Financial Implications of Car Ownership and Use: A Social and Spatial Distributional Analysis.

Dr Tim Chatterton

Senior Research Fellow

University of the West of England, Bristol

Prof. Jillian Anable

Professor of Transport and Energy Demand

University of Aberdeen

Dr Sally Cairns

Senior Research Fellow

Transport Research Laboratory and University College London

Prof. Eddie Wilson

Chair in Intelligent Transport Systems

University of Bristol

Dr Godwin Yeboah

Research Fellow

University of Aberdeen

Abstract

This paper presents a new perspective on assessing the financial impacts of private car usage in England and Wales, using novel datasets to explore implications of motoring costs (Vehicle Excise Duty and road fuel costs) for households as part of the overall costs of their energy budget. Using data from an enhanced version of the Department for Transport 'MOT' vehicle test record database, combined with Department of Energy and Climate Change domestic gas and electricity consumption, we look both at patterns of car usage and consequent energy consumption, and examine road fuel as a proportion of total household direct energy consumption. We consider how both of these vary spatially in relation to levels of median income.

Introduction

With increasing digitisation of vehicle records, new opportunities are being afforded to researchers interested in exploring car usage at the level of individual vehicles. In particular, periodic vehicle safety and emissions inspections are providing a fruitful source of data. Globally these tests are becoming increasingly common, taking place in all 27 EU Member States, 32 States in the US, and at least 17 countries in Asia (Cairns et al., 2014; Chatterton et al, 2015). Data from these tests are being put to a range of uses, including understanding spatial patterns and elasticities of car ownership and usage (Moyce and Lloyd, 2013; Reardon et al., 2015; Yeboah et al., 2015), understanding geographical patterns of vehicle emissions (Chatterton et. al, 2015a), relationships between vehicle usage and urban form (Diao and Ferreira, 2014), implications of future city growth on greenhouse gas emissions

(Ferreira et al, 2013), issues of environmental and energy justice (Chatterton et al., 2015b) and the potential positive and negative impacts of pay-per-mile vehicle insurance (Ferreira and Minikel, 2013).

We explore the financial implications of car use by combining annual data from 30 million vehicles from the UK vehicle inspection ('MOT') test and accompanying registration data with Vehicle Excise Duty (VED) (an annual vehicle tax in the UK) and fuel costs. We place these costs in the context of domestic expenditure on electricity and gas use by using energy consumption data from 24.5 million electricity meters and 21 million gas meters (DECC, 2014). While much previous work has looked at motoring costs longitudinally, particularly with respect to price elasticities of road fuel (e.g Dargay, 2007, Goodwin et al, 2004), in this paper we look instead at how expenditure on motoring varies spatially and in relation to levels of median income. This places the work more in line with work on household expenditure (for example Dresner and Ekins, 2006; Brand and Boardman, 2008; Druckman and Jackson, 2008; Thumin and White, 2008; Gough et al., 2011; Buchs and Schnepf, 2013a, 2013b and Hargreaves et al., 2013). However, this body of work generally has no, or very limited, spatial detail as it tends to be based on limited sample survey data, predominantly the UK Living Costs and Food Survey (formerly the Family Expenditure Survey and National Food Survey). In this study, our examination of expenditure has focused on VED and fuel costs as these are the motoring costs which are most directly influenced by national taxation policy, and therefore reflect political decisions.

Costs of Car Ownership

The costs of running a car are made up of fixed annual costs (VED, MOT test fee, insurance etc.), sporadic costs (repair and maintenance) and fuel costs and, greatest of all, depreciation. The overwhelming impact of the balance of these costs is that *"annual average cost per mile decreases as the annual mileage increases and is frequently perceived as merely the cost of fuel"* (RCEP, 1994: Box 7C). Figure 1 shows the average annual household costs of car ownership by income decile calculated from the UK Living Costs and Food Survey (LCFS) (ONS, 2012). These vary in total from £660 for the lowest income decile, to £7,649 for the highest. The proportion of this that is spent on fuel varies between 32.3% for the highest decile and 42.6% for the second highest decile (36.6% overall). The living costs survey accounts for VED (and motoring fines) as a subsection of 'Licences, Fines and Transfers' alongside Stamp Duty for house purchases. Although the overall section is split by income decile, no such split is available for VED and motoring fines separately, so in Figure 1 these have been allocated proportionally according to the whole section. The overall average VED paid is £156 per household. The LCFS accounts for the cost of a vehicle in terms of purchase price, which is calculated as an average over all the households (although not every household purchases a vehicle each year). Another common way of reflecting this cost is in terms of depreciation (the annual reduction between the purchase price and the resale value). This has been estimated at around 15% per year (CarsDirect, 2013), and was estimated, in 1994, to represent 42% of average annual vehicle costs (RCEP, 1994) compared to between 21 and 35% (average 29.4%) for purchase costs in the LCFS for 2011.

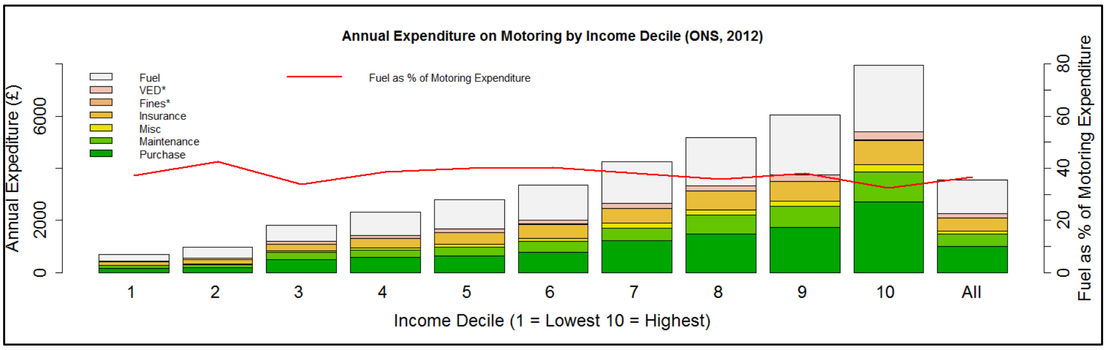

Figure 1: Annual expenditure on running a car by income decile (ONS, 2012 - *indicates no split across deciles available – see text))

To illustrate the difficulties in calculating the *full* cost of car ownership, it is worth considering Lynn Sloman's analysis from her book Car Sick:

"The typical car owning, Briton today devotes nearly 1,300 hours a year to his or her car. It takes him over 500 hours to earn the money first to buy the car and then to pay for petrol, insurance, repairs and parking. He spends another 400 hours every year sitting in his car while it goes and while it waits in traffic jams. More than 250 hours are devoted to a myriad small tasks associated with a car: washing it, taking it to the garage for repair, filling it with petrol, looking for the car keys and walking to the car, de-icing the windscreen in winter, and finding a parking space at the end of every trip. Finally, he has to work about 100 hours every year to earn the money to pay the extra building society interest because he has chosen a house with a garage rather than one without. All in all, the typical British car driver in 2005 devoted three and a half of his sixteen waking hours to his car. For this time, he travels a little less than 10,000 miles per year. His average speed is less than 8 miles an hour roughly the same as the speed at which he could travel on a bicycle." (Sloman, 2006, p1-2).

A highly detailed spatial analysis might also consider the impact of local policies on motoring costs, such as residential parking, workplace parking levies, low emissions zones, congestion charging and so forth. However, as already stated, this paper does not attempt to consider the full costs of car ownership and use, but focuses specifically on VED and fuel cost, representing around 40% of total car costs (according to LCFS figures) and representing the proportion of costs that national level policy has direct control over. We describe these briefly below.

Vehicle Excise Duty

Taxation of motor vehicles was first introduced in the UK in the 19th Century under the Customs and Inland Revenue Act 1888 which extended the definition of 'Carriage' from "*any vehicle drawn by a 'horse or mule, or horses or mules', to 'embrace any vehicle drawn or propelled' upon a road or, tramway, or elsewhere than upon a railway, by steam or electricity, or any other mechanical power*". Key issues that have surrounded VED from the start have involved issues of fairness and equity as well as questions over the appropriate purpose of the tax. As early as 1909, there were objections to the imposition of the tax. In a House of Commons debate around the introduction of a graduated VED based on horsepower, Mr Joynston William Hicks, then MP for Manchester North West stated: *"I hold that a motor car has now become almost a necessity, that it is very largely a commercial vehicle, not used, it is true, for carrying goods in that sense, but used by doctors and travellers, and by many people for other than purely pleasure purposes. In that sense I do not think a motor car can be classed as a luxury, and, therefore, should not be taxed as such."* (Hansard, 1909). He goes on to provide informative figures on the ownership and usage of vehicles *"In 1905, which were the latest figures, there were 2,732 motor cars of the average value of £374. Therefore the fashion is not so very luxurious after all. A very large proportion were small power cars. In 1906 the motor cars travelled 44,352,000 miles, and there were only 16 accidents."* (*ibid.*). He then proceeds to set out a range of arguments as relevant today as they were then, including whether it is reasonable to charge a flat rate for access to the roads (and whether the funds raised should be ring-fenced for road maintenance), what the justification is for charging motor cars but not horses (for which we may now read bicycles), and whether the tax should be graded on the basis of size, engine size/power or the amount of dust resulting from them.

A comprehensive history of UK VED is provided in Butcher (2015), but key changes to the basic framework set out at the start of the 20th Century are set out in Table 1. Up until 1992, in addition to VED, the UK had a 10% car purchase tax. However this was ended as part of plans to increase fuel duty with the 'fuel duty escalator' (see below), however a new graded first year rate of VED was introduced in 2008 (See Table 1). Current rates of VED are shown in Table 2. Exemptions currently exist for a number of vehicles under the Vehicle Excise and Registration Act 1994, in particular "electrically propelled vehicles" and "light passenger vehicles with low CO_2 emissions (i.e. that the emissions figure for the vehicle does not exceed 100 g/km)". Disabled people are also exempt, however it has not been possible to account for this within this study. It is also worth noting that for people who do not wish to pay VED in an annual lump sum, options to pay monthly by Direct Debit or for only six months increase costs by 5% and 10% respectively.

Table 1: Key changes to VED since the start of the 20th Century

Year	Key change to Vehicle Excise Duty (VED)
1937	The ending of hypothecation of the motor vehicle taxes so that it went into the Consolidated Fund and was no longer used specifically for highway maintenance.
1978	Labour proposals to end VED and replace it with a 20 pence-per-gallon increase in fuel duty.
1980	A decision by the Conservatives to retain VED in order to enable the maintenance of a vehicle register for "the police and vehicle control".
1990	The Institute for Fiscal Studies produced a report on Environmental Taxes (Pearson & Smith, 1990) which explored different ways in which taxes could be levied to cover environmental externalities. It concluded that a move from taxing ownership to taxing use could cut fuel consumption usage by 8%, but that there would be potential negative effects on rural populations and other locked-in high mileage users (though this might be countered in the long-run by a shift to more efficient cars) and possible inflationary effects on the economy by increasing the costs of goods moved by road.
1994:	A Royal Commission on Environmental Pollution report into *Transport and the Environment* (RCEP, 1994) favoured covering external costs through charges related to use rather than ownership.
2001:	Following announcements in the 1999 and 2000 Budgets, a new graded VED system was put in place. For all new cars registered from August 2001 onwards, a VED banding system was put in place based primarily on CO_2 emissions but with *"a discount for 'cars using cleaner fuels and technology and a small supplement on diesel cars to reflect their higher emissions of particulates and other local air pollutants"* (HM Treasury, 2000, para 6.62). Cars registered between 1973 and 2001 were split into two groups: smaller engine cars <1,200cc and larger engine cars. Cars registered before 1973 were classed as 'classic cars' and exempted under the 1998 Budget.
2002	New VED rates were applied to motorcycles to encourage their use in the place of cars, especially for commuting purposes due to lower impacts on the environment and congestion.
2006	A new seven band (A-G) VED system, still with petrol/diesel differentials was introduced, however the top rate only applied to vehicles registered from March 2006 onwards. Separate rates were introduced for vans (pre- and post-2001, and a separate rate for Euro IV). Cars pre-2001 were split into above or below 1,559cc.
2010	Thirteen different CO_2 bands were created "to strengthen the environmental signal" along with differential first year rates of VED (HM Treasury, 2009).
2008	A new graded first year rate of VED was introduced: zero for cars emitting <130g/kmCO_2, equivalent to the standard rate for vehicles emitting between 131 and 160g/kmCO_2, and £950 over this amount.
2015	For cars registered after 1st April 2017, first year rates will vary according to the carbon dioxide (CO_2) emissions of the vehicle, varying from £0 to £2,000 across 13 CO_2 bands. A flat Standard Rate (SR) of £140 will apply in all subsequent years, except for zero-emission (i.e. electric) cars for which the SR will be £0 (rather than the current 100g/km CO_2 threshold). Cars with a list price above £40,000 will attract a supplement of £310 on their SR for the first 5 years in which the SR is paid (HM Revenue & Customs, 2015). Through emphasising CO_2 emissions at the point of purchase, the new regime supposedly puts more pressure on manufacturers to reduce emissions. Controversially, the funds will become hypothecated to establish a new 'road fund' (previously abandoned in 1937).

Table 2: Current rates of Vehicle Excise Duty (since 2010)

Cars Registered on/after 1st March 2001													
Band	A	B	C	D	E	F	G	H	I	J	K*	L	M
CO_2 (g/km)	<= 100	101-110	111-120	121-130	131-140	141-150	151-165	166-175	176-185	186-200	201-225	226-255	Over 255
Petrol/ Diesel Cars	£0	£20	£30	£110	£130	£145	£180	£205	£225	£265	£290	£490	£505
Alt. Fuel Cars	£0	£10	£20	£100	£120	£135	£170	£195	£215	£255	£280	£480	£495

Cars Registered before March 2001		Light Goods Vehicles		Motor bikes				Tricycles	
<= 1549cc	£145	Pre-2001	£225	<= 150cc	151-400cc	401-600cc	Over 600cc	<= 150cc	> 150cc
>1549 cc	£230	Euro IV/V	£140	£17	£38	£59	£81	£17	£81

Fuel Costs

Fuel costs are comprised of two main elements: basic costs of fuel and taxation. In the UK fuel duty for petrol and diesel (and biofuel equivalents) is one of the highest in the world at £0.5795 per litre, with standard rate VAT added on the top (OECD, 2013). Between January 1990 and October 2015, this resulted in the total tax being paid on a litre of petrol comprising between 53 and 86% of the total pump price. When adjusted for inflation, petrol prices have increased by only 18% between October 1990 and October 2015 (from £0.85/litre to £1.08/litre), however there have been significant price spikes, with a maximum in April 2012 when petrol costs reached a 2015 equivalent of £1.47/litre (see Figure 2).

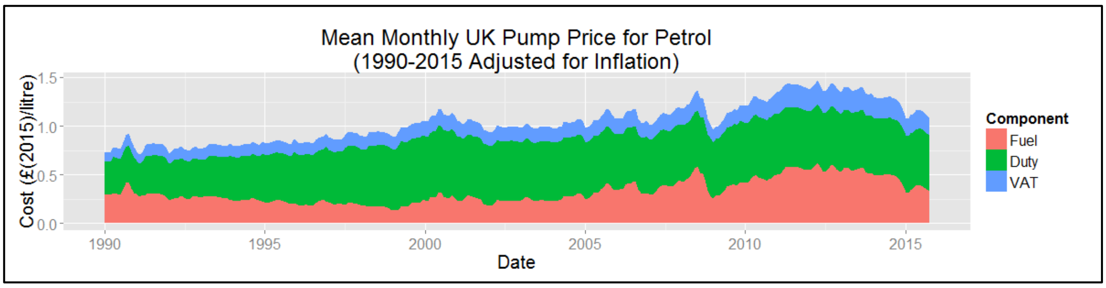

Figure 2: Relative composition of UK pump price for petrol (1990-2015) (DECC, 2015)

Between 1992 and 1999, in a move towards an increasing tax on use rather than ownership, the UK government introduced the 'fuel duty escalator'. This was an annual increase in fuel duty above the rate of inflation. Initially it was a 5% per annum increase, and then from 1997 it increased to 6% (Potter and Parkhurst, 2005). The initial intention of the Conservative government was to double the price of fuel at the pump in order to a) encourage manufacturers to develop more efficient vehicles, b) discourage non-essential car-use, and c) provide a more even playing field for public transport (Gray et al., 2001). The tax allegedly went largely unnoticed for most of the decade due to falling oil prices in real terms. However, as prices began to rise in 1999 its effects started to become more apparent, particularly by road haulage companies, leading to campaigns to abolish it. Even after it was abolished in November 1999, increases in the price of crude oil led to continuing price rise resulting in campaigns to reverse the historic increases and eventually to the UK-wide fuel protests in September 2000 (Santos and Catchesides,2005; Dresner et al., 2006).

Methodology

Through analysis of vehicle characteristics (year of registration, engine size, and fuel type) and the annual distance driven, it is possible to estimate both annual VED and fuel costs for every private vehicle in Great Britain, including cars, minibuses, vans (<3.5t) and two and three wheeled vehicles. Due to limitations of comparative data on income, we have only performed the analysis for England and Wales.

The basic principles of this analysis are set out in detail in Chatterton et al. (2015a). Further to that analysis, the MOT test record dataset has been 'enhanced' through the addition of a number of new parameters that have been acquired through a UK vehicle stock table from the Driver Vehicle Licensing Agency (DVLA). In particular, the DVLA data allows the linking of each vehicle to the Lower-layer Super Output Area of the registered keeper (a relatively socially homogeneous area of, on average, around 700 households, and 1600 persons), the CO_2 emissions (available for approximately 68% of vehicles (i.e. those registered after 2001) as well as an indication as to whether the vehicle is registered by a private individual or a corporate entity. This last parameter has allowed us, for the purposes of this analysis, to investigate only privately owned vehicles. Also, the provision of data from the DVLA stock table has allowed the identification and tracking of vehicles less than three years old. For the purposes of this analysis, the fields of interest from the MOT/DVLA dataset are: LSOA of registered keeper, date of first registration, MOT test class, fuel type, and engine size. The analysis is done for all LSOAs in England and Wales, and unless stated otherwise, where figures for vehicle costs or fuel use are given per household, this refers to *only those households with cars*.

Following a modified version of the methodology set out in Wilson et al. (2013), an estimate of annual distance (km)) travelled has been calculated for each vehicle. For vehicles without a valid MOT test in the base year (2011) due to being less than three years old, the annual distance has been estimated by taking the odometer reading at the first (post-2011) test and averaging this between the date of the test and the date of first registration. Then, using the methodology from Chatterton et al. (2015a), the fuel economy (litres/100km) has been calculated for each vehicle and a CO_2 rating (g/km) calculated for those vehicles which do not have an official CO_2 emissions banding from the DVLA data. Where any of the numeric fields are missing, these have been replaced by an average figure for all other vehicles in the LSOA. Where vehicles do not have a valid fuel type, these have been classified as petrol.

Then, on the basis of MOT test class, registration date, engine size and CO_2 emissions, each vehicle has been placed in a VED class and assigned an annual VED rate according to the categories set out in Table 1. On the basis of the annual km travelled, fuel economy and fuel type, the annual fuel consumption and cost for each vehicle was then calculated. The latter was based on 2011 average prices of £1.33 per litre for standard unleaded, £1.39 for diesel and £0.73 for LPG (DECC, 2012). In the absence of prices from DECC or other UK sources on the cost of CNG as a road fuel, this has been set to £0.54, based on the LPG: CNG cost ratio obtained from the US (USDoE, 2015). For electric vehicles, a figure of 3.3pence per km has been used based on an average 2011 domestic electricity price of 14.1p per kWh (DECC 2015) and an 80kw Nissan Leaf using the NextGreenCar fuel cost calculator[1].

Comparative Fuel and VED costs, and their Spatial Distribution

Figure 3 shows the distribution of VED per vehicle as a proportion of combined annual fuel and VED costs. This indicates that, for the majority of vehicles, VED is only around 10-20% of the total amount of these costs. Mean costs for fuel and VED per kilometre are 14.9p/km Figure 4 shows maps of average household expenditure on VED and road fuel (for those households with cars). Urban areas stand out particularly sharply on these maps since, even though households without cars have been excluded. In these areas those households that have cars still tend to own fewer vehicles than in rural areas, leading to much lower average per household costs. This may be because there is less need for cars due to accessibility of services and/or better public transport provision, or it may be due to higher on-street parking charges or significantly higher property prices for urban properties with off-street parking, the latter costs being examples of ones we cannot account for in this analysis. The bivariate plot on the right allows the identification of areas of high VED/low-medium fuel cost cars particularly in suburban areas on the periphery of London and the Home Counties. This combination is likely to denote lower mileage vehicles (potentially strongly correlated with levels of rail commuting). In general, rural areas are particularly characterised by high VED and high fuel costs. Areas with lower VED but high mileage appear to be more prevalent in the north of England and Wales.

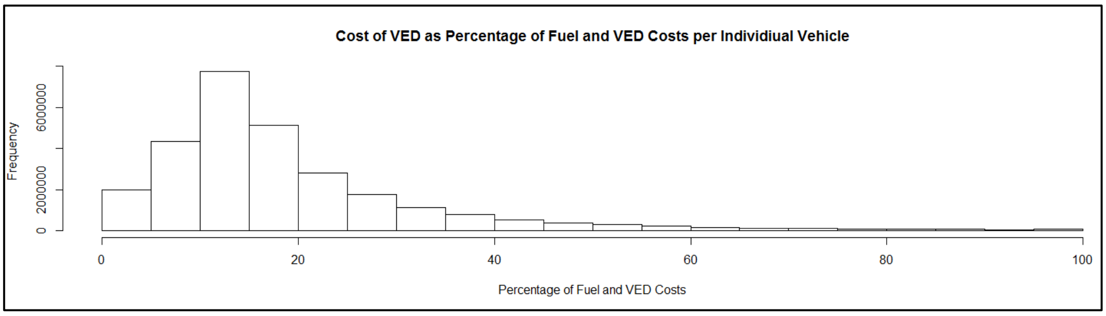

Figure 3: VED as Percentage of total (VED + Fuel) costs

[1] http://www.nextgreencar.com/cost-calculators/nissan/leaf/45426/

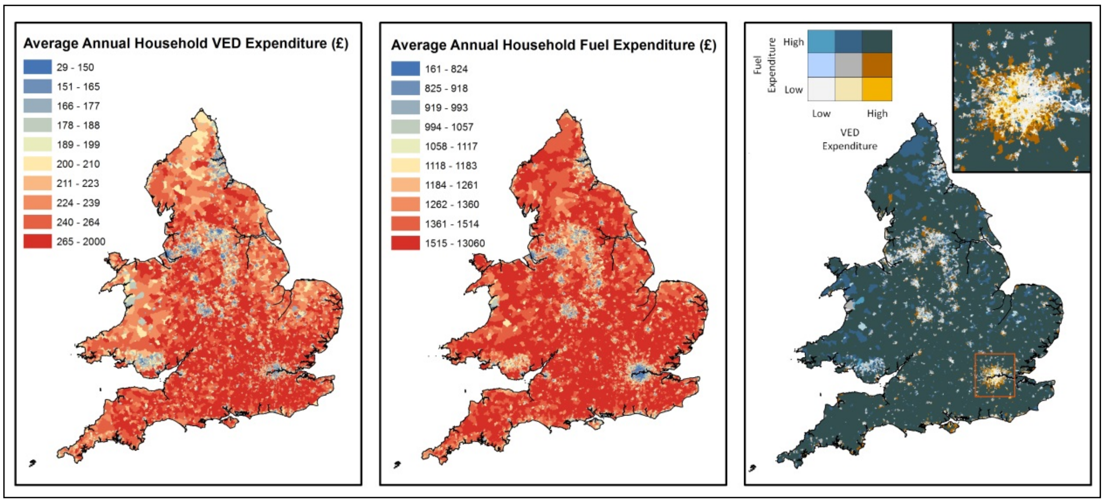

Figure 4: Univariate and bivariate maps of average household VED and road fuel expenditure (2011)

Figure 5 shows differences in expenditure on road fuel between urban and rural areas. It uses the UK Office for National Statistics Urban-Rural categorisation (Bibb & Brindley, 2013) which groups areas into classes (A: Major Conurbation, B: Minor Conurbation, C: City and Town: D: Rural Town and Fringe and E: Rural Village). It is evident that, in general, urban areas (A/B/C) lead to lower expenditure on road fuel and rural areas (D/E) tend to spend more on road fuel.

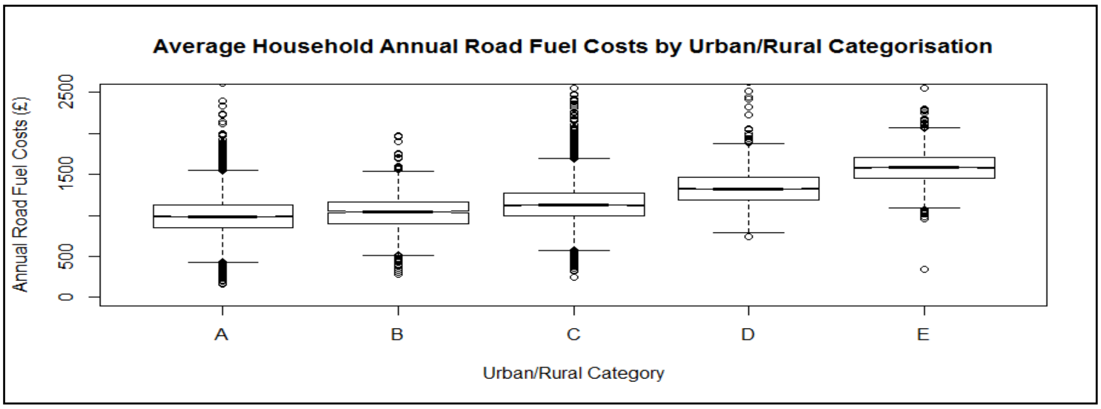

Figure 5: Average Household Annual Road Fuel Costs (for households with cars) by ONS Urban/Rural Classification (Y-axis cropped at £2500 to exclude extreme outliers)

VED Expenditure and Income

Figure 6 shows average household expenditure on VED (for households with cars) in relation to median household income at the LSOA level (Experian, 2011). The plots indicate a significant increase in outlay on VED with increasing income (N.B. barely visible notches on the box and whisker plots indicate a significant difference between medians where there is no overlap). In the left-hand plot, there is a notable downward spike where there are lower household VED costs at lower incomes. Comparing this to the right-hand plot, it is evident that these are tending to occur in the second and third income quartiles.

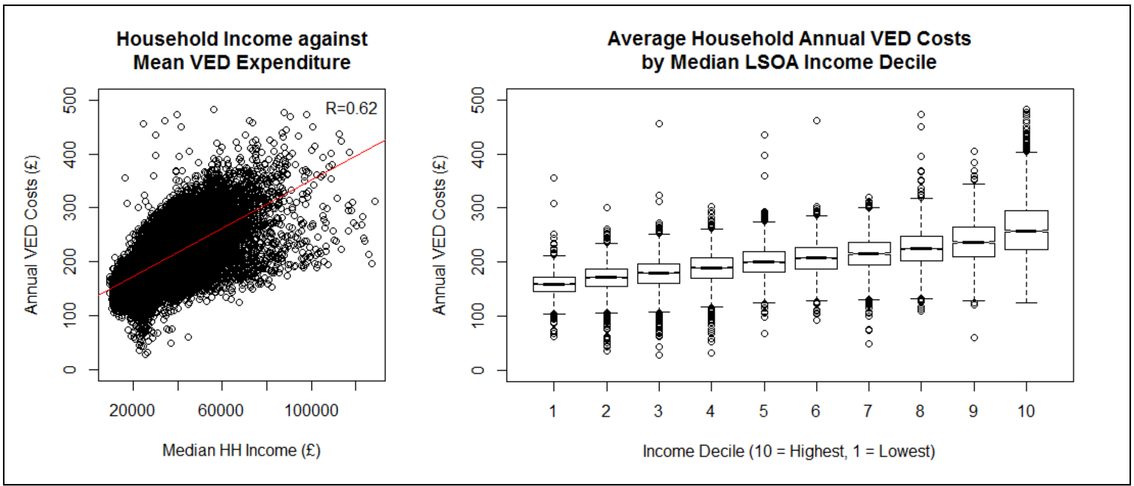

Figure 6: Average Household Annual Road Fuel Costs by Experian Median Income and Income Decile (Y-axes cropped at £500 to exclude extreme outliers)

Road Fuel Expenditure and Income

Figure 7 shows average household expenditure on road fuel (for households with cars) in relation to median household income at the LSOA level. This indicates that although there is a tendency for expenditure to increase with income, this is not nearly as strong as for VED (R = 0.31 as opposed to R=0.62 for VED). Of note in the scatter plot are some areas that stand out with low income/low fuel costs, and high income/low fuels costs. The box and whisker plot indicates that the former tend to be in the 2nd and 3rd income deciles rather than the lowest and they also appear to correspond to a similar area to that shown in the scatterplot in Figure 6.

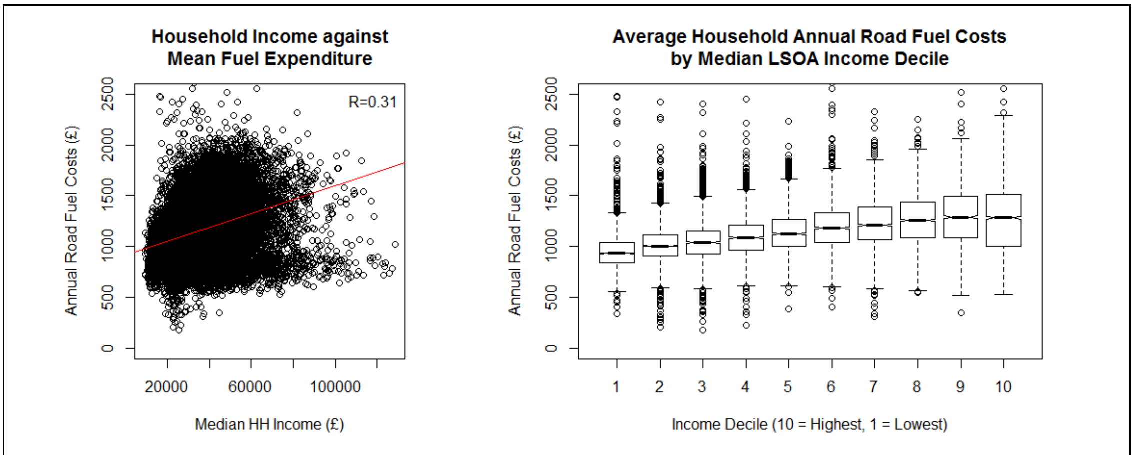

Figure 7: Average Household Annual Road Fuel Costs by Experian Median Income and Income Decile (Y-axis Cropped at £2,500 to exclude extreme outliers)

Comparison with Expenditure on Domestic Gas and Electricity

Given the increasing push to electrify transport, as well as space/water heating and cooking, there is a need to begin to understand how energy use from cars relates to domestic energy consumption (Chatterton et al., 2015b). Figure 8 shows data from the Living Cost and Food Survey (ONS, 2012) for relative expenditure on domestic energy. These range from £723 for the lowest income decile to £1,149 for the highest. (This compares with the greater range for the fuel component of motoring costs in Figure 1 running from £260 to £2,574).

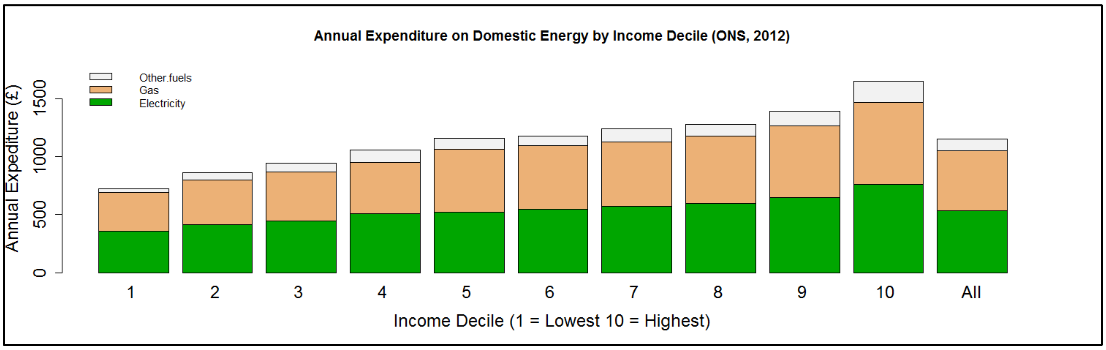

Figure 8: Annual expenditure on domestic energy by income decile (ONS, 2012)

For the work presented in this paper, average prices for gas and electricity were calculated from the DECC 2012 Quarterly Energy Report (DECC, 2012) for a kWh of gas and electricity based on a 'typical' annual household consumption of 18,000 kWh and 3,300khw respectively. The calculated prices based on the standard credit payment (not direct debit or prepayment, and taking no account of Economy 7/dual tariff differentials) across all suppliers was £0.042 per kWh for gas and £0.143 per kWh for electricity. These were then applied to LSOA level data from DECC on average household gas and electricity consumption (DECC, 2014). Use of other fuels (oil, bottled gas, solid fuels etc.) has not been incorporated into the analysis, but as Figure 8 shows this is a small fraction of expenditure. It is also very unevenly distributed, particularly with regard to where use is due properties not being connected to the mains gas grid (see Chatterton et al., 2015b)

Figure 9 provides a comparison of the fuel costs of car use alongside expenditure on domestic gas and electricity consumption. Average household expenditure on gas and electricity (for households with a gas or electricity meter) tends to be roughly equivalent, although the distribution indicates expenditure on gas compared to electricity varying by up to a factor of two. In terms of expenditure on road fuel (by households with cars), again expenditure is roughly equivalent, with those households spending more on one, tending to spend more on the other. However, there is a divergent tendency in the areas of higher expenditure, with one cluster having very high expenditure on road fuel but not on domestic energy, as well as a group that have lower expenditure on car fuel but high domestic energy consumption.

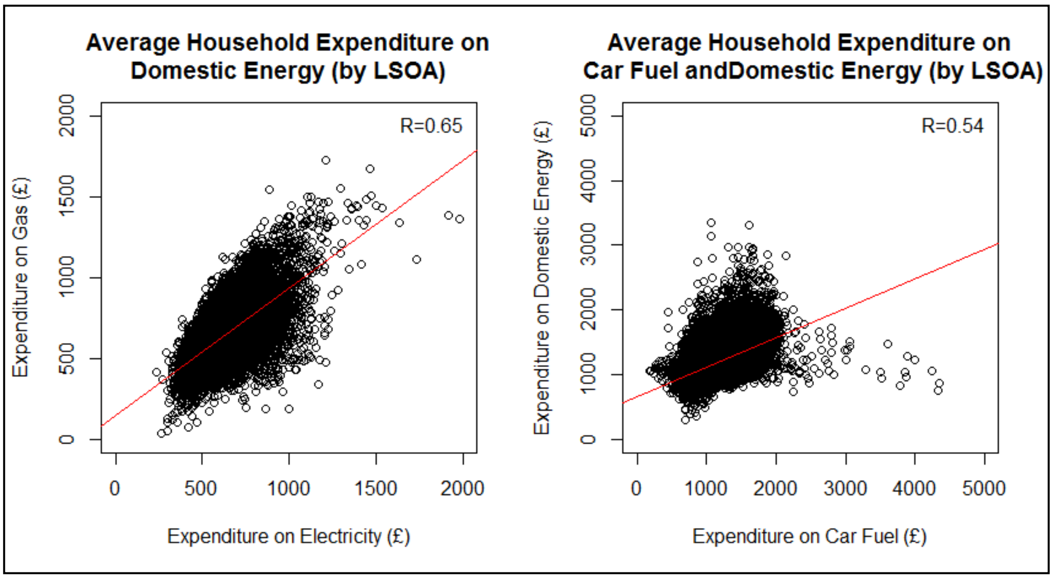

Figure 9: Comparison of average household expenditure on gas, electricity and road fuel (2011)

Proportion of Income Spent on VED, Road Fuel and Domestic Energy

In order to better evaluate the financial impact of expenditure on VED, road fuel and domestic energy on different households, the average household expenditure has been calculated as a percentage of median income for each LSOA and then analysed in relation to levels of poverty (N.B. In order to allow a comparison across both England and Wales a method has been employed using the Breadline Britain Index, developed by Gordon and Pantazis (1997) to estimate the percentage of households in poverty in any given area. The method is described in detail in Chatterton et al. (2015b)). The plots in Figure 10 show: on the x-axis, the mean number of households in poverty for each poverty decile; and on the y-axis, the mean expenditure as a percentage of income for these (with 95% confidence intervals around the mean). The pattern for road fuel and VED is particularly intriguing. For households with cars, there appears to be a strongly regressive pattern, with households in lower income bands likely to be spending more of their income on these costs than higher income households. However, this pattern reverses when the motoring costs are spread over *all households* (right hand plot), potentially reflecting the differential levels of car ownership in the different income deciles. A similar plot for domestic energy appears very similar to the left hand plots, with domestic energy costs rising from around 6% of income to around 11% of income for the poorest areas.

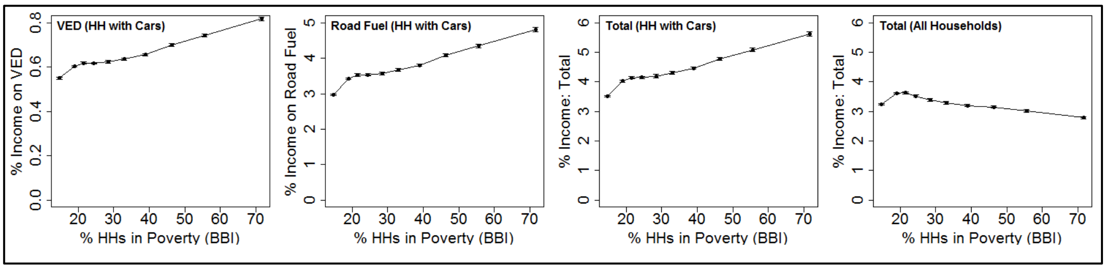

Figure 10: Average Household Expenditure on VED/Road Fuel/Domestic Energy as Percentage of Median Income (N.B. Poorer areas to the right)

Discussion and Conclusion

There is a significant debate about whether existing taxes on car use are socially regressive, relating to how far car use can be seen as luxury or necessity (see, for example, Sterner, 2012; Santos & Catchesides, 2005). This relatively simple analysis has indicated the strong tendency for VED and fuel costs, together with other household energy costs, to be socially regressive *when households own cars*, in that expenditure on these items represents a higher proportion of household income at lower income bands. The actual effects of this are likely to be greater in real life as the inability of poorer households to pay by the cheapest means (e.g. unable to pay 12-month lump sum car tax, or have pre-pay electricity meters) will exacerbate these costs. This is because, although expenditure on any of these things has a variable or even discretionary element to it, some parts of it are likely to represent a basic need. At the same time, however, it needs to be remembered that significant proportions of households don't own cars, and are reliant on other forms of transport (particularly public transport), which, in turn, may be dependent on tax revenue to operate, and so the case for reducing motoring taxation as a socially progressive policy is complex.

It can be argued that the grading of VED by age and CO_2 band enables it to be less regressive as a mode of taxation than a fixed rate, as it allows people to effectively choose what rate of tax they are happy to pay. However, in reality, whilst vehicle size is often a choice, it is also the case that newer vehicles (which tend to be more efficient and therefore attract lower VED) also tend to be more expensive, whilst older, more inefficient cars which attract higher rates of VED may be more affordable at the point of purchase, locking poorer households into higher running costs in the long-term (Lucas & Pangbourne, 2012). Future work will enable investigation of the interplay between vehicle age, size and price, and the extent to which VED appears to have influenced purchasing patterns by different income groups.

The future changes to VED that are due to apply from 2017 will set a standard rate of VED at £140 for all except electric vehicles and thus remove (except at purchase) any VED incentive towards purchasing cleaner non-electric vehicles. It may be the case that we are moving to a time in the uptake of electric vehicles where this absolute tax distinction between 'zero-emission' and 'polluting' is appropriate. However, VED is not the only way in which those able to afford to purchase EVs will enjoy significant financial benefits, as not only are EVs more efficient to run in terms of energy, but, in the UK, the fuel is taxed significantly less. In 2015, domestic electricity invoked a total tax of 5% VAT, compared to a mean total tax of over 68% on petrol[2]. Given that the initial purchase price of electric vehicles is relatively high, the greater ability of the wealthy to purchase access to cheaper mobility through EVs is going to have significant implications both for social justice and the Government's tax revenue. However, increasing tax on electricity would only exacerbate the already regressive nature of energy prices which is illustrated above.

Acknowledgements
The work has been undertaken under EPSRC Grant EP/K000438/1. Grateful thanks to members of DfT, VOSA, DVLA and DECC, who have provided advice and support for this work, and to other members of the project team: Dr Oliver Turnbull at University of Bristol, Simon Ball and Paul Emmerson at TRL Ltd, and Dr Jo Barnes at the University of the West of England.

MOT Project website http://www.abdn.ac.uk/ctr/research/currentbr-research-projects/mot/

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[2] Based on an energy intensity of 9.7kWh/litre for petrol, at the 2011 prices cited in the paper, petrol costs 13.7pence per kWh compared to 14.1pence for electricity; however electric motors are far more efficient at converting fuel into motion.

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