Fuel Taxes

Introduction

This record of evidence forms part of the work undertaken by UKERC's Technology and Policy Assessment team relating to its project on policy strategy for carbon emissions reduction in the passenger transport sector. The material was produced alongside the project's main report and since it supports that report, it was judged appropriate to make this material available to a wider audience. The main report itself '*What Policies are Effective at Reducing Carbon Emissions from Surface Passenger Transport*?', and the supporting evidence can be found at:

http://www.ukerc.ac.uk/ResearchProgrammes/TechnologyandPolicyAssessment/TPAProjects.aspx

Explanation of Content

Evidence on this policy measure has been collected by the TPA team on the basis that it has, or may have, the potential to result in carbon dioxide emissions reductions in the passenger transport sector. This evidence document begins with a summarised description of the policy measure. The evidence itself follows the summary and is presented in table form.

Each piece of evidence has been assigned a separate row and tabulated using four columns:

- Year of publication, arranged chronologically, beginning with the most recent year
- Name of author, including where applicable additional cited authors (and year); and a Reference ID number.
- Type of evidence:
  - Evidence containing quantitative information is denoted by the letter 'Q'
  - Qualitative evidence is denoted by the letter 'C' for 'comment'
- The evidence itself

The evidence was originally gathered and assessed using several sub-headings. The purpose of this was primarily internal i.e. to facilitate the handling of evidence and the production of the main report. These sub-headings have been retained here as follows:

- Policy Measures and Carbon Savings
- Other potential CO_2 Impacts i.e. outside of the immediate policy influence
- Other Benefits e.g. air quality improvement or traffic congestion reduction
- Policy Costs and/or Revenues i.e. to local or national government
- Business and Consumer Costs
- Unintended Consequences e.g. rebound effect
- Reasons/Arguments for Carbon Savings Achievement or Failure
- Policy Suitability for the UK

A list of references follows the evidence tables. Note that the Reference ID numbers are allocated by Reference Manager, the referencing software used by the TPA team.

Any charts, figures and tables referenced in the evidence are not reproduced here but can be found in the original publication or evidence material.

Where no relevant evidence was found for a particular sub-heading, this has been noted.

Policy Description

The evidence recorded here covers taxes applied to transport fuels, operating on a pay per use basis. This includes evidence on the 'Fuel Duty Escalator' (FDE) in the UK which was a Treasury commitment to automatically increase fuel duty rates above inflation in each Budget. Fuel taxes differentiated by CO_2 content are discussed in the 'Fuel CO_2 policies' document.

Fuel taxes impact on a variety of different leverage points of travel behaviour. In the short term, mode choice, vehicle distance, driving style and car occupancy can be affected. Longer-term effects may include encouraging the purchase of more efficient vehicles and choice of residential and work location.

Evidence Tables

Carbon Savings and Policy Measures

Year	Author	Type	Evidence
			General
2006; 1998	Potter (ref 2190); Ayres (ref 11245)	C	Fuel tax impacts on a variety of different points of leverage of travel behaviour and these influences differ according to timescale after implementation. In the short run, fuel tax increases can cause reductions in vehicle mileage by encouraging a reduction in unnecessary trips and influencing modal choice and car occupancy (Potter 2006, Ayres 1998). Short run effects may also include more efficient driving styles. In the longer run, drivers would see a clear economic incentive to drive more fuel efficient vehicles, retire old, inefficient vehicles earlier and potentially to make less car dependent home and work location choices. The effects are all the greater as this tax applies to used as well as new cars.
			Elasticities
2008	Komanoff (ref 11550)	Q	Komanoff (2008) estimates that the short-run U.S. fuel price elasticity reached a low of -0.04 in 2004, but this increased to -0.08 in 2005, -0.12 in 2006 and -0.16 in 2007. This probably reflects a number of factors, particularly the growing share of total household budgets devoted to fuel.
2007	Gallagher (ref 11461)	C	Gallagher (2007) cites recent evidence that drivers are becoming less sensitive to increases in gas prices, which might explain why vehicle-miles travelled is increasing.
2007 2007	Kahn (ref 11336) citing Goodwin et al, 2004; Small and Van Dender (ref 11527);	Q	"…the effect of CO_2 taxes and high fuel prices may be having a shrinking effect in the more car-dependent societies. While the evidence is solid that price elasticities used by Goodwin [see below] were indeed around –0.25, in earlier years, new evidence indicates a quite different story. Small and Van Dender (2007) found that price elasticities in the USA dropped to about –0.11 in the late 1990s, and Hughes et al. (2006) found that they dropped even further in 2001–2006, to about –0.04. The

Year	Author	Type	Evidence
2006	Hughes et al. (ref 11526)		explanation seems to be that people in the USA have become so dependent on their vehicles that they have little choice but to adapt to higher prices."
2006; 2008; 2008	CERA (ref 11548) Litman (ref 11529) Williams-Derry (ref 11549)	C	US evidence from the period since 2006, when elasticities appear to be increasing, reflects both much higher absolute prices and income/wider economic effects. In 2007 and 2008, per capita fuel consumption and vehicle travel declined, suggesting that fuel prices are high enough to significantly affect consumer behaviour.
2006	Hughes, Knittel and Sperling (ref 11526)	Q	There is some evidence from the USA that demand may be becoming much more inelastic in that recent studies suggest that the short run price elasticity of demand for gasoline fell from -0.21/-0.34 in the 1975-1980 time period, to -0.034/-0.077 in the 2001- 2006 time period. The authors of that report hypothesise a number of reasons for this dramatic change, including the impact of suburban development on the share of journeys that are non-discretionary and the reduced scope for shift to non-motorised transport modes. As a result, people in the USA have become so dependent on their vehicles that they have little choice but to adapt to higher prices.
2004	Goodwin et al. (ref 11524)	Q	Fuel price elasticities of demand have been a particularly rich area of research, studying both the effects on fuel consumption and on traffic levels. Goodwin, Dargay and Hanly (2004) cite 69 studies published since the previous round of literature reviews in 1992 and summarise the values in the literature. The estimates of fuel consumption have been obtained by applying dynamic models to various sorts of longitudinal data using econometric methods to split out all the factors determining demand (prices, income and socio-economic and demographic factors) as well as through literature reviews of similar analyses and judged to be the best defined results for developed countries.
2004: 2004	Goodwin et al. (ref 11524) Graham & Glaister (ref 11525)	Q	Several reviews suggest that short run elasticity of demand for road fuel is around -0.25 to -0.3.
2004 2007 2004	Goodwin et al. (ref 11524**)** Buchan (ref 11452) Goodwin et	Q	Taking Goodwin's figures: ▪ if the price of fuel were to increase by 10% and be sustained at that level, this would result in a 2.5% decrease in fuel used within a year, split approximately into two thirds more efficient driving and one third less distance traveled. Buchan (2007) however, states that evidence in the UK points to this split being approximately equal between distance travelled in the short term.) ▪ Fuel consumption effects will build up over a period

<table>
<tr><th>Year</th><th>Author</th><th>Type</th><th>Evidence</th></tr>
<tr><td></td><td>al. (11524)</td><td></td><td>of about 5 years to a reduction of about 6% in the volume of fuel, comprised of the volume of traffic falling by about 3% and the efficiency in the use of fuel rising to around 4%.
▪ This translates into a 3% reduction in the mileage per car and an 11% increase in fuel efficiency per car.
▪ In addition, the total amount of vehicle ownership can be affected – by less than 1% in the short term, but building up to around 2.5% reduction in the longer term.</td></tr>
<tr><td>1999</td><td>Plotkin (ref 11409) citing Dahl, 1986; and citing Plotkin and Green, 1997</td><td>Q</td><td>Plotkin (1999) expresses the idea that elasticities are reducing: Studies done in the 1970s and early 1980s of fuel price effects on fuel demand (Dahl 1986) found that fuel demand was very responsive to fuel price over the long term – that a 10% increase in price would cause a drop in fuel use of approximately the same percentage, with half the drop coming from improved vehicle efficiency and half from reduced travel. More recent estimates, discussed in Plotkin and Green (1997), project only about a 5-6% decrease in fuel use from a 10% price increase. Thus, a $0.50/gallon gasoline tax (added to a baseline $1.25/gallon) might be expected to reduce gasoline use by perhaps 20% over the long run.</td></tr>
<tr><td colspan="4">The table below summarises fuel price elasticities drawn from the evidence base.
<u>Fuel Price elasticities</u>
<table>
<tr><th>Category</th><th>Short term elasticity (mean) (within 1 year)</th><th>Long term elasticity (mean) (5 years)</th></tr>
<tr><td>Fuel consumption (total)</td><td>-0.3[1]
-0.25[2]</td><td>-0.7[1]
-0.64[2]
- 0.3 / -0.4[3]</td></tr>
<tr><td>Fuel consumption (per vehicle)</td><td>-0.08[2]</td><td>-1.1[2]</td></tr>
<tr><td>Traffic volume (total vehicle km)</td><td>-0.15[1]
-0.10[2]</td><td>-0.3[1]
-0.29[2]
-0.2[3]</td></tr>
<tr><td>Vehicle fuel efficiency</td><td>-0.15[2]</td><td>-0.40[2]</td></tr>
<tr><td>Vehicle ownership</td><td>-0.08[2]</td><td>-0.25[2]</td></tr>
</table>
[1] (11525 Graham & Glaister 2004)
[2] (11524 Goodwin et al 2004)
[3] (11551 Jansson & Wall 1994; 2446 Michaelis & Davidson 1996; 11552 Johansson & Schipper 1997; 11175 Kageson 2003)</td></tr>
<tr><td></td><td></td><td></td><td>Effect on distance travelled</td></tr>
<tr><td>2007</td><td>Buchan (ref 11452)</td><td>C</td><td>There tends to be a lower effect of fuel price increases on the number of journeys – in other words, distance is</td></tr>
</table>

Year	Author	Type	Evidence
			reduced by making journeys shorter.
2007	Buchan (ref 11452)	Q	What happened during the decade to 2000 is consistent with the elasticities quoted above: the short-term impact of fuel duty between 1994 and 1999 was for every 10% increase in cost, a 3% decrease in fuel used.
2006	Potter (ref 2190)	C	Rises in traffic levels in Britain over the decade to 2000 had been relatively low, despite levels of economic growth that had previously stimulated significant traffic growth.
2006 2002	Potter (ref 2190) citing Anable and Boardman 2005 Glaister (ref 3521)	Q	The extent to which the price of fuel is an effective tool to influence modal choice has been the subject of some contention. For example, in the UK, the rate of growth in traffic declined *after* the fuel duty escalator was *removed*. For example, in 2001, pump prices fell by around 20% but the underlying growth in traffic fell to 1.2%, having been at about 2% p.a. between 1994 and 2000 (citing Anable and Boardman, 2005). This can be explained by a number of factors including: ▪ Long run versus short run adaptations made by people to their location and travel choices leading to a lag effect ▪ The importance of the *total* cost of motoring as well as the cost of motoring relative to other travel modes ▪ Other factors that may have contributed to the slowing of traffic growth. For instance, Glaister (2002) points out that road capacity was not increased in the UK during the post 2000 period. ▪ The rate at which incomes increase/ decrease. Glaister's research found that the demand for fuel is affected not only by its price but also by disposable income.
2002	Glaister (ref 3521)	Q	The Fuel Duty Escalator apparently contributed to a significant slowing of traffic growth over about two years, despite strong economic growth during this period. Between January 1998 and July 2000, a combination of rising oil prices and fuel tax meant that the fuel price index rose by 23% above inflation. Assuming a traffic elasticity of –0.3, this would be expected to reduce traffic by about 7% over the two and a half years, or an average of 2.8 per cent per year. This is of the same order as the growth that would be expected as a result of economic growth. So, the evidence on traffic is consistent with the view that the government did, indeed, manage almost to halt traffic growth over a period of 2 years or so. This was not achieved by any complicated transport policy, but by the simple policy of increasing fuel tax, supported by increasing world crude oil prices.
2002	Gurikova (ref 11463**)**	Q	In the US, when gasoline prices go up, a majority of the American adult population tend to say it would not reduce the amount of driving because of the increase. However, when asked later whether they actually drove or planned

Year	Author	Type	Evidence
			on driving as much as they did when gasoline prices were lower, Americans reported a decrease in the amount of their driving. This finding is consistent with the graph shown in Figure 1. The graph illustrates that Americans actually drive less when gasoline prices increase. When gasoline prices go down, the U.S. public is not likely to report that they would drive more because of the decrease but the fact is that they do drive more when gasoline prices are low.
			Effect on car purchase
2007	Anable and Bristow (ref 12297)	Q	In the UK, petrol and diesel tax rates are the same, whereas in Europe diesel rates are much lower than for petrol, typically by 38% in the EU15. In this context, it is interesting to note regarding car ownership that the UK has far less diesel penetration than across the rest of the EU (about 30% less).
2007; 1999	Lane (ref 11328); Jansen and Denis (ref 592**)**	C	There is an acknowledgement of consumer 'myopia' – that is the underestimation of future running costs by buyers thus weakening the effect of fuel taxes on car choice.
2004	Goodwin et al (ref 11524**)**	Q	As for absolute levels of car ownership, the evidence is not entirely clear. However, the estimates of price elasticities conclude that there is a reduction in car ownership in reaction to a 10% fuel price increase of less than 1% in the short term and about 2.5% in the longer term. Goodwin (2004) notes that both car ownership and car travel are more sensitive to car prices than to fuel prices, but that income is the most important determinant of both.
2003	Hayashi (ref 11176)	Q	Hayashi (2003) used an integrated model of car purchasing, owning (including scrappage and repurchasing) and use (including driver behaviour). Hayashi found the choice of disposal/repurchase and the choice of car class are much less influenced by use tax, but rather by purchase and ownership taxes. However the sensitivity analysis identified car usage tax as the most significant parameter in reducing CO_2. Hayashi shows that an equivalent average increase of 21% in average fuel tax does not significantly affect purchase behaviour. On the other hand, the reduction rate in CO_2 emissions is at the highest, due to shorter travel distances and more efficient driving practices. Also, ownership tax changes result in a fairly large shift to smaller car class while purchase tax has a very small effect. Hayashi says the combination of preferential purchase and ownership taxes and use tax increases yields the highest CO_2 reduction (30%) and the highest revenue increase (75%). The preferential purchase and ownership taxes in this policy scenario utilized different tax rates for each car classes to make a small car more preferred to the bigger alternatives. The use tax on the other hand involves an annual increase of two percent

Year	Author	Type	Evidence
			in fuel taxes.
2002	COWI (ref 11264)	C	Myopia leads various authors to conclude that instruments that target car buying behaviour directly such as differentiated purchase taxes and car labelling are more effective at influencing car purchasing behaviour and that, by comparison, fuel tax increases provide only very small reductions of the average CO_2 emissions of new cars. Nevertheless, fuel taxes are generally deemed to have some effect on the specific fuel economy of the vehicle stock at least over the longer term and are generally agreed to be a very effective means of controlling the total CO_2 emissions that are attributable to passenger car transport.
2002	Gurikova (ref 11463**)**	Q	With cost being a critical factor in motivating them to purchase a more fuel-efficient vehicle, on average, Americans say they would pay more than $2,100 additional for a vehicle that gets 10 percent better fuel economy.
1999	Jansen and Denis (ref 592**)**	Q	Fuel taxes are already high and consumers tend to demand short payback periods for fuel-saving technology in new cars. This implies a higher discount rate for fuel efficiency than for other types of investment. Jansen and Denis (1999) undertook a model simulation (using EUCARS passenger transport model) designed to yield a 10% reduction in CO_2 emissions compared to the baseline. The necessary tax is introduced in the year 2000, is based on the carbon content of the fuel and is equivalent to a 26% price increase for fuels. Jansen and Denis (1999) concludes that the criticism of fuel tax due to the market failure effect of myopia may be exaggerated and overall fuel tax is the tax which has the greatest impact on CO_2 because it acts on so many different points of leverage simultaneously. Despite myopia, the bulk of the emission reduction (roughly 5.5%) stems from technical improvements in fuel consumption for each vehicle type. The full effect of their improved fuel efficiency, however, arises when all cars that were bought before the introduction of the higher tax are taken out of circulation. Next to technical change, the average fuel efficiency rises as a consequence of a shift to smaller cars. The tax also has a transitory effect on the average fleet age as car ownership patterns take time to adjust to the new tax rates. In the short run, the adjustment could result either in an older fleet because of reduced car sales or a younger fleet because of increased scrappage of predominantly older gas-guzzlers. In addition, because a fuel tax acts significantly like a mileage tax, driving per vehicle decreases by roughly 3% in 2010. The higher speed and an increase in public transport by 5% counteract slightly the overall emission reduction of the fuel tax.

Year	Author	Type	Evidence
1999	Jansen and Denis (ref 592**)**	Q	A further impact of the tax is a noticeable reduction in the number of cars in circulation by 2.1% in the short run and slightly more (2.3%) in the long run.
1999	Jansen and Denis (ref 592**)**	C	A CO_2 tax implies a high proportional burden on diesel (due to its higher energy content), yet it is presently subject to relatively low taxes in many European countries and is characterised by a high annual mileage per vehicle.
			Other modelling results
2003	Anderson et al. (ref 11240)	Q	Anderson et al (2003) assessed the impact on annual carbon emissions of a variety of transport policy instruments on their own and in combination. They assessed an increase in road fuel price – rather than duty (using an excel spreadsheet model). It was found that an increase in fuel price of 10% had the potential to reduce carbon emissions by 4.05% by 2010 (7.56% by 2050). This comes about from drivers reducing their journeys and driving more fuel-efficiently as well as choosing cleaner vehicles in the longer term, though it is not clear how much of the carbon reduction comes from which behaviour. In Table 6.1 it can be seen how this instrument compares to others in the model and the effects of combinations of policies. These are expressed in terms of annual carbon savings in 2010 and 2050, and percentage savings compared to the baseline emissions in each of those years. Note, there is some overlap between tool 3 (fuel/carbon tax) and tool 10 (fuel price increase of 10%). These both represent the impact of increased taxation on petrol and diesel fuels but the impact is felt in different ways, but the carbon tax only results in different vehicle choices, as new car buyers select more efficient cars.
2002	Hensher (ref 2024)	Q	Figure 5 of Hensher (2002) traces the impacts of a carbon tax in. The imposition of an increase in the tax on automobile fuel, via its impact on unit operating cost (c/vkm) has an immediate and direct influence on (i) the use of each vehicle for particular trips such as the commuter trip (i.e. mode choice, which includes both a switch to public transport and vehicle-substitution from within the household's vehicle park), (ii) a change in the *timing* of the commuter journey to reduce the increased costs associated with traffic congestion, and hence (iii) a change in the overall and non-commuting use of each automobile available to a household. It also directly affects the household's choice of types of automobiles from the set of conventional fuel, electric and alternative-fuel vehicles (the last two vehicle fuel types introduced in any year, under a reasonable expectation of availability). The indirect impacts include a change in residential location.
2002	Hensher (ref 2024)	Q	Hensher (2002) attempts to demonstrate the policy-value of an integrated model system, by selecting a carbon tax as an application scenario and evaluated it for the city of

Year	Author	Type	Evidence
			Perth (Western Australia). The model focussed on the impact on greenhouse gas emissions and total end user cost over the period from 2001 up to 2004. He concludes via his model that if a carbon tax of 20 cents/kg (he does say what this means in terms of a percentage increase) were implemented, the average vehicle operating cost after equilibration would increase by 18.18%. Total government revenue would increase by 14.82%. The total end user money cost would increase by 7.34% while total end-user generalised cost would be reduced by 0.344%. Modal commuter shares for automobile trips would decrease while those for public transport would increase. Total annual vehicle kilometres would reduce by 2.309% and total greenhouse gas emissions would reduce by 2.392%. One can obtain these indicators for each application year in the evaluation period, and calculate the accumulated impact of the policy over a given period.
			Other evidence on the effect of fuel prices
2008	Hensher (ref 11464)	C	Overall, Hensher (2008) suggests that a carbon tax may offer the most attractive way forward when balancing efficiency, equity and sustainability considerations.
2007	Kahn (ref 11336)	Q	Fuel taxes are about 8 times higher in the UK than in the USA, resulting in fuel prices that are about three times higher. UK vehicles are about twice as fuel-efficient; mileage travelled is about 20% lower and vehicle ownership is lower as well.
2007	Anable and Bristow (ref 12297) citing Defra, 2006; and citing HM Treasury, 2007	Q	In the UK, the effects of the Fuel Duty Escalator are still felt in terms of emissions which are estimated to have been 1.9 MtC higher by 2010 if the policy had never existed (citing Defra 2006). This compares to 2.3 MtC for the Voluntary Agreement package (including car labelling, VED and company car tax) using the same methodology. The 2007 budget announced an increase in the fuel duty rate of 2 pence per litre (ppl) from October 2007, and increases in the next two years of 2ppl and 1.84 ppl respectively. These increases are expected to secure carbon savings of 0.16 MtC per year by 2010-11 in a scenario of falling crude oil prices, 18% from 2007 to 2009 (citing HM Treasury 2007).
2006	ECMT (ref 11271)	C	The European Conference of Ministers of Transport progress reviews states that ‘‘Carbon and fuel taxes are the ideal measures for addressing CO_2 emissions. They send clear signals and distort the economy less than any other approach.”
2004	Goodwin et al (ref 11524)	Q	To achieve a target of reducing total fuel demand from the surface passenger transport sector by 25% with price elasticity of fuel demand at -0.6 (the long run figure from Goodwin et al, 2004) would require a price rise of 41.7%.
2003	Harmsen (ref 11449)	Q	Harmsen’s 2003 review of policies summarises the effectiveness of UK and German CO_2 policies and concludes: “Obviously, the effect of a fuel tax increase

Year	Author	Type	Evidence
			depends on the size of the tax increase. The effects referred in the replies from the questionnaire imply increases in the order of 15% in Germany and 35% in UK. The reported effect from this increase is a reduction in CO_2 emissions of 1 Mt in Germany and between 2.5 Mt and 6 Mt in UK, corresponding to 0.5 - 3,5% of total CO_2 emissions in the transport sector. The German reply applies an elasticity of -0.3, which corresponds to the short-term effect of fuel price changes."

Other CO2 Impacts

Year	Author	Type	Evidence
			No specific evidence found

Other Benefits

Year	Author	Type	Evidence
2006	Defra (ref 11253)	C	Defra (2006) state that improved air quality was included in ancillary benefits for a cost effectiveness calculation and note that whilst the only ancillary effect valued is air pollution there will clearly be other beneficial impacts such as congestion reduction, noise and other environmental benefits and additional costs in terms of lost consumer surplus.

Policy Costs and/or Revenues

Year	Author	Type	Evidence
2007 2007 2006 2003	Anable and Bristow (ref 12297) US GAO (ref 11191) ECMT (ref 11271) Harmsen (ref 11449)	C	The revenue raising nature of this policy is one reason why a variety of commentators conclude the cost-effectiveness of this instrument is high compared to other instruments (Harmsen, 2003; Anable and Bristow, 2007; ECMT 2006, US GAO, 2007). In addition, this is due to the lack of rebound effect associated with its introduction and the fact that it is cheap to administer.
2007	US GAO (ref 11191**)**	C	US GAO (2007) reviewed the evidence and claimed: "…this literature and all of the economists with whom we spoke stated that a tax on gasoline or carbon would be cost-effective, whereas increasing CAFE standards would not be as cost-effective. For example, CBO estimated that increasing the gasoline tax to achieve a 10 percent reduction in fuel consumption would cost far less than an increase in CAFE standards".
2007	Anable and Bristow (ref 12297) citing	Q	In the UK, Defra (2006) estimate the cost-effectiveness of the fuel duty escalator (FDE), to yield a net *benefit* of £250 per tonne of carbon (including air quality benefits), compared to, say, a net *cost* of £105-220 t/C for a

Year	Author	Type	Evidence
	Defra 2006		Voluntary Agreement with car manufacturers reaching 135g/km by 2020. Indeed, Defra calculate fuel duty to be one of the most cost-effective instruments across all sectors included in its Climate Change Programme.
2003	CBO (ref 11603	C	CBO (2003) estimated that increasing the gasoline tax to achieve a 10 percent reduction in fuel consumption would cost far less than an increase in CAFE standards".
2002	Glaister (ref 3521) citing Coates 1999	Q	"In 1975, tax revenue from the road sector was £13 billion and public spending on roads was a little lower at £11.5 billion. By 1997 tax revenue had increased to £31 billion, yet spending had fallen to £6 billion."
1995	Koopman (ref 5890)	Q	In the US, the CAFE system was found to cost 4.5 times more than a gasoline tax.

Business and Consumer Cost

Year	Author	Type	Evidence
2004	Ekins and Dresner (ref 11528) citing Blow and Crawford, 1997	C	Petrol taxes are not regressive in the aggregate because poorer households are less likely to have a car. However, petrol taxes are regressive *among* motorists (citing Blow and Crawford, 1997).
2003	Hayashi (ref 11176)	Q	In general, the price of fuel in Europe and Japan is significantly higher than in North America, almost entirely due to the difference in fuel taxes. However, taking the total amount across different tax components narrows this gap, as can be seen in Figure 1.
2001	AIT (ref 11239)	Q	Figure 4 from a study by the Institute of Fiscal Studies (cited in AIT, 2001) shows the poorest 10% pay far more proportionally than the richest.
1999	Jansen and Denis (ref 592)	C	Jansen and Denis (1999) points to the reduction in welfare loss that can occur from reduced congestion and increased travel speeds. The environmental benefits of reducing emissions, as well as reductions in noise and accidents would reduce welfare costs even further. Overall, CO_2/ fuel tax is actually likely to lead to the smallest welfare loss per tonne of carbon abated because of the absence of a rebound effect.
1995	Koopman (ref 5890)	Q	Some authors directly compare the burden on consumers from fuel tax versus fuel economy standards. Koopman (1995) concludes that for CO_2 savings of 10%, a CAFE scheme has 20% higher welfare than a CO_2 tax, and this would widen further for more ambitious CO_2 targets. On the other hand, unlike CAFE, fuel tax does not increase the cost of new cars to consumers. In addition, fuel taxes have a relatively greater welfare benefit as a result of revenue redistribution.

Unintended Consequences

Year	Author	Type	Evidence
			Air quality
1999	Plotkin (ref 11409)	C	The scale of additional benefits from fuel tax is open to question. "Although fuel taxes or carbon taxes should be more efficient than fuel economy standards, their economic efficiency suffers from the fact that most of the externalities of motor vehicle travel – which fuel or carbon taxes would seek to "internalize" – do not vary directly with fuel use. Health damages from emissions of fine particulates may even vary somewhat inversely with fuel use, since fuel-efficient diesels emit more particulate matter than less-efficient gasoline engines."
1999	Johnstone (ref 1108)	C	"While the case for fuel taxes is strong since it is administratively simple to implement and since it targets some of the most important emissions effectively (particularly CO_2 emissions), it is apparent that while emissions of non-CO_2 pollutants are likely to fall due to reduced vehicle use, measures designed to increase fuel efficiency will not provide effective incentives for reducing the emission-intensity of vehicle technologies in terms of emissions per kilometre (citing Dowlatabadi, 1996). This is reflected in the fact that fuel taxes are often applied in conjunction with command-and-control regulations such as mandatory catalytic converters and/or a vehicle inspection and maintenance programme." However, as an alternative (or complementary) policy, in Johnstone's study, the case for vehicle characteristics taxes was examined.
			Equity issues
2007	Buchan (ref 11452)	C	Buchan (2007) notes that so called "environmental taxes" are often combined with the idea of redistributing revenues, broadly to the people from whom they are collected. Thus an additional fuel duty which had the purpose of changing travel patterns (for example encouraging walking and cycling), and encouraging more efficient cars, could be recycled broadly as follows: ▪ The amount raised from personal travel would go back to the population as and the amount raised from business (who would pay the duty on fuel used by commercial vehicles) would go back to individual businesses. The way in which this is distributed will have different effects. For example, a lump sum paid annually to every UK resident would probably have a slight negative impact on GDP, but be of positive help to the least well off and child welfare. If the fuel duty (or any other environmental tax or levy) came back in the form of a reduction in income tax or national insurance it would probably be positive in GDP terms but favour people who are better off. ▪ Parallel to this, business costs would be increased by higher road fuel costs and this could come back

Year	Author	Type	Evidence
			as employer national insurance reductions, or rate rebates, either as a lump sum or graduated according to size or turnover. Again, lump sums would favour smaller, more marginal businesses and this may well be the preferred option to support small business creation and the role of local shops.
2008	Litman (ref 11488**)**	C	The evidence on the equity impacts of fuel tax is mixed. Although it reduces the affordability of driving (reduced vertical equity), it internalizes a greater portion of motor vehicle costs (increased horizontal equity) and increases transport options for non-drivers (increased vertical equity). It is overall impacts on affordability and consumer welfare depends on the quality of vehicle and transport options available, and how revenues are used (if consumers can easily purchase more fuel efficient vehicles, easily shift to other modes or benefit from reductions in other taxes, they can be better off overall).
2003	Harmsen (ref 11449)	C	Similarly, Harmsen (2003) observes that fuel taxes are typically argued to be regressive, i.e. to affect the lower income groups the most, but claims that "while this argument is valid to some extent, one should however also note that the ultimate effect will depend also on whether the instrument is accompanied by other instruments that pull in the opposite direction (and where the tax can be said to provide some of the revenue necessary to finance this). Such instruments could be for example improvements of the service level of public transportation (which is used the most by low income groups that do not possess a car)."
1998; 1995	Ayres (ref 11245); Koopman (ref 5890)	C	Many authors believe a fuel tax policy would especially burden the poor and those who live in rural areas since they have little opportunity to purchase high efficiency vehicles or limit their driving, respectively. These authors note the extra taxes paid as a percentage of income in various demographic groups.
			Economy-wide effects
2007	Barker (ref 11428)	C	It is not only fuel tax which may have macro-economic disadvantages and it is therefore about the combination of policies in place. Barker (2007) highlights the relationship between Fuel taxes and the Voluntary Agreements (VAs). He uses an integrated top-down–bottom-up model (MDM-E3) to analyze the macroeconomic effects of the 'VA package' (comprising the VA on reduced CO_2 from vehicles; company car tax; and graduated VED) vs. Fuel Taxes. The results show that the VAs yield positive macroeconomic effects in economic terms, with small increases in GDP and employment and small reductions in general inflation, alongside significant reductions in final energy demand and CO_2 emissions. In contrast, fuel taxes set at a level to achieve the same level of CO_2 reductions raise prices and lower GDP and employment. If fuel duties are recycled in the economy, reducing income taxes, then the undesirable macroeconomic impacts of fuel duties can

Year	Author	Type	Evidence
			be largely eliminated. Nonetheless, there will still be significant equity implications from fuel duties, because payment of the fuel duties is not directly linked to reductions in income taxes. However, if the VAs are combined with a smaller increase in fuel duties, established to make the package inflation neutral, then the agreements become more effective in reducing energy and emissions.
1999	Plotkin (ref 11409)	C	"If the tax change is revenue neutral with receipts used to reduce other taxes, the net economic impact will depend on the relative efficiencies of the new and displaced taxes. It is theoretically possible, if the displaced tax is particularly inefficient and distorting, that the overall long-term impact of the new tax on GNP could be positive, though the regressive aspects of fuel and carbon taxes will yield negative distributive effects on economically-vulnerable populations if the tax revenues are not used to compensate for such effects…Further, revenue-neutral fuel or carbon taxes may be constructed to have little long-term cost to the national economy, though short-term adjustment costs are inevitable."
1999	Plotkin (ref 11409)	C	Short term GNP impacts can be moderated by introducing tax increases gradually over a number of years, though consumer acclimatization to a gradual tax increase conceivably might reduce the tax's effect on travel behaviour and vehicle purchases, yielding lower benefits in reduced oil use and greenhouse gas emissions.
1998	Ayres (ref 11245)	C	The opposition to raising fuel tax is often based on the assumption that they will negatively affect inflation and GDP. Ayres (1998) states that any mechanism that reduces fuel consumption by raising the variable cost of driving causes a deadweight loss. This loss represents the foregone consumer surplus benefit of driving. If the policy also raises the overall cost of driving, as a gasoline tax is often assumed to do, then further losses will result. The increased cost will reduce the disposable income level of the average household and cause inflation. These effects will cause short-term economic slowdown, though they will stimulate investment and encourage long-term economic growth. In the short term, however, the additional losses will cause drivers to conserve even more fuel, making the policy extremely cost-effective but potentially increasing poverty, unemployment, and social upheaval. "Other tax cuts could help avoid this short-term suffering. Income-tax rebates would help maintain disposable income levels for consumers, and reductions in the employer-paid payroll tax would help dampen inflation."
1997	Koopman (ref 7677**)**	C	It is hard to justify why transport should be singled out for relatively high tax rates when the objective is to reduce economy-wide CO_2 emissions – fuels already have high tax on them.

Year	Author	Type	Evidence
			Reduction in Government revenue
2004	Stopher (ref 517)	Q	Stopher (2004) notes an interesting policy dilemma re fuel taxes: "Many governments around the world have instituted extensive excise taxes on petrol and other fossil fuels. With the exception of the federal tax component in the United States, these taxes are generally not hypothecated and represent a substantial source of government income. Given this, governments may well consider policies that would reduce petrol consumption to be against their interests. At best, they may be reluctant to pursue aggressive policies that would result in significant reductions in the amount of taxes collected from fuel. For example, the hybrid vehicles have been shown to average as low as 2–3 l/100 km, compared to average consumption by conventional cars of around 10– 13 l/100 km. A general shift to such fuel-efficient vehicles would have the implication of decreasing fuel excise tax revenues to one fifth of their present levels. Fuel cell vehicles may achieve even greater economies, by reducing fuel consumption to as low as 1 l/100 km or less—a reduction in fuel excise tax revenues of more than 90%."

Reasons/Arguments for Carbon Saving Achievement or Failure

Year	Author	Type	Evidence
			General
2008	DoT (ref 11594)	Q	In the first half of 2008 vehicle miles travelled declined 2.8% relative to 2007.
2008	Cortright (ref 11530)	C	In the US, starting in 2007 and 2008 there has been substantial declines in the sale of fuel inefficient vehicles such as SUVs and light trucks, and reduced demand for housing in automobile-dependent locations, indicating that consumers are taking fuel costs into account when making long-term decisions.
			Importance of total price/cost
2004	Ekins and Dresner (ref 11528) and citing Glaister, 2002	Q	Glaister (2002) explains how despite the focus of the public on the cost of fuel as a result of the fuel duty escalator, the cost of motoring (including purchase, maintenance, petrol and oil, and tax and insurance) between 1987 and 2001 remained relatively stable – at or below its 1980 level in real terms, even though the real cost of fuel in 2003 was 12% higher than in 1980. This was partly a result of a reduction in vehicle purchase price. Ekins and Dresner (2004) explain: "In contrast to overall motoring costs, public transport fares have risen in real terms over the last 20 years. In 2001, bus and coach fares were 31 per cent higher and rail fares 37 per cent higher than in 1980. Over the same period, average disposable income has gone up more than 80 per cent in real terms. Transport has therefore become more affordable, with a greater improvement in the affordability of car use than that of public transport."

Year	Author	Type	Evidence
2004	Ekins & Dresner (ref 11528)	C	The effectiveness of fuel taxes as a policy lever will be limited if the total cost of motoring is falling, especially if it is falling relative to the alternatives.
1998	Bohlin (ref 824)	Q	A Swedish carbon tax, which added about 20% to oil costs, had no noticeable impact on transport, as other costs were so dominant.
			Price versus income elasticity
2006	ECMT (ref 11271) citing Goodwin et al, 2004	Q	"For transport, the main reason why a carbon tax would have limited effects is that price elasticities tend to be substantially smaller than the income elasticities of demand. From Goodwin (2004) we conclude that the price-elasticity of total transport demand can be 0.6 in the long run and the income-elasticity of demand is a factor 1.5-3 higher. This implies that price of fuels must rise faster than incomes to curb CO_2 transport emissions if the price mechanism is used as the principal policy tool. One reason for the low price elasticity is that environmentally motivated price increases are largely invisible within the overall movement in fuel prices caused by volatility in international oil markets".
2002	Glaister (ref 3521)	Q	In the long run a 10% increase in income will increase fuel demand by 11%.
			The need for predictable and gradual increases in price
2007	World Energy Council (ref 11480)	C	The World Energy Council notes UK and German experience and concludes the taxation of fuel should follow an escalator approach with periodical growth rates in order to influence car use behaviour in the longer term. Otherwise, consumers tend to get used to the higher prices in the longer term and the short-term effects of a rise in taxes are counterbalanced.
2008	Litman (ref 11488); and citing Metschies, 2005	C	One of the most appropriate emission reduction strategies is to gradually and predictably increase fuel taxes. At a minimum, fuel taxes should increase to reflect all public expenditures on roadways and traffic services (citing Metschies, 2005).
2007	ECMT (ref 11272)	C	"This type of policy is particularly effective if it adjusts excise duties annually, as was the case in the UK, in order to keep the cost of transport in line with increases in real incomes".
2007	CFIT (ref 11294)	C	Organisations such as the Commission for Integrated Transport believe that the policy should be one which guarantees stable and sustained fuel prices to maintain the price signal and lock-in the benefits of efficiency improvements. They advocate that the new Climate Change Committee in the UK should fulfil the function of advising the Government on whether and by how much fuel duty may need to increase as part of its anticipated review of progress towards carbon targets. CfiT anticipate that in periods of high oil prices, fuel duty may not need to rise in order to ensure carbon reductions. This could also bring assurance to business and consumers regarding the future cost of their fuels.
2007	Buchan	Q	Similar to CfiTs proposal, Buchan (2007) identifies the

Year	Author	Type	Evidence
	(ref 11452)		fuel tax increase needed to balance his targeted increase in fuel efficiency of the average car of 62.5% between 2006 and 2020. This results in the total vehicle stock in the UK achieving an efficiency increase of 42.2%. The fuel duty increases in Table 8.2 have been designed to match this (including the addition of VAT) so that there is no overall incentive to increase travel by car. The less efficient the car, the greater will be the incentive to its owner to use it less. This is consistent with the overall policy objective. In revenue terms, if motorists drive the same distance as today in their more efficient vehicles, the revenue from fuel duty will stay the same and their fuel costs per mile will stay the same. It should be noted that all the figures are in 2006 prices (no allowance made for inflation). Thus this proposal is not the same as the fuel escalator, where increases used a fixed percentage increase in duty every year. The introduction is phased, to allow more time for new cars to enter the fleet, but this must be accompanied with a clear commitment to follow the pattern through until 2020. This will enable car owners to make secure long term choices.
2006	Eddington (ref 11509)	C	Regardless of the tax, the total fuel price can go down as well as up depending on the world oil price. Fuel prices have increased substantially in recent years due more to fluctuations in world oil price rather than increased taxation. Given the elasticities of demand, if the world oil price were to drop substantially, this would lead to increased vehicle use and CO_2. Even without a fall in fuel price, fuel *costs* could fall due to forecast improvements in vehicle efficiency.
			Magnitude of the increase
2006	Robert (ref 4789)	Q	Drastic increases of fuel price would have a significant impact on private vehicle travel. However, even a doubling of the fuel price would still require a mix of renewable fuels of 58% in order to reach 1.5 tons per capita in total (0.35 ton/ capita transport emissions) in Stockholm by 2030, corresponding to about a 70% reduction of greenhouse gas emissions. The most substantial impact per unit of price increase observed in this study would be to increase fuel costs from 0.8 SEK/km to 2 SEK/km. It would reduce CO_2 emissions by 21%, which would require a mix of renewable fuel vehicles of 53% in Stockholm County. However, only a marginal relative emission impact of just 6% is evident from an additional increase in fuel price from 2 SEK/km to 3SEK/km.
2006	Potter (ref 2190) citing Bates et al. 2004	Q	Potter (2006) cites Bates et al. (2004) who modelled the possible effect of fuel duty on congestion and stated that: "to keep [traffic] demand at its present levels and therefore congestion on average no worse than it is now, would require motoring charges or tax to be five times the current level of fuel duty, an annual increase of 6% every

Year	Author	Type	Evidence
			year (the same rate of increase as the fuel duty escalator which led to the fuel duty protests after only a few years)".
2003	Harmsen (ref 11449)	C	"As the price elasticity of demand is relatively inelastic significant price increases would be required to produce large savings in CO_2. Therefore it may be best used as a measure to lock in savings from other measures and further incentivise efficiency savings."
2001	AIT (ref 11239); and citing Glaister and Graham, 2000	Q	The UK public believed the fuel duty escalator to be a revenue raising measure. Consumers need to use their cars, and so will absorb any price increases. Also, rising incomes overall, will mean that more people will be able to drive more, and so fuel tax has not, and will not lead to reductions. AIT cites Glaister & Graham (2000) who suggest that fuel duties would need to be increased by at least 10% a year to secure a significant reduction in car use. AIT conclude that fuel tax could never be increased enough to make a significant impact on emissions, within the limits of political acceptability. It cites "research conducted during the European Commission's Auto Oil II programme in 1999" which suggested that CO_2 savings from an even more aggressive fuel tax regime would be limited. Figure 5 shows that increases of 20% above 1999 levels, which are in fact extremely unlikely for political reasons, would achieve very modest CO_2 savings.
			Carbon content tax
2008	King (ref 11335**)**	C	Taxation (i.e. fuel duty) is already used to price carbon in the transport sector and it has a significant impact on demand and incentives for alternative fuels. In this way, it can have a similar effect on CO_2 emissions from the sector to that of including road transport in a trading scheme. However, there are also important differences. For example, including road transport in the EU ETS has advantages over tax with regard to establishing a single price for carbon across sectors and across countries, as well as in providing consistent incentives across the life cycle of fuels. Tax has advantages with regard to simplicity, revenue flexibility, stability and tax sovereignty.
1999	Jansen and Denis (ref 592**)**	C	The most cost-effective instrument should be a tax on the carbon content of fuel because (1) it would activate all leverages for reduction (emissions technology of vehicle, characteristics of fuel, age of vehicle, vehicle degradation, maintenance, fleet size, composition of fleet, average trip length and total distance driven, speed and driving style, location, time of use and load) and (2) it would allow consumers to equalise marginal costs across all leverage points. Any other instrument would be less efficient.
			Combining fuel tax with other taxes and policies
2007	Buchan (ref 11452)	C	A variety of commentators conclude that multiple policies should be employed to compensate for the way consumers heavily discount future fuel savings when they make decisions on the purchase of a new car. Such authors tend to illustrate the important benefits of adopting an

Year	Author	Type	Evidence
			integrated approach to correct various market failures. Also, it is often noted that using one mechanism to achieve significant change means the level at which it is applied will have to very strong, and the risk of failure, for example through unforeseen side effects, is high. A basket of policies that support each other will mean each can be applied at a more moderate level and the risks are reduced.
2007	Buchan (ref 11452)	C	Buchan (2007) argues for a new car sales levy, which does not apply to the most efficient vehicles, together with a phased increase in fuel duty and a revised annual VED. The inclusion of the sales levy is for the simple reason that it applies directly to the purchase decision. To do the same through VED would require much more draconian increases. This is because people would tend to discount the value of the VED in future years – a principle which is widely accepted in all financial appraisal. In addition an emphasis on VED would do little to discourage use. Buchan suggests the sales tax is supplemented with the fuel duty increase and VED reform. A guaranteed scrap value is not central but is considered to be beneficial. A summary of the new charges is shown in Figure 8.1.
2007 2007	CfIT (ref 11294); Anable and Bristow (ref 12297)	C	Fuel taxes are also needed themselves to lock in the benefits of other policies such as fuel efficiency improvements.
2007	US GAO (ref 11191**)**	C	"Because a gasoline or carbon tax could have such broad effect on consumer decisions, it could be used to complement CAFE or, if set at an appropriate level, to replace CAFE standards. The economic literature we reviewed indicates that a gasoline or carbon tax would produce greater oil savings than increasing CAFE standards alone and at less cost."
2007; 1999	ECMT (ref 11272); Jansen and Denis (ref 592**)**	C	Jansen and Denis (1999) concludes that the best policy mix consists of fuel taxes that are combined with differentiated purchase taxes to correct for the assumed 'myopia' of under-estimation of fuel costs by car buyers. This was also the conclusion of the ECMT (2007).
2003	Hayashi (ref 11176)	C	Preferential taxation based on engine size and fuel economy, in combination with fuel taxation, will effectively reduce CO_2 emission and increase government revenue.
1999	Soberman (ref 3801)	C	Analysis suggests the fairly obvious conclusion that the greatest impacts of pricing automobile use occur within markets where reasonable alternatives to the private automobile actually exist. The inference here is that there should be reasonable access to public transportation if fuller cost pricing of automobile use is to have much impact. Also the accessibility of different activities is important; and vice versa, the influence of the transport system (i.e. accessibility) and the urban structure are significant factors in assessing the effects of pricing in the transport system.

Year	Author	Type	Evidence
1999	Jansen and Denis (ref 592**)**	C	Jansen and Denis (1999) show the importance of imputing marginal costs of public funds – i.e. the effect on Government funds. They conclude that for a CO2 strategy, even if market inefficiencies are pervasive, fuel taxes remain the most efficient broad –based instrument to achieve reduction. No other comes close to equalising marginal costs across so many emissions reduction channels. It also raises revenues and reduces other transport externalities.
1999	Jansen and Denis (ref 592**)**	Q	The assumption of myopia is potentially of larger importance than for CO2, because here technical solutions are relatively more important. Even so, model simulations strongly imply that a mix of differentiated purchase and circulation taxes provide a cost-effective means to reduce noxious emissions when the welfare metric incorporates the effects of changes in tax revenue and other externalities. The best policy mix for reduction of conventional emissions includes an emissions-based kilometre tax combined with a purchase feebate. This allows a 60% reduction in toxic emissions [i.e. not just CO2] without noticeable loss of welfare.
1999	Jansen and Denis (ref 592**)**	Q	A combination of a fuel/CO2 tax with a 'gas guzzler' differentiated purchase tax could reduce CO_2 emissions by over 25% without reducing well-being. For example, Jansen and Denis compares the cost-effectiveness of a CO_2 tax with alternative reduction instruments organise into four groups: standards; feebates; hybrid feebates with taxes; and instruments directed at other policies e.g. road pricing and NOx tax. With the exception of road pricing, the curves are upward sloping, reflecting negligible start-up costs and increasing marginal costs of reduction achievement. The assumed degree of 'myopia' is important here. A fuel tax alone cannot provide a least-cost way to achieve reductions if markets do not function efficiently. A cheap first step to adjust for myopia could be a mandatory labelling of likely costs of fuel use during the life of a car. The authors show that for small emissions reductions, a purchase feebate or even a regulatory introduction of fuel efficiency alone provides viable zero cost options – because the starting point is already a fairly substantial fuel tax. However a combination of fuel tax and feebate appears to be the superior solution.
1997	Koopman (ref 5890); and citing Koopman 1995a	C	Koopman (1997) notes that the link between CO_2 and the policy must be direct: The efficiency of economic instruments to curb transport externalities depends critically on the extent to which they are linked with the underlying problem (citing Koopman, 1995a). The closer the link, the more efficient the instrument, because it gives economic agents incentives to exploit a wide range of mitigation options. It can therefore be concluded that fuel taxes are only truly efficient in respect of CO_2 emissions where the link between charge and emissions is direct.
1995	Koopman	C	If consumers underestimate vehicle lifetime fuel use when

Year	Author	Type	Evidence
	(ref 5890)		buying a vehicle, this makes a case for coupling the CO_2 tax with a gas guzzler policy, or other equivalent purchase incentive.
			Replacing or coupling fuel tax with road pricing or carbon trading
2008	Hensher (ref 11464)	C	On balance Hensher favours the mix of improved fuel efficiency and a variable user charge: "Overall it appears that a mix of technology (i.e. fuel efficiency improvements) and pricing through a carbon tax or a variable user charge is the way forward assuming continuing use of fossil fuels. The carbon tax, in the presence of improved fuel efficiency is likely to be linked to reduced CO_2 per vehicle kilometre and hence will not have as great an impact on reduced vehicle kilometers traveled as a variable user charge".
2004	Stopher (ref 517)	C	Replacing the fuel excise tax with a distance-based road-user charge that is revenue neutral would remove the dilemma faced by government that encouragement of more fuel-efficient vehicles will reduce government revenues. "At the same time, by making this shift a revenue neutral shift, there should be greater public acceptance of the change. Furthermore, hypothecation of the revenues raised by a kilometrage fee would provide a much greater potential public acceptance, as has been found with the proposed area scheme in London. By shifting away from the fuel-based charge to a distance-based charge, revenue becomes separated from fuel-efficiency, which seems to be a desirable direction to pursue."
2001	Proost (ref 3773)	C	The reform of taxes in the transport sector will require a substitution of mainly fuel excise taxes by road pricing and other instruments. Fuel pricing is an inefficient instrument to solve transport externalities because it cannot discriminate between peak and off-peak travel and because it induces consumers to invest disproportionally in fuel saving.
1999	Jansen and Denis (ref 592**)**	C	The joint benefits in reducing numerous transport-related problems are also the reason why local measures, such as road pricing, should form part of a cost-effective emissions reduction strategy. An additional advantage of these instruments is that they can be targeted to local hotspots.
1995	Koopman (ref 5890)	C	Koopman (1995) supports economy wide carbon fees and tradable permit schemes first, as being the most cost effective way to save carbon, through equalising the marginal cost of carbon abatement across all sources.
			Public Acceptability
2007	ECMT (ref 11272)	C	"The experience of the UK fuel duty escalator, introduced in 1993 and frozen in 2000, and opposition to increases in Germany's eco-tax demonstrates the political difficulties involved with policies that operate through fuel taxes. Public acceptability is unlikely to cease to be a constraint on the use of fuel carbon taxes for the foreseeable future."

Year	Author	Type	Evidence
2007b	CEC (ref 11259)	C	CEC (2007b) explains why use of fuel duty was not considered further in the Commission's review of mechanisms to achieve vehicle CO_2 targets "Concerns about its effectiveness and political acceptability have led to excluding the option of relying exclusively on excise duties on transport fuels as a policy option. The equity considerations raised by the tax rates that would be needed to have a significant impact on vehicle fuel efficiency limit the political acceptability of this option, especially in a context where oil prices have significantly increased in the past years."
2006	Potter (ref 2190)	C	Some commentators are not convinced that the environmental message will win over the public: "There is a widespread perception that the motorist is simply a convenient source of revenue and that the environmental justification of taxation is little more than a matter of presentation."
2004 2006	Begg (ref 3472) Potter (ref 2190)	C	Begg (2004) describes the huge impact of the political unacceptability of the Fuel Duty Escalator in the UK. The resulting fuel protests led to the loss of the Government's 20-point lead in the opinion polls in 1 month. The policy was then abandoned in the 2000 Budget after the fuel protests and duty was subsequently frozen in money terms (i.e. reduced in real terms) in the budgets of 2001 and 2002 and increased in line with inflation in 2003. By 2004, allowing for inflation, there had been a cut of around 6 ppl in petrol and diesel fuel duty rates, and the Government abandoned its only lever for managing traffic levels. Potter claims the UK alone reduced annual automobile and truck taxation by nearly £2 billion (about US$3 billion).
2004	Begg (ref 3472)	C	Some feel the protests could at least be in part put down to a lack of communication of the policy goal by the Government. For example, Begg (2004) says "…this may be related to public perception of the policy goal...the Government was perhaps mistaken in allowing the escalator to be perceived as a purely fiscal policy. If it had been more aggressive in justifying the policy on environmental grounds (vis-a-vis raising revenue for public expenditure) then direct action, and the abandonment of the policy, may have been avoided."
2004	Begg (ref 3472)	C	Begg (2004) notes that communication about the total tax burden may be beneficial. The widespread public consensus is that UK fuel duty is the highest in Europe, and therefore should not be raised. Undoubtedly, UK fuel duty rates are the highest in Europe, but when all motoring taxes are taken into account – such as purchase tax, vehicle excise duty, fuel tax and road tolls, the UK total tax burden on the motorist is on par with average European rates – however the general public seem unaware of this.
2006	Potter (ref 2190)	C	There is widespread feeling governments are now very wary of simply charging higher rates for existing transport

Year	Author	Type	Evidence
			tax measures and that public acceptability is getting to be more and more of a barrier. Potter believes that transport taxation in the UK, particularly upon fuel, is an increasingly controversial subject.
2003	Harmsen (ref 11449)	C	Harmsen (2003) and many other authors cite the demonstrations about the price of fuel witnessed in the UK and some other European countries in 2000 and thus comment how challenging the use of fiscal instruments can be.
2003	Harmsen (ref 11449)	C	There are few solutions suggested to the issue of public acceptability. Harmsen (2003) observes for UK and Germany that tax increases always meet some resistance. In the UK and the German case this resistance was overcome by a gradual introduction of the tax increase. This feature gives the economy and the consumer's time to adjust to the new tax levels. Furthermore, the German fuel tax increase was compensated by a simultaneous decrease in the income tax. In addition, revenue redistribution may be important in achieving public acceptance. Harmsen notes “The more acceptable measures seem to be those which reform or change the way charges or taxes are levied sometimes in a revenue neutral way.” Harmsen also believes it should be noted that acceptability may in some cases, depending on the size and the nature of the tax changes, also reflect concerns about transaction costs. For example, significantly changing the relative size of the diesel tax compared to the petrol tax, may involve substantial transaction costs, and concerns about this may be at the heart of the opposition to the change. This does not apply in the UK where there is no tax differential between petrol and diesel. From an ecological and competitive point of view, an EU-wide eco-tax would be desirable. Harmsen (2003) cites the German reply to his study which stated that an essential barrier from a political point of view was the national solo effort, which was made when introducing the eco-tax. Harmsen concludes that as the price elasticity of demand is relatively inelastic significant price increases would be required to produce large savings in CO_2. Therefore it may be best used as a measure to lock in savings from other measures and further incentivise efficiency savings.
2002	Glaister (ref 3521)	C	“Increasing taxation was an explicit emissions-reducing policy as well as a traffic-reducing policy in the first 3 years of the 1997 government.”

Policy suitability for UK

Year	Author	Type	Evidence
			See public acceptability issues in section titled ‘Reasons/Arguments for Carbon Saving Achievement or

Year	Author	Type	Evidence
			Failure’ above.

References

AIT & FIA 2001 – 11239 - Fuelling the Debate - A Fair, efficient and environmental fuel tax policy, Alliance Internationale de Tourisme and the Fédération Internationale de l'Automobile, Brussels.

Anable, J. & Bristow, A. L. 2007 – 12297 – Transport and Climate Change: Supporting document to the CfIT report, Commission for Integrated Transport.

Anderson 2003 – 11240 - A Study into the Tools for Influencing Consumer Behaviour in Transport Choices

Anderson, R. 2003 – 11240 - A Study into the Tools for Influencing Consumer Behaviour in Transport Choices, AEAT, ED01512.

Ayres 1998 – 11245 - Consumer Incentives to Reduce Greenhouse Gas Emissions from Personal Automobiles

Ayres, G. 1998 – 11245 - Consumer Incentives to Reduce Greenhouse Gas Emissions from Personal Automobiles, Society of Automotive Engineers, Inc..

Barker, T. & Rubin, J. D. 2007 – 11428 - Macroeconomic Effects of Climate Policies for Road Transport: Efficiency Agreements Versus Fuel Taxation for the United Kingdom, 2000-2010, Transportation Research Board 86th Annual Meeting p. 15p.

Begg, D. & Gray, D. 2004 – 3472 - Transport policy and vehicle emission objectives in the UK: is the marriage between transport and environment policy over?, Environmental Science & Policy, vol. 7, no. 3, pp. 155-163.

Blow, L. & Crawford, I. 1997 – 11555 - The Distributional Effects of Taxes on Private Motoring, London: Institute for Fiscal Studies

Bohlin, F. 1998 – 824 - The Swedish carbon dioxide tax: effects on biofuel use and carbon dioxide emissions, Biomass and Bioenergy, vol. 15, no. 4-5, pp. 283-291.

Buchan, K. 2007 – 11452 - National project on transport policies to address climate change, MTRU.

CEC 2007 – 11259 - Results of the review of the Community Strategy to reduce CO2 emissions from passenger cars and light-commercial vehicles, Commission of the European Communities, Brussels.

CERA 2006 – 11548 - *Gasoline and the American People*, Cambridge Energy Research Associates, Cambridge, Massachusetts.

CfIT 2007 – 11294 - Transport and Climate Change: Advice to Government from the Commission for Integrated Transport, Her Majesty's Stationery Office.

Cortright, J. 2008 – 11530 - Driven to the Brink: How the Gas Price Spike Popped the Housing Bubble and Devalued the Suburbs, CEOs for Cities

COWI 2002 – 11264 - Fiscal Measures to Reduce CO2 Emissions from new Passenger Cars, European Commission's Directorate-General for Environment.

DEFRA 2006 – 11253 - Synthesis of Climate Change Policy Evaluations, Department for Environment, Food and Rural Affairs, London.

DEFRA 2006 – 11553 - Climate Change the UK Programme 2006, Department for the Environment, Food and Rural Affairs, White Paper Cm 6764

DoT 2008 – 11594 - Traffic Volume Trends, June 2008, Office of Highway Policy Information, US Department of Transportation, Federal Highway Administration.

ECMT 2006 – 11271 - Cost effectiveness of CO2 mitigation in transport.

ECMT 2007 – 11272 – Cutting Transport CO2 Emissions - What Progress?

Eddington 2006 – 11509 - The Eddington Transport Study, Department for Transport, London.

Ekins, P. & Dresner, S. 2004 – 11528 - Green Taxes and Charges, Joseph Rowntree.

Gallagher, K. S., Collantes, G., Holdren, J., Frosch, R., & Lee, H. 2007 – 11461 - Policy Options for Reducing Oil Consumption and Greenhouse-Gas Emissions from the U. S. Transportation Sector, Energy Technology Innovation Policy, Belfer Center for Science & International Affairs, John F. Kennedy School of Government, Harvard University., Cambridge, MA.

Glaister, S. 2002 – 3521 - UK Transport Policy 1997-2001, Oxford Review of Economic Policy, vol. 18, no. 2, pp. 154-186.

Goodwin, P., Dargay, J. and Hanly, M. 2004 – 11524 - Elasticities of road traffic and fuel consumption with respect to price and income: a review. Transport Reviews, 24(3), 275-292

Graham, D. J. & Glaister, S. 2004 – 11525 - Road Traffic Demand Elasticity Estimates: A Review, Transport Reviews, vol. 24, no. 3, pp. 261-274.

Gurikova, T. & Davis, S. 2002 – 11463 – TRANSPORTATION ENERGY SURVEY DATA BOOK 1.1, Oak Ridge National Laboratory, Oak Ridge, TN.

Harmsen, R., KROON, P., Ybema, J. R., Jespersen, M. S., & Jordal-Jørgensen, J. 2003 – 11449 – INTERNATIONAL CO2 POLICY BENCHMARK FOR THE ROAD TRANSPORT SECTOR - Results of a pilot study, ECN, ECN-C--03-001.

Hayashi, Y., Kato, H., & TEODORO, R. V. R. 2003 – 11176 - AN ANALYSIS OF THE EFFECTS OF CAR AND FUEL TAXES ON CO2 EMISSIONS IN JAPAN AND GERMANY, in Managing Transitions, Transportation Research Board, pp. 229-250.

Hensher, D. A. 2002 – 2024 - A systematic assessment of the environmental impacts of transport policy - An end use perspective, Environmental & Resource Economics, vol. 22, no. 1-2, pp. 185-217.

Hensher, D. A. 2008 – 11464 - Climate change, enhanced greenhouse gas emissions and passenger transport – What can we do to make a difference?, Transportation Research Board 86th Annual Meeting, vol. 13, no. 2, pp. 95-111.

HM Treasury 2008 – 11602 - Pre-Budget Report 2008, HM Treasury, London.

Hughes, J., Knittel, C., & Sperling, D. 2006 – 11526 - Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand, Institute of Transportation Studies, University of California, UCD-ITS-RR-06-16.

Jansen and Denis (1999) – 592 – A welfare cost assessment of various policy measures to reduce pollutant emissions from passenger road vehicles

Jansen, H. & Denis, C. 1999 – 592 – A welfare cost assessment of various policy measures to reduce pollutant emissions from passenger road vehicles, Transportation Research Board 86th Annual Meeting, vol. 4, no. 6, pp. 379-396.

Jansson, J. O. & Wall, R. 1994 – 11551 - Bensinskatteforandringars effekter, Swedish Ministry of Finance, (Ds 1994:55).

Johansson, O. & Schipper, L. 1997 – 11552 - Measuring the Long-Run Fuel Demand of Cars: Separate Estimations of Vehicle Stock, Mean Fuel Intensity, and Mean Annual Driving Distance, Journal of Transport Economics and Policy, vol. 31, no. 3, pp. 277-292.

Johnstone, N. & Karousakis, K. 1999 – 1108 - Economic incentives to reduce pollution from road transport: the case for vehicle characteristics taxes, Transport Policy, vol. 6, no. 2, pp. 99-108.

Kageson, P. 2003 – 11175 – ASSESSMENT OF EUROPEAN INITIATIVES TO REDUCE FUEL CONSUMPTION AND CO2 EMISSIONS, Transportation, Energy, and Environmental Policy: Managing Transitions pp. 204-228.

Kahn Ribeiro, S., Kobayashi, S., Beuthe, M., Gasca, J., Greene, D., Lee, D. S., Muromachi, Y., Newton, P. J., Plotkin, S., Sperling, D., & Wit, R. 2007 – 11336 – Transport and its infrastructure., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA..

King, J. 2008 – 11335 - The King Review of low-carbon cars - Part 1: The potential for CO2 reduction; Part 2: Policy Recommendations, HM Treasury, London.

Komanoff, C. 2008 – 11550 - We Explain Gasoline Demand (including why it's sticky), Carbon Tax Center, New York.

Koopman, G. J. 1995 – 5890 - Policies to reduce CO2 emissions from cars in Europe: a partial equilibrium analysis, Journal of Transport Economics and Policy; 29 (1) Jan 95 p. -70.

Koopman, G. J. 1997 – 7677 - Long-term challenges for inland transport in the European Union: 1997-2010: Consequences for transport fuel economy and use, Energy Policy, vol. 25, no. 14-15, pp. 1151-1161.

Litman, T. 2005 - 3344 - Efficient vehicles versus efficient transportation. Comparing transportation energy conservation strategies, Transport Policy, vol. 12, no. 2, pp. 121-129.

Litman, T. 2008 – 11488 - Smart Transportation Emission Reductions - Identifying Truly Optimal Energy Conservation And Emission Reduction Strategies, Victoria Transport Policy Institute, Victoria, BC.

Litman, T. 2008 – 11529 - Transportation Elasticities: How Prices and Other Factors Affect Travel Behavior, Victoria Transport Policy Institute, Victoria, BC.

Metschies, G. 2005 – 11554 - *International Fuel Prices*, German Agency for Technical Cooperation.

Michaelis, L. & Davidson, O. 1996 – 2446 - GHG mitigation in the transport sector, Energy Policy, vol. 24, no. 10-11, pp. 969-984.

Plotkin, S. 1999 – 11409 – Technologies and policies for controlling greenhouse gas emissions from the US automobile and light truck fleet, Transportation Quarterly, vol. 53, no. 2, pp. 7-30.

Potter, S., Enoch, M., Rye, T., Black, C., & Ubbels, B. 2006 – 2190 - Tax treatment of employer commuting support: An international review, Transport Reviews, vol. 26, no. 2, pp. 221-237.

Proost, S. & van Regemorter, D. 2001 – 3773 - Are there cost-efficient CO2 reduction possibilities in the transport sector? - Combining two modelling approaches, International Journal of Vehicle Design, vol. 26, no. 2-3, pp. 116-130.

Robert, M. & Jonsson, R. D. 2006 – 4789 – Assessment of transport policies toward future emission targets: A backcasting approach for Stockholm 2030, Journal of Environmental Assessment Policy and Management, vol. 8, no. 4, pp. 451-478.

Small, K. A. & Van Dender, K. 2007 – 11527 - *Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect*, Energy Journal, vol. 28, no. 1, pp. 25-51.

Soberman 1999 – 3801 - Impacts of full cost pricing on the sustainability of urban transportation: towards Canada’s Kyoto commitments

Soberman, R. M. & Miller, E. J. 1999 – 3801 - Impacts of full cost pricing on the sustainability of urban transportation: towards Canada's Kyoto commitments, Canadian Journal of Civil Engineering, vol. 26, no. 3, pp. 345-354.

Stopher 2004 – 517 - Reducing road congestion: a reality check

Stopher, P. R. 2004 – 517 - Reducing road congestion: a reality check, Transport Policy, vol. 11, no. 2, pp. 117-131.

Williams-Derry, C. 2008 – 11549 - Braking News: Gas Consumption Goes Into Reverse, Sightline Institute , Seattle.

World Energy Council 2007 - 11480 - Energy Efficiency Policies around the World: Review and Evaluation, World Energy Council, London.

U.S.Government Accountability Office 2007 – 11191 – Vehicle Fuel Economy: Reforming Fuel Economy Standards Could Help Reduce Oil Consumption by Cars and Light Trucks, and Other Options Could Complement These Standards, U.S. Government Accountability Office.