

State Highway Funding in New England: The Road to Greater Fiscal Sustainability

Methodological Appendix

This appendix describes the data, adjustments, and calculations employed in Figure 1 and in the historical and forward-looking simulations conducted for this report.

Figure 1

Figure 1 shows real gasoline tax revenue associated with a hypothetical light-duty vehicle with average fuel efficiency traveling 10,000 miles per year and paying a fixed nominal tax rate of 18.4 cents per gallon. Actual average light-duty-vehicle fuel-efficiency estimates are from *Highway Statistics*, published by the Federal Highway Administration (FHWA), and projections are from the Energy Information Administration (EIA). Nominal revenues are adjusted for inflation using the actual values of the consumer price index for all urban consumers (CPI-U) from the U.S. Bureau of Labor Statistics (BLS) and projections from the Congressional Budget Office (CBO).

Actual tax rates

We culled data from various state and federal sources to identify excise tax rates in effect in each New England state in each month back to 1993. We computed the average annual tax rate as the simple average of the prevailing monthly rates in a given calendar year. For example, if a state levied an excise tax of 18 cents per gallon for the first six months of a calendar year and a tax of 20 cents per gallon for the second six, the average annual rate would be 19 cents per gallon.

To obtain the effective cents-per-gallon rate for Vermont's Motor Fuel Transportation Infrastructure Assessment (MFTIA) through Q1 2013, we applied the statutory 2-percent rate to the average retail price for the prior quarter reported by the Vermont Department of Public Service, adjusted to remove state and federal taxes. For subsequent quarters and for the state's Motor Fuel Tax Assessment (MFTA), we relied on quarterly cents-per-gallon rates reported by the state's Department of Motor Vehicles. We computed the average annual tax rate as the simple average of the prevailing quarterly tax rates in a given calendar year.

To obtain the effective cents-per-gallon rate for Connecticut's petroleum products gross earnings tax, we applied the effective percentage tax rate in effect in a given month to the average per-gallon wholesale price of regular gasoline excluding taxes for that month as reported by the EIA. The effective rate (equal to $s/(1-s)$ where s is the statutory rate) takes into account a 1987 state Supreme Court decision that found that taxes collected from the

petroleum products gross earnings tax are themselves subject to the tax.¹ Beginning in April 2012, the effective percentage rate was applied to the minimum of the reported monthly wholesale price or \$3.00 per gallon, reflecting the cap that was adopted. We computed the average annual tax rate as the simple average of the prevailing monthly tax rates in a given calendar year.

The total actual tax rates for Connecticut and Vermont were obtained by summing the fixed and effective cents-per-gallon variable-rate components.

Actual gallons of gasoline taxed

For gallons taxed, we relied on the net volume of gasoline taxed in each state for that year, as reported in the FHWA's *Highway Statistics* Table MF-2 (various years).

Actual vehicle miles traveled

Because the report focuses on gasoline taxes, we are interested in state-level estimates of aggregate vehicle miles traveled (VMT) by light-duty vehicles (for example, cars, SUVs, mini-vans, pick-up trucks), which are the types of vehicles that have traditionally relied on gasoline as opposed to diesel or other forms of fuel. The FHWA reports state-level VMT data for all motor vehicles only; by contrast, national estimates are broken down by light- versus heavy-duty vehicles (*Highway Statistics*, Table VM-1, various years). To obtain estimates for state-level light-duty VMT we multiplied the national ratio of light-duty VMT to all-motor-vehicle VMT (computed from data in Table VM-1) by state-level all-motor-vehicle VMT (*Highway Statistics*, Table VM-2) for all New England states except Vermont (see below). This calculation was performed separately for urban and rural vehicle miles traveled, and the results were summed together. This estimate assumes that light-duty vehicle travel represents the same proportion of total vehicle travel in each New England state as in the nation as a whole.

We used a somewhat different approach in Vermont after observing a pronounced jump in all-motor-vehicle VMT between 2000 and 2001, reported in the *Highway Statistics* data. Upon investigation, we learned that: (1) the jump in the data was due to the state's adopting a new methodology for calculating VMT for local road systems and that therefore local VMT were probably underreported in earlier years; and (2) the *Highway Statistics* data do not reflect revisions made to data collected under the new system in its initial years. For 2001 and later, we relied on revised data on all-motor-vehicle VMT available from the Vermont Agency of Transportation (VTrans). For previous years, we adjusted the VTrans data to attempt to correct for underreporting associated with the old, local road methodology. We did this by assuming

¹ Independent Connecticut Petroleum Association Member Services Bulletin #18. June 2008.

that overall (local + nonlocal) VMT grew at the same rate as nonlocal VMT between 1993 and 2001. The nonlocal VMT data, which are from *Highway Statistics*, are presumed to be unaffected by the change in methodology. Specifically, for year t :

$$\text{Overall VMT}_t = \text{Overall VMT}_{t+1} \times \frac{\text{Non-local VMT}_t}{\text{Non-local VMT}_{t+1}}.$$

In other words, overall VMT for 1999 was calculated as overall VMT for 2000 multiplied by the ratio of nonlocal VMT in 1999 to nonlocal VMT in 2000.

Retail gas prices

We relied on state-level monthly average retail prices, excluding taxes, for regular gasoline reported by the EIA for the period through February 2011, after which these data were suspended. To estimate tax-exclusive retail prices, by state, for the remainder of the period, we relied on average monthly tax-inclusive retail prices reported by the EIA for Massachusetts (the only New England state for which these data are reported) and known information about actual tax rates. First, we subtracted actual federal and Massachusetts gas tax rates (including environmental fees) to obtain estimated tax-exclusive retail prices for Massachusetts for the full period. For March 2011 and forward, we then multiplied the Massachusetts estimated tax-exclusive retail price by the average monthly ratio of each state's tax-exclusive retail price to Massachusetts' tax-exclusive retail price for the period from March 2010 to February 2011.

To create a time-series of tax-inclusive retail prices for the non-Massachusetts states, necessary for elasticity calculations, we simply took the time-series of actual and estimated tax-exclusive prices developed above and added in known information about actual federal and state tax rates (including environmental fees).

We computed the average annual retail prices (both tax-exclusive and tax-inclusive) as the simple averages of the average monthly prices.

CPI-indexed gas tax

For 1993, the hypothetical tax rate for each state was equal to the total actual tax rate. For subsequent years, t :

$$\text{Hypothetical tax rate}_t = \text{Hypothetical tax rate}_{t-1} \times \frac{\text{CPI}_{t-1}}{\text{CPI}_{t-2}}.$$

The CPI refers to the consumer price index for all urban consumers as reported by the Bureau of Labor Statistics.² The tax is indexed to lagged changes in the CPI and other indexing factors described below, to better reflect the delay with which data are released and available for a state to use to adjust its tax rate.

CCI-indexed gas tax

For 1993, the hypothetical tax rate for each state was equal to the total actual tax rate. For subsequent years, t :

$$\text{Hypothetical tax rate}_t = \text{Hypothetical tax rate}_{t-1} \times \frac{CCI_{t-1}}{CCI_{t-2}}.$$

The CCI is an index of highway construction costs. Through 2006, this index is based on the FHWA's composite-bid price index (BPI). Subsequent years are based on the annual average of quarterly values of the FHWA's national highway construction cost index (NHCCI). The NHCCI began in 2003, supplanting the BPI, which was discontinued in 2006. According to the FHWA, the NHCCI was "intended to replace the [BPI] in the future, but also to be compared with the BPI for historical purposes." Both indexes attempt to capture material and labor costs associated with highway construction, based on information from bids submitted for highway construction contracts. We obtained annual index values by averaging quarterly values.

Fuel efficiency indexed gas tax

For 1993, the hypothetical tax rate for each state was equal to the total actual tax rate. For subsequent years, t :

$$\text{Hypothetical tax rate}_t = \text{Hypothetical tax rate}_{t-1} \times \frac{FE_{t-2}}{FE_{t-3}}.$$

FE represents the national average miles traveled per gallon of fuel consumed for all light-duty vehicles, as reported in the FHWA's *Highway Statistics* Table VM-1 (various years). Unlike the CPI- and CCI-indexed taxes, which incorporate a one-year lag in the indexing factor, the fuel-efficiency-indexed tax is adjusted with a two-year lag to better reflect the longer delay associated with the release of average fuel-efficiency data.

CPI/CCI and fuel-efficiency indexed gas taxes

For 1993, the hypothetical tax rate for each state was equal to the total actual tax rate. For subsequent years, t :

² We also ran alternative versions of the CPI-indexed gas and VMT taxes, using the CPI-U for Boston-Brockton-Nashua, following the same indexing methodologies described in this appendix.

$$\text{Hypothetical tax rate}_t = \text{Hypothetical tax rate}_{t-1} \times \frac{CI_{t-1}}{CI_{t-2}} \times \frac{FE_{t-2}}{FE_{t-3}},$$

where CI is the CPI or CCI as described above, and FE is the average light-duty vehicle fuel efficiency as described above.

Price-based gas tax

Each state's price-based tax rate was selected to generate the same amount of revenue in the base year (1993) as the state's actual total gas tax. Specifically, the percentage rate is given by:

$$\text{Hypothetical tax rate} = \frac{\text{Total actual tax rate}_{1993}}{\text{Retail price}_{1992}},$$

where the total actual tax rate is each state's total per-gallon gas tax rate (including any price-based taxes and excluding environmental fees) and retail price is the tax-exclusive retail price developed above. To obtain the effective per-gallon tax rate for a given year, this hypothetical fixed percentage of price is multiplied by the average tax-exclusive retail price for the prior year. Thus, by design, the effective per-gallon tax rate for the base year, 1993, will simply equal the total actual tax rate for 1993.

We also examine an alternative version of the price-based tax, where the percentage tax rate is applied to the current year wholesale price. Here the percentage rate is given by:

$$\text{Hypothetical tax rate} = \frac{\text{Total actual tax rate}_{1993}}{\text{Wholesale price}_{1993}},$$

where the total actual tax rate is each state's total per-gallon gas tax rate (including any price-based taxes and excluding environmental fees) and wholesale price is the tax-exclusive wholesale price of regular gasoline as reported by the EIA.³ To obtain the effective per-gallon tax rate for a given year, this hypothetical fixed percentage of price is multiplied by the average tax-exclusive wholesale price for that year.

Dual gas tax

The dual gas tax structure employed in our system assumes a 5-percent, price-based tax plus a reduced fixed excise tax selected, such that, combined, the two components produce the same

³ The EIA's monthly wholesale price series includes some missing values for Maine, New Hampshire, Rhode Island, and Vermont. We imputed missing prices based on the relationship of each state's price to the Massachusetts price in months with non-missing data.

level of revenue in the base year (1993) as the state's actual total gas tax.⁴ The amount of the excise tax is given by:

$$\text{Hypothetical excise tax rate} = \text{Total actual tax rate}_{1993} - (.05) \times \text{Retail price}_{1992},$$

where the total actual tax rate is each state's actual total per-gallon gas tax rate (including any price-based taxes and excluding environmental fees) and retail price is the tax-exclusive retail price developed above. To obtain the effective per-gallon tax rate for a given year, the 5-percent tax is applied to the average tax-exclusive retail price for the prior year and added to the hypothetical fixed per-gallon excise component.

We also examine an alternative version of the dual gas tax in which the 5-percent, price-based tax is applied to the current year wholesale price. Here the amount of the fixed excise component is given by:

$$\text{Hypothetical excise tax rate} = \text{Total actual tax rate}_{1993} - (.05) \times \text{Wholesale price}_{1993},$$

where the total actual tax rate is each state's actual total per-gallon gas tax rate (including any price-based taxes and excluding environmental fees) and wholesale price is the tax-exclusive wholesale price of regular gasoline reported by the EIA.

Adjusted gallons taxed

To account for the fact that drivers may reduce their gasoline consumption in response to price increases, we adjusted actual gallons taxed by each state for each of the indexed or price-based gas tax alternatives as follows for year t :

$$\text{Adjusted gallons}_t = \text{Actual gallons}_t \times \left[1 + E \times \frac{(\text{Hypothetical rate}_t - \text{Actual rate}_t)}{\text{Tax-inclusive retail price}_t} \right],$$

where E is the estimated tax price elasticity of demand for gasoline, actual rate is each state's actual total tax rate (including any price-based taxes and excluding environmental fees), and hypothetical rate is the hypothetical tax rate for each alternative as developed above.

Our main results assume a tax price elasticity of demand for gasoline of -0.4, which is consistent with estimates of long-term elasticity used by the CBO.

Adjusted vehicle miles traveled

⁴ The choice of 5 percent is arbitrary. However, it is in line with the combined rate of Vermont's MFTIA and MFTA, which was originally 4 percent and is currently 6 percent.

To account for the fact that drivers may reduce driving in response to price increases, we adjusted estimated actual light-duty VMT for each state for each of the alternatives as follows for year t :

$$\text{Adjusted VMT}_t = \text{Actual VMT}_t \times \left[1 + E \times \frac{(\text{Hypothetical rate}_t - \text{Actual rate}_t)}{\text{Tax-inclusive retail price}_t} \right],$$

where E is the estimated tax price elasticity of VMT, actual rate is each state's actual total tax rate (including any price-based taxes and excluding environmental fees), and hypothetical rate is the hypothetical tax rate for each of these alternatives, as developed above.

Our main results assume a tax price elasticity of vehicle miles traveled of -0.2, which is consistent with estimates of long-term elasticity used by the CBO.

Estimated actual revenues

We obtained estimated actual revenues by multiplying each state's total actual tax rate (including any price-based taxes and excluding environmental fees) by gallons of gasoline taxed by that state. This produced aggregate nominal revenues. To compute real revenues per 10,000 vehicle miles traveled, we converted nominal revenues into constant 2014 dollars, using the CPI-U, and divided by estimated light-duty vehicle miles traveled as developed above, finally multiplying by 10,000.⁵

Simulated revenues

We assumed simulated revenues equaled actual revenues in 1993. For other years, we obtained simulated revenues for each funding alternative by multiplying each state's hypothetical tax rate by adjusted gallons taxed. This produced aggregate nominal revenues. To compute real revenues per 10,000 vehicle miles traveled, we converted nominal revenues into constant 1993 dollars, using the CPI-U, and divided by adjusted vehicle miles traveled, as developed above, finally multiplying by 10,000.

Forward-looking simulations

We conducted forward-looking simulations only for Massachusetts; because we are relying largely on national rather than state-specific projections; simulations for the other New England states would show similar patterns. We also focused on three alternatives: a flat-rate gasoline excise tax, a CPI-indexed gasoline excise tax, and a gasoline excise tax indexed to both the CPI and average fuel efficiency.

⁵ The 2014 index value is based on the average of monthly values through July.

We projected forward the CPI-U using CBO projections through 2024, then assumed constant growth of 2.4 percent per year thereafter.⁶

We projected forward light-duty vehicle miles traveled, and gallons of gasoline taxed, using EIA projections of light-duty vehicle miles traveled, and gasoline consumption, respectively. We projected forward average light-duty vehicle fuel efficiency based on the ratio of EIA-projected light-duty vehicle miles traveled and gasoline consumption.

The new base year for the forward-looking simulations was 2014. We assumed the Massachusetts 2014 excise tax rate (24 cents per gallon) as the flat excise tax for the 2014–2040 period (Figure 8 reports on data through 2033). We generated hypothetical CPI-indexed and CPI- and FE-indexed tax rates for the period in the same manner as for the historical simulations. Simulated revenues were obtained by multiplying hypothetical tax rates by projected gallons taxed, adjusted for elasticity, as described above.

For the elasticity adjustments, we projected Massachusetts' tax-inclusive retail price under each alternative, using EIA projections of wholesale gasoline prices and distribution costs per gallon (added together, these were assumed to represent the tax-exclusive retail price), and added to this the hypothetical state tax, a fixed 18.4-cents-per-gallon federal tax, and a fixed 2.5-cents-per-gallon environmental fee.

⁶ The figure 2.4 represents the projected growth from 2023 to 2024; projected average annual growth between 2012 and 2024 was slightly lower, at 2.2 percent.