DISCUSSION PAPER

Should Fuel Taxes Be Scrapped in Favor of Per-Mile Charges?

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RESOURCES
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Abstract

This paper discusses the appropriate balance between traditional gasoline taxes and charging by the mile, focusing mainly on economic efficiency considerations. We begin with a brief discussion of the five major passenger vehicle externalities of concern—local pollution, greenhouse warming, oil dependency, traffic congestion, and traffic accidents—summarizing evidence on the dollar value of the externalities for passenger vehicles in the United States. We then discuss how much fuel taxation might be justified to account for these externalities, as well as how much taxation might be appropriate on fiscal grounds, assuming per-mile charges are unavailable. Finally, we discuss to what extent fuel taxation should be replaced with per-mile charges.

Key Words: gasoline tax, mileage tax, motor vehicle externalities, fiscal interactions

JEL Classification Numbers: H21, H23, R48

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Across industrial countries there is heightened concern about the social costs of automobile use. Most obvious in the daily life of the individual motorist is the wasted time and stress associated with relentlessly increasing traffic congestion in urban centers. Another issue, which was a key topic of debate at the 2005 meeting of the G8 industrial countries, is the looming threat of global warming; automobiles are a major contributor to greenhouse gas emissions and, unlike electricity generation, there is no low-emissions alternative to traditional fuels that is currently viable. And the escalation in world oil prices from $12 per barrel in early 1999 to well over $50 per barrel in mid-2005 has reignited fears about dependency on a volatile world oil market set to become ever more dominated by the Persian Gulf, where around 60% of the world's known oil reserves are located.

The major policy instrument used to penalize automobile use and encourage fuel conservation has been fuel taxes (supplemented with vehicle registration fees and, sometimes, fuel economy standards imposed on vehicle manufacturers). For practical purposes, however, fuel taxes appear to have reached their limits. In the United Kingdom, fuel tax protests in 2000 put paid to automatic, above-inflation increases in fuel tax rates. And in the United States, where federal and state fuel tax revenues have fallen by more than half in real terms since 1960, growing shortfalls in funds for transportation projects have recently led to a plethora of local referenda tying funding for specific projects to a variety of other revenue sources, such as sales and property taxes.

Moreover, increasing recognition of the limits of fuel taxes to deal with some of the adverse side effects of the automobile, particularly traffic congestion, has coincided with technological advances that for the first time have made feasible more sophisticated alternatives to the fuel tax. Using Global Positioning Systems (GPS), which are increasingly incorporated into new vehicles, or electronic debiting from smart cards, it is now possible, at very low cost, to charge motorists on a per-mile basis, according to the degree of congestion on the road at the time the driving occurs. Unlike fuel taxes, such finely tuned pricing offers the hope of a far better distribution of driving patterns across different roads at different times of day, by encouraging people to avoid driving at the rush hour peak, or to seek out less congested routes, and by avoiding penalizing driving on uncongested roads in rural areas or at off-peak hours.

In the United Kingdom, following the success of cordon pricing in alleviating congestion in London's central business district, the national government is considering scrapping fuel taxes altogether and replacing them with the first-ever nationwide system of per-mile charges for automobiles. In the United States, road pricing has been confined to a handful of single-lane freeway tolls (for example in California and Texas), though there is growing interest at the state and local levels. There is also interest in using new technology to charge automobile insurance on a per-mile basis rather than on a lump-sum basis.

This paper discusses the appropriate balance between traditional gasoline taxes and per-mile charging, mainly focusing on economic efficiency considerations. To set the scene, we provide a brief discussion of the five major passenger vehicle externalities of concern—local pollution, greenhouse warming, oil dependency, traffic congestion, and traffic accidents[1]— summarizing evidence on the dollar value of the externalities for gasoline-powered vehicles in the United States.[2] We then discuss how much fuel taxation might be justified to account for these externalities, as well as how much taxation might be appropriate on fiscal grounds, assuming per-mile charges are unavailable. Following that we discuss to what extent fuel taxation should be replaced with per-mile charging.

Passenger Vehicle Externalities

Local Air Pollution

Combustion of gasoline leads to emissions of nitrogen oxide and volatile organic compounds that through particulates and smog formation have effects on human mortality and morbidity, as well as impair visibility and harm local ecosystems. Obviously damages from emissions vary greatly across different regions, with local population exposure as well as geographic and climate conditions affecting the assimilation of emissions into the local atmosphere. And since damage estimates are dominated easily by mortality effects, they are sensitive to assumptions about the assumed value per extra fatality, which is contentious.[3] Nonetheless, from recent empirical literature for the United States, a reasonable central estimate

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[1] An externality occurs when an individual's behavior imposes a cost on society that the individual does not take into account. For example, individuals do not take into account the added congestion or pollution resulting from their own driving, as these costs are borne by others rather than being a private cost. Economists advocate the use of taxes or other regulatory measures to increase the cost of driving, fuel, or other products so that they fully reflect external costs. We do not discuss the road damage externality, that is, the wear and tear on the road network, as this is primarily caused by heavy-duty trucks rather than passenger vehicles.

[2] Gasoline vehicles account for 98% of the U.S. passenger vehicle fleet.

[3] Economists have elicited people's willingness to pay to reduce fatality risk from direct questionnaires and from studies that compare wages across occupations with different fatality rates, holding other factors constant. From these studies, the cost per additional fatality is measured at around $1.5–$8 million (€1.2–€6.6 million).

for the nationwide damages from local emissions might be around $0.02 per mile (e.g., U.S. Federal Highway Administration [FHWA] 2000) or $0.40 per gallon (€0.08 per liter), given that the (on-road) fuel economy of the current passenger vehicle fleet is about 20 miles per gallon.

Pollution damage estimates have fallen substantially over time with the tightening of emissions-per-mile standards on new vehicles, improved durability of pollution control equipment over the vehicle lifetime, and the retirement of the oldest, most polluting vehicles from the in-use fleet. Moreover, emissions-per-mile standards on new passenger vehicles will be tightened dramatically over the next few years. Thus, the problem of local pollution from automobiles is being solved steadily over time in the United States as manufacturers make technological improvements to new vehicles to satisfy progressively tighter emissions standards. Also over the next few years, emissions standards for light-duty trucks (minivans, sport utility vehicles, pickup trucks) will be brought into line with those for cars, so it will no longer be the case that light trucks produce significantly more local emissions per mile driven than cars.

Global Warming

Most conventional studies put the present value of damages to the market sectors of the world economy from future climate change induced by today's greenhouse gas emissions at below $50 per ton of carbon (e.g., Pearce 2003), which is equivalent to less than $0.12 per gallon (€0.03 per liter) of gasoline. These estimates are relatively modest because the bulk of future world gross domestic product (GDP) is not especially sensitive to the changes in climate predicted by scientific models in coming decades; the climate sensitive activities—agriculture, forestry, coastal activities, protection against sea level rise—are a small proportion of world GDP. Moreover, even though today's emissions may cause effects several decades or even centuries into the future[4], the use of discounting greatly reduces the present value of these effects in today's dollars.

However, these economic damage estimates for carbon emissions are highly speculative and contentious. Ecological (non-market) effects, such as species loss, are difficult to quantify. There is dispute over the appropriate discount rate to apply to effects of today's emissions that are very far into the future; some analysts argue for using a lower rate for such long-range effects than typically used in medium-term cost benefit analyses. Estimated damages are sensitive to different assumptions; for example, using a discount rate of 2% rather than 5% increases the present value of damages occurring 100 years from now by 18 times. But probably the most troublesome issue is how to account for the risk of abrupt, non-linear climate change that could have catastrophic consequences; one possibility is a reversal of the Gulf Stream that currently warms Europe. These non-linearities are not well understood and are usually excluded from economic assessments of damages from greenhouse gas emissions.

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[4] Emissions have atmospheric lifespans of around 100 years and due to very gradual heat diffusion processes in the oceans, it takes a long time for the climate system to adjust to its new equilibrium following a change in atmospheric forcing from today's emissions.

Oil Dependency

Economists have focused on two main costs of oil consumption that are not considered by individual energy consumers. The first arises from U.S. market power in the world oil market; that is, the ability of the country as a whole to affect world oil prices. Individual importers do not account for their effect on bidding up the world oil price (by an infinitesimal amount), thereby raising costs for all other domestic importers and enacting a transfer from domestic oil importers to foreign suppliers. This externality can be significant given the large volume of imports into the United States. Obligations under the World Trade Organization likely preclude any internalization of the externality through a direct tariff on oil imports; this means that it is legitimate to include it in computations of the most economically efficient tax on consumption of petroleum products.[5] Unfortunately, it is difficult to pin down accurately the world price effect of a given reduction in U.S. oil imports because it is unclear how OPEC and other oil-producing nations might respond. At one extreme, they may respond by attempting to sterilize the effect on world oil prices by cutting back their own production; conversely, they may have a very limited ability to respond.

The second external cost is macroeconomic disruption costs caused by various adjustment costs in response to energy price shocks that may not be fully taken into account by individuals, firms, and investors. These might include the costs of temporarily idled labor and capital as some industries contract in response to higher energy prices or the costs to firms of being stuck with an inherited capital stock that is too energy intensive at the higher energy price. Studies have attempted to quantify the risk of disruption costs using postulated scenarios for the risk of future oil price shocks, evidence on the GDP effects of price shocks, and assumptions about the extent to which private markets anticipate and are able to hedge against price risk.

Estimates of the combined market power and disruption components put the external cost of oil consumption (at the margin) at around $0 to $15 per barrel of oil (e.g., Leiby et al. 1997) or $0 to $0.36 per gallon (€0 to €0.08 per liter) of gasoline.

One caveat to these estimates is that along with most analysts we consider it inappropriate to account for U.S. Mid-East military spending in computations of the marginal

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[5] This depends on the reasonable assumption that changes in the domestic demand for oil would mainly be met, at the margin, by changes in imports, rather than changes in domestic production.

external cost of oil use.[6] Another caveat is that studies base scenarios for future price shocks on past experience. It is difficult to incorporate, for example, the risks of terrorist attacks on oil supply infrastructure or a political takeover in Saudi Arabia (the swing producer of oil) by extreme elements hostile to the West, events that could cause sharp increases in future world oil prices.

Traffic Congestion

To assess the benefits of fuel taxes from reduced traffic congestion requires an estimate of marginal congestion costs per mile averaged across daily driving at peak and off-peak periods and across driving in all urban and rural areas of the United States. The marginal congestion cost reflects the added delay to all other drivers resulting from the presence of one extra vehicle on the road; hours of delay are typically valued at around half the hourly market wage. One study that attempts such an estimate of averaged marginal congestion costs for the nation is U.S. FHWA (2000); their best assessment for passenger vehicles is $0.05 per mile.

However, this estimate needs to be adjusted because peak-period driving (which is dominated by people driving to and from work) is less responsive to higher fuel prices than driving at off-peak periods and on rural roads. This consideration reduces the congestion benefits from higher fuel taxes because a disproportionate amount of the reduced driving occurs on relatively free flowing rural or off-peak urban roads. Making this adjustment, the marginal congestion cost (for assessing fuel taxes) might be around $0.03–$0.04 per mile (Parry and Small 2005) or $0.60–$0.80 per gallon (€0.13–€0.17 per liter) at current average miles per gallon.

Traffic Accidents

There is some consensus among economists on how the total cost to society of traffic accidents can be measured, and estimates amount to several hundred billion dollars per year for the United States, where more than 40,000 people are killed on the roads annually and almost 3 million others are injured. However, it is much more difficult to assess the marginal external accident cost per mile, which is the cost borne by society as a whole from the elevated risk of accidents due to an extra mile of driving. The marginal external cost is needed to account for highway safety in assessments of the economically efficient fuel tax.

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[6] In principle, they would be included in a computation of the total (rather than marginal) external costs of U.S. oil dependency. However, analysts view military expenditures as a fixed cost that would not vary in response to a moderate fall in U.S. oil imports. Moreover, quantifying expenditures for the protection of oil supplies is difficult, because part of military spending in the Middle East is for other objectives (such as promoting peace and democracy in the region) rather than protecting oil supplies.

One tricky issue is sorting out what costs individuals might themselves take into account in deciding how much to drive versus other costs that they ignore. For example, they make take into account injury risks to themselves and other family members but not injury risks to pedestrians. More importantly, it is not clear how extra driving by one motorist affects the accident risk for other drivers adjusted by the average severity of crashes. All else being the same, extra driving by one individual will increase the likelihood that other drivers will crash, as there is less road space between vehicles. But drivers may compensate for higher traffic volumes by driving more slowly or more carefully; this compensating behavior will dampen the increased frequency of vehicle collisions, and slower driving speeds will cause a given accident to be less deadly. In principle, an extra vehicle on the road could increase, have no effect, or even decrease the severity-adjusted accident risk for other drivers.

Recent studies (e.g., U.S. FHWA 2000) have put the marginal external cost of traffic accidents at around $0.02 to $0.07 per mile, depending in part on whether a portion of injuries to other motorists in multi-vehicle crashes are included or excluded. These estimates reflect a variety of different costs, including property damages to automobiles, medical costs associated with injuries (borne by group insurance or taxpayers), travel delays due to accidents, and forgone market productivity from injuries; they also reflect economists' valuations of personal injury costs and fatality risks.

The Appropriate Fuel Tax to Address Automobile Externalities

If the only policy instrument available to the government is the gasoline tax, the economically efficient tax to address the range of passenger vehicle externalities described above is given by the following formula:[7]

{fuel-related externalities ($ per gallon): carbon emissions, oil dependency}

+

{mileage-related externalities ($ per mile): congestion, accidents, local pollution}

×

{miles per gallon}

×

{fraction of gasoline reduction due to reduced mileage}

There are three noteworthy points about the role of mileage-related external costs in the economically efficient fuel tax. First, and consistent with recent evidence, local pollution emissions are counted as an external cost that is proportional to vehicle miles driven, rather than proportional to fuel use (which depends on fuel economy as well as miles driven). This reflects the fact that emissions standards are defined in grams per mile (rather than grams per gallon);

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[7] See Parry and Small (2005). Their formula also incorporates fiscal considerations that are discussed below.

that standards are the same for all cars and all light trucks, so that a vehicle with relatively low miles per gallon does not pollute more per mile than other vehicles (within car and light-truck categories); and that state-of-the-art pollution control equipment is more durable over vehicle lifetimes. The second point is that miles per gallon, which converts external costs measured in cents per mile to cents per gallon, will rise with higher fuel taxes as people respond over time by purchasing smaller vehicles and manufacturers incorporate additional fuel saving technologies in new vehicles.

The third and most important point is that mileage-related externalities are scaled back by the fraction of the tax-induced reduction in gasoline that, at the margin, is due to reduced driving as opposed to long-run improvements in average fleet fuel economy. The smaller the portion due to reduced driving, the smaller will be the gain from reducing mileage-related externalities per gallon of fuel reduction. This consideration is important because evidence suggests that only around 40% of the fuel reduction over time will come from reduced driving; 60% of it will come from increased fuel economy (e.g., Parry and Small 2005).

Using the above formula and the range of values for external costs described above yields a tax on the order of $1 per gallon (€0.22 per liter) to address passenger vehicle externalities. This amounts to about 2.5 times the current U.S. tax rate of $0.40 per gallon (€0.09 per liter)[8] but less than one third of the current U.K. tax of $3.30 per gallon (£0.50 pence per liter), which is the highest among Organisation for Economic Co-operation and Development countries.

Fiscal Arguments for Fuel Taxes

To consider the fiscal arguments for gasoline taxes, we will focus on the economic distortion in the economy-wide labor market created by the tax system. In a competitive labor market (as in the United States), roughly speaking firms will employ labor up to where the value of the added output from the last worker equals the gross wage paid to that worker. And for those individuals who join the labor force, the benefits to them from working—the net of tax wage—should exceed the costs of working in terms of the value of time they could have spent in activities such as child-rearing or leisure pursuits, while the opposite applies for those who choose not to join the labor force. On average, federal income taxes, state income taxes, payroll taxes, and other taxes combine to drive a wedge of around 35%–40% between the gross wage paid by employees and the net of tax wage received by households; this wedge also reflects the difference between the economic benefit to society from additional labor supply and the economic cost. To maximize economic efficiency, labor should be supplied until the economic benefits from extra work effort equal the economic costs. Taxes depress labor supply below this efficient level though a variety of behavioral responses, such as discouraging overtime,

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[8] The federal tax is $0.18 per gallon, which was last changed in 1993, and state taxes average about $0.22 per gallon.

discouraging existing workers from taking a second job, encouraging earlier retirement, and discouraging the partner of a working spouse from also joining the labor force.

Gasoline taxes impinge upon tax-induced economic distortions in the labor market in two opposing ways (e.g., Goulder et al. 1997). First, they reduce the need to raise revenue from labor taxes in order to finance the government's budget. This means that labor taxes are lower than they would otherwise be and, consequently, their distortionary effect on labor supply is lower, implying a savings in economic efficiency costs. On the other hand, higher fuel taxes increase the costs of transportation and commuting to work; this discourages labor supply as the returns to work effort by households—the amount of goods they can purchase from their take-home pay—is reduced.

Available evidence suggests that up to a point there is a net economic gain from these two effects in the specific case of gasoline taxes (but not product taxes in general). This means that leaving aside externality arguments, some level of gasoline taxes would still be appropriate to finance the government's spending needs in conjunction with labor income taxes. A recent study by West and Williams (2004) that takes into account both externalities and the appropriate balance between gasoline taxes and labor taxes in financing the government's budget finds that the economically efficient gasoline tax is around $0.30 per gallon higher than the level justified on externality grounds alone.

The Balance Between Fuel Taxes and Per-Mile Charges

Adding fiscal considerations to the externality estimate cited above and leaving aside the dispute and uncertainty over the value of certain external costs, our best assessment implies an economically efficient gasoline tax for the United States on the order of $1.00–$1.50 per gallon (€0.22–€0.33 per liter). Suppose, naïvely, that there were no practical obstacles to raising U.S. gasoline taxes; should fuel taxes actually be raised to this level? Probably not.

Gasoline taxes are efficient at reducing oil use and carbon emissions, both of which vary in direct proportion to fuel consumption. But if we believe the economic assessments, the current tax of $0.40 per gallon covers most, and perhaps all, of the external costs from carbon emissions and oil dependency, which combined amount to about $0.10–$0.50 per gallon. And there are much better instruments for reducing the other externalities—congestion, accidents, and local emissions—that vary in proportion to miles driven rather than fuel use.

Consider first a simple charge per mile driven that is the same regardless of where the driving occurs or what time of day. This tax is much more efficient than a fuel tax at reducing the mileage-related externalities because all of the behavioral response to the policy comes from reducing mileage. Under a fuel tax, only around 40% of the behavioral response to the tax comes from reducing mileage; the majority of it comes from long-run improvements in fuel economy. Put another way, the per-mile tax is a less costly way to reduce driving because it avoids increases in fuel economy that have net economic costs once the carbon and oil dependency externalities have been taken into account in the level of fuel tax.

Calculations by Parry and Small (2005) for the United States suggest that the economically efficient tax on mileage (with no fuel tax) to account for externality and fiscal considerations would be $0.14 per mile, which is equivalent to $2.80 per gallon at the current level of fuel economy. That is, a much higher overall level of automobile taxation is warranted—almost as high as the current U.K. tax—if the tax is on mileage rather than fuel use.

But a policy far better than uniform mileage charges to reduce traffic congestion is peak-period pricing. This involves charging vehicles on a per-mile basis, with the charge rising and falling as the level of congestion on urban roads rises and falls with the morning and afternoon peaks. This pricing scheme encourages a spreading out of the rush hour peak as some people drive earlier, or later, than the peak to avoid paying the highest fee. And, unlike a uniform mileage tax, peak-period pricing does not penalize people for driving on uncongested roads in rural areas or at off-peak times of day.[9]

Unlike a congestion tax, the ideal policy to reduce traffic accidents would take driver characteristics into account. An example of such a policy is pay-as-you-drive (PAYD) automobile insurance. This involves replacing the current system of insurance premiums, which are essentially lump-sum payments that vary very little with mileage, with premiums that vary in direct proportion to annual miles driven, so that if an individual chooses to drive 20,000 miles per year rather than 10,000, he would pay twice as much insurance. By charging on a per-mile basis, PAYD would deter driving in the same way that a uniform mileage tax does. However, it is more effective in reducing traffic accidents because the per-mile charge would be scaled by the driver's rating factor, which insurance companies determine based on factors such as age, region, and past driving record. This means that the reduction in driving induced by the insurance reform would be concentrated disproportionately among drivers with the highest accident risks, as they face the greatest per mile charges.[10]

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[9] Fees could be collected electronically via debiting by overhead meters from pre-paid, in-vehicle credit cards as vehicles enter freeways. Alternatively, with on-board GPS systems individuals could be mailed a bill based on a record of where and when they have driven during the past month. In the latter case, stringent legal safeguards would be required to prevent misuse of information collected by government agencies on individuals' driving behavior.

[10] To some extent, we may see a market-driven transition to PAYD over the next decade or so given that technology for monitoring vehicle mileage is now available and that low-mileage drivers (who currently subsidize high-mileage drivers) have an incentive to opt for PAYD. Experiments with PAYD are emerging at the state level. For example, in Oregon insurance companies have been offered a state tax credit of $100 per motorist for the first 10,000 motorists who sign up for PAYD insurance plans.

PAYD would not fully address the problem of drunk driving, which accounts for around a third of U.S. highway deaths. A better policy would be to increase penalties for intoxicated driving, especially for repeat offenders, as well as raise detection rates.

Interestingly, PAYD may also be more politically feasible than a new mileage tax. This is because it does not impose a new tax burden on the motorist; instead the average motorist is compensated for the new per-mile charge by a reduction in current lump-sum insurance payments.

Conclusion

Fuel taxes should not be scrapped entirely in favor of mileage taxes. Some level of fuel taxation is appropriate to reflect the external costs of carbon emissions and oil dependency in the price of fuel. And fuel taxes provide ongoing incentives for the development and adoption of fuel saving technologies, as well as encouraging the purchase of hybrid and alternative fuel vehicles.

However, the case for substantially raising fuel taxes beyond the level warranted by carbon emissions and oil dependency externalities seems weak given that the technology is now available for far superior pricing policies to address the important mileage-related externalities—traffic congestion and accidents. It is encouraging that the U.K. government is considering a radical shift of automobile taxation away from fuel taxes to variable, per-mile charges.

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