calculate the change in the external costs associated with the mixed-tax alternative.

## **Appendix C: Price Shocks**

The Energy Information Administration (2010a) included many factors in its fuel consumption forecasts, including the expected fuel economy standards, improved technology, and projected economic conditions. It did not, however, include the risk of a geopolitical disruption, such as a war or an upsurge in anti-West policies in an oil producing country. To include geopolitical price shocks in our model, we turned to other sources. In 2005, with funding from the U.S. Department of Energy, Stanford University's Energy Modeling Forum conducted a series of workshops in which military, geopolitical, and oil market experts predicted the probabilities of various geopolitical disruptions and how such disruptions might affect the world's oil supply. The assembly focused on four regions: Saudi Arabia, Other Persian Gulf, Russia and Caspian States, and West of Suez (a broad category including several African countries, Mexico, and Venezuela). They considered the stability and internal factors affecting those regions, the amount of oil production each region offers, and the excess capacity they might offer if another region's production faltered (Huntington and Beccue, 2005). Phillip Beccue and Hillard Huntington then used their expertise to render a final assessment differentiating disruptions by their magnitude, probability of occurrence in the next 10 years, and expected duration (short: 1-6 months, medium: 6-18 months, and long: over 18 months).

In 2010, Stephen Brown and Huntington used the 2005 predictions to calculate the annual probability of disruptions ranging from 0 to 17 million barrels per day (MMBD). They found, for instance, that a given year in the near future has an 84 percent chance of no disruption, a 3 percent chance of a 2 MMBD disruption, and only a 0.013 percent chance of a 17 MMBD disruption. Their results are in Table C1.

**Table C1: Annual Probabilities of an Oil Price Shock**

<b>Disruption size (million barrels/day)</b>	<b>Average Price Percent Increase</b>	<b>Annual probability</b>
0	0	0.84
1	9	0.031
2	17	0.033
3	26	0.045
4	35	0.0022
5	44	0.0078
6	52	0.010
7	61	0.011
8	70	0.0076
9	78	0.0011
10	87	0.0016
11	96	0.0012
12	105	0.0017
13	113	0.00083
14	122	0.00051
15	131	0.00099
16	139	0.00012
17	148	0.00013

Source: Authors, adapted from Brown and Huntington (2010) and Huntington and Beccue (2005)

Brown and Huntington (2010) also reviewed research on the price elasticities of supply and demand and the income elasticity of demand. They arrived at a midpoint, short-run elasticity of -0.136 and thereby concluded that oil prices will rise about 7.35 percent ( $= 1/0.136$ ) for every 1 percent reduction in oil supply.

In our model, we use Brown and Huntington's (2010) annualized probabilities to add the likelihood of a shock to each year. We then use a 7.35 percent gain in prices for every 1 percent reduction in oil supply and the Energy Information Administration's predictions of world crude oil supply to calculate how much world prices would rise in response to a shock. The price shocks last for one year, after which prices return to their original trajectories. Finally, we assume that because Wisconsin's oil use does not have any international effect, Wisconsin prices before taxes would vary with world prices. Thus, we added the effects of geopolitical disruptions

to our model, accounting for the annual probabilities of those effects and expected variation in world oil production.



## **Appendix D: Estimation of Motor Fuels Elasticity**

The elasticities of demand for gasoline and diesel play an important role in this analysis. In economics, an elasticity is a statement of how quantity demanded changes with a change in a product's price. Elasticities of demand are generally negative because a price increase results in a drop in demand for that product. In our context, elasticities can be short-run or long-run. A short-run elasticity is the change in quantity demanded due to a price change in a time-frame where consumers do not have time to adjust their demand factors greatly. For example, when the price of gasoline approached \$4 per gallon in 2008, people had little choice to save money but to drive less by consolidating trips, walking, taking public transit, carpooling, etc. In the long run, consumers have more flexibility—they could move closer to their workplace, buy more fuel-efficient vehicles, or move to denser urban areas that require less driving.

We used the Energy Information Administration (2010a) forecast for price and quantity demanded of motor fuels from 2011-2020. We adjusted the quantities appropriately to yield Wisconsin demand and assumed that all future national price changes would be mirrored in Wisconsin. The administration made a number of reasonable assumptions to derive a reliable forecast for price and quantity. Our mixed-tax alternative would reduce the current excise tax of 32.9 cents per gallon by an appropriate amount and replacing it with a sales tax so that on the day the policy became active, the Wisconsin driver would see the same price at the pump. However, as time progresses with a 5 percent sales tax in place, any price changes would be magnified by 5 percent. For our projects, we had to use elasticity to adjust the quantity demanded based on the slight price difference between the baseline projection and the price projection under the mixed-tax alternative.

The changes in social costs and benefits are from the changes in consumption (generally a reduction) driven by the sales tax. Because the elasticity is the link, it is possibly the most important parameter in the model. Gasoline demand elasticity has been a heavily studied subject since the late 1970s. A meta-analysis by Molly Espy (1998) suggests that the mean, short-run price elasticity is -0.26 and the mean, long-run price elasticity is -0.58. While this is probably the most recognized meta-analysis of gasoline elasticity, a major shortcoming is that it is an international study focusing on many countries (generally fully industrialized ones). Her model shows that European studies find more elastic numbers whereas the values for the United States are more inelastic.

Adding another level of complexity is that there has been a fairly well documented shift in elasticity since the 1980s. In absolute terms, the value has become more inelastic, meaning consumers are less sensitive to price changes from the late-1990s through 2005. This finding is documented in Hughes et al. (2008) and Park and Guochang (2010). Jonathan Hughes (2008) and his colleagues find an elasticity of -0.034 for the short run. John Cooper (2003) finds a short-run elasticity of -0.061 and a long-run elasticity of -0.453. Sung Park and Guochang (2010), however, also find an increasingly elastic demand for motor fuels from 2005 onward. In our model's sensitivity analysis, we draw values of elasticity from a uniform distribution with bounds taken to be -0.034 and -0.26 for the short-run elasticity and -0.453 and -0.58 for the long-run elasticity.

Few recent estimates of diesel fuel price elasticity exist. The limited evidence available suggests that diesel elasticities are roughly comparable to those of gasoline. Parry (2006) examines a collection of analyses, settling on an economywide diesel fuel price elasticity of -0.4. Taking account of the downward shift of elasticity estimates over time, we incorporate this as an

upper bound for long-run elasticity. He notes that an elasticity estimate of -0.24 is more appropriate in the short run. This was set as the lower bound of the long run elasticity and an upper bound of the short run. A low estimate from Parry's study is -0.04; this was employed as a lower bound for the short-run price elasticity of diesel demand.

## **Appendix E: Explanation of Projecting the Excise Tax**

Because we project all values through 2020 in real dollars, the current excise tax, while fixed at a nominal value of 32.9 cents per gallon, essentially declines by the rate of inflation. To determine expected inflation through 2020, we consulted two sources. The first is the core personal consumption expenditure released by the Congressional Budget Office (2010). We selected this measure instead of the consumer price index because its inflation projections are slightly lower, meaning our projections of government revenue due to a change in the motor fuel tax are higher than they would be if based on the consumer price index forecast. The Congressional Budget Office figures put core personal consumption expenditure at 1.4 percent through 2014 and 2 percent through 2020. Second, the U.S. Federal Reserve (2010) reported on December 6, 2010, that the spread between a 10-year Treasury bill and a 10-year Treasury Inflation Protected Security is 2.17 percent. Therefore, we allow expected inflation to vary by 1.4 to 2.17 percent annually.

## **Appendix F: Marginal Excess Tax Burden Calculation**

Ian W.H. Parry (1999) estimates the marginal excess tax burden (METB) of labor taxation based upon several factors, including labor supply elasticity, demand elasticity for tax-favored consumption, labor taxation, and the purpose of the additional revenue (transfer payments or public goods). We assume that the revenue would be used for public goods as part of the Transportation Fund, and that Wisconsin demand and supply elasticities would vary similarly to national elasticities. Parry employs three point estimates for the labor tax rate: a central estimate of 0.36, a low estimate of 0.32, and a high estimate of 0.40. Because the average effective tax rate for the Wisconsin income tax is about 4 percent (Wisconsin Legislative Fiscal Bureau, 2009), we estimate the METB of the state income tax as the difference between estimates of METB for tax rates equal to 0.32 and 0.36. Thus, we estimate a range of 0.01 to 0.07 for the METB of the Wisconsin state income tax. Returning to Parry's work, we employ a range for METB of the federal income tax based upon his central estimate of labor taxation. In our analysis, METB for federal income tax varies between 0.06 and 0.57.

## **Appendix G: Externalities Not Explicitly Considered**

Our analysis did not take into account greenhouse gases, oil dependency, and other externalities

### *Greenhouse Gases*

The social costs of greenhouse gases and global warming may be substantial. Light-duty vehicles account for a fifth of carbon dioxide emissions in the United States (Parry et al., 2007). However, researchers attempting to quantify that social cost have produced a wide range of figures – from 5 (Nordhaus and Boyer, 2000) to 12 (meta-analysis by Tol, 2005) to 72 (Stern, 2006) cents per gallon of gasoline. Moreover, these costs are generally calculated based on world losses resulting from changing weather patterns, tropical disease, agricultural adjustments, and the effects of the rising sea levels in low-lying areas. The researchers usually do not consider costs only borne by the United States, and, as the United States may become involved in international political disruptions and suffer more direct effects, the national cost of global warming is difficult to predict. Thus, though ignoring greenhouse gases limits our analysis, we chose not to consider their social costs. We therefore likely underestimate the social benefits of higher gasoline taxes. Parry (2006), in reviewing the studies above, tentatively estimated greenhouse gas costs to the world at 6 cents per gallon of gasoline consumed.

### *Oil Dependency*

Oil dependency may be thought of as the cost all U.S. taxpayers bear to pay for national military action that ensures a regular supply of oil. Though Parry et al. (2007) claimed 12 cents per gallon consumed, he and other authors have noted that military spending may be fixed, and thus not responsive to proportionally small decreases in consumption. As we are not considering the whole of Wisconsin's consumption but rather the change in gasoline consumption resulting

from a change in tax, we assumed that the relatively minor ensuing consumption change would not alter the nation's military expenses. Military actions, pursued for many reasons that may include oil, would likely not be reduced even if Wisconsin consumes somewhat less gasoline. We therefore did not include the uncertain and most likely unaffected cost of oil dependency in our analysis.

#### *Other Externalities*

We did not consider many other externalities because their effects were negligible. The cost of noise from light-duty vehicles was inconsequential (Parry et al., 2007). Environmental costs such as water pollution and waste, for instance, were very small. The Victoria Transport Policy Institute reports 1.4 cents and 0.04 cents per VMT for these costs, respectively (Litman, 2009). Urban sprawl, subsidized parking, road facilities, and land-use patterns may change as driving patterns change, but they generally respond slowly and therefore did not factor into our considerations of the upcoming decade.

## **Appendix H: Deadweight Loss Calculation**

The deadweight loss for consumers was calculated by assuming a linear demand schedule for motor fuels in each year. We know the elasticity and an actual quantity demanded and price of both diesel and gasoline. Using this, we estimated the slope of the demand curve. The supply curve is flat because Wisconsin does not consume enough fuel to alter the prevailing price in the United States. The sales tax shifts the supply curve, creating a triangle under the demand curve, above the supply curve and between the two consumption values. We found the area of this triangle for each year over 2011-2020. From the definition of marginal excess tax burden, we used this consumer deadweight loss to calculate our implied marginal excess tax burden for the proposed motor fuel tax.



## Appendix I: Parameter Ranges

Parameter Value(s)	Parameter Name	Source(s)
(numerous)	Gasoline Consumption Forecasts	Energy Information Administration (2010a), Wisconsin Department of Revenue (2010)
(numerous)	Diesel Consumption Forecasts	Energy Information Administration (2010a), Wisconsin Department of Revenue (2010)
(numerous)	Gasoline Percent Change in Price Forecast	Energy Information Administration (2010a), Wisconsin Department of Revenue (2010)
(numerous)	Diesel Percent Change in Price Forecast	Energy Information Administration (2010a)
(numerous)	Price Spike Probabilities and Magnitudes	Energy Information Administration (2010a), Huntington and Beccue (2005), Brown and Huntington (2010)
\$3.01	Wisconsin starting gasoline price	Energy Information Administration (2010b)
\$2.70	Wisconsin starting diesel price	Energy Information Administration (2010c), American Petroleum Institute (2010b)
21.2 to 24.3	Light-Duty Vehicle Average Fuel Economy (miles per gallon)	Energy Information Administration (2005), Energy Information Administration (2010a)
68 to 133	Heavy-Duty Vehicle Average Fuel Economy (ton-miles per gallon)	ICF International (2009)
-0.034 to -0.26	Price Elasticity of Gasoline Demand (short-run)	Espey (1998), Brons et al. (2007), Hughes et al. (2008), Park and Gouchang (2010)
-0.453 to -0.58	Price Elasticity of Gasoline Demand (long-run)	Espey (1998), Brons et al. (2007), Hughes et al. (2008), Park and Gouchang (2010)
-0.04 to -0.24	Price Elasticity of Diesel Demand (short-run)	Parry (2006)
-0.24 to -0.4	Price Elasticity of Diesel Demand (long-run)	Parry (2006)
0.15	Marginal Excess Tax Burden of Wisconsin Income Tax	Ballard, et al. (1985)
0.15	Marginal Excess Tax Burden of Federal Income Tax	Ballard, et al. (1985)
0.035	Discount Rate	Newell and Pizer (2000)
1.69 to 19.59 cents	Social Cost of Local Pollution for Light-Duty Vehicles (per mile traveled)	Parry et al. (2007)
0.118 to 1.277 cents	Social Cost of Local Pollution for Heavy-Duty Vehicles (per ton-mile traveled)	Forkenbrock (1999), Litman (2009)
3.69 to 5.27 cents	Social Cost of Congestion for Light-Duty Vehicles (per mile traveled)	Parry et al. (2007)
\$0 to 1.148 cents	Social Cost of Congestion for Heavy-Duty Vehicles (per ton-mile traveled)	Forkenbrock (1999), Litman (2009)
2.11 to 7.385 cents	Social Cost of Traffic Accidents for Light-Duty Vehicles (per mile traveled)	Parry et al. (2007)
10.5 to 37 cents	Cost of Road Maintenance for Heavy-Duty Vehicles (per ton-mile)	Litman (2009), U.S. Federal Highway Administration (2000)
0.718 to 0.871 cents	Social Cost of Traffic Accidents for Heavy-Duty Vehicles (per ton-mile traveled)	Forkenbrock (1999), Litman (2009)
0.057 - 0.059 cents	Social Cost of Noise for Heavy-Duty Vehicles (per ton-mile traveled)	Forkenbrock (1999), Litman (2009)

## Appendix J: Stata Input Data and Command Files

This appendix contains the Stata code used to perform the statistical analysis found in the report. Table J1 contains the Wisconsin consumption, price, and average miles-per-gallon forecast data that was used in the statistical analysis.

**Table J1: Model input data (Wisconsin)**

Year	Gas Base (gallons per day)	Diesel Base (gallons per day)	Percent Change in Price Gas- Base	Percent Change in Price Diesel- Base	Percent Change in Price Gas-Alt	Percent Change in Price Diesel- Alt	Car mpg
2011	7,155,820.74	2,100,171.67	1.32	0.95	1.38	1.00	21.2
2012	7,172,127.34	2,181,023.39	5.50	6.23	5.78	6.55	21.4
2013	7,149,426.48	2,229,707.41	9.00	4.98	9.45	5.23	21.7
2014	7,122,880.13	2,257,194.08	3.86	3.30	4.05	3.46	21.9
2015	7,100,499.85	2,275,701.56	1.71	3.09	1.79	3.25	22.3
2016	7,044,068.66	2,296,140.14	2.25	3.24	2.36	3.41	22.6
2017	7,044,759.09	2,315,389.76	2.05	2.46	2.15	2.58	23
2018	7,006,477.68	2,340,769.55	1.60	2.68	1.68	2.81	23.5
2019	7,007,961.62	2,369,456.04	1.16	1.54	1.21	1.62	23.9
2020	7,003,506.02	2,394,998.83	1.42	1.21	1.50	1.27	24.3

Source: Authors

```
clear matrix
clear
cd "U:\CBA Project\Final Final"
version 11.0
set more 1
set mem 100m
set matsize 150
# delimit ;

* Inputs spreadsheet with parameters from EIA;
insheet using "FuelInput2.csv", comma;

* Sets project timeline to 10 years from 2011 through 2020;
drop if year==2010;
drop if year>2020;

* Creates row number indicator;
gen obsb = _n;
```

```

* List of essential parameters;

* Starting price, & raises price by percentages based on EIA projections;
  gen CurrGasP=3.006;
    replace CurrGasP = (pcgaspricebase+1)* CurrGasP[_n-1] if _n>=2;
  gen CurrDieselP=2.699;
    replace CurrDieselP = (pcdieselpricebase+1)* CurrDieselP[_n-1] if _n>=2;
* Discount Rate;
  gen d=0.035;
* Sets Marginal Excess Tax Burden (METB) for WI & federal revenue;
  gen WIMETB = 0.01 + uniform()*0.06;
  gen USmetb = 0.06 + uniform()*0.51;
* Fuel Economy for trucks (ton-miles/gal);
  gen trucktmpg=68;
*Set current excise tax and inflation range according to projected core PCE change
from CBO;
  gen currentexcise = 0.329;
  gen inflation = 0.014 + uniform()*0.0064;
  gen inflationadjuster = (1+inflation)^(obsb);
  replace currentexcise = currentexcise/inflationadjuster;

* Externalities;
* Local pollution car $/mile, truck $/ton-mile;
  gen localpollutioncar=0.02;
  gen localpollutiontruck=0.001;
* Congestion car $/mile, truck $/ton-mile;
  gen congestioncar=0.02;
  gen congestiontruck=0.0017;
* Accidents car $/mile, truck $/ton-mile;
  gen accidentscar=0.03;
  gen accidentstruck=0.0069;
* Noise car not applicable, truck $/ton-mile;
  gen noisetruck=0.00057;
* Road maintenance only applies to trucks $/ton-mile;
  gen maintenancetruck=0.105;

* Declare price elasticities for gas and diesel;
  gen elasticitylongrunG = -0.453;
  gen elasticityshortrunG = -0.034;

  gen elasticitylongrunD = -0.24;
  gen elasticityshortrunD = -0.04;

* Creates discount factor that discounts mid-year;
  gen midyear=obsb-.5;
  gen discounter = (1+d)^midyear;

* Replacing parameters with values drawn from ranges to facilitate the Monte Carlo
Simulation;
* Truck MPG range;
  replace trucktmpg=68+(uniform())*65;
  replace trucktmpg=trucktmpg[1] if year>2011;
* Externality range;
  replace accidentscar=0.0211+uniform()*0.05275;
  replace congestioncar=0.0369+uniform()*0.0158;
  replace localpollutioncar=0.0169+invinbeta(1.5,15, uniform())*0.179;
  replace localpollutioncar=localpollutioncar[1] if year>2011;

  replace accidentstruck=0.00718+uniform()*0.00153;
  replace congestiontruck=0+uniform()*0.01148;
  replace localpollutiontruck=0.00118+invinbeta(1.5,15, uniform())*0.01159;
  replace localpollutiontruck=localpollutioncar[1] if year>2011;
  replace noisetruck=0.00057+uniform()*0.00002;

```

```

        replace maintenancetruck=0.105+uniform()*0.265;
* Elasticity Range;
        replace elasticitylongrunG = -0.453-
(uniform()+uniform()+uniform()+uniform())*0.127/4;
        replace elasticitylongrunD = -0.24-
(uniform()+uniform()+uniform()+uniform())*0.16/4;

        replace elasticityshortrunG = -0.034-
(uniform()+uniform()+uniform()+uniform())*0.226/4;
        replace elasticityshortrunD = -0.04-
(uniform()+uniform()+uniform()+uniform())*0.2/4;

* Code below uses draws from a uniform distribution to account in chances of a price
spike in motor fuel;
        gen randomnumber = runiform();
* Gasoline price shocks;
        replace CurrGasP = CurrGasP*1 if randomnumber[_n]>0 & randomnumber[_n]<=0.844 &
obsb>1;
        replace CurrGasP = CurrGasP*1.0871 if randomnumber[_n]>0.844 &
randomnumber[_n]<=0.875 & obsb>1;
        replace CurrGasP = CurrGasP*1.0174 if randomnumber[_n]>0.875 &
randomnumber[_n]<=0.907 & obsb>1;
        replace CurrGasP = CurrGasP*1.2614 if randomnumber[_n]>0.907 &
randomnumber[_n]<=0.953 & obsb>1;
        replace CurrGasP = CurrGasP*1.349 if randomnumber[_n]>0.953 &
randomnumber[_n]<=0.956 & obsb>1;
        replace CurrGasP = CurrGasP*1.435 if randomnumber[_n]>0.956 &
randomnumber[_n]<=0.963 & obsb>1;
        replace CurrGasP = CurrGasP*1.523 if randomnumber[_n]>0.963 &
randomnumber[_n]<=0.973 & obsb>1;
        replace CurrGasP = CurrGasP*1.610 if randomnumber[_n]>0.973 &
randomnumber[_n]<=0.984 & obsb>1;
        replace CurrGasP = CurrGasP*1.697 if randomnumber[_n]>0.984 &
randomnumber[_n]<=0.991 & obsb>1;
        replace CurrGasP = CurrGasP*1.784 if randomnumber[_n]>0.991 &
randomnumber[_n]<=0.993 & obsb>1;
        replace CurrGasP = CurrGasP*1.871 if randomnumber[_n]>0.993 &
randomnumber[_n]<=0.994 & obsb>1;
        replace CurrGasP = CurrGasP*1.958 if randomnumber[_n]>0.994 &
randomnumber[_n]<=0.995 & obsb>1;
        replace CurrGasP = CurrGasP*1.523 if randomnumber[_n]>0.963 &
randomnumber[_n]<=0.973 & obsb>1;
        replace CurrGasP = CurrGasP*1.610 if randomnumber[_n]>0.973 &
randomnumber[_n]<=0.984 & obsb>1;
        replace CurrGasP = CurrGasP*1.697 if randomnumber[_n]>0.984 &
randomnumber[_n]<=0.991 & obsb>1;
        replace CurrGasP = CurrGasP*1.784 if randomnumber[_n]>0.991 &
randomnumber[_n]<=0.993 & obsb>1;
        replace CurrGasP = CurrGasP*1.871 if randomnumber[_n]>0.993 &
randomnumber[_n]<=0.994 & obsb>1;
        replace CurrGasP = CurrGasP*1.958 if randomnumber[_n]>0.994 &
randomnumber[_n]<=0.995 & obsb>1;
        replace CurrGasP = CurrGasP*2.046 if randomnumber[_n]>0.995 &
randomnumber[_n]<=0.997 & obsb>1;
        replace CurrGasP = CurrGasP*2.132 if randomnumber[_n]>0.997 &
randomnumber[_n]<=0.998 & obsb>1;
        replace CurrGasP = CurrGasP*2.219 if randomnumber[_n]>0.998 &
randomnumber[_n]<=0.999 & obsb>1;
        replace CurrGasP = CurrGasP*2.307 if randomnumber[_n]>0.999 &
randomnumber[_n]<=0.9993 & obsb>1;
        replace CurrGasP = CurrGasP*2.394 if randomnumber[_n]>0.9993 &
randomnumber[_n]<=0.9995 & obsb>1;

```

```

        replace CurrGasP = CurrGasP*2.481 if randomnumber[_n]>0.9995 &
randomnumber[_n]<=1 & obsb>1;
* Diesel price shock;
        replace CurrDieselP = CurrDieselP*1 if randomnumber[_n]>0 &
randomnumber[_n]<=0.844 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.0871 if randomnumber[_n]>0.844 &
randomnumber[_n]<=0.875 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.0174 if randomnumber[_n]>0.875 &
randomnumber[_n]<=0.907 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.2614 if randomnumber[_n]>0.907 &
randomnumber[_n]<=0.953 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.349 if randomnumber[_n]>0.953 &
randomnumber[_n]<=0.956 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.435 if randomnumber[_n]>0.956 &
randomnumber[_n]<=0.963 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.523 if randomnumber[_n]>0.963 &
randomnumber[_n]<=0.973 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.610 if randomnumber[_n]>0.973 &
randomnumber[_n]<=0.984 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.697 if randomnumber[_n]>0.984 &
randomnumber[_n]<=0.991 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.784 if randomnumber[_n]>0.991 &
randomnumber[_n]<=0.993 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.871 if randomnumber[_n]>0.993 &
randomnumber[_n]<=0.994 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.958 if randomnumber[_n]>0.994 &
randomnumber[_n]<=0.995 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.523 if randomnumber[_n]>0.963 &
randomnumber[_n]<=0.973 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.610 if randomnumber[_n]>0.973 &
randomnumber[_n]<=0.984 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.697 if randomnumber[_n]>0.984 &
randomnumber[_n]<=0.991 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.784 if randomnumber[_n]>0.991 &
randomnumber[_n]<=0.993 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.871 if randomnumber[_n]>0.993 &
randomnumber[_n]<=0.994 & obsb>1;
        replace CurrDieselP = CurrDieselP*1.958 if randomnumber[_n]>0.994 &
randomnumber[_n]<=0.995 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.046 if randomnumber[_n]>0.995 &
randomnumber[_n]<=0.997 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.132 if randomnumber[_n]>0.997 &
randomnumber[_n]<=0.998 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.219 if randomnumber[_n]>0.998 &
randomnumber[_n]<=0.999 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.307 if randomnumber[_n]>0.999 &
randomnumber[_n]<=0.9993 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.394 if randomnumber[_n]>0.9993 &
randomnumber[_n]<=0.9995 & obsb>1;
        replace CurrDieselP = CurrDieselP*2.481 if randomnumber[_n]>0.9995 &
randomnumber[_n]<=1 & obsb>1;

* BASELINE REVENUE FORECAST;

* Adjusts baseline consumption for impact of price shocks;
        replace wigasdbasegalday = wigasdbasegalday + ((CurrGasP[_n]-CurrGasP[_n-
1])/CurrGasP[_n-1])*(wigasdbasegalday*elasticityshortrunG) if randomnumber > 0.844 &
obsb>1;
        replace widieseldbasegalday = widieseldbasegalday + ((CurrDieselP[_n]-
CurrDieselP[_n-1])/CurrDieselP[_n-1])*(widieseldbasegalday*elasticityshortrunD) if
randomnumber > 0.844 & obsb>1;

* Creates baseline revenue scenario for gas & diesel demand*;

```

```

    gen BaseRevenueGas = wigasdbasegalday*365*currentexcise;
    gen BaseRevenueDiesel = widieseldbasegalday*365*currentexcise;

* Discounts Baseline Revenue;
    gen DiscountedBaseRevGas = BaseRevenueGas/discounter;
    gen DiscountedBaseRevDiesel = BaseRevenueDiesel/discounter;
    gen DiscountedBaseTotalRev=DiscountedBaseRevGas+DiscountedBaseRevDiesel;

* Creates running sum for baseline;
    egen GrossBaseRevTotal = sum(DiscountedBaseTotalRev);

* ALTERNATIVE REVENUE FORECAST;
* Excise tax adjustment from new motor fuel tax policy, based on current prices
calculated above;
    gen AltGasExcise = 0.329-(0.05*CurrGasP[1]);
    gen AltDieselExcise = 0.329-(0.05*CurrDieselP[1]);

* Creates year-on-year percent change in gas and diesel baseline consumption;
    gen Basewigaspc=1;
        replace Basewigaspc=1+(wigasdbasegalday[_n]-wigasdbasegalday[_n-
1])/wigasdbasegalday[_n-1];
    gen Basewidieselpc=1;
        replace Basewidieselpc=1+(widieseldbasegalday[_n]-widieseldbasegalday[_n-
1])/widieseldbasegalday[_n-1];

* Adjusts alternative quantity demanded based on elasticities;
    gen Altwigasgalday = wigasdbasegalday;
        replace Altwigasgalday = ((elasticitylongrunG * [pcgaspricealt-
pcgaspricebase]) * Altwigasgalday[_n]+
        Altwigasgalday[_n]) if year>2011;
    gen Altwidieselgal = widieseldbasegalday;
        replace Altwidieselgal = ((elasticitylongrunD * [pcdieselpricealt-
pcdieselpricebase]) * Altwidieselgal[_n] +
        Altwidieselgal[_n]) if year>2011;

* Adjusts baseline consumption for impact of price shocks;
        replace Altwigasgalday = Altwigasgalday + (1.05*(CurrGasP[_n]-CurrGasP[_n-
1])/CurrGasP[_n-1])*(Altwigasgalday*elasticityshortrunG) if randomnumber > 0.875 &
obsb>1;
        replace Altwidieselgal = Altwidieselgal + (1.05*(CurrDieselP[_n]-
CurrDieselP[_n-1])/CurrDieselP[_n-1])*(Altwidieselgal*elasticityshortrunD) if
randomnumber > 0.875 & obsb>1;

* Creates alternative revenue scenario for gas & diesel demand;
    gen AltRevGas = Altwigasgalday*365*(0.05*CurrGasP+AltGasExcise);
    gen AltRevDiesel = Altwidieselgal*365*(0.05*CurrDieselP+AltDieselExcise);

* Discounts Alternative Revenue;
    gen DiscountedAltRevGas = AltRevGas/discounter;
    gen DiscountedAltRevDiesel = AltRevDiesel/discounter;
    gen DiscountedAltTotalRev=DiscountedAltRevGas+DiscountedAltRevDiesel;

* Creates running sum for alternative revenue case;
    egen GrossAltRevTotal = sum(DiscountedAltTotalRev);

* Calculates difference in revenue;
    gen diff = DiscountedAltTotalRev-DiscountedBaseTotalRev;

* ACTUAL COST BENEFIT;

* Calculates METB of WI Revenue;
    gen WIMETBbenefit = WIMETB*(DiscountedAltTotalRev-DiscountedBaseTotalRev);

* Negative Externalities;

```

```

* Local pollution;
  gen localcarbase=localpollutioncar*(365*wigasdbasegalday*carmpg);
  gen localcaralt=localpollutioncar*(365*Altwigasgalday*carmpg);

  gen localtruckbase=localpollutiontruck*(widieseldbasegalday*365*trucktmpg);
  gen localtruckalt=localpollutiontruck*(Altwidieselgal*365*trucktmpg);

  gen localpollution=(localtruckalt-localtruckbase)+(localcaralt-localcarbase);
  gen Discountedlocalpollution=localpollution/discounter;

* Congestion;
  gen congestioncarbase=congestioncar*(365*wigasdbasegalday*carmpg);
  gen congestioncaralt=congestioncar*(365*Altwigasgalday*carmpg);

  gen congestiontruckbase=congestiontruck*(widieseldbasegalday*365*trucktmpg);
  gen congestiontruckalt=congestiontruck*(Altwidieselgal*365*trucktmpg);

  gen congestion=(congestiontruckalt-congestiontruckbase)+(congestioncaralt-
congestioncarbase);
  gen Discountedcongestion=congestion/discounter;

* Accidents;
  gen accidentscarbase=accidentscar*(365*wigasdbasegalday*carmpg);
  gen accidentscaralt=accidentscar*(365*Altwigasgalday*carmpg);

  gen accidentstruckbase=accidentstruck*(widieseldbasegalday*365*trucktmpg);
  gen accidentstruckalt=accidentstruck*(Altwidieselgal*365*trucktmpg);

  gen accidents=(accidentstruckalt-accidentstruckbase)+(accidentscaralt-
accidentscarbase);
  gen Discountedaccidents=accidents/discounter;

* Noise;
  gen noisetruckbase=noisetruck*(widieseldbasegalday*365*trucktmpg);
  gen noisetruckalt=noisetruck*(Altwidieselgal*365*trucktmpg);

  gen noise=(noisetruckalt-noisetruckbase);
  gen Discountednoise=noise/discounter;

* Maintenance;
  gen
maintenancetruckbase=maintenancetruck*(widieseldbasegalday*365*trucktmpg)*0.688;
  gen maintenancetruckalt=maintenancetruck*(Altwidieselgal*365*trucktmpg)*0.688;

  gen maintenance=(maintenancetruckalt-maintenancetruckbase);
  gen Discountedmaintenance=maintenance/discounter;

* Loss of federal excise tax due => Federal METB;
  gen USgasexcise=0.184;
  gen USdieselexcise=0.244;

  gen
USrevenuebase=USgasexcise*(365*wigasdbasegalday)+USdieselexcise*(widieseldbasegalday*3
65);
  gen
USrevenuealt=USgasexcise*(365*Altwigasgalday)+USdieselexcise*(Altwidieselgal*365);

  gen USrevenueDIFF=USrevenuealt-USrevenuebase;
  gen discountedUSrevenue=USrevenueDIFF/discounter;
  egen totalUSrevenueimpact=sum(discountedUSrevenue);

  gen USrevMETB=USmetb*discountedUSrevenue;

```

```

* Calculate Intrinsic Deadweight Loss for each year for baseline and alternative for
diesel and gasoline;

* Alternative price forecasts;
  gen AltwigasP = CurrGasP;
  replace AltwigasP = (CurrGasP[_n]-
AltGasExcise)*(1+pcgaspricealt[_n])+AltGasExcise if _n>1;
  gen AltwidieselP = CurrDieselP;
  replace AltwidieselP = (CurrDieselP[_n]-
AltGasExcise)*(1+pcdieselpricealt[_n])+AltDieselExcise if _n>1;

* Generate slopes for gas then diesel;
  gen slopebasegas = CurrGasP/(elasticitylongrunG * wigasdbasegalday);
  gen slopealtgas =AltwigasP/(elasticitylongrunG * Altwigasgalday);

  gen slopebasediesel = CurrDieselP/(elasticitylongrunD * widieseldbasegalday);
  gen slopealtdiesel = AltwidieselP/(elasticitylongrunD * Altwidieselgal);

* Uses long run elasticity for anything besides a price spike. If price difference,
use short-run.
These replacements must go in after the CurrGasP and CurrDieselP are drawn from
distribution;
  replace slopebasegas = CurrGasP/(elasticityshortrunG * wigasdbasegalday) if
randomnumber>0.844;
  replace slopealtgas = AltwigasP/(elasticityshortrunG * Altwigasgalday) if
randomnumber>0.844;

  replace slopebasediesel = CurrDieselP/(elasticityshortrunD *
widieseldbasegalday) if randomnumber>0.844;
  replace slopealtdiesel = AltwidieselP/(elasticityshortrunD * Altwidieselgal) if
randomnumber>0.844;

* Area of Change in Direct DWL;
  gen DWLgas = 0.5*(AltwigasP-CurrGasP)*(365*(CurrGasP-AltwigasP)/slopealtgas);
  gen DWLdiesel = 0.5*(AltwidieselP-CurrDieselP)*(365*(CurrDieselP-
AltwidieselP)/slopealtdiesel);

* NPV of Direct DWL;
  gen DWLPVgas = DWLgas/discounter;
  gen DWLPVdiesel = DWLdiesel/discounter;
  gen DWLPVtotalyearly = DWLPVgas + DWLPVdiesel;

* Calculation of intrinsic Motor Fuels Tax METB;
  egen DWLtotal = sum(DWLPVtotalyearly);
  gen RevTotalDiff=GrossAltRevTotal-GrossBaseRevTotal;

* This calculates the Total METB for the policy (ie over the 10 years window);
  gen METBcalculatedtotal = DWLtotal/RevTotalDiff[10];

* Cost Benefit Calculation WI Standing;
  gen WINetBenefits=-
(Discountedlocalpollution+Discountedcongestion+Discountedaccidents+Discountednoise+Dis
countedmaintenance+
  DWLPVgas+DWLPVdiesel)+WIMETBbenefit;
* Cost Benefit Calculation US Standing;
  gen USNetBenefits=-
(Discountedlocalpollution+Discountedcongestion+Discountedaccidents+Discountednoise+Dis
countedmaintenance+
  DWLPVgas+DWLPVdiesel)+WIMETBbenefit+USrevMETB;

* Summed net benefits;
  egen WINb=sum(WINetBenefits);

```



```

egen USnb=sum(USNetBenefits);

st Benefit Calculation WI Standing;
    gen WInetBenefits=-
(Discountedlocalpollution+Discountedcongestion+Discountedaccidents+D

clear matrix
clear
cd "U:\CBA Project\Final Final"
version 11.0
set more 1
set mem 100m
set matsize 150

use junk
clear
drop _all
gen obs=_n
save junk, replace

* This loop has 1000 iterations, which runs the Monte Carlo simulation;
local i=1
while `i' <= 1000 {
    clear
    do "Monte Carlo No Spike No Inflation"
    collapse diff WInb USnb DiscountedBaseTotalRev DiscountedAltTotalRev, by(year)
    append using junk
    save junk, replace
    local i=`i'+1
}

drop obs

* Creates variables to track state revenue and benefit categories;
    *gen diff2=GrossAltRevTotal-GrossBaseRevTotal

    *gen pposrev=1 if diff2>0
        *replace pposrev=0 if diff2<0
    *tab1 pposrev

    *gen localpollution = 10*Discountedlocalpollution
    *gen congestion = 10*Discountedcongestion
    *gen accidents = 10*Discountedaccidents
    *gen noise = 10*Discountednoise
    *gen DWL = 10*DWLPVgas + 10*DWLPVdiesel
    *gen WIMETB = 10*WIMETBbenefit
    *gen USMETB = 10*USrevMETB
    *sum localpollution congestion accidents noise DWL WIMETB USMETB

* Puts net benefits and revenue in millions of dollars units;
    *gen WImil = WInb/1000000
    *gen USmil = USnb/1000000
    *gen diffmil = diff2/1000000

* Creates histograms for Net Benefits and Revenue;

# delimit ;
*histogram diffmil, bin(100) fraction ytitle("Fraction of trials")
xtitle("Present Value of Revenue Impact (Millions of US 2010 Dollars)")
title("Distribution of Present Value of WI Revenue")
subtitle("Imposition of five percent ad valorem motor fuels sales tax")

```

```

caption("Key Statistics: Discount Rate = 3.5 percent, 10 year time horizon (2011 to
2020)");

# delimit ;
*histogram WImil, bin(100) fraction ytitle("Fraction of trials")
xtitle("Present Value of Net Benefits (Millions of US 2010 Dollars)")
title("Distribution of Present Value of Net Benefits - WI Standing")
subtitle("Replacement of excise tax with mixed tax alternative, including reduced
excise and ad valorem components")
caption("Key Statistics: Discount Rate = 3.5 percent, 10 year time horizon (2011 to
2020)");

*histogram USmil, bin(100) fraction ytitle("Fraction of trials")
xtitle("Present Value of Net Benefits (Millions of US 2010 Dollars)")
title("Distribution of Present Value of Net Benefits - US Standing")
subtitle("Replacement of excise tax with mixed tax alternative, including reduced
excise and ad valorem components")
caption("Key Statistics: Discount Rate = 3.5 percent, 10 year time horizon (2011 to
2020)");

# delimit ;
table year, c(mean DiscountedBaseTotalRev) row col format(%9.3f);

table year, c(mean DiscountedAltTotalRev) row col format(%9.3f);
s")
xtitle("Present Value of Net Benefits (Millions of US 2010 Dollars)")
title("Distribution of Present Value of Net Benefits - US Standing")
subtitle("Replacement of excise tax with mixed tax alternative, including reduced
excise and ad valorem components")
caption("Key Statistics: Discount Rate = 3.5 percent, 10 year time horizon (2011 to
2020)");

# delimit ;
table year, c(mean DiscountedBaseTotalRev) row col forma

```

## Appendix K: Results from Additional Scenarios

In addition to the scenario described in the report (fixed excise tax with price shocks), this appendix outlines the results from the four others we considered. Each scenario compares the mixed-tax alternative to a nominal and real (adjusted for inflation) excise tax, each with and without price shocks.

(2): Nominal excise tax at 32.9 cents, without price shocks

(3) Excise tax rises with inflation, with price shocks

(4) Excise tax rises with inflation, without price shocks

(5) Nominal excise tax at 32.9 cents with price shocks and marginal excess tax burden (METB) set to zero.

*Scenario (2): Simulation without price shocks where base case is 32.9 cent nominal excise tax*

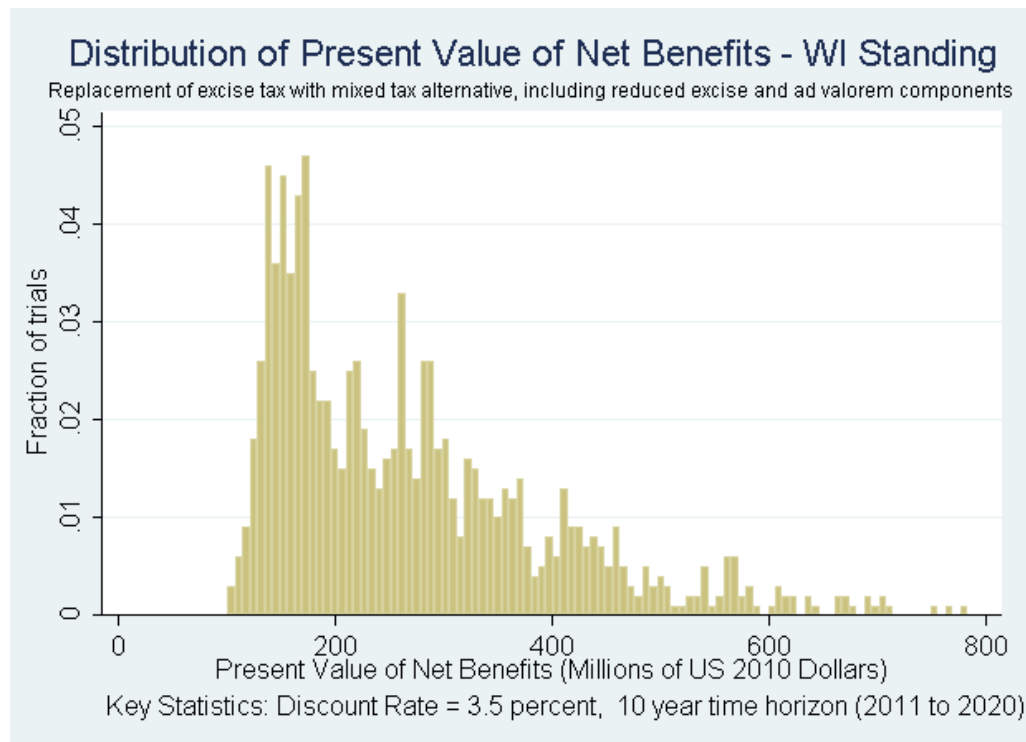
Eliminating the price shocks substantially alters estimation of net benefits. In this simulation, mean net benefits are \$268 million for Wisconsinites and \$266 million for Americans as a whole from 2011 through 2020. The range of net benefits for Wisconsin standing runs from \$101 million to \$783 million, while the range of net benefits for national standing runs from \$99.6 million to \$780 million (see Table K1 for additional statistics and Figures K1 and K2 for histograms of net benefits estimates).

**Table K1: Present value of net benefits due to replacement of nominal 32.9 cent excise tax on motor fuels with a mixed-tax alternative (billions of 2010 dollars) – no risk of price shock**

Standing	Minimum	Maximum	Mean	Standard Deviation	Number of Estimates
Wisconsin	0.101	0.783	0.268	0.127	1000
Nation	0.0996	0.780	0.266	0.216	1000

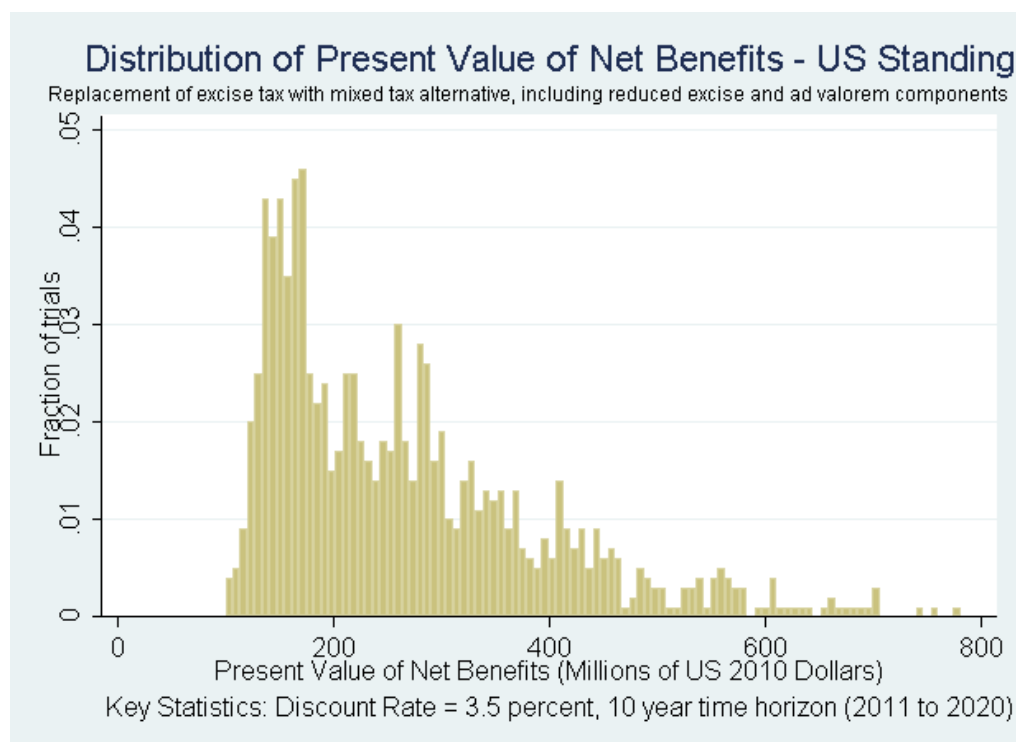
Source: Authors

**Figure K1: Price shocks excluded and base case excise tax simulated in nominal terms**



Source: Authors

**Figure K2: Price shocks excluded and base case excise tax simulated in nominal terms**



Source: Authors

*Scenario 3: Simulation with price shocks where base case is 32.9 cent real excise tax (excise tax rises with inflation)*

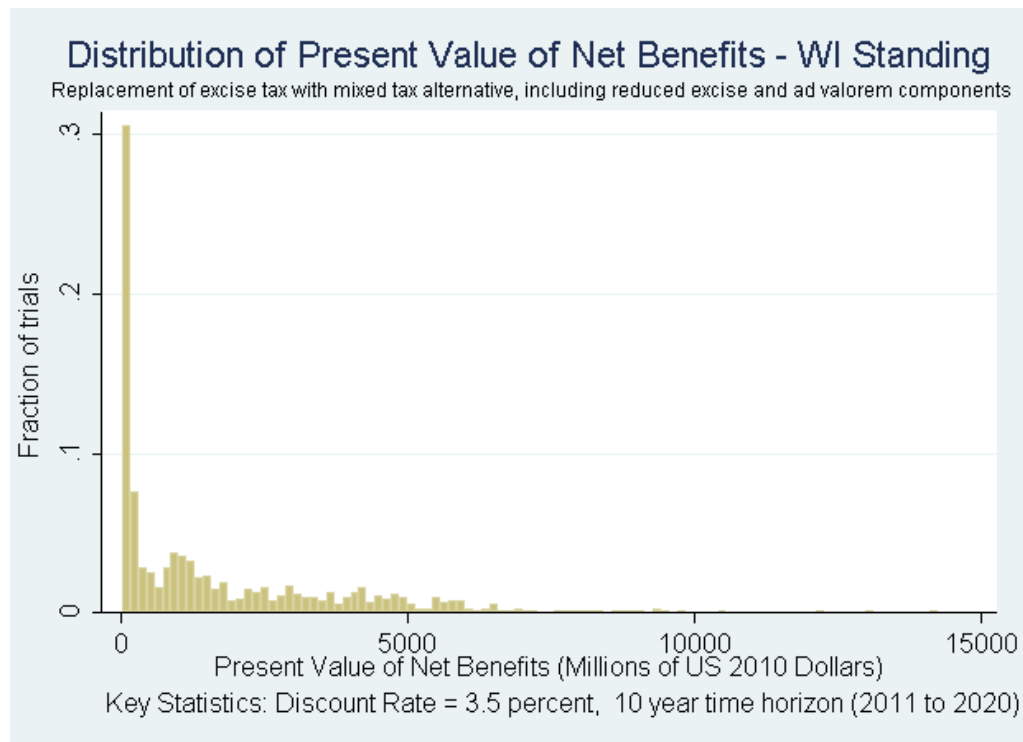
Making the excise tax constant in real dollar terms over the 10-year horizon of the study only has a modest impact on estimation of net benefits. In this simulation, mean net benefits are \$1.81 billion for Wisconsin residents and \$1.8 billion for Americans as a whole from 2011 through 2020. The range of net benefits for Wisconsin residents runs from \$26.1 million to \$14.2 billion, while the range of net benefits for national residents runs from \$21.1 million to \$14.2 billion (see Table K2 for additional statistics and Figures K3 and K4 for histograms of net benefits estimates).

**Table K2: Present value of net benefits due to replacement of real 32.9 cent excise tax on motor fuels with a mixed-tax alternative (billions of 2010 dollars) – risk of price shock included**

Standing	Minimum	Maximum	Mean	Standard Deviation	Number of Estimates
Wisconsin	0.026	14.2	1.81	2.18	1000
Nation	0.021	14.2	1.80	2.17	1000

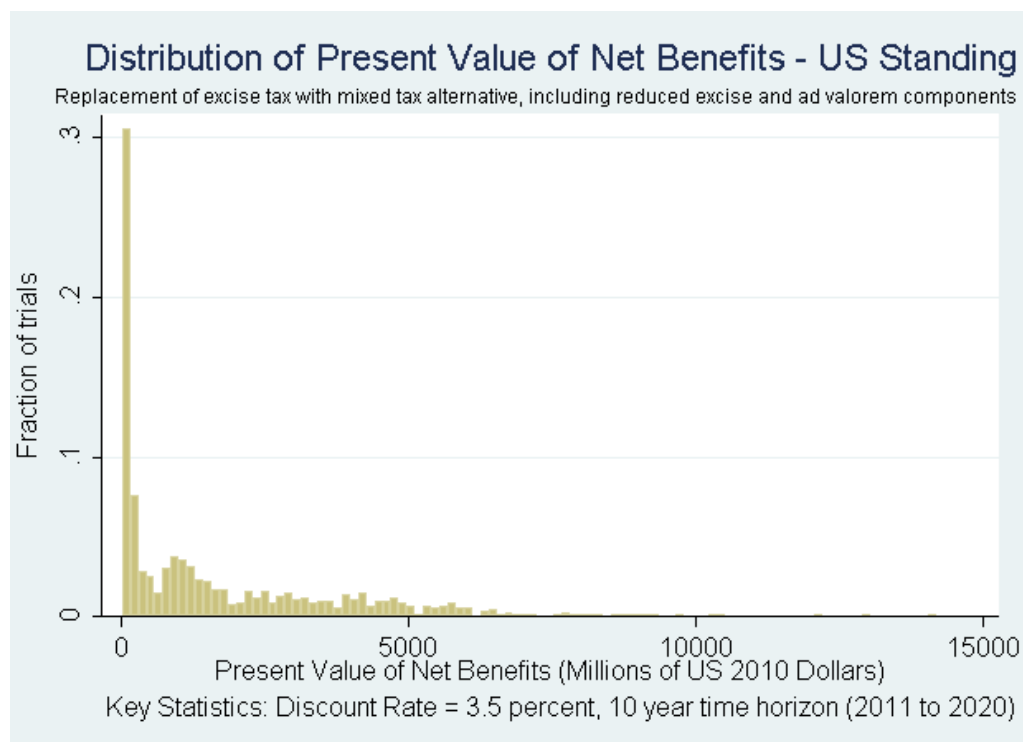
Source: Authors

**Figure K3: Price shocks included and base case excise tax simulated in real terms**



Source: Authors

**Figure K4: Price shocks included and base case excise tax simulated in real terms**



Source: Authors

*Scenario 4: Simulation without price shocks where base case is 32.9 cent real excise tax (excise tax rises with inflation)*

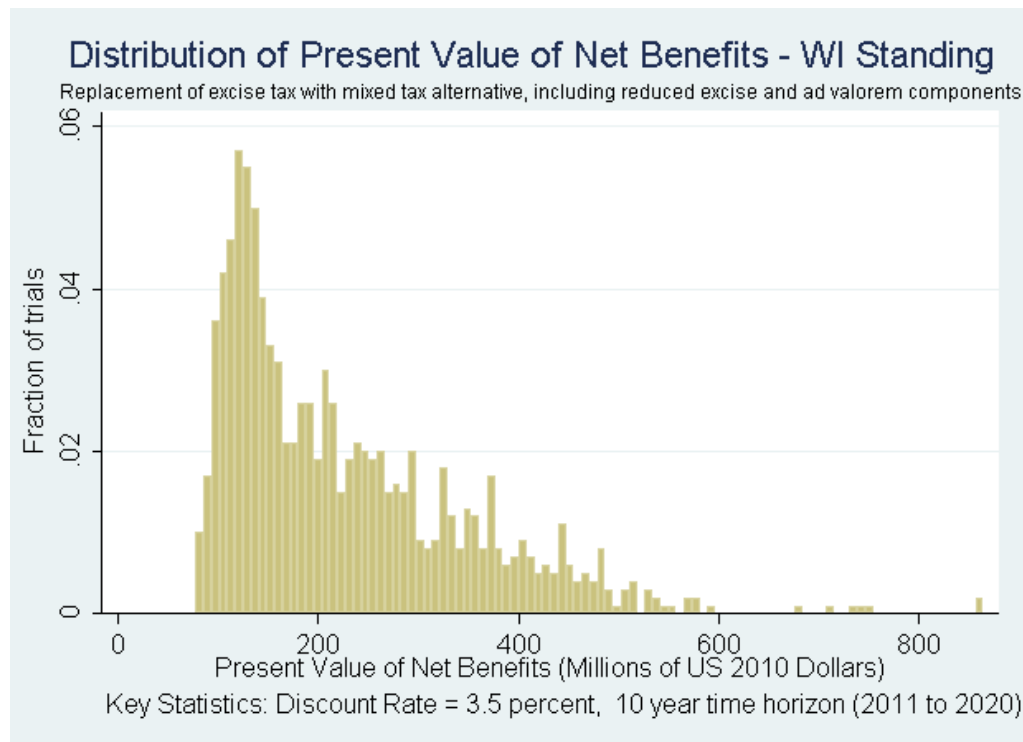
The impact of eliminating price shocks dominates the effect of making the excise tax constant in real dollars over the time horizon. In this simulation, mean net benefits are \$227 million for Wisconsinites and \$224 million for Americans as a whole from 2011 through 2020. The range of net benefits for Wisconsin standing runs from \$77 million to \$865 million, while the range of net benefits for national standing runs from \$76 million to \$856 million (see Table K3 for additional statistics and Figures K5 and K6 for histograms of net benefits estimates).

**Table K3: Present value of net benefits due to replacement of real 32.9 cent excise tax on motor fuels with a mixed-tax alternative (billions of 2010 dollars) – no risk of price shock**

<b>Standing</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Number of Estimates</b>
Wisconsin	0.077	0.865	0.227	0.121	1000
Nation	0.076	0.856	0.224	0.120	1000

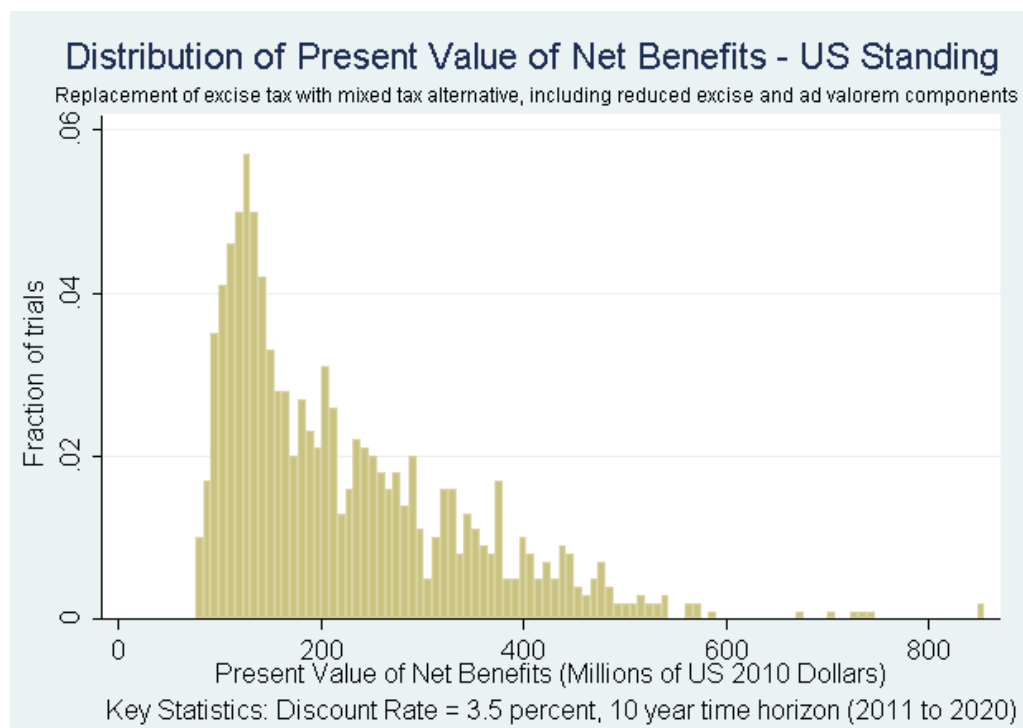
Source: Authors

**Figure K5: Price shocks excluded and base case excise tax simulated in real terms**



Source: Authors

**Figure K6: Price shocks excluded and base case excise tax simulated in real terms**



Source: Authors



*Scenario 5: Simulation with price shocks where base case is 32.9 cent nominal excise tax and METB is set to zero*

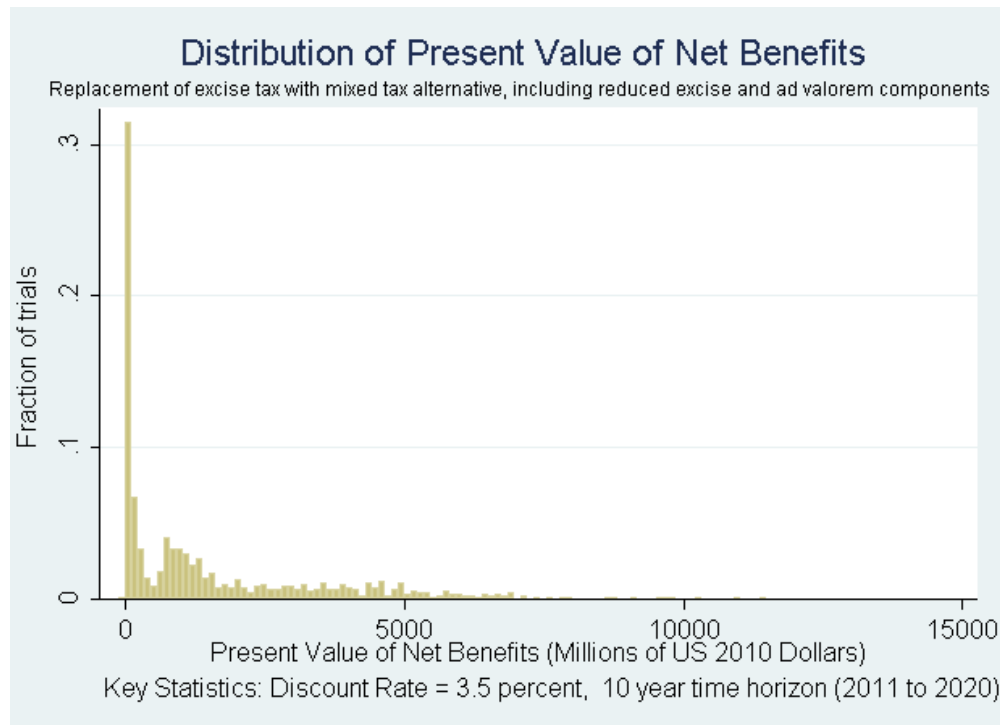
The impact of setting METB equal to zero makes Wisconsin and U.S. net benefits equal, because the difference between the two was due to federal METB. In this simulation, mean net benefits are \$1.64 billion from 2011 through 2020. The range of net benefits extend from -\$110 million to \$11.5 billion. The rare incidence of negative revenue occurs due to the removal of the benefit of METB, while the direct deadweight loss of the policy is still being counted (see Table K4 for additional statistics and Figure K7 for a histogram of net benefits estimates).

**Table K4: Present value of net benefits due to replacement of real 32.9 cent excise tax on motor fuels with a mixed-tax alternative (billions of 2010 dollars) – no risk of price shock**

<b>Standing</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Mean</b>	<b>Standard Deviation</b>	<b>Number of Estimates</b>
Wisconsin	-0.11	11.5	1.64	2.06	1000
National	-0.11	11.5	1.64	2.06	1000

Source: Authors

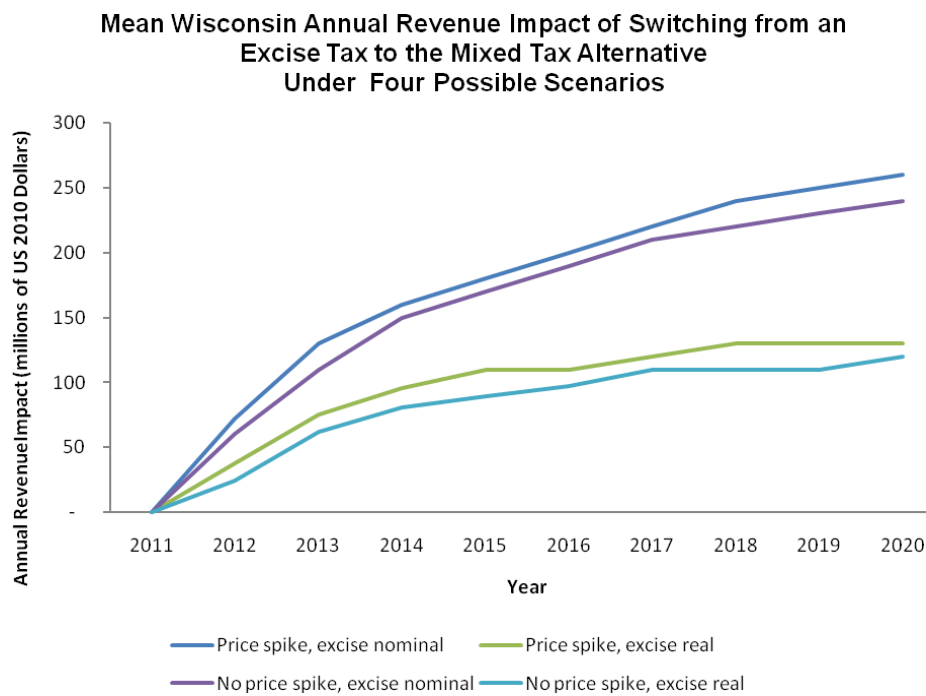
**Figure K7: Price shocks included, excise tax in nominal dollars, METB set to zero (standing irrelevant – net benefits the same for Wisconsin or national standing)**



Source: Authors

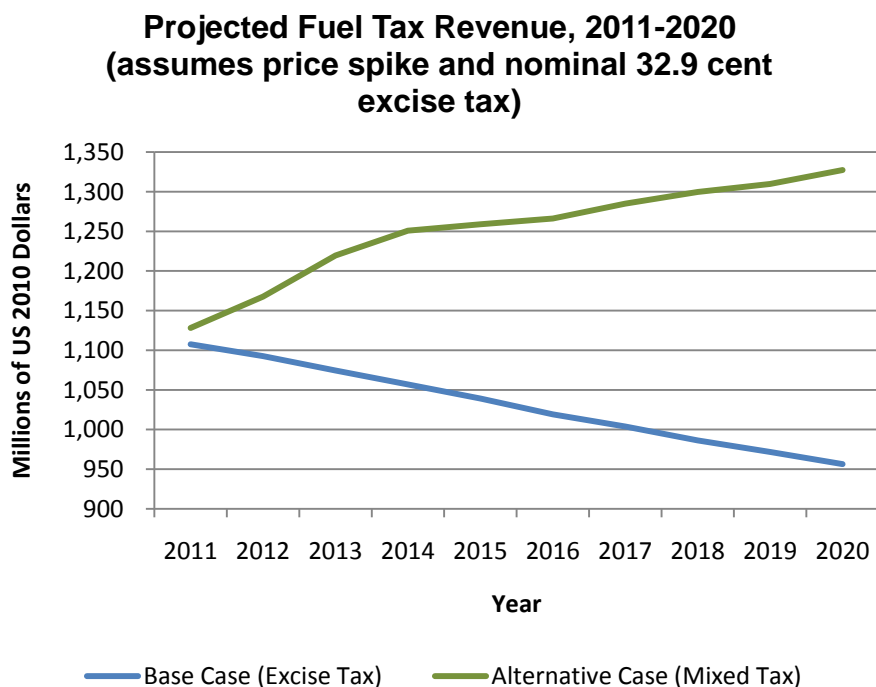
Figures K8-K13 show the average Wisconsin fuel tax revenue under the four scenarios of the mixed-tax alternative compared to the status quo.

**Figure K8: Mean Wisconsin Revenue under Four Additional Scenarios**



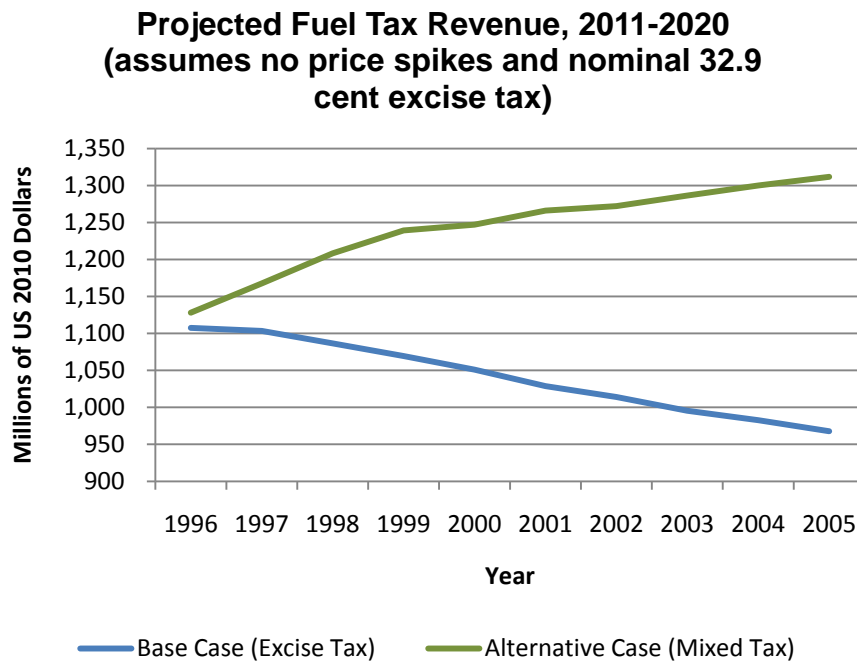
Source: Authors

**Figure K9: Projected Wisconsin Fuel Tax Revenue assuming price shocks and nominal 32.9 cent excise tax**



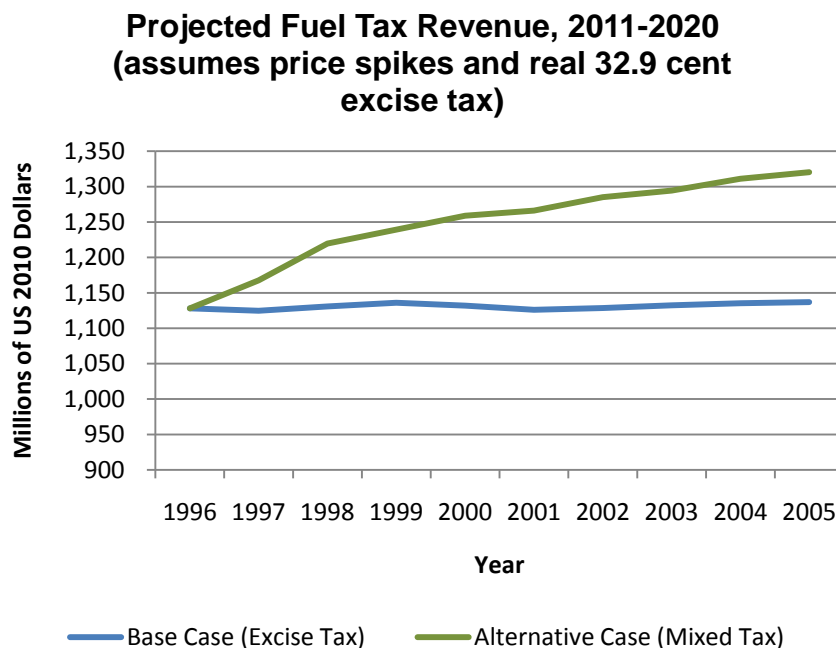
Source: Authors

**Figure K10: Projected Wisconsin Fuel Tax Revenue assuming no price shocks and nominal 32.9 cent excise tax**



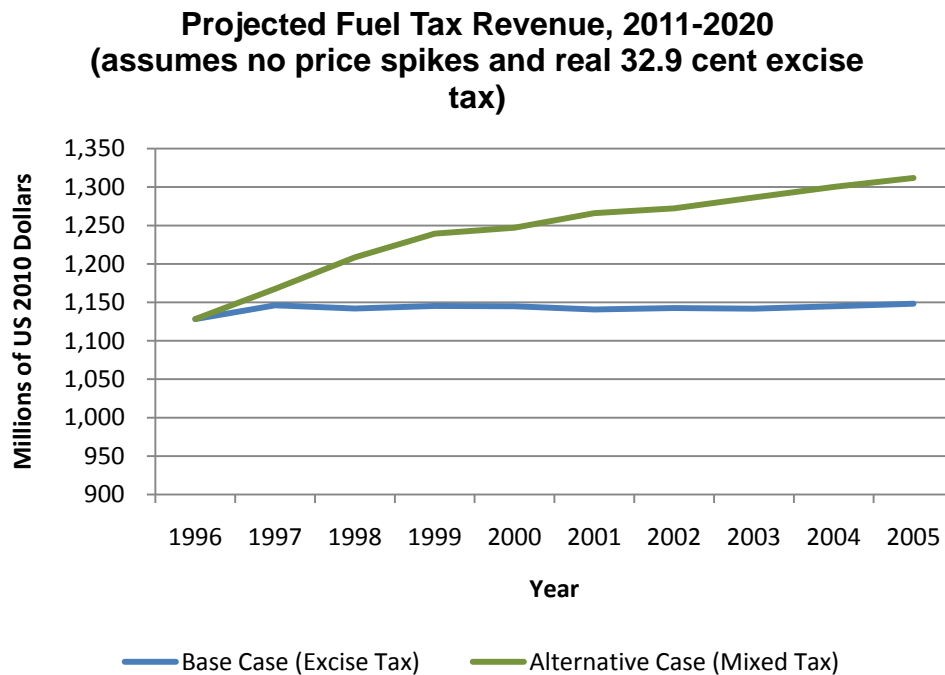
Source: Authors

**Figure K11: Projected Wisconsin Fuel Tax Revenue assuming price shocks and real 32.9 cent excise tax**



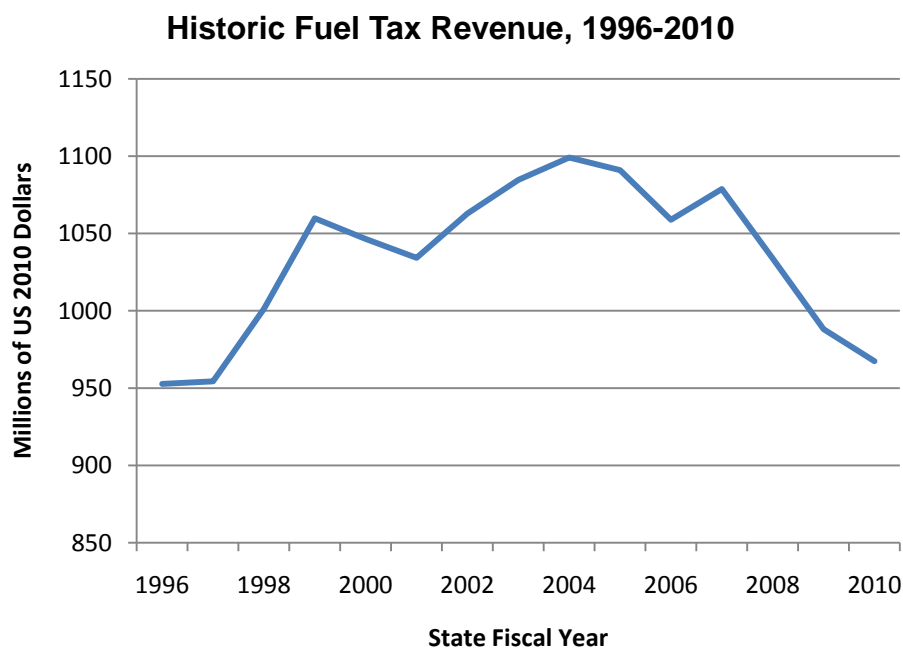
Source: Authors

**Figure K12: Projected Wisconsin Fuel Tax Revenue assuming no price shocks and real 32.9 cent excise tax**



Source: Authors

**Figure K13: Historic Wisconsin Fuel Tax Revenue**



Source: Authors

## **Appendix L: Transition Costs**

Studies have attempted to measure the impact of fuel price shocks in terms of gross domestic product (GDP) and inflation impacts. Basic observations show that sudden oil price increases generally accompany economic contraction and high inflation (De Fiore et al., 2006). The facts that cars are durable goods and consumers lack the ability to switch to substitute goods in the short term as motor fuel prices rise contribute to the negative social welfare impacts of oil price shocks. Jones et al. (2004) estimate that the oil-price-GDP elasticity during price shocks to be approximately -0.055. Thus, a doubling of the oil price, a 100 percent increase, would be expected to cause a 5.5 percent drop in national output. This substantial impact is most likely accompanied by a drop in social welfare; however, no social welfare impact estimates were available in the literature, which contributes to a weakness of our model. Fortuitously, because the crux of our analysis rests in comparing the base case excise tax to the mixed-tax alternative, both of which experience the same price shock in the same years, the only missing effect in terms of transitional costs is the 5 percent amplification of the price shock in the alternative model. Based on the size of the GDP impacts estimated above, the 5 percent amplification seems unlikely to significantly affect net benefits; however, our model results should still be interpreted with due caution on account of this missing cost component.