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Reforming the Taxation of Vehicle Use and Ownership

An overview of papers presented at the CTS symposium 18-19 September 2014

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Abstract
In many economies, motor fuel taxes have long been the main instruments for generating tax revenues from the transport sector. Nowadays they are also rationalized on the grounds of reducing congestion, carbon emissions, local air pollution, energy dependency, and sometimes accident costs. However, for several reasons, there is now much debate about reforming or partially replacing these taxes. This debate raises several kinds of research questions, including efficient design of such tax instruments and what factors affect their design in reality, CTS organised an international symposium where recent research regarding these issues was presented. This report summarises some findings from the symposium.

Keywords: Fuel tax, vehicle tax, transport pricing.

JEL Codes: R41, R48.

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KTH VETENSKAP OCH KONST

1 INTRODUCTION

In many economies, motor fuel taxes have long been the main instruments for generating tax revenues from the transport sector. Nowadays they are also rationalized on the grounds of reducing congestion, carbon emissions, local air pollution, energy dependency, and sometimes accident costs. However, for several reasons, there is now much debate about reforming or partially replacing these taxes. First, motor fuel taxes are increasingly complemented by more targeted instruments, including fuel efficiency and emission standards, parking charges, and congestion pricing systems. Second, alternative fuels (biofuels, natural gas, electricity, etc.) are starting to replace gasoline and diesel and these new fuels are often left untaxed or even are subsidized. Third, annual vehicle and sales taxes are commonly differentiated according to the vehicles' environmental and safety qualities. Lastly, the need for fiscal consolidation after the crisis has heightened interest in additional revenue sources, not least in countries that have traditionally subsidized petroleum.

Many of these trends will continue and may accelerate in the future, eroding the principal revenue base (fossil fuels) of traditional transportation taxes, and affecting the discussion of how externalities (notably those related to congestion, climate, air pollution, accidents, and road wear and tear) and fiscal needs are best handled in the transport sector. In this context, a number of research questions arise:

1. How effectively do current fuel taxes contribute towards environmental, fiscal, distributional, and other objectives of concern to policymakers? What is the role of (differentiated) vehicle and sales taxes?
2. What are the drivers of change in tax policy in road transport? What makes countries introduce new pricing and regulatory instruments and prevents them from reforming fuel and vehicle taxes? Is this perhaps the result of tax competition between countries or different levels of government, or a reluctance to burden motorists more?
3. What might be a more effective or less costly mix of fiscal and regulatory policies to better achieve the same objectives? What are the major impediments to policy reform restructuring and how might they be overcome? Is there, for example, a role for earmarking transportation revenues? To what extent can, and should, road pricing schemes replace or complement fuel taxes at a local or national level, in both developed and developing countries?

The Centre for Transport Studies at KTH organized a symposium on 18-19 September 2014 in Stockholm where 18 papers on these topics were presented and discussed. This document provides an overview of these papers, with some context and discussion.

2 WHAT ARE IDEAL FUEL AND VEHICLE USE TAXES?

There is strong variation in motor fuel and vehicle tax rates around the world. A well-known example is the comparatively low level of fuel taxes in the US, where the gasoline tax is only one third of that in Europe. Neighboring countries with identical income levels can have very different vehicle taxes; compare, for example, purchase taxes in Denmark and Sweden. Danish vehicle purchase taxes can be more than 100% of the vehicle price but are zero in Sweden. There is also strong variation in the type of technologies that is promoted by the vehicle taxes: flexi-cars are supported in Sweden, electric cars are heavily promoted in Norway and the share of diesel in new car sales has varied between 20% in the Netherlands and 75% in Belgium, at least partly because of differences in tax treatment.

Economic theory suggests a few principles to qualify a fuel and vehicle tax system as optimal:

a) Fuels are priced at the full social cost: production cost plus externalities related to the use of the fuel itself.
b) Vehicles are sold at full social cost: production cost, including external costs associated to their production.
c) Externalities associated with the use of cars (rather than to fuel consumption), including external congestion costs, external accident costs, noise, etc. need to be priced.
d) The tax system should raise enough public revenues fairly (in accordance with equity principles that dominate in social and political choices) and with a minimum of distortions (i.e. a minimum of deviations from consumption and production choices that are based on marginal social costs).
e) Transaction costs of the tax system should be as low as possible.

There are (at least) three problems with applying the principles:

a) The principles are not shared or understood by all stakeholders.
b) There are definitional and measurement problems concerning the size of external costs and effects of policies on them. More generally, the information requirements for designing tax systems according to the listed principles are very high (and costly).
c) Implementing ideal or near ideal ownership, fuel and use taxes may be very costly.

Designing a satisfactory tax system is a matter of compromise (a second best instrument choice) that involves maximizing the desired effects and minimizing the undesired effects, in a context of incomplete information and differing views on the weight of different effects. Evaluating systems requires analysis based on coherent and evidence-based models of vehicle ownership, use and fuel choice.

2.1 Using the fuel tax to internalize externalities when it is the only instrument: A rule of thumb

Ian Parry (IMF) presented an overview of what fuel taxes should look like in different countries when they are the only instrument to internalize external costs of car transportation. He proposes to calculate the optimal fuel tax for each area as follows:

Fuel tax/liter =

+ carbon damage/liter

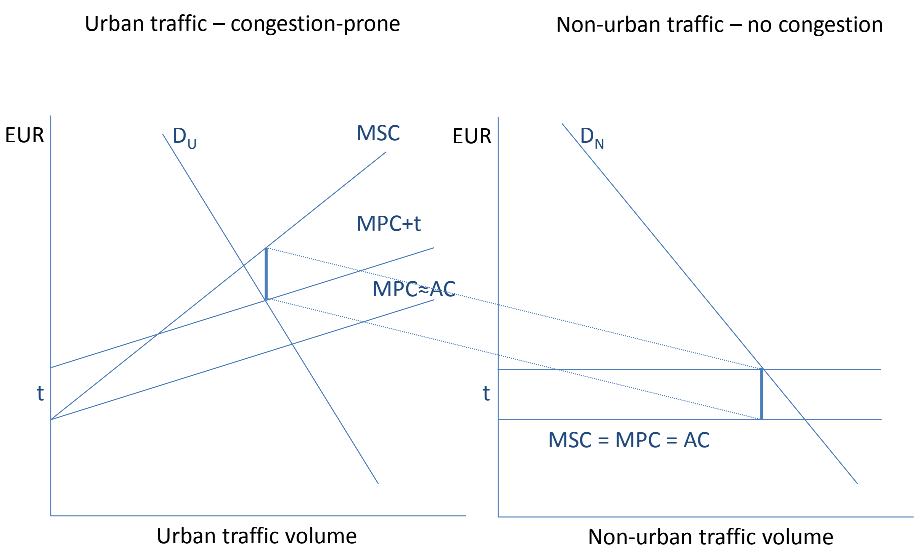
+ (marginal external congestion, accidents , air pollution costs per vehkm)(km/liter) γ

where γ = fraction of fuel reduction from reduced vehicle use

Estimates for each of these components are available but remain highly uncertain.

Carbon damage estimates vary from a few dollars per ton of CO_2 to 50 \$ or more. A value of 35\$/ton implies around 0.10 US cents/liter, or less than 1/5th of current fuel taxes in the EU. Remember that a new car will emit between 2 to 3 ton of CO_2 per year for a mileage of 10 to 15000 km/year. Important to mention is also that a cost efficient climate policy requires that the CO_2 tax or permit price is more or less the same in all sectors of the economy. The reason is that all sectors reduce emissions up to the point where the marginal abatement cost of the pollutant equals the CO_2 tax or permit price. While carbon damages do not depend on where they are emitted, the other external costs are strongly place and time specific. So if fuel taxes are used to curb them, balance must be struck between high fuel taxes in urban, congested areas and the country side. If available and not too costly, other pricing instruments should be used to handle the other external costs.

When congestion externalities are relatively high compared to other external costs, as is the case in many urban regions by most evidence, the formula above shows that we do not have enough instruments as the same tax has to regulate car use with very different levels of external costs. The following figure illustrates the factors determining the second-best fuel tax when it is used to internalize marginal congestion costs, and when the tax is uniform across a congestion-prone urban travel market and a non-urban market that for simplicity we assume to be not congestion-prone.



In the uncongested travel market, the marginal welfare loss of increasing the fuel tax is equal to the fuel tax. In the congested market, the tax increases welfare as long as it brings the user cost closer to the social cost, and the marginal welfare gain is the gap between the marginal social cost and the user price inclusive of tax. The second-best fuel tax is **t**, for which the marginal welfare gain in the congested market is equal to the marginal loss in the uncongested market. This second-best tax in general is different from the weighted average external congestion cost across both, because congestion declines as the tax leads to less driving.

Another important factor in applying the above fuel tax formula is that higher fuel taxes give rise to more fuel efficiency but one is interested in reduction of mileage rather than in fuel efficiency. This is why the γ parameter, which is typically smaller than 1 (Parry et al (2014) suggest 0.5), corrects the mileage related externalities.

Parry et al. show that not many countries have fuel taxes in line with the estimates they calculate from their formula. Of course, many countries have already other instruments in place (like differentiated vehicle taxes, parking charges etc.) and these change the level of the optimal fuel tax. Moreover, there are also other considerations and constraints affecting the optimal fuel tax – cf. the list in the introduction.

2.2 Some (perhaps unexpected) implications

The simple fuel tax principle put forward has some immediate implications when one considers more fuel efficient vehicles or the use of other fuels than gasoline or diesel. Consider first more efficient vehicles. Applying the fuel tax principle has three policy implications.

First, in many countries a fuel efficiency standard improves strongly the fuel efficiency of cars. This implies that the ”km/liter” fraction goes up and that the fuel tax per liter has to go up if one wants the fuel tax to be able to internalize the mileage related externalities.

A second implication has to do with the need – or absence thereof – to encourage the purchase of more fuel efficient vehicles. If car consumers are not myopic, or not too strongly myopic, a fuel tax (that takes care of many more externalities than climate damage, so is high from a pure carbon point of view) is a sufficient incentive to buy more fuel efficient cars and additional subsidy or tax policies to promote more efficient vehicles are unlikely to pass the cost benefit test. The effects of a reform of fuel taxes have been discussed in almost all presentations of national programs during the symposium (papers of Mayeres, Mabit, Fridstrom (this symposium)).

A third implication is that an unchanged (nominal) tax rate, combined with increasingly efficient vehicles and slow growth of total mileage, decreases total gasoline and diesel tax revenues. When these tax revenues are the principal source of infrastructure funding, as they are in the US, and it is difficult to increase the tax rate for political reasons, one needs to look for other sources of revenue (cfr. paper of Munnich (this symposium)). The long term fuel demand elasticity is high, so further tax increases may not generate a lot more revenues (for example, Goodwin et al., 2004, summarizes 175 studies and find a mean elasticity of -0.64). In some countries, the elasticity may even be close to -1, in which case a tax increase would not generate more revenues at all.

The same problem occurs in a less directly visible form where fuel tax revenues are not earmarked for transport infrastructure spending. In that case those responsible for general tax revenues become increasingly interested in maintaining revenue from transport. When the traditional fuel tax base erodes and low carbon objectives make it difficult to raise more tax revenue from alternative transport energies, mileage based taxes become increasingly appealing, at least when raising them is not too costly

Taxing diesel and gasoline

Consider next the implications of the simple fuel tax formula for the tax treatment of other fuels than gasoline, in particular diesel.

At present, the most popular alternative for gasoline is diesel. Diesel cars have strongly gained market share over the last 20 years in Europe. In many countries this diesel penetration is the result of taxes that are lower per liter than in the case of gasoline combined with a better fuel efficiency for diesel cars. This is not at all in line with the principle of the correct fuel tax advanced above. Since a diesel car often consumes less fuel per km than a gasoline car, internalizing the non-climate externalities would require a higher tax per liter for diesel than for gasoline. This is not the only issue on diesel cars as there is still a lot of controversy over the health effects of diesel cars and the emission rate in other conditions than those of the test cycle. Technological progress in diesel engines, in diesel fuel quality (less sulfur) and in exhaust technology (particulates trap) makes it a more acceptable engine technology, although on-road performance of even Euro VI diesel vehicles lags behind that of gasoline cars.

If fuel taxes were set according to the formula above, some fuels (biofuels, electricity) are automatically encouraged when they do not emit greenhouse gases as they will not have to pay the CO2 component of the tax. But often the tax reduction on biofuels is much larger than the CO2 component. In most countries that promote electric vehicles, electricity is not taxed at all or taxed at low rates, and sometimes it is freely available in public loading stations. In these cases, the implicit subsidy is large. Munnich (this symposium) takes the case of Minnesota where an electric car driven 10 000 miles per year implies a foregone gas tax revenue of 154 $ per year. If US electricity is paying a carbon tax or is participating in an ETS system, the 154 $ could be justified as a large carbon tax that is avoided. In Europe a similar car would save 1200 $ in gasoline taxes, as the EU has an ETS system in place, a small part of the gas tax savings could be justified as already taxed carbon emissions but the loss in yearly revenues and the uninternalized mileage externalities are still of the order of 1000 $/year.

Encouraging new fuels and new technologies ideally requires a combination of R&D support and user subsidies[1] to stimulate pure knowledge as well as learning by doing. These two positive externalities are not supplied sufficiently by private car manufacturers. Exactly how large these additional stimuli should be is difficult to compute. But a broader set of instruments is clearly more effective than a very high fuel tax subsidy.

According to the EU, security of fuel supply and import independence are other justifications for stimulating biofuel and electricity but very few studies do compare this energy security policy with other policies like storage or stimulating the adoption of CNG vehicles.

In conclusion, the fuel tax is, and should be, used to pursue many objectives but doing so involves trade-offs. Since different kinds of emissions and also other externalities vary in time and space in different ways, a combination of instruments is ideally required (e.g. urban congestion charges, distance taxes and standards). The current fuel tax treatment of diesel in comparison with gasoline and the fuel tax subsidies for alternative fuels are not compatible with the principles laid out above. Moreover, agglomerations and cities will be increasingly interested in supplementing, even substituting the gasoline taxes with instruments that are better suited for other externalities than climate. The two main problems will be acceptability and the cost of implementation.

[1] Acemoglu, Aghion et al argue that directed technological change requires giving the subsidy to the desired (in this case low carbon) technologies alone (as long as technologies are substitutes). The key policy approach is to reduce the cost of future abatement, and this is not best done by raising the cost of current emissions but by stimulating clean technology.

3 ESTIMATING AND SIMULATING CONSUMER BEHAVIOR

As the number of policy instruments is limited, one needs a careful balancing of the different positive and negative effects of a tax change and this requires good models for vehicle ownership and use.

Brownstone (this symposium) showed how good quality of data is crucial for obtaining reliable estimates. He takes the example of the NHTS survey where serious measurement problems bias both coefficient and confidence band estimates. A second pervasive problem he notes is the too high aggregation level of vehicle types in many car choice models. This means that underlying consumer heterogeneity is ignored and it leads to bias in point estimates and strong underestimation of standard errors. Allowing for the full heterogeneity in estimation is superior but leads to very broad confidence intervals, which ultimately means that the data is not of sufficient quality to support estimates that are sufficiently precise to be of any practical use.

Mulalic (this symposium) analysed the role of fixed and variable charges in car purchase behavior in Denmark using a Lancaster type of approach. They develop a model where quality characteristics of a car affect both fixed and variable costs, and where consumers care about the quality characteristics and trade quality versus total cost. Using sales data, they find that consumers do indeed trade off both fixed and variable costs of cars versus quality characteristics such as size.

4 ANALYSING REFORM PROPOSALS OF FUEL/VEHICLE TAXES

Barla (this symposium) used differences in gasoline taxes across different areas in Canada to estimate the price elasticities of gasoline and to see how they are affected by the availability of substitutes. He found the availability of transit increases the price elasticities. Next he uses a disaggregated version of Parry & Small's (2005) model to calculate how these differences translate into optimal fuel tax differences, finding that fuel taxes should be considerably higher (16 – 22 cents per litre) in urban areas than in rural areas because of their internalization effect on other externalities.

Mabit (this symposium) analysed the Danish reform of vehicle taxes in 2007, which features a bonus-malus system for fuel efficiency. A simulation tool for new car purchases was used to assess the relative influence of the vehicle tax reform, higher fuel prices and technological developments. He found that technological developments were far more important than the change in vehicle taxes and fuel prices. The technological development consisted in the availability of more fuel efficient vehicles and the availability of more diesel car options.

Munk-Nielsen (this symposium) analysed the very strong penetration of diesel cars in Denmark with a sophisticated econometric exercise. The diesel share in new car purchases increased from less than 10% in 1999 to 45% or more in 2009. He analyzed the vehicle tax reforms of 1997 and 2007. He found that the strong increase of diesel car share was not necessary to decrease the CO_2 emissions of cars. The same decrease could have been reached at much lower cost by more efficient gasoline cars.

Mayeres (this symposium) used a simulation model for car purchase decisions in the Flanders region. The region is responsible for the yearly traffic tax but not for the fuel taxes, which are federal. She found that the car stock composition is not strongly influenced by changes of the traffic tax, an increase of 25% of the traffic tax on diesel cars led to only small reductions in the share of diesel cars.

Huse (this symposium) analysed the Swedish green car rebate, a poorly designed support programme intended to increase usage of renewable fuels (ethanol), but which actually subsidised flex fuel vehicles even if they would run on conventional fuels, and which as a consequence led to higher CO2 emissions.

Fridstrom (this symposium) used a custom-made econometric model to find that reduced purchase vehicle taxes are more effective for technology change (EVs) and greenhouse gas abatement than increased fuel taxes. This was met with some surprise. This result can probably be attributed to the very high purchase taxes in Norway, which implies that a reduction of the purchase tax translates into a very high premium for electric cars.

Khanna (this symposium) analyzed the political economy of the promotion of biofuels in Brazil. Brazil is a major user and exporter of biofuels in the world. It has pursued a mix of policy interventions in the fuel sector to achieve multiple objectives of economic and social development, promoting biofuels and reducing dependence on oil. These include a biofuel blend mandate, a tax on gasoline and a tax credit on biofuels. In an effort to keep overall energy costs for the economy low, the government has under-priced domestically-produced crude oil which is sold to the refineries below the import-parity price for oil. Using a stylized partial equilibrium model of the transportation and sugarcane related sectors in Brazil they show that the biofuel policies were rather inefficient second best policies.

5 COSTS AND BENEFITS OF IMPLEMENTING DRASTIC CHANGES IN CAR AND FUEL TAXES

John Bates (this symposium) showed summary statistics from the UK travel survey that suggest that 94% of drivers pay nothing for parking, and the remaining 6% pay only a small amount. Combining this info with driving profiles was said to support a pricing reform with a density-dependent distance-based charge and a parking charge for parking durations longer than 2 hours.

Jokinen (this symposium) compares the costs of an integrated fuel tax with those of a satellite-based distance charge. The integrated fuel tax would be set at the level appropriate for dense areas in peak hours, allowing income tax rebates for travel in less dense and less congested conditions. This system is expected to be relatively cheap because enforcement (normally one of the main cost drivers) is easy given the incentives for drivers to comply. As the discussant pointed out, however, it may not be legally possible to put the burden of proof (that too much taxes were paid initially) with taxpayers. Also, some of the implementation cost estimates in the paper seemed very low.

Munnich (this symposium) presented the results of studies for Minnesota on the introduction of a distance charge for cars and trucks. In the US, the gasoline taxes are very low and the revenue base has been eroded by the improved fuel efficiency of cars. Distance charges are not only efficient to raise revenues but are also considered a more fair way of raising revenues. Many recognize the need for a distance based system, but there is still a lot of skepticism.

Tscharaktschiew (this symposium) used an extension of the Parry & Small (2005) approach to compute the right level of gasoline taxes. More precisely, how much should the gas tax increase when the market share of EVs rises. This can lead to extreme scenarios as higher gas taxes keep increasing the share of electric vehicles that are not priced properly. A much easier solution would be to add a mileage tax for electric vehicles.

6 LOOKING FOR THE RIGHT INSTITUTIONAL FRAMEWORK TO APPLY THE PRINCIPLES

Three contributions looked into the institutional aspects of a tax reform.

Proost (this symposium) used a more abstract model to analyze the reform of car taxes in a country where urban regions have severe congestion while rural regions have almost none. In the absence of other tax instruments, the gasoline tax is used as a second best instrument to address climate change and congestion in urban areas. This means a too high tax in rural areas and a too low tax in urban areas. An obvious reform is to replace the high gasoline tax by a lower gasoline tax combined with a specific instrument for urban regions. This can be a cordon toll, a parking tax or much better a fine toll adapted to departure times. It is difficult for a federal government to implement a differentiated parking tax or toll in function of local conditions for two reasons. First there is the risk of exploitation of one region by another when one region or an incomplete coalition of regions is in power at the federal leveland second there is the asymmetric information: regions tend to be better informed about local conditions. The conclusion is that we need a bottom-up initiative from the regions or cities to introduce new instruments. In reality however not many regions actually did this.

Mandell (this symposium) analysed the problems that appear in a federation when each of the regions (or member states) can tax trucks via diesel fuel taxes and via distance charges. Distance charges are spreading quickly in Europe and the questions are why this is so and whether this leads to a better equilibrium. He uses a two-country model with local as well as international truck traffic. The international truck traffic can choose where to fill up. It is shown that, whenever one of the two countries implements distance charges for trucks, it can lower its fuel tax and win market share on the fuel market for international trucks. In a non-cooperative game setting, the diesel tax is driven to zero. The end result is distance charges that are larger than the external costs. When each country has also to consider the effects on its diesel cars, results will be somewhat mitigated. The end result may be too low fuel taxes on diesel cars and a excessively high (fuel+distance) taxes on the use of trucks.

Kossak (this symposium) analysed the drivers and history of the introduction of distance charges in Germany. Germany has a distance charge for trucks since 2005. This distance charge replaced the Eurovignette system (a fixed charge per year, a system that is still in use in several countries). He noted that despite the additional revenues from the distance charges, Germany still has an important infrastructure financing gap and argued that this is because the revenues of distance charges and gasoline taxes are not earmarked to road infrastructure. A second important point is that despite many recommendations and its potential to manage traffic flows better, a distance charge for cars has never been seriously considered by the political world.

Chang (this symposium) analyzes the gasoline tax setting behavior of US states. US states can add a state gasoline tax to the federal tax and this state tax can be as important as the federal tax. He is in particular interested in how the political election cycle affects tax changes. One could expect that politically salient taxes such as gasoline taxes would be more affected by election cycles than less salient taxes such as corporate taxes, but surprisingly, the authors find no such difference: the timing of elections affect the timing of changes in all the studied kinds of taxes in the same way. The second surprising result is that the election cycle affects the probability of tax changes, but does not affect the actual level of the taxes. That suggests that though it can be difficult to increase gasoline taxes, it may be no harder to increase gasoline taxes by a lot than by a little.

7 CONCLUSIONS

The workshop brought together a selection of papers on fuel taxes and its alternatives from Europe and from the US. It is difficult to draw policy conclusions from papers that studied such a wide variety of tax policies. But we can make a few general observations.

First in the case of cars, one has barely started to study alternatives for fuel taxes. Most studies focus on the promotion of alternative fuels or promotion of more fuel efficient vehicles via different types of subsidy and tax mechanisms. The studies that computed the welfare costs of alternative fuels often found that these policies were not cost-effective in terms of carbon reduction.

Second, in the case of trucks, there is already much more experience with distance charging, particularly in Europe.

Third, most of the literature focused strongly on the effects on the car purchase decisions and much less on the long term car and truck use decisions and on the revenue raising effects.

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9 SYMPOSIUM PROGRAM

Program committee: Maria Börjesson (KTH), Jonas Eliasson (KTH), Jan-Eric Nilsson (VTI & KTH), Ian Parry (IMF), Stef Proost (KTH & KULeuven), Kurt Van Dender (OECD)

Speaker	**Title**
Jonas Eliasson (CTS)	Introduction
Brownstone D. (UCIrvine) Disc: Huse	Modeling Tax and Regulatory Policies for Household Transportation and the Neglected Impact of Measurement Error
Bates J (UK) Disc: Jan-Eric Nilsson (VTI)	Using the National Travel Survey to investigate road transport taxes
Huse C.(Stockholm S Econ) Disc: Brownstone	Fast and Furious (and Dirty):How Asymmetric Regulation May Hinder Environmental Policy
Barla (Laval) Disc: MAtas (UAB)	Are Gasoline Short-run Demand Elasticities different across Cities?
Mayeres (VITO-B)	A simulation model for analysing the reform of car taxation in

Disc: Fridstrom (TOI)	Flanders
Fridström (TOI-N)	Vehicle or fuel taxation for greenhouse gas abatement? An empirical modelling exercise
Mulalic (DTU-DK) Disc: Mabit	Fixed and variable cost of automobiles
Mabit (DTU-DK) Disc: Habibi (CTS)	Vehicle type choice under the influence of a tax reform and rising fuel prices
Munk Nielsen (U Copenhagen) Disc: Mayeres	Diesel Cars and Environmental Policy
Parry I. (IMF) disc: Van Dender K. (OECD)	International perspective on Fuel tax reform
Proost S. (KTH-KULeuven) Disc: Brosio (Torino)	Future of gasoline taxes--a vertical tax competition approach
Tscharaktschiew S. (TUDresden) Disc: Mandell	How much should gasoline be taxed when electric vehicles conquer the market?
Chang A. (Federal Reserve Board) Disc: Khanna	On the Politics of gasoline and other taxes
Khanna M.(UIUC) Disc: Chang	The Political-Economy of Biofuel and Cheap Oil Policies in Brazil
Jokinen (Aalto, F) Disc: Eliasson (CTS)	Integrated Fuel and Car Use Taxation by Satellite Tracking
Kosak A. (Germany) Disc: Munnich	Tax-Financing or User-Financing the Road Infrastructure Case-study Germany
Munnich L. (U Minnesota) Disc: Kosak	Minnesota Task Force for Mileage-Based User Free Policy
Mandell (KTH) Disc: Cohen (UCI)	Distance charges and fuel taxes on trucks – effects from strategic interactions