Fuel taxes as an energy saving policy – potential misperceptions of dynamic effects

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Abstract

A road fuel tax can be a cost-efficient policy instrument that internalizes some of the external costs of driving such as air pollution, greenhouse gas emissions, congestion and noise, and may also stimulate conservation and gradually improve the fuel economy of the car fleet. Fuel taxes are however often unpopular among the public, even when there is popular support for the principle of governmental policy to mitigate pollution and improve energy efficiency. This study is a first step in examining whether some of the opposition towards fuel taxes could be the result of overlooking or misperceiving some of the time-dynamic effects in the fuel tax system. While principle-based tax resistance may be unlikely to change quickly, resistance that is the result of misperceptions or overlooked factors could potentially be reduced if the economic system of fuel taxation was better understood. First, in part 1, we discuss the potential for overlooked factors and misperceptions. Second, in part 2 we use survey data from the United Kingdom to test for one potentially overlooked factor in the fuel tax system directly, namely the effect of fuel taxes on the average fuel economy of the car fleet. We find that the opposition towards fuel taxes is strong, and we do not find evidence indicating that the effect of taxes on fuel economy is not considered. Respondents also provide good estimates of the delay associated with changing the composition of the car stock. The results could be explained by the finding that respondents do not seem to have a high willingness to pay for having a more fuel economic car fleet as a country, even in a situation where high oil prices in the future are considered a risk. This indicates principled opposition rather than misunderstandings or overlooked factors. Future studies could examine more of the potential misperceptions and overlooked factors that are presented in part 1.

1. Introduction

While road fuel taxes are often favored by economists and policymakers, they are frequently protested by the public. This conflict between policymakers and the general population is potentially problematic when the public in principle supports government measures to reduce greenhouse gas emissions and to use energy more efficiently (Kallbekken, Kroll et al. 2011), and it is worthwhile to study why fuel taxes are opposed and how effective policies can be designed in order to increase acceptance. As all environmental and energy-saving measures come with a cost and fuel taxes are favored by economists for their cost efficiency, it is interesting to study why they are so out of favor with the public.

This study has two parts. First, we use a theoretical model to show the potential misperceptions of fuel tax effects in general, developing a general hypothesis that the hostility towards them may partly be caused by misperceiving or not taking into account some of the effects of fuel taxes, so that they are seen as more costly than they actually are. Second, we use survey data from a sample of the adult population in the United Kingdom to test for one important potentially overlooked factor, namely whether the effect of taxes on average fuel economy is considered.

Importantly, our study is focused on the energy-saving effects of fuel taxes and not their effects on CO_2 emissions. While climate policy may be a strong motivation for fuel taxes, the belief that emissions from human activity are influencing climate change may not have majority support. In

the United Kingdom for example, only 48% of those surveyed in a 2007/2008 Gallup poll said they believed increasing temperature was caused by human activities (Gallup 2007/2008). The figures for other European countries and the United States were in a similar range. When examining what influences and may influence public opinion, it is therefore important to also address the non-environmental effects of fuel taxes, even when the motive is emission reduction.

1.1.Opposition to fuel taxes – previous studies

Opposition towards fuel taxes has been extensively studied, and a large number of explanatory factors have been presented. The variation in attitudes and perceptions is great among individuals, but perhaps the most persistent factor, seen in multiple studies, is an apparent lack of faith that the tax revenue will be fairly handled by the government, indicated by the fact that earmarking tends to increase acceptance (Hsu, Walters et al. 2008; Kallbekken and Aasen 2010; Kallbekken, Kroll et al. 2011; Sælen and Kallbekken 2011). Dresner, Jackson et. al. (2006a) find that the incentive effect of environmental taxes may be overlooked by the public in European countries that have implemented environmental tax reform, although Kallbekken and Aasen (2010) find some evidence to the contrary in a focus group study in Norway. In Dresner, Jackson et al. (2006a), where several European countries were compared, a common suspicion was that the supposed environmental effects of a "green" tax reform were just being used to sell the policy to the public, while the real motive was to raise more government revenue.

We know less about public attitudes towards fuel taxes as an instrument to improve fuel economy and to reduce the general need for driving in society. In a poll by the New York Times (2006) somewhat confusing results were found; while a majority (85%) opposed a federal tax on gasoline, 55% said they would support it if it would "….reduce the United States' dependence on foreign oil", and 59% would support it if it would "cut down on energy consumption and reduce global warming"[1]. The willingness to use a higher gasoline tax to reduce income or payroll taxes or to "pay for the war on terrorism" were significantly lower (28% and 24%[2] respectively) (Times 2006) This would seem to indicate that respondents did not believe a gasoline tax would have much of an effect on gasoline use, oil dependence and the environment, which would be consistent with the findings of Dresner, Jackson et al. (2006a). Possibly, this could be explained by the perception that there are few possibilities to cut down on driving in the short term, and / or that drivers are basically stuck with the car that they have for a long time. In other words, there may be a conscious or unconscious preference for weighing short-term costs higher, while the potential for cost reduction in the long term is either forgotten or highly discounted. This hypothesis forms a basis for our study.

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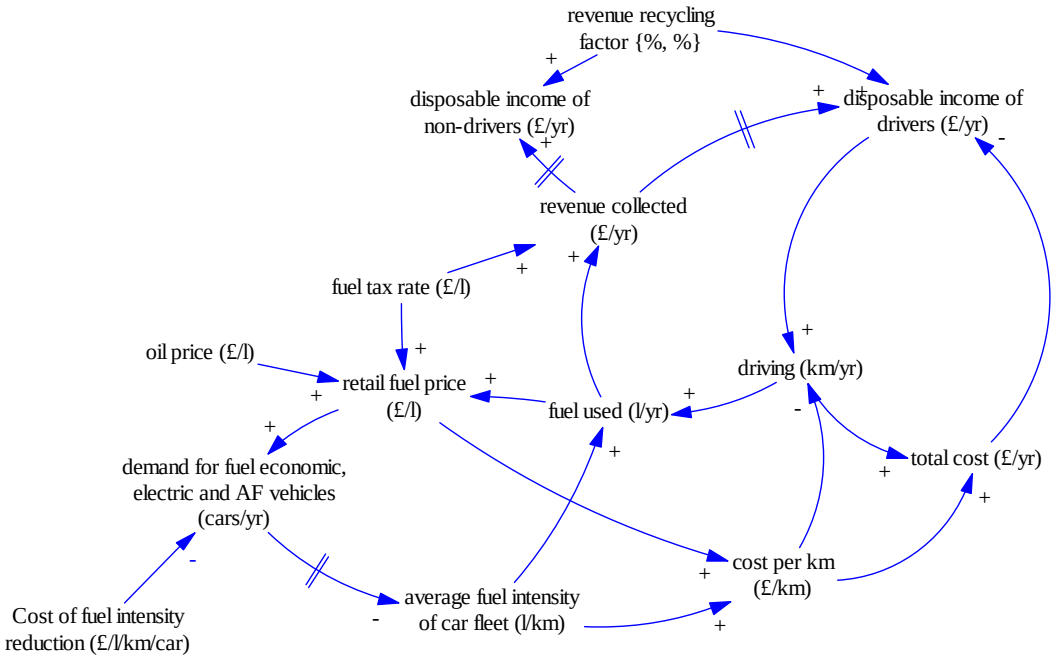
[1] An interesting finding when taking into account that this number may be higher than the percentage of people who believe global warming is a man-made problem – a 2007/2008 Gallup poll found this to be 49% in the United States. See Gallup (2007/2008). "Poll: Awareness, Opinions About Global Warming Vary Worldwide, see http://www.gallup.com/poll/117772/Awareness-Opinions-Global-Warming-Vary-Worldwide.aspx#2."

[2] When answering this question, respondents had by then been asked whether they would support a $2/ gallon tax increase. While the question of willingness to pay for the war on terrorism did not present any particular tax level, the answer could potentially be influenced by having brought a salient cost to mind in a previous question.

2. Fuel tax effects, potential misperceptions

In the following, we describe a theoretical model of some of the more complex effects of fuel taxes and illustrate it by causal loop diagrams (CLDs). For an introduction to CLDs, see Sterman (2000). With formalization, the model could be simulated with realistic parameter values, but this is not done here. As the mechanisms are not overly complex the diagrams should be sufficient to explain the model, and the purpose is simply to communicate the mechanisms, not to replicate historical behavior or to make numerical predictions.

2.1. Effect on fuel economy, recycling of tax revenue



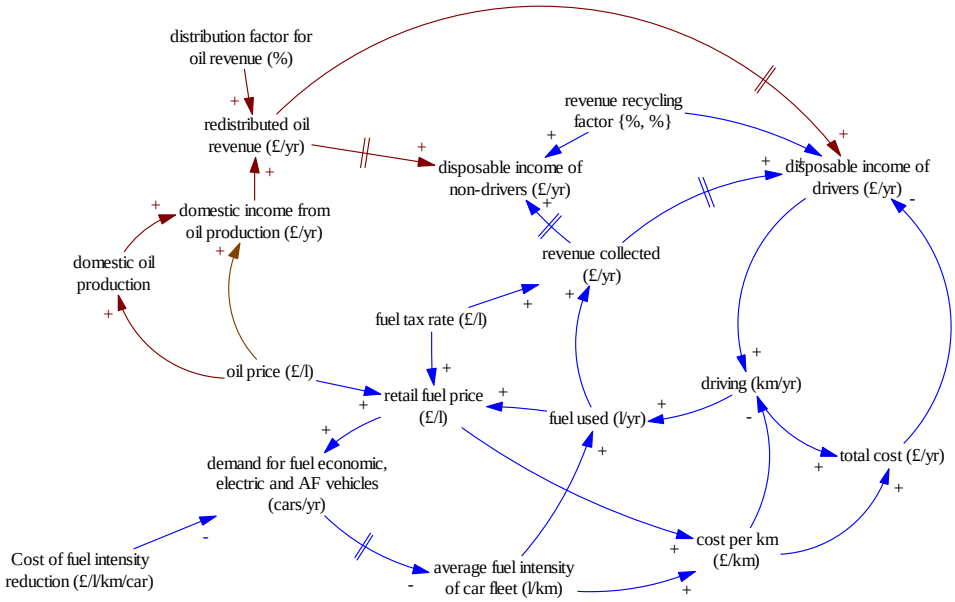
The diagram shows how a higher retail fuel price will increase the average cost of driving per km in the short term, but there is an offsetting effect from the slower, gradual transition to lower fuel intensity in the car fleet. The effect of fuel prices on fuel economy follows from standard economic theory and has empirical support (Clerides and Zachariadis 2008; Schipper 2008) The magnitude of this effect depends on the costs of reducing fuel intensity – not only in direct costs, but also by the decreased utility for car buyers who have preferences for larger cars, for example. The initial reduced driving may also put some downward pressure on the fuel prices set by retailers, although this effect may be uncertain. Expenses from fuel consumption drain the budgets of drivers and balances driving, but their budgets are also, to an extent, replenished by the recycling of the tax revenue. The “revenue recycling factor” broadly represents governmental spending policy. It is represented as the portion of fuel taxes that are directly or indirectly returned to the economy, whether by direct payments, the reduction of other taxes or by providing services that would otherwise have to be paid for privately. The factor also

incorporates the population distribution between drivers and non-drivers, allocating part of the revenue to each group depending on government policy. Unless the redistribution is done by direct cash payments or reductions of other taxes, the effect on disposable income will typically be delayed, as it takes time for the government to establish services that can save voters money.

The revenue recycling factor is a crucial element when addressing both the efficiency and the acceptance of fuel taxes. If the government is wasteful with the tax revenue it collects, taxpayers get little back, and there may be undesirable distribution policies. But it is hard to imagine an economy where taxpayers get *nothing* back – the factor should at the least be larger than 0, meaning that the actual cost of driving is not increased by an amount directly proportional to a fuel tax increase. The delay associated with revenue recycling does however mean that there is lag between paying the tax and getting a government service back. Even direct cash rebates or reduction of other taxes may come with a delay, although probably shorter.

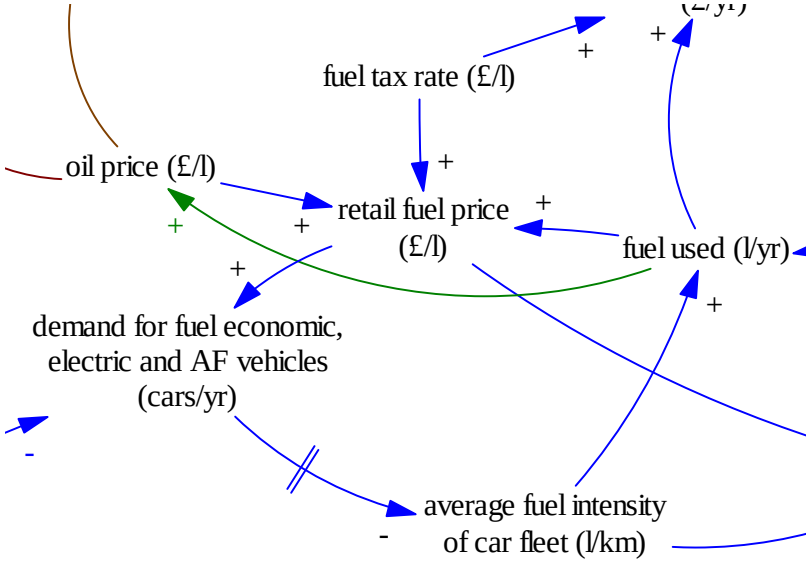
2.2. Domestic oil production

For countries with domestic oil production some of the price paid at the pump eventually comes back to the population, so that for large producers, high oil prices do not necessarily increase the price of fuel relative to income. Again, however, this depends on whether the country's oil industry actually benefits the population (including drivers) in general, and the effect may be weak is ownership is concentrated or government institutions are functioning badly. This is illustrated by the "distribution factor for oil revenue", which, if high, will recycle revenue from oil production back to the population with a delay. In other words, seeing high prices at the pump because of high oil prices should theoretically be seen in a less negative light in countries that are large producers and where the oil industry benefits the population, whether through ownership, employment or redistributed tax revenue from the industry.



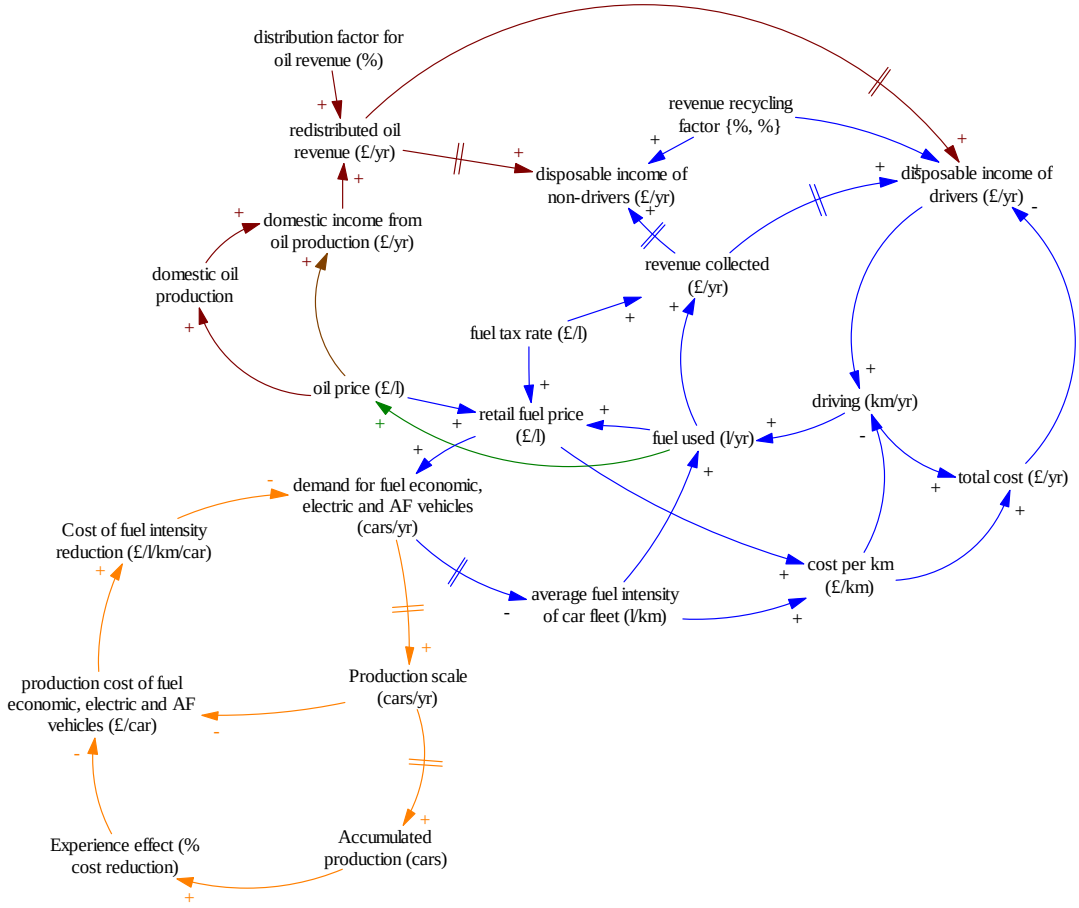
2.3. Large-market effects on oil prices

If a country's market for fuel is large, fuel taxes may have a significant effect on the global price of crude oil. Initially, an increase in the fuel tax rate would be expected to decrease fuel demand, putting downward pressure on the global crude oil price as well as on fuel producers and retailers. The longer-term expected effect would be an improvement in average fuel economy that could reduce demand, and thus oil prices, further. This effect has been described in more detail by Stoft (2008).



2.4. Large-market effects on automobile producers

Large automobile markets may have an effect on producers. If higher fuel prices result in increased demand for more fuel economic cars, electric cars or alternative-fuel vehicles, large markets should be expected to have a bigger influence. The effect is especially important if we consider learning curves and the potential to reduce production costs with experience and increased scale, which holds the potential for crossing a "tipping point" and thus tap into positive feedback loops for diffusion (Struben and Sterman 2007).



For an introduction to learning curves and scale effects, see for example Baloff (1971), Argote and Epple (1990) and Struben and Sterman (2007).

2.5. Summary

The causal model described above illustrates some of the more complex and dynamic effects of fuel taxes. The complex relationships indicate that the potential for misperceptions is there, especially if we consider the apparent difficulty people may have with understanding feedback mechanisms and time delays (Sterman 1989b; Moxnes 1998). Several effects are beneficial, indicating that the costs of a fuel tax increase should not be measured as a 1-to-1 relationship. The delay of the effects may however be long, and it may therefore be difficult for an individual driver to identify what he "gets back" for the taxes, while the price at the pump is more salient.

The model would predict that fuel taxes, with all other factors equal, should be seen in a more positive light in countries that

- Have well-functioning political institutions to ensure that the use of revenue is in accordance with public opinion

- Have large enough fuel and automobile markets to influence the crude oil price and automobile manufacturers
- Are net oil importers – especially if the market size indicates that oil prices could be lowered by a fuel tax

The model could be expanded. For example, patterns of settlement or localization, the prevalence of bike paths, public transportation and urban parking spaces may be influenced by long-term fuel tax policies.

3. Survey design

A survey was conducted in the UK through the polling company YouGov. From their database of respondents, a weighted sample of 2713 adults (>18 y) in the UK was drawn, and responded by means of an online questionnaire on January 22nd -24th, 2012. The sample is designed and weighted according to demographics[3] in order to form a close representation of the UK adult population.

The respondents answered the following 5 questions:

1. The price, per litre, of petrol or diesel in Britain is about £1.35 at the pump. This price includes a fuel duty (tax) of about 60 pence per litre. What do you think the British government should set the fuel duty at, starting in 2012?
    1. *I think the government should set the fuel duty to ____pence/litre*
    2. *Don't know*

2. As well as a fuel duty of about 60 pence per litre, petrol and diesel prices also reflect the costs of crude oil. Now, assume you were convinced that world crude oil production was going to decline in the next ten years and that very high and lasting crude oil prices could be expected from about 2020. What do you think the British government should set the fuel duty at, starting in 2012?
    1. *I think the government should set the fuel duty to ____pence/litre*
    2. *Don't know*

3. A car´s fuel consumption per mile affects the costs of driving. The lower the average fuel consumption, the less vulnerable the individual driver and the nation is to high crude oil prices. The UK has had fuel duties on petrol and diesel for many decades. Do you think these fuel duties have influenced people's choices of cars? *Fuel duties have made people choose cars with:*
    1. *Much lower fuel consumption per mile*
    2. *Lower fuel consumption per mile*
    3. *Same fuel consumption per mile*
    4. *Higher fuel consumption per mile*
    5. *Much higher fuel consumption per mile*
    6. *Don't know*

[3] See http://www.yougov.co.uk/about/about-QA.asp for details about the weighting procedure.

4. Please assume that because of high fuel prices, all people looking for a brand new car buy a model with low fuel consumption per mile. If this was the case, how long, in years, do you think it would be before 4 out of 5 of today's cars were replaced with these new low consumption models? If you are unsure, please make your best guess.
    1. *About _____years*
    2. *Don't know*

5. The last two questions asked you about the effect fuel duties have on fuel consumption and the time it would take for most drivers to switch to low consumption cars. Now that you have had a chance to think about these issues, would you reconsider your answer to the earlier question on the fuel duty? As well as a fuel duty of about 60 pence per litre, petrol and diesel prices also reflect the costs of crude oil. Now, assume you were convinced that world crude oil production was going to decline in the next ten years and that very high and lasting crude oil prices could be expected from about 2020. Taking this into account, what do you think the British government should set the fuel duty at, starting in 2012?
    1. *I think the government should set the fuel duty to ____pence/litre*
    2. *Don't know*

3.1. Null hypotheses

Essentially, the same question is asked in Q1, Q2 and Q5 but with changed conditions: In Q2 and Q5, a scenario of future crude oil scarcity is described, implying that the value of fuel economy will increase. This question is included in order to induce motivation for those who may not consider fuel economy to be relevant. Q5 differs from Q2 in that when answering Q5 the respondent has answered question Q3 and Q4. These questions, although they do not provide new information, are hypothesized to activate thought processes that could influence the respondent's answer. For example, if a clear change was seen in Q5, we would have evidence to suggest that the effect on fuel economy was not considered when answering Q1 or Q2. In all three questions, respondents are informed that the current fuel duty is about 60 pence per liter[4]. This acts as a first benchmark in each respondent's series of answers.

Additionally, we hypothesize that respondents who believe fuel taxes to have had a strong effect on fuel economy will tend to view them more favorably, either in the "base" scenario (Q1), the "scarcity" scenario (Q2) or in both.

Null hypotheses:

$H1_0$: Responses to question Q1 and Q2 will not differ for the individual respondent.
$H2_0$: Responses to question Q2 and Q5 will not differ for the individual respondent.

[4] At the time of the survey, the fuel duty was 58 pence per litre (See HM Revenue and Customs http://www.businesslink.gov.uk/bdotg/action/detail?itemId=1085465445&type=RESOURCES). Although this more accurate number could be used in the study, we believe an approximation is sufficient for its purpose, as the answer to Q1 is not its focus. Moreover, if people have a tendency to round off numbers, a benchmark of 58 p could mean that some respondents who are uninterested or whose opinion would be best described as "no change" would answer 60 p (more likely than 56 p, for example), introducing upward bias.

$H3_0$: Responses to Q1 and Q3 will be positively correlated.
$H4_0$: Responses to Q2 and Q3 will be positively correlated.

The structure of Q1, Q2 and Q5 can be thought of as a "within- subject" design, in which the interesting measure is how the individual respondent adjusts his or her answer when conditions change. While a comparison of the mean responses gives a good first indication of the effect of the introduced condition, important information may be overlooked if the magnitude of the adjustment between two questions is differs between those who adjust their answer up and those who adjust it down. A majority of respondents who adjust in a given direction may be canceled out by a smaller group who make larger adjustments in the other direction. In terms of testing systemic understanding, we consider the proportion of respondents that chooses a certain direction of adjustment to be more interesting than the magnitude of adjustment, although magnitude should not be overlooked either. For $H3_0$ and $H4_0$, we use weighted least-squared regression.

4. Results

In the following, *entries* refer to all valid responses except "don't know" out of 2713 respondents. A (w) denotes a weighted figure.

4.1. Responses Q1, Q2 and Q5

	Mean (p/litre)	Mean (w) (p/litre)	Entries	Entries (w)
Q1	44,224	44,509	2091	2090,72
Q2	44,269	44,417	1824	1811,15
Q5	45,357	45,387	1893	1890,11

The outlier (ID=2326, Q1= 3000) was removed.

4.2. Responses Q3

Q3 asks respondents to evaluate the effect fuel taxes in the UK on the fuel economy of cars on the road.

Fuel duties have made people choose cars with:	% (w)	% of entries (w)
Much lower fuel consumption per mile	21	26
Lower fuel consumption per mile	44	54
Same fuel consumption per mile	12	15
Higher fuel consumption per mile	3	4
Much higher fuel consumption per mile	1	1
Don't know	19	-

There is a clear tendency towards the opinion that fuel duties have influenced people's choice of cars. 65% (w) of respondents answered that the fuel duty has contributed to improve fuel economy, and if "don't know" answers are excluded, the figure is 80% (w). Whether these

numbers should be considered high or low is open to interpretation, but it seems clear that only a small minority (4% and 5%) believe that average fuel economy has been *negatively* affected by the fuel duty.

4.3 Responses Q4

Q4 asks respondents to make their best guess about how long it would take to replace 80% of the car fleet. The outlier (ID=1064, Q4=1000) was removed.

Time to replace 80% of cars on road	% (w)
Less than 5 years	7
5-9 years	20
10-14 years	27
15-19 years	8
20 years or more	12
Don't know	26

The mean response (weighted and unweighted) is 11,6 years. 8 respondents answered 100 years or more; these could potentially be unserious entries or entries based on misunderstandings. If these are considered outliers and removed, the mean response is 11,2 unweighted and 11,1 weighted. The weighted median when removing only ID1064 is 8,2 years and 8,155 when removing entries of 100 years or more.
There is a clear tendency for respondents to enter “round numbers” (5, 10, 15 etc.) in this question, suggesting that intuition and guesswork may be prevalent. This would be unsurprising. The most common response (including “don’t know”) is 10 years.

4.4. Change between Q1 and Q2

In total 1803 of 2713 respondents made valid entries to both Q1 and Q2. The outlier (ID=2326, Q1= 3000) was removed.

	Unweighted	Weighted	Proportion (w)
# of respondents Q2 > Q1	279	310,74	0,17
# of respondents Q2 = Q1	1287	1247,31	0,70
# of respondents Q2 < Q1	237	236,27	0,13
Sum (n)	1803	1792,97	1,00

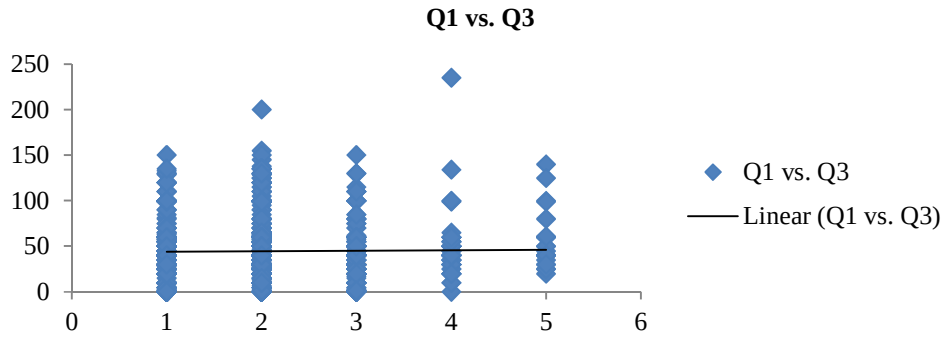
4.5. Change between Q5 and Q2

In total 1704 of 2713 respondents made entries to both Q2 and Q5. No outliers were removed.

	Unweighted	Weighted	Proportion (w)
# of respondents Q5 > Q2	210	217,16	0,13
# of respondents Q5 = Q2	1347	1318,01	0,78
# of respondents Q5 < Q2	147	153,59	0,09
Sum (n)	1704	1688,76	1,00

4.6. Regression Q1 and Q3

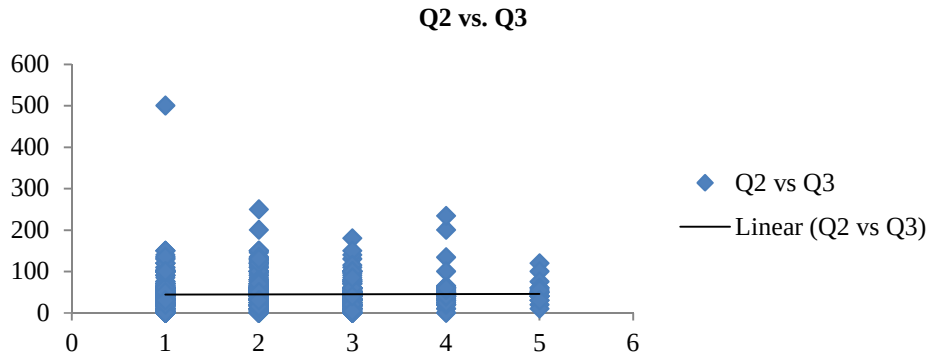
Figure 4a shows the plot of Q1 vs. Q5.



Using weighted least squares regression, we find that the slope parameter is small and statistically insignificant:

		Standard error	t	p-value
R	0,019			
R^2	<0,001			
Standard error of the estimate	26,95			
Intercept	43,76	1,1661	26,353	<0,001
Slope	0,63	0,777	0,808	0,419

4.7. Regression Q2 and Q3



Using weighted least squares regression, we find that the slope parameter is small and statistically insignificant:

		Standard error	t	p-value
R	0,027			
R^2	0,001			
Standard error of the estimate	28,92			
Intercept	42,94	1,899	22,613	<0,001
Slope	0,97	0,887	1,087	0,277

4.8. Results summary

A clear majority of respondents answer in Q1 that they would prefer a lower fuel duty than today, and the mean preference for the duty level is considerably lower than the current fuel duty. When the future "scarcity" scenario is introduced in Q2, the most common response is to not adjust the desired fuel duty in any direction (70% (w) of entries), and the percentage of unchanged answers between Q2 and Q5 is even higher (78% (w)). For those who do adjust, the tendency is upwards adjustment both from Q1 to Q2 and from Q2 to Q5, and both are significant at the 0,01 level if only entries that make adjustments are considered (using a normal binomial sign test which excludes neutral entries). However, the more interesting result is the low percentage of change, meaning that on average, the prospect of future oil scarcity does not change opinions of the level of fuel taxes today. The low rate of change between Q2 and Q5 would indicate that the effect on fuel economy probably was considered when answering Q1 and Q2.

Responses to Q3 and Q4 show that most respondents believe fuel taxes contribute to fuel economy in the car fleet, and that it takes time to replace it. The average scrapping age of cars in the UK is approximately 13,2 years, according to the British newspaper The Telegraph (2011). This would suggest that the respondents' mean estimate of 11,1 years (w) and mode of 10 years to replace 80% of the fleet seems fairly accurate.

5. Discussion

The majority of respondents believes fuel taxes have contributed to improving the fuel economy of the car fleet and are aware that the process may take a long time, but do not see a scenario of future oil scarcity as an argument for neither a lower nor a higher fuel tax today. The findings indicate that it is unlikely that voters are simply not thinking about the effect on fuel economy, or that they believe the car fleet could quickly be replaced if prices should soar. This rules out two potential misunderstandings.

We are still left with many potential contributing factors to the strong opposition towards fuel taxes as a Pigouvian instrument for energy policy. A useful distinction may be made between misperceptions and principled opposition – while clearing up a misperception has the potential to change opinions, opposition based on principles is unlikely to change as easily. For example, if one takes the normative "libertarian" view that government should not interfere in the price-setting of any product unless there are externalities, even when it believes people are acting against their own interests, only a clear demonstration of externalities can be convincing. And in the case of burning fuel, only about half of the British population believes in its main potential

externality - climatic change (Gallup 2007/2008). Still, it should not be overlooked that the survey found little support for abolishing the fuel duty altogether and overnight, with a mean desired level of ca. 45 p/litre from 2012. This would make fuel in the UK relatively cheap compared with many OECD countries, but still clearly more expensive than in the United States. The fact that the average fuel economy of the car fleet has steadily improved in Britain since 1970 (Schipper 2008) could suggest a higher "tolerance" for taxes, and the effect of localization and settlement patterns, public transportation and other infrastructure on the need for driving may also be significant. There may be a reinforcing feedback loop at work which is stronger in the United States than in Britain, similar to the one described in Hsu, Walters et al. (2008): As long as fuel taxes and prices are low (as they have long been in North America), infrastructure and average fuel economy slowly adapts to a state that requires more fuel per unit of economic welfare produced, which leads to strong political opposition towards raising fuel taxes. The result is a lock-in situation with a transportation sector that may be vulnerable to rapid oil price increases, but where it is politically infeasible to raise taxes as a policy instrument.

Drawing on the model in section 2, we would expect that the potential effect on the oil market and automobile producers would be less for the UK than for a larger market, such as the United States. In theory, this could explain some of the opposition in the UK and in smaller countries, but it is unknown whether these arguments are considered at all by the general public.

6. Conclusion

The study presents a theoretical model which summarizes some of the dynamic effects of road fuel taxes, drawing on standard economic theory. The model's purpose is to show the potential for misperceptions and overlooked factors that could lead to a view of fuel taxes as more expensive than they actually are. We then test public opinion for attitudes towards using fuel taxes as a policy instrument to improve fuel economy of the car fleet, and find that while the effect is considered, opposition is still strong and unchanged.

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