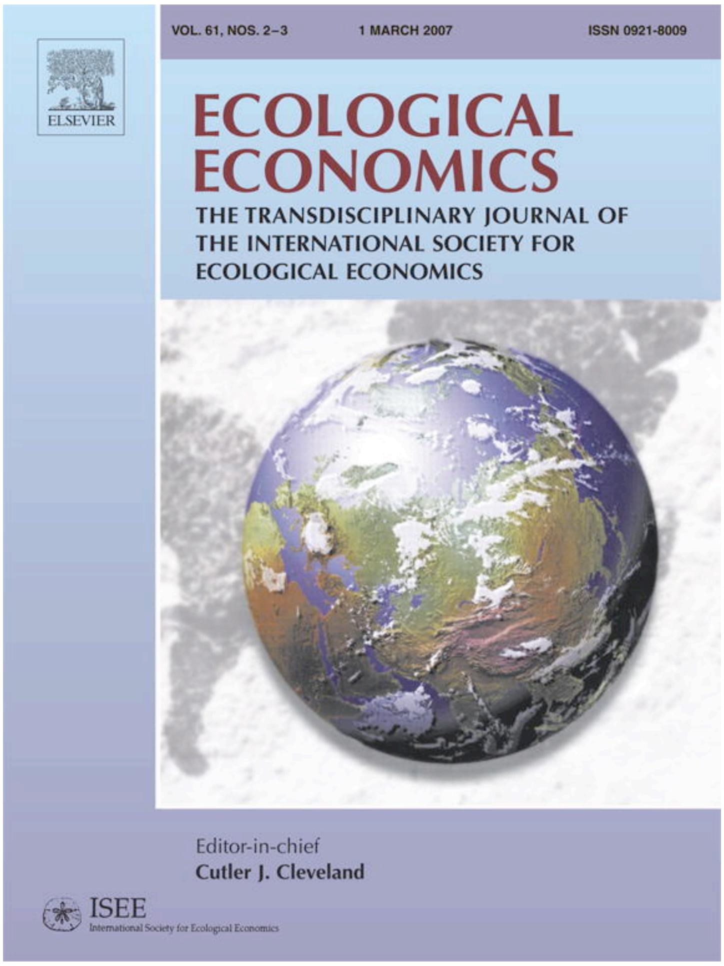
VOL. 61, NOS. 2–3
1 MARCH 2007
ISSN 0921-8009
ELSEVIER
ECOLOGICAL ECONOMICS
THE TRANSDISCIPLINARY JOURNAL OF THE INTERNATIONAL SOCIETY FOR ECOLOGICAL ECONOMICS
Editor-in-chief
Cutler J. Cleveland
ISEE
International Society for Ecological Economics

ECOLOGICAL ECONOMICS 61 (2007) 409–416

available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/ecolecon

ANALYSIS

# Motor fuel taxation, energy conservation, and economic development: A regional approach☆

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ARTICLE INFO

*Article history:*
Received 1 December 2005
Accepted 10 March 2006
Available online 12 May 2006

*Keywords:*
Motor fuel taxation
Energy conservation
Regional development
New England

ABSTRACT

Combustion of motor fuels has a variety of environmental impacts on local, regional and global scales. Taxing motor fuels more heavily would mitigate those environmental impacts. However, many governments are reluctant to increase motor fuel taxes because they fear that the tax incidence will be regressive and that economic development will be impeded. Using data for the New England region of the United States, this paper argues that an oil-importing region can conserve energy, avoid regressive impacts and encourage economic development by taxing motor fuels more heavily and rebating the incremental revenues to owners of motor vehicles.





## 1. Introduction

Without doubt, the motor vehicle is central to daily life in the United States. In 2003, the nation's fleet of autos, trucks and buses numbered 231.4 million. There was nearly one auto for every two Americans (FHWA, 2003, Table MV-1). In order to service this vehicle fleet, governments at the federal, state and local levels had constructed 3.97 million miles of public roads by 2003, almost 23.7% of that mileage in urban regions (FHWA, 2003, Table VM-1).

This enormous fleet of vehicles and extensive network of streets and highways permits an unprecedented degree of mobility in the contemporary United States. In 2003, vehicles logged 2.89 trillion miles of travel (FHWA, 2003, Table VM-1), the equivalent of more than 6 million round trips between our planet and its moon. Along the way, those vehicles burned 169.6 billion gallons of gasoline and diesel fuels (FHWA, 2003, Table MF-21).

Mobility of people and freight carries a high price tag, however. In 2001, the private cost of operating an automobile (fuel, depreciation, maintenance, etc.) ranged from 20 to 50 cents per mile (Harrington and McConnell, 2003: 21). Of greater relevance to this study are the numerous external costs associated with the nation's dependence on motor vehicles to transport drivers, passengers and cargo. Soil and groundwater contamination from leaking fuel storage tanks is a widespread problem, for example. The US EPA (2005) has confirmed nearly 449 thousand leaks from underground tanks.[1]

The operation of vehicles results in highway fatalities and injuries, noise pollution, and urban road congestion. In 2000,

☆ The author would like to thank the Lincoln Institute of Land Policy and the University of New Hampshire Vice President for Research and Public Service for their financial support of this research project. They do not necessarily endorse the findings and proposals contained in this paper.
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[1] Many, but not all, of these tanks contained gasoline and diesel fuel stored at retail locations.

0921-8009/$ - see front matter 
doi:10.1016/j.ecolecon.2006.03.012

more than 40,000 people died in traffic accidents and 3.1 million received injuries (Parry, 2004: 346).[2] Road congestion led to 3.7 billion hours of travel delay in 85 metropolitan areas during 2003 alone (Schrank and Lomax, 2005: 1).

During their operation, motor vehicles also emit a wide variety of combustion products into the atmosphere. Several of these emissions contribute to health problems at the local and regional scale. McCubbin and Delucchi (1999), for example, find that vehicles are a primary source of small suspended particles and that particulate matter contributes to asthma attacks and other respiratory problems. Neidell (2004) reports that as much as 90% of carbon monoxide in California cities comes from vehicle tailpipes and that this air pollutant apparently elevates the hospitalization rate of young children.

In the presence of heat and sunlight, two types of auto emissions contribute to the formation of ground-level ozone. Hubbell et al. (2005) estimate that if all locations in the U.S. were to comply with the EPA 8-h standard for ozone exposure, there would be 800 fewer premature deaths, 4 thousand fewer hospital admissions and 900 thousand fewer school absences per year.

Another category of external cost associated with vehicle emissions is reduced atmospheric visibility. Although sulfates discharged from power plants and industrial plants are a major source of haziness during summer months, nitrous emissions from autos also play a substantial role (US EPA, 2005).[3] Survey research by Crocker and Shogren (1991) revealed that visitors to a Cascades wilderness site were willing to pay for improvements in visibility. In a more recent study of house prices in four California counties, Beron, Murdoch and Thayer (2001) found that, after controlling for ozone and suspended particle concentrations, a one-mile improvement in mean visibility was associated with a 3% to 8% increase in sales price. Visibility is an environmental amenity that people value and are willing to pay for.

Still another external cost of vehicle emissions is damage to forests, agricultural crops and other forms of plant life. Murphy et al. (1999) have estimated that eliminating ozone precursor emissions from vehicle tailpipes would have increased U.S. agricultural output by 3.5 to 6.1 billion dollars in 1990.

These and other empirical studies suggest that there are significant external costs at the regional and local scales associated with the use and storage of motor vehicles. Two surveys of empirical estimates suggest that these external costs could total as much as 66 cents per vehicle mile (Harrington and McConnell, 2003: 23).[4] This implies that the external costs of motor vehicle transport could be substantially higher, at the margin, than the private costs incurred by the operators of those vehicles.

## 2. Crafting an appropriate policy response

This difference between the private and social costs of motor vehicle transport points to a major misallocation of resources within the U.S. economy. What is to be done? The theory of optimal taxation points to a variety of specific levies, each intended to reduce the external costs associated with a particular dimension of motor vehicle use. Road congestion, for example, could be tackled by a road use fee tailored to the time of day on a particular roadway (Mills, 1998: 77).[5] Traffic accidents could be reduced by a vehicle mileage fee tailored to driver age and vehicle characteristics (Parry, 2004: 350). Air pollution resulting from tailpipe emissions could be abated by spatially differentiated emissions charges (Tietenberg, 1994: 58–70). Although theoretically attractive, proposals such as these are unlikely to result in adoption of a set of optimal taxes on vehicle-related externalities. Political opposition to new tax instruments, heavy information requirements and high administrative costs pose serious obstacles to implementation of optimal levies on the various externalities associated with motor vehicle use and storage.

The second-best, but politically feasible, alternative would be to reform and increase the existing excise tax on retail purchases of motor fuels. In a study of California, for example, Fullerton and West (2003: x) have found that using the gas tax to reduce vehicle emissions could achieve 62% of the maximum gain in social welfare via an emissions charge. Grabowski and Morrisey (2004: 588) report that the long-run elasticity of traffic fatalities with respect to the real price of gasoline is −0.34. This finding supports the comment of Parry (2002: 30) that the gas tax is the "next-best response for curbing…accidents." Mills (1998: 79) argues that road use tolls are the preferred policy tool to control highway and street congestion but that "[a]s a practical matter, there is much to be said for fuel taxes. They are by far the cheapest taxes to collect…[and] are almost impossible to evade.…' Finally, Brueckner (2001: 77) has stated that a higher gas tax could be "a practical means of remedying … sprawl."[6] If raising a single tax has the potential to reduce air pollution, highway fatalities, traffic jams and metropolitan sprawl, then this fiscal policy deserves serious consideration.

Although an increase in federal excise taxes on gasoline and diesel fuel should be considered, this paper argues that a state or regional approach to motor fuel taxation is warranted in the United States.[7] One reason is that the U.S. Congress shows little inclination to raise taxes of any sort.[8] Another

[2] Not all of the costs of highway accidents are borne by parties other than the vehicle operator, however. Parry (2004) estimates that the accident costs imposed on other parties total 56 to 163 billion dollars per annum.

[3] The Region 1 office of US EPA reports that 56% of the nitrous oxides discharged during 2002 in New England came from motor vehicle tailpipes.

[4] This estimate is the sum of the high estimates for each category of external cost in Harrington and McConnell (2003, Table 3), excluding the (suspiciously low) estimated costs of global climate change.

[5] A simple version of this theoretical proposal was adopted in central London in 2003.

[6] McGibany (2004) provides some empirical evidence that heavier state taxation of gasoline is associated with more densely populated urban areas. The econometric technique employed, however, does not allow the author to distinguish between cause and effect.

[7] Although the following arguments focus on the United States, one could make similar arguments for Canada, Brazil, Germany,

[8] The federal tax on gasoline was last increased in 1994, when its nominal rate reached 18.4 cents per gallon. During the next decade, the inflation-adjusted tax rate fell by 21.6%. This decline in the real value of the federal tax rate means that national policy today provides weaker protection from detrimental externalities associated with motor vehicle operation than a decade ago.

reason is that federal policy to restrain automotive energy use has focused since 1975 on fuel-efficiency, or CAFE, standards for newly manufactured vehicles, not on taxation of fuel use by the entire vehicle fleet.[9]

In addition to pointing out the limitations of federal policy in the United States, one can also make an affirmative case for higher motor fuel taxes at the state and regional level. Oates (1999: 1132), for example, has argued that there are "potential gains from experimentation with a variety of policies for addressing social and economic issues. And a federal system may offer some real opportunities for encouraging such experimentation and thereby promoting 'technical progress' in public policy." That is, successful experiments in some states can provide empirical evidence favoring future changes in both state and federal policy. According to Fisher and Costanza (2005), state and local governments representing a quarter of the U.S. population have already undertaken policies to reduce carbon emissions.

But are some regions within the United States better suited as sites for policy experiments than others? Regional diversity within the nation suggests that the answer is yes. As Lang and Dhavale (2005) have shown, 2/3 of the U.S. population now resides in ten megapolitan regions covering 1/5 of the nation's land area.[10] These regions have distinctive cultural features and physical environments, have coalesced around stretches of interstate highway and are distinguished by their signature industries. Table 1 provides some evidence that regions can vary substantially in population density, land cover, motor vehicle ownership and use, and energy production. Because of these and other interregional differences, Nicol (2003: 210) finds that the price and income elasticities of demand for gasoline also differ among U.S. regions. Hence, the economic impacts of higher fuel taxes could vary substantially across the nation's landscape.

This paper argues that the New England states, either individually or as a regional coalition, are prime candidates for higher motor fuel taxes. One reason is that refined oil products are an import into the region because New England neither produces nor refines petroleum. Hence, most of the revenues from retail fuel purchases flow to other states or regions of the world.[11] A second reason is that southern New England is a highly urban region and offers commuters relatively good public transit service.[12] This suggests that the price elasticity of demand for gasoline is higher in parts of New England than the national average. Hence, a gas tax hike would likely induce a relatively large amount of energy conservation, even in the short run.

**Table 1 – Regional differences in the United States**

| | Texas | New England |
|---|---|---|
| Population, 2004, millions | 22.49 | 14.24 |
| Land area, 2000, thousands sq. miles | 261.80 | 62.81 |
| Percent land area Forested, 1997 | 6.5 | 76.6 |
| Motor vehicles, 2003, millions | 14.89 | 11.96 |
| Highway fuel use, 2003, billions gallons | 14.39 | 7.98 |
| Vehicle miles traveled, 2003, billions | 223.42 | 129.91 |
| Percent VMT in urban areas, 2003 | 64.7 | 73.8 |
| Crude oil output, 2004, millions barrels per day | 1.07 | 0 |
| Oil refining capacity, 2005, millions barrels per day | 4.63 | 0 |

Sources: "State Data," "Summary Report 1997 National Resources Inventory" and "State and County Quick Facts."

Still another reason is that the New England states, with the exception of Maine, have relatively high per capita incomes (Aghdasi et al., 2005). Despite their relative affluence, these states have been experiencing slow population growth, with the exception of New Hampshire. As Partridge and Rickman (2003:33) have observed, this could reflect some combination of "congestion, environmental, or weather-related disamenities."[13] Because county-level rates of employment growth are positively associated with environmental quality (Pagoulatos et al., 2004), reducing the external costs of motor vehicle transportation could help New England to attract and retain skilled employees who could easily locate in other regions (Partridge and Rickman, 2003:35). A final reason for considering New England is that the region's governors have already stated that they seek "to reduce … [greenhouse gas] emissions … [and] to implement actions that result in higher efficiency in the transportation of passengers and goods" (NEG/ECP, 2001: 5).

Of course, a major political obstacle to higher motor fuel taxation is the widespread perception that the gas tax imposes a regressive burden on the commuting public. There is substance to this fear but, as Chernick and Reschovsky (1997) have noted, the use of annual household incomes instead of multi-year average incomes to measure tax incidence tends to exaggerate the regressive effects of gasoline taxation. In addition, as West (2005) has pointed out, regressivity is dampened by lower vehicle ownership rates among poor households. At the same time, however, a larger portion of the gas tax is shifted to motorists in less populous states like Vermont and Maine, thereby increasing its regressive tendencies in those jurisdictions (Chouinard and Perloff, 2004).

However regressive the gas tax might tend to be, those tendencies can be erased by a simple feature of tax policy design: As a higher gas tax rate is introduced in a state, *the incremental revenues from that tax hike could be rebated in equal shares to its*

[9] A number of researchers have concluded that the gas tax is superior to fuel-efficiency standards as a tool of public policy. See, for example, CBO (2003) and West and Williams (2005).

[10] For example, the most populous of these regions is the Northeast, ranging from southern Maine to eastern Virginia. It encompasses major metropolitan areas such as Boston, New York, Philadelphia, Baltimore and Washington.

[11] Iledare and Olatubi (2004) note that higher petroleum prices tend to lower unemployment rates and raise both personal incomes and state tax revenues in Alabama, Louisiana and Texas. The same cannot be said of New England.

[12] Connecticut, for example, has an extensive network of intercity rail and bus routes. The public transit authority in the Boston area serves 175 cities and towns and provides almost 800,000 one-way trips per day.

[13] During 2003, the per capita travel delay because of road congestion was 51 h in Boston, 33 h in Providence and 32 h in Bridgeport–Stamford. From 1982 to 2003, those traffic delays per person increased by 37, 28 and 27 h per year, respectively (Schrank and Lomax, 2005: Tables 1 and 4).

*registered vehicle owners*. This idea is hardly new: Shepard (1976) and President Gerald Ford (1975: 33) advanced similar plans during the first oil price shock thirty years ago. West and Williams (2004: 551) find that a one-dollar increase in the federal gas tax combined with a lump-sum transfer of the extra revenues to households would have a decidedly progressive incidence.

## 3. Motor fuel taxation and regional development

Could it be that an oil-importing region of a national economy, New England for example, would gain economically from a gas tax hike combined with a rebate provision? There are a number of theoretical reasons for answering in the affirmative. In the first place, households are geographically mobile within the United States and make residential location choices based upon regional differences in labor market opportunities, state and local tax and public expenditure policies, and environmental amenities. As McGranahan (1999) has shown, nonmetropolitan counties with better climates, water access and variable topographies have enjoyed rapid population growth during recent decades. Unfortunately, state and local policymakers are unable to alter those characteristics of their regions. However, Bayer, Keohane and Timmins (2005) have documented that metropolitan areas in the U.S. with lower air pollution levels tended to enjoy a net flow of migrants from 1990 to 2000. Hence, if a region were to improve its relative environmental quality by restraining its motor fuel consumption, it could expect a positive impact on labor supply growth, especially for more educated labor, after a time lag.

Another economic development argument for increasing motor fuel taxes within an importing region is that a reduction in automotive emissions could help to prevent tighter federal regulations on factories, power plants and other stationary emitters of ozone precursors. In June 2004, the U.S. Environmental Protection Agency designated all of Connecticut, Massachusetts and Rhode Island and parts of New Hampshire and Maine as nonattainment areas under its 1997 eight-hour ozone standard. The Region 1 EPA office estimates that 56% of nitrous oxide and 27.4% of the volatile organic compound emissions in 2002, both precursors to atmospheric ozone formation, came from vehicle tailpipes. However, the mobile source control strategies required by the 1990 Clean Air Act amendment are likely to have had a negligible impact on vehicle use and fuel efficiency.[14] Hence, as regional fuel consumption grows, the political pressure builds to tighten federal emissions standards on stationary sources, thereby threatening a region's future industrial competitiveness in national and global markets (Heninger and Shah, 1998). A higher motor fuel tax at the state or regional level could help to reduce that risk associated with federal environmental policy.

**Table 2 – Economic development impacts of gas tax hike-and-rebate plan for region importing motor fuels**

| | Short run | Long run |
|---|---|---|
| Reallocation of household spending to regionally produced goods and services | + | ++ |
| Labor supply growth induced by regional amenity improvements | | + |
| Avoidance of stricter stationary-source emissions regulations within the region | | + |
| Higher fuel prices for vehicle-dependent businesses within the region | −− | − |
| Lower import price for motor fuels and reduced vulnerability to global price shocks | + | + |

**Table 3 – Retail price changes in 2003 after gas tax hike (cents per gallon)**

| CT | ME | MA | NH | RI | VT | All six states |
|---|---|---|---|---|---|---|
| 47.5 | 48.5 | 47.5 | 49.5 | 47.5 | 48.5 | 45.0 |

For oil-importing jurisdictions, higher taxation of motor fuels can have another competitive benefit for the regional economy. As Chouinard and Perloff (2004) have reported, higher fuel taxes are usually shared by motorists, on the one hand, and retailers, refiners and crude oil producers, on the other hand. They estimate that less than half of a federal tax hike is borne by the retail customer because market supply is less than perfectly elastic. In California, only three-quarters of a state tax hike can be shifted to motorists by station owners. Admittedly, a tax hike by a small state like Vermont is likely to be fully shifted to vehicle operators. However, if several New England states were to raise their fuel taxes simultaneously, they could function as a buying cartel and thereby lower the import price of refined oil products shipped into the region.[15] Lowering both the import price and quantity consumed of motor fuels would improve the region's trade balance with the rest of the world and also reduce its vulnerability to the growing volatility of gasoline prices in the U.S. market (Akarca and Andrianacos, 1998).

Because the price elasticity of demand for motor fuels increases with time, that improvement in the trade balance of an importing region would tend to grow, the longer that a gas tax hike is in effect. Some producers within the region would enjoy higher sales as households reallocated a portion of their after-tax-and-rebate incomes from imported motor fuels to products of the region. Admittedly, higher retail pump prices would tend to increase operating costs for vehicle-dependent businesses within the region, but those cost increases would tend to abate as enterprises invested in fuel-efficient vehicles and eliminated low-value trips from their travel schedules.[16] As summarized in

[14] These strategies include mandating intensified vehicle inspection programs, enhanced gasoline vapor recovery at retail outlets, and the use of reformulated gasoline within the nonattainment region. For more details, see www.epa.gov/region1/airquality/index.html.

[15] Liski and Tahvonen (2004) have made the theoretical argument that an international coalition of oil-consuming nations could lower the import price that they pay to oil-exporting nations by introducing a tax on carbon emissions in a coordinated fashion. A coalition of oil-importing states could pursue a similar strategy, albeit with more modest results.

[16] Opposition of vehicle-dependent business owners (taxi operators, parcel delivery firms, etc.) could be reduced if the gas tax increase were phased in over several years and if the first rebate checks to vehicle owners were mailed before the first phase of the tax increase. This form of financial assistance to vehicle owners would require some short-term borrowing by participating state governments.

Table 2, the theoretical case is strong, although not conclusive, that the economy of an importing region would benefit from a gas tax hike-and-rebate policy.

## 4. Policy simulations for New England

In an effort to learn whether a gas tax hike-and-rebate plan could have favorable economic impacts on an oil-importing state or region, I have performed a number of tax policy simulations using a regional econometric model of the six New England states. REMI Policy Insight is a proprietary model that combines a regional input–output table with econometrically estimated investment, migration and other behavioral equations. Although similar in structure to computable general equilibrium models, the REMI forecasting and simulation model incorporates various stock-adjustment time lags and does not require product and factor markets to clear continuously.[17]

Using the empirical assumptions detailed in the Appendix to this paper, I have simulated the economic impacts of enacting a permanent excise tax increase of 50 cents per gallons during 2003 in each of the six New England states individually or by all six states simultaneously. Once enacted, the nominal tax rate is assumed to increase in later years so that the real tax hike is preserved.

After taking into account differences in supply and demand elasticities among the states of the region, I have calculated the probable increases in retail pump prices following the tax hike. Table 3 reports the rough magnitudes of those retail price adjustments.

Using the short-run price elasticities reported in Appendix Table 1A, these retail price hikes allow one to forecast the immediate decline in gasoline consumption in each jurisdiction following the enactment of a stiffer tax on motor fuel purchases. In the case of Connecticut, for example, a 50-cent per gallon tax hike in 2003 would have increased the average pump price by 47.5 cents per gallon, or by 24.7%. A retail price hike of that magnitude would have lowered quantity demanded by 7.9% in 2003, an amount equal to 136.5 million gallons. After accounting for a loss of state tax revenue resulting from fewer gallons sold, one finds that the net gain in Connecticut tax revenue following a 50-cent tax hike would have been $761.3 million.[18] By assumption, this net revenue gain would have been distributed in equal shares to the owners of more than 2.9 million registered motor vehicles. Tables 4 and 5 summarize these calculations for each of the states in New England.

The differences among the six states in projected rebates per vehicle are quite striking, ranging from $245 in Rhode Island to $414 in Maine. One can explain these potential differences by recognizing two facts about the states of northern New England: (1) they have lower population densities and hence the typical vehicle trip covers more miles; and (2) they attract significant numbers of out-of-state tourists who purchase motor fuels and who could generate rebate dollars for in-state vehicle owners.

**Table 4 – Short-run adjustments in motor fuel use after state tax hike (millions gallons per year)**

| CT | ME | MA | NH | RI | VT |
|---|---|---|---|---|---|
| −136.5 | −65.5 | −258.1 | −51.9 | −34.3 | −28.5 |

In addition to inducing energy conservation and generating tax revenue for transfer payments to vehicle owners, a state gas tax hike of 50 cents per gallon could generate substantial amenity benefits for the residents of the region. Utilizing conservative assumptions about the magnitude of those benefits,[19] I arrive at the estimates summarized in Table 6.

## 5. Projected regional impacts of gas tax reform

Imagine that a single state government in New England had implemented a 50 cent per gallon gas tax hike in 2003 and rebated the net increase in tax revenues to that state's vehicle owners. As reported in Table 7, my tax policy simulations project that every state in New England would have enjoyed a boost to both employment and per capita income in the years after the change in state tax policy. Over time, the positive employment effect would have strengthened but, with the exception of Massachusetts, the impact on per capita income would have weakened. Partial dissipation of the immediate income gain is understandable because early gains in employment and amenity benefits would have attracted more immigrants to the state, some of whom would have augmented labor supply and restrained earnings growth.

Note that the magnitude of the projected employment and income gains would have varied substantially among the New England states. Connecticut could have expected the most modest stimulus to its state economy, probably because of expenditure leakages to its western neighbor, New York. Maine and Vermont, on the other hand, could have expected significant boosts to employment and disposable incomes because of a transfer of purchasing power from nonresident tourists to resident vehicle owners.

What if the governments of the six New England states had agreed in 2003 to simultaneously raise their gas tax rates by 50 cents per gallon? As detailed in Table 8, all six states would have experienced greater boosts to employment (compared to the baseline forecast) than they could have enjoyed from a single-state tax hike. Because Connecticut would have received a small additional boost to employment from a regional tax hike, its incentive to join a regional coalition would have been weak. New Hampshire, on the other hand, would have enjoyed a substantially larger boost to employment if all of the New England states had joined a tax hike-and-rebate coalition. There are several reasons for the stronger employment impact of a multi-state tax reform: (1) Environmental quality

[17] For another use of the REMI model to generate regional tax simulations, see England (2003). For still other examples of REMI-based policy research, go to www.remi.com.

[18] To be specific, the net gain in Connecticut motor fuel revenue in 2003 would have been ($0.50 per gallon*1591.3 million gallons)−($0.2513 per gallon*136.5 million gallons)=$761.3 million.

[19] Those assumptions are detailed in the Appendix to this paper.

**Table 5 – Tax rebates to vehicle owners in 2003**

| | Total rebates (millions $) | Rebate per vehicle ($) |
|---|---|---|
| CT | 761.3 | 260.46 |
| ME | 427.7 | 414.39 |
| MA | 1,416.0 | 261.31 |
| NH | 358.0 | 317.51 |
| RI | 195.1 | 245.38 |
| VT | 185.0 | 366.19 |

and amenity benefits would increase in each state because of its own tax hike but by even more because of tax hikes in neighboring states; (2) There would be a smaller increase in retail motor fuel prices within each state if the region's states acted as a buying cartel, thereby exporting more of the additional tax burden to parties outside the region; and (3) A higher portion of the fiscal stimulus from import-substituting consumption choices would remain within the region as a whole.

Coordinated action by the six state governments would provide a very modest additional boost to per capita income in the short run. However, over the course of ten or twenty years, the income gains from coordinated adoption of a tax hike-and-rebate plan, although positive, would be somewhat lower than those from single-state adoption. The apparent reason is that more rapid job growth and environmental quality improvements would accelerate net migration to New England and thereby dampen growth of real wage rates.

## 6. Conclusions

In a recent interview, the chief economist of the International Energy Agency declared that heavy dependence on petroleum to operate an economy "is not a sustainable energy future" (Williams and Bahree, 2005). In a similar fashion, the International Climate Change Taskforce (2005, co-chaired by Senator Olympia Snowe) has bluntly stated, "Governments [should] remove barriers to and increase investment in renewable energy and energy efficient technologies and practices through such measures as the phase-out of fossil fuel subsidies…."

Although national governments certainly need to take coordinated action to reduce the carbon-intensity of the global economy, governments at the state and regional scale should not hesitate to take action, especially if their economies are heavy net importers of petroleum products.

**Table 6 – Amenity benefits in 2003 resulting from tax hike (millions $)**

| | Internal to state | Spillovers to other states |
|---|---|---|
| CT | 116.1 | 13.6 |
| ME | 55.7 | – |
| MA | 219.4 | 25.8 |
| NH | 44.2 | 2.6 |
| RI | 29.2 | – |
| VT | 24.2 | 1.4 |

**Table 7 – Projected impacts of single-state motor fuel tax reform in 2003 (percent difference from baseline forecast)**

| | CT | MA | ME | NH | RI | VT |
|---|---|---|---|---|---|---|
| *Employment* | | | | | | |
| 2005 | .08 | .11 | .47 | .19 | .13 | .28 |
| 2015 | .08 | .12 | .46 | .22 | .14 | .28 |
| 2025 | .12 | .15 | .56 | .29 | .17 | .35 |
| *Real disposable income per capita* | | | | | | |
| 2005 | .10 | .13 | .74 | .31 | .16 | .55 |
| 2015 | .09 | .13 | .44 | .21 | .13 | .34 |
| 2025 | .08 | .13 | .44 | .18 | .13 | .34 |

This paper has argued that regional economies like that of New England could enjoy environmental quality improvements, faster job growth and higher real incomes if state governments enacted higher taxes on motor fuels and rebated the incremental tax revenues to motor vehicle owners within their jurisdictions.

## Appendix A. Simulation Assumptions

Any policy simulation embodies empirical assumptions of various kinds. In this Appendix, I describe several assumptions used to generate the policy impact forecasts reported in the body of this paper. The short-run and long-run price elasticities of demand for motor fuels used to predict the amounts of energy conservation induced by higher pump prices are summarized in the Table 1A.

Table 1A–price elasticities of demand for motor fuels

| | Short run | Long run |
|---|---|---|
| Connecticut | 0.32 | 0.8 |
| Maine | 0.27 | 0.7 |
| Massachusetts | 0.32 | 0.8 |
| New Hampshire | 0.25 | 0.7 |
| Rhode Island | 0.32 | 0.8 |
| Vermont | 0.27 | 0.7 |

These elasticities are based upon surveys of econometric research found in Nicol (2005) and Crawford and Smith (1995). U.S. averages are then adjusted informally for population

**Table 8 – Projected impacts of coordinated adoption of fuel tax reform by six New England states in 2003 (percent difference from baseline forecast)**

| | CT | MA | ME | NH | RI | VT |
|---|---|---|---|---|---|---|
| *Employment* | | | | | | |
| 2005 | .10 | .16 | .50 | .27 | .18 | .32 |
| 2015 | .10 | .17 | .49 | .33 | .23 | .29 |
| 2025 | .14 | .22 | .67 | .44 | .29 | .40 |
| *Real disposable income per capita* | | | | | | |
| 2005 | .12 | .16 | .74 | .34 | .17 | .58 |
| 2015 | .10 | .12 | .33 | .14 | .09 | .33 |
| 2025 | .10 | .12 | .34 | .10 | .08 | .34 |

densities and availability of public transit in the New England states. Short-run elasticities are assumed to increase exponentially to the long-run value after a decade.

Following the findings of Storchmann (2005), it is assumed that the income elasticity of demand for motor fuels is unitary in each New England state. This assumption is used to calculate the expected increase in fuel consumption and the associated increase in total transfer payments to vehicle owners as economic growth occurs.

In order to simulate the economic impacts of a gas tax hike, one needs to make assumptions about what portion of the tax increase is shifted to motorists and what portion is shouldered by retailers within the state and by outside oil producers and refiners. This study assumes that the retail markup per gallon remains unchanged after the tax hike and equals 10.37 cents per gallon (1996 $). Following Chouinard and Perloff (2004), I assume that the proportion of the tax increase borne by oil producers, refiners and other firms outside a state or broader region increases with the region's share of national gasoline consumption and with the its price elasticity of demand, as summarized in Table 2A. Note that the immediate cut in import price is assumed to be larger if a coalition of states enacts the 50 cents per gallon tax hike simultaneously.

Table 2A–short-run change in import price at regional boundary (2003 cents per gallon)

| CT | ME | MA | NH | RI | VT | All New England |
|---|---|---|---|---|---|---|
| −2.5 | −1.5 | −2.5 | −0.5 | −2.5 | −1.5 | −4.5 |

Because of rising price elasticity of demand, the cut in import price is assumed to reach six cents per gallon after a decade in the southern New England states and 5.25 cents per gallon in the northern states of the region.

According to Parry (2002), the average externality from the air pollution, traffic congestion and highway accidents associated with motor fuel use is approximately $1.70 per gallon in the U.S. I make the conservative assumption that the amenity benefit per gallon conserved is equal to half that amount (85 cents per gallon) in the taxing jurisdiction. A spillover benefit of 5 cents per gallon in downwind states, if any, is also assumed. That is, a gas tax hike in Connecticut is assumed to generate modest amenity benefits for residents of Massachusetts and Rhode Island. A tax hike in Maine, on the other hand, is assumed to benefit only the residents of that state.

Finally, I assume that there is no net increase in production costs in Connecticut, Massachusetts, New Hampshire, and Rhode Island following the imposition of a higher motor fuel excise. The reason is that the calculated rebates to the owners of business vehicles are at least as large as the estimated incremental expense of fueling those vehicles. Only in Maine and Vermont are the rebates insufficient to compensate business owners for higher pump prices. Hence, I assume that the net change in production costs would have been $30.3 million in Maine and $10.3 million in Vermont in 2003. In those two states, the extra production costs are allocated equally among the forestry, public utility, construction, manufacturing and transport industries.

The REMI Policy Insight model forecast public policy impacts by comparing the trajectory of a regional economy after a hypothetical change in public policy to a standard forecast of that region's trajectory in the absence of a public policy change. Five policy variables provided entry points into the REMI model for the purpose of simulating a gas tax hike-and-rebate plan: consumer price (share), exogenous final demand (retail trade, amount), transfer payments (amount), amenity value (amount), and production cost (amount). All amounts were adjusted to the price level of 1996.

In each state or region, an estimate of the percentage change in retail pump price in 2003 following a 50 cent per gallon excise tax hike was calculated. This percentage change in retail price was then allowed to decline over a decade as the price elasticity of demand increased to its long-run value. Exogenous final demand (1996 $ amount) was used to account for the loss of gross revenues of fuel retailers within a state or region because of a reduction in gallons sold. This revenue loss to the retail sector grows over the course of a decade because of the increase in price elasticity of fuel demand as vehicle owners discover and adopt methods to conserve motor fuels.

Transfer payments (amount) is used to account for the total rebates to owners of registered noncommercial vehicles within a state or region. The standard region control model forecast about growth of real disposable income plus an assumption of unitary income elasticity of demand for motor fuels are used to project the growth of total rebates after 2003. Amenity value (amount) is used to account for the net immigration of households and workers to the state or region because of environmental quality and other amenity improvements resulting from the tax policy change. Finally, production cost (amount) is used to account for the net increase in business costs in Maine and Vermont because rebates to commercial vehicle owners are insufficient to offset higher fuel costs associated with the operation of those vehicles for business purposes.



## REFERENCES

Aghdasi, Eamon, DeCoff, Tom, Gerew, Nelson, Hershbein, Brad, Mergo, Teferi, Turner, Nick, 2005. The economic performance of the New England states in 2004: an overview. New England Economic Indicators i–xiv (April–May).

Akarca, Ali T., Andrianacos, Dimitri, 1998. The relationship between crude oil and gasoline prices. International Advances in Economic Research 4 (3), 282–288 (August).

Bayer, Patrick, Keohane, Nathaniel, Timmins, Christopher, 2005. Migration and Hedonic Valuation: the Case of Air Quality. Duke University Department of Economics (working paper).

Beron, Kurt, Murdoch, James, Thayer, Mark, 2001. The benefits of visibility improvement: new evidence from the Los Angeles metropolitan area. Journal of Real Estate Finance and Economics 22 (2/3), 319–337 (March–May).

Brueckner, Jan K., 2001. Urban sprawl: lessons from urban economics. Brookings-Wharton Papers on Urban Affairs, pp. 65–97.

Chernick, Howard, Reschovsky, Andrew, 1997. Who pays the gasoline tax? National Tax Journal 50 (2), 233–259 (June).

Chouinard, Hayley, Perloff, Jeffrey M., 2004. Incidence of federal and state gasoline taxes. Economic Letters 83 (1), 55–60 (April).

Congressional Budget Office, 2003. The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax (December).

Crawford, Ian, Smith, Stephen, 1995. Fiscal instruments for air pollution abatement in road transport. Journal of Transport Economics and Policy 29 (1), 33–51 (January).

Crocker, Thomas D., Shogren, Jason F., 1991. Ex ante valuation of atmospheric visibility. Applied Economics 23 (1), 143–151.
England, Richard W., 2003. State and local impacts of a revenue-neutral shift from a uniform to a land value tax: results of a simulation study. Land Economics 79 (1), 38–43 (February).
Federal Highway Administration, 2003. Highway Statistics. U.S. Department of Transportation, Washington DC.
Fisher, Brendan, Costanza, Robert, 2005. Regional commitment to reducing emissions. Nature 438, 301–302 (November 17).
Ford, Gerald, 1975. Public Papers of the Presidents of the United States: Book I — January 1 to July 17, 1975. U.S. Government Printing Office, Washington, DC.
Fullerton, Don, West, Sarah, 2003. Public Finance Solutions to Vehicle Emissions Problems in California(December). http://www.bepress.com/fullertonwest.
Grabowski, David C., Morrisey, Michael A., 2004. Gasoline prices and motor vehicle fatalities. Journal of Policy Analysis and Management 23 (3), 575–593 (Summer).
Harrington, Winston, McConnell, Virginia, 2003. Motor vehicles and the environment. Resources for the Future Report (April).
Heninger, Brian T., Shah, Farhed A., 1998. Control of stationary and mobile source air pollution: reducing emissions of hydrocarbons for ozone abatement in Connecticut. Land Economics 74 (4), 497–513 (November).
Hubbell, Bryan J., Hallberg, Aaron, McCubbin, Donald R., Post, Ellen, 2005. Health-related benefits of attaining the 8-hr ozone standard. Environmental Health Perspectives 113 (1), 73–82 (January).
Iledare, Omowumi, Olatubi, Williams O., 2004. The impact of changes in crude oil prices and offshore oil production on the economic performance of U.S. Coastal Gulf States. The Energy Journal 25 (2), 97–113.
International Climate Change Taskforce, 2005. Meeting the Climate Challenge: Recommendations of the International Climate Change Taskforce (January).
Lang, Robert E., Dhavale, Dawn, 2005. America's megapolitan areas. Land Lines 17 (3), 1–4 (July).
Liski, Matti, Tahvonen, Olli, 2004. Can carbon tax eat OPEC's rents? Journal of Environmental Economics and Management 47 (1), 1–12 (January).
McCubbin, Donald R., Delucchi, Mark A., 1999. The health costs of motor-vehicle-related air pollution. Journal of Transport Economics and Policy 33 (3), 253–286 (September).
McGibany, James M., 2004. Gasoline prices, state gasoline excise taxes, and the size of urban areas. Journal of Applied Business Research 20 (1), 33–41 (Winter).
McGranahan, David A., 1999. Natural amenities drive rural population growth. Agricultural Economic Report, vol. 781. U.S. Department of Agriculture Economic Research Service (September).
Mills, Edwin S., 1998. Excess commuting in U.S. metropolitan areas. In: Lars, Lundqvist, Lars-Goran, Mattsson, Kim, Tschangho John (Eds.), Network Infrastructure and the Urban Environment. Springer-Verlag, Berlin, pp. 72–83.
Murphy, J.J., Delucchi, M.A., McCubbin, D.R., Kim, H.J., 1999. The cost of crop damage caused by ozone air pollution from motor vehicles. Journal of Environmental Management 55 (4), 273–289 (April).
Neidell, Matthew J., 2004. Air pollution, health, and socio-economic status: the effect of outdoor air quality on childhood asthma. Journal of Health Economics 23 (6), 1209–1236 (November).
NEG/ECP, 2001. Climate change action plan 2001. The Conference of New England Governors and Eastern Canadian Premiers (August).
Nicol, C.J., 2005. Elasticities of demand for gasoline in Canada and the United States. Energy Economics 25 (2), 201–214 (March).
Oates, Wallace E., 1999. An essay on fiscal federalism. Journal of Economic Literature 37 (3), 1120–1149 (September).
Pagoulatos, Angelos, Goetz, Stephan J., Debertin, David L., Johannson, Tulin, 2004. Interactions between economic growth and environmental quality in U.S. counties. Growth and Change 35 (1), 90–108 (Winter).
Parry, Ian W.H., 2002. Is gasoline undertaxed in the United States? Resources 148, 28–33 (Summer).
Parry, Ian W.H., 2004. Comparing alternative policies to reduce traffic accidents. Journal of Urban Economics 56 (2), 346–368 (September).
Partridge, Mark D., Rickman, Dan S., 2003. Do we know economic development when we see it? Review of Regional Studies 33 (1), 17–39.
Schrank, David, Lomax, Tim., 2005. *The 2005 Urban Mobility Report*. Texas A and M University System: Texas Transportation Institute.
Shepard, Lawrence, 1976. The short-run incidence of a gasoline tax rebate plan. Journal of Economic Issues 10 (1), 169–171 (March).
Storchmann, Karl, 2005. Long-run gasoline demand for passenger cars: the role of income distribution. Energy Economics 27 (1), 25–58 (January).
Tietenberg, Tom H., 1994. Economics and Environmental Policy. Edward Elgar, Aldershot, UK, pp. 58–70.
U.S. Environmental Protection Agency (US EPA), 2005. UST Program Facts. Office of Solid Waste and Emergency Response (June).
West, Sarah E., 2005. Equity implications of vehicle emissions taxes. Journal of Transport Economics and Policy 39 (1), 1–24 (January).
West, Sarah E., Williams III, Roberton C., 2004. Estimates from a consumer demand system: implications for the incidence of environmental taxes. Journal of Environmental Economics and Management 47 (3), 535–558 (May).
West, Sarah E., Williams III, Roberton C., 2005. The cost of reducing gasoline consumption. American Economic Review 95 (2) (May).
Williams, Selina, Bahree, Bhushan, 2005. IEA urges global changes in oil use. Wall Street Journal 8, A2 (November).