JRF programme paper:
Climate change and social justice

The distribution of UK household CO_2 emissions: Interim report

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This paper:

- presents initial findings from a quantitative study into the likely social distributional impacts of UK Government energy and climate change policies;

- aims to further the development of socially just and environmentally effective carbon reduction policies, by:
  - revealing the distributional consequences of current and possible future policies to reduce carbon emissions from UK households.
  - enhancing understanding of these social aspects of climate policy within energy, climate change and social policy arenas.

The Joseph Rowntree Foundation (JRF) commissioned this paper to inform its work on climate change and social justice, a programme which supports the development of socially just responses to climate change in the UK.

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The Joseph Rowntree Foundation has supported this project as part of its programme of research and innovative development projects, which it hopes will be of value to policy-makers, practitioners and service users. The facts presented and views expressed in this report are, however, those of the authors and not necessarily those of JRF.

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Executive Summary

Introduction and aims

This report presents initial findings from a quantitative study, undertaken by the Centre for Sustainable Energy and the Universities of Bristol and Oxford, to explore the likely social distributional impacts of UK Government energy and climate change policies. Presented here is an analysis of the distribution of household carbon emissions drawing on a new and comprehensive dataset developed in phase 1 of the project. As far as we are aware, this is the first integrated analysis of emissions based entirely and directly on nationally representative survey data on: consumption of household fuels; private road travel; public transport usage; and domestic and international aviation. The analysis provides new evidence and insight into who is responsible for emitting how much carbon dioxide, and identifies the relative contributions of different aspects of consumption to household carbon emissions.

The research study – "Understanding the Social Impacts of UK Climate Policies" – aims to further the development of socially just and environmentally effective carbon reduction policies, by:

- revealing the distributional consequences of current and possible future policies to reduce carbon emissions from UK households;
- enhancing understanding of these social aspects of climate policy within energy, climate change and social policy arenas.

Context

UK Government policies to reduce CO_2 emissions do not impact UK households uniformly. The majority of these policies are funded by consumers via energy bills – that is, all customers pay a set amount on each unit of energy consumed. Household characteristics interact with various aspects of the design, implementation and uptake of such policies to determine the way individual households, and groups of similar households, benefit. For example the Feed-in Tariff (FiT) generates a revenue stream for households able to overcome the capital barriers to taking advantage of the opportunity presented by the policy; however this revenue is raised from the electricity bills of all households. Consequently the FIT can be expected to have a regressive distributional impact across UK households.

The Climate Change Act 2008 created a legally binding target to reduce the UK's emissions of greenhouse gases (GHGs) to at least 80 per cent below 1990 levels by 2050. The Government set out three carbon budgets for a phased reduction in emissions to the 2050 target. The Climate Change Commission (CCC) then recommended that the Government establish a fourth budget for 2023–2027 which set a limit of 1,950 MtCO2e (a cut of 50 per cent on 1990). The Government accepted this ambitious target in May 2011 (DECC 2011: Implementing the Climate Change Act 2008: the Government's proposal for setting the fourth carbon budget).

These targets reflect the increasingly urgent need to reduce emissions. The UK carbon reduction policy framework is likely to have to become increasingly aggressive if we are to progress toward these targets. It is therefore essential that we understand the social distributional impacts of both existing and proposed policies, so that we can feed this understanding back into the policy design process. This is a requirement if we are to implement policies which:

(i) minimise (or at the very least, avoid exacerbating) the hardship faced by vulnerable households;

(ii) are fair, and are seen to be fair: a likely precondition for successful carbon reduction policies.

Methods

Perhaps surprisingly given the urgency of the situation, there is at present is no unified dataset representing household carbon emissions from all direct sources (By "direct sources" we refer to the emissions of carbon dioxide associated with the consumption of household fuels and transport energy services – this excludes emissions embodied in the production and distribution of other goods and services). This research project seeks to address this fundamental gap. While a detailed report on the research methodology employed to develop this data is beyond the scope of this paper, the key inputs required to meet the aims of the project are summarised below.

To understand the distribution of household carbon emissions and model the likely impacts of Government policies, a quantitative representation is needed of the following:

- Energy use and CO_2 emissions from UK households (covering household fuels, private road transport, public transport, and aviation).

- Housing condition and characteristics, and hence carbon reduction opportunities.

- Access to alternative transport modes and services.

The following data sources have been used to construct these representations:

Category	Element	Survey dataset	Year	Source
Energy and CO_2	Household fuels	Living Costs and Food Survey (LCF) (formerly The Expenditure and Food Survey or EFS)	2004–2007	ONS
	Private road transport	National Travel Survey (NTS)	2002–2006	DfT
	Public transport	National Travel Survey	2002–2006	DfT
	Domestic leisure flights	National Travel Survey	2002–2006	DfT
	International leisure flights	Air Passenger Survey (APS)	1999–2008	CAA
Housing condition and		English House Condition	2007	CLG

characteristics	Survey (EHCS)		
Transport Mode Accessibility	National Travel Survey	2002–2006	DfT

Energy consumption and emissions are first derived from survey data in each of the above nationally representative datasets (LCF for household fuels; NTS for private road travel, public transport and domestic aviation; and the APS for international air travel). The resulting emissions estimates are then combined using advanced statistical methods (Multiple imputation using Markov-chain Monte Carlo – see Section 2: Data and Methods) to produce a single synthetic dataset of household carbon emissions from all sources listed above.

Two distinct phases have been applied in the methodology. The first phase involves creating an LCF-based dataset of carbon emissions from all the above sources representative of all households within Britain. This can then be analysed to further understanding of the social distribution of emissions from all direct sources across GB households. This initial phase is the focus of the analysis presented in this paper.

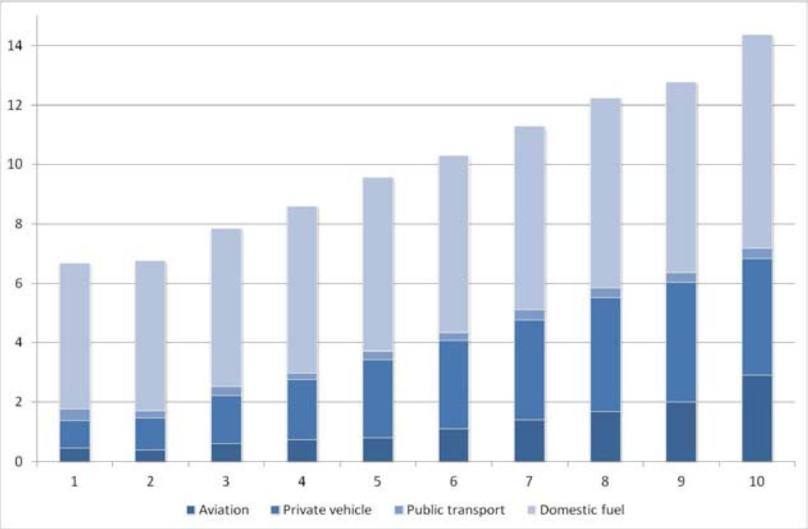
The second phase in the project is to develop an EHCS-based dataset containing the same suite of household fuel, personal travel and international air travel carbon emissions data (albeit limited to England only) as described above (this time imputed from the LCF, NTS and APS respectively), complete with the detailed housing condition data contained within the EHCS. The latter is required both for a detailed assessment of household carbon abatement opportunities, and to model the impacts of energy efficiency and carbon emission reduction policies. This second phase of research is underway and will be published in 2012.

The distribution of GB household emissions

The key points to note from the analysis of the distribution of household carbon emissions by socio-demographic variables are summarised below.

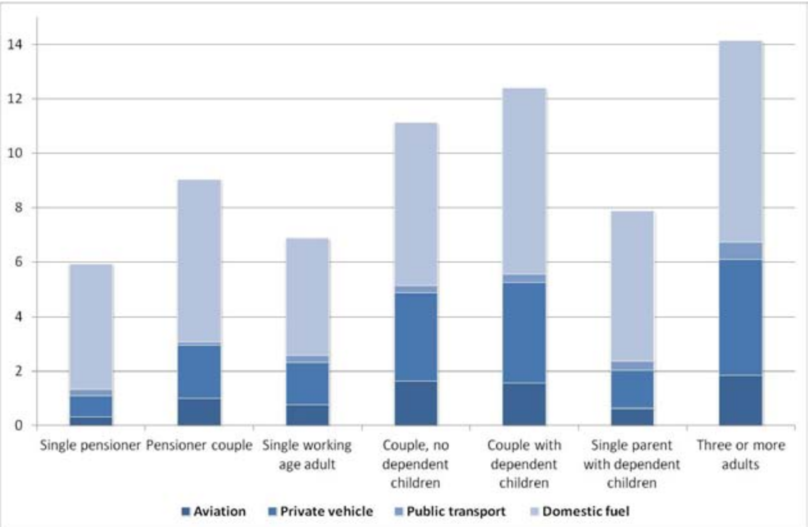
Mean average CO_2 emissions are strongly correlated with income: households within the highest equivalised income decile have mean total CO_2 emissions more than twice that of households within the lowest equivalised income decile. Emissions from private road travel and aviation account for a high proportion of this differential: aviation emissions of the highest income decile are more than six times that of the lowest income decile.

Fig. A: Mean annual total CO_2 emissions from all sources by equivalised household income decile (metric tons)



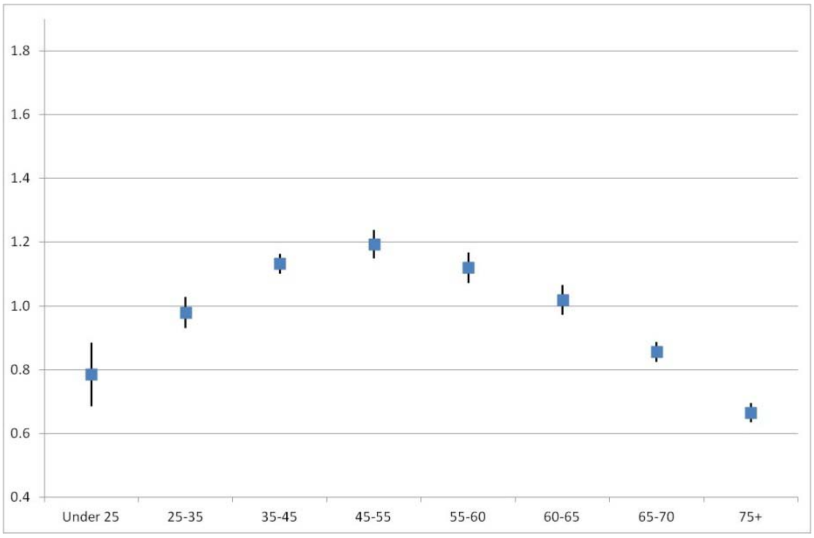
Multi-adult households and couples (with or without children) have significantly higher CO2 emissions on average compared with other household types. Mean CO2 emissions are lowest in single pensioner households, who have notably low transport-related emissions compared to other household types.

Fig. B: Mean annual total CO_2 emissions from all sources by household type (metric tons)



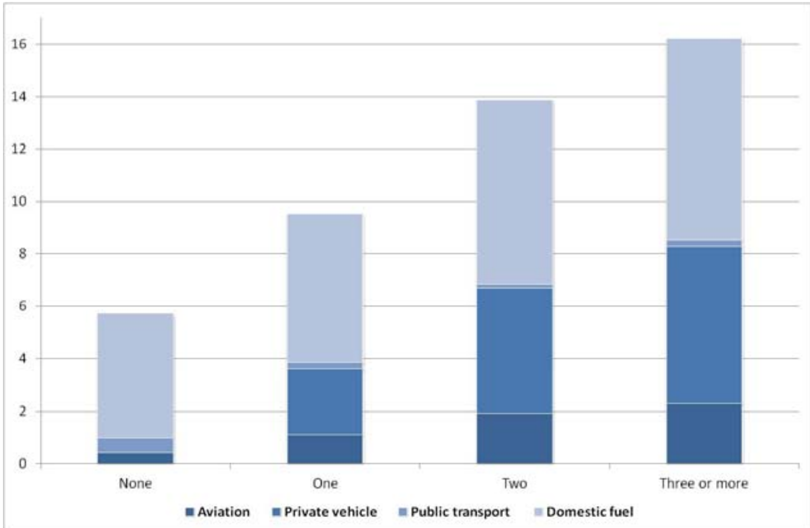
Mean household total CO2 emissions have a parabolic relationship with age, with a peak in the middle-years (HRP aged 35-60years). This trend in emissions across life course is likely to reflect underlying differences in income and command over resources associated with age, as well as social differences in household size and composition.

Fig. C: Mean annual total CO_2 emissions from all sources by age of HRP *(rescaled)*



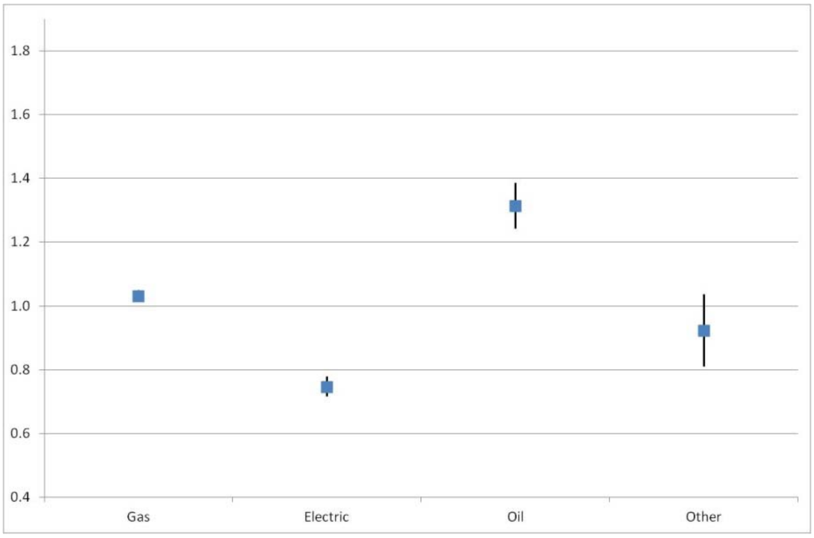
There is a strong, linear relationship between car ownership and average household carbon emissions. As expected, the difference in mean total emissions is mainly attributable to emissions from private vehicles. However, further analysis shows car ownership is a strong predictor of emissions from other sources (notably aviation and domestic fuel). These variations in other emissions sources associated with levels of car ownership is likely to reflect the indirect impacts of other socio-economic differences (and especially inequalities in equivalised household income) which are also associated with car ownership, as discussed further below.

Fig. D: Mean annual CO_2 emissions from all sources by number of cars in household *(metric tons)*



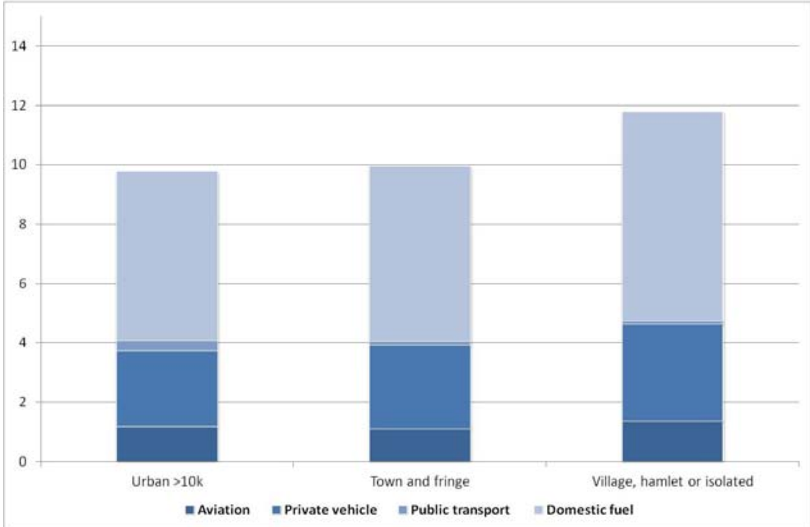
Analysis by domestic heating fuel shows average household emissions are significantly higher for households using oil to heat their home and lowest for electrically heated households. This can be primarily associated with the variation in carbon emissions of different household fuels (i.e. oil is far more carbon intensive), but it is also likely that domestic fuel type is a proxy for a wide range of socio-economic inequalities within the population, including income, property size and type, which will affect patterns of household energy consumption.

Fig. E: Mean annual total CO_2 emissions from all sources by domestic fuel type *(rescaled)*



Differences in mean household CO2 emissions by settlement type appear modest relative to other socio-demographic variations. These differences are nonetheless significant, with rural household CO2 emissions being one-fifth higher than urban households. Emissions from domestic fuel use appear to vary more substantially by settlement type compared to other social dimensions, with rural household fuel CO2 being around 25 per cent higher than in urban dwellings.

Fig. F: Mean annual CO_2 emissions from all sources by settlement type *(England and Wales only) (metric tons)*



Estimated effect sizes

Analysis of variance (ANOVA) of mean total household CO_2 emissions presented in this report has shown significant differences between groups as defined by: income; tenure; number of workers in the household; employment status; age; socio-economic group; settlement type; car ownership and domestic heating fuel.

The estimated effect size – that is, the degree to which the different variables listed above can be said to explain or predict variations in CO2 emissions – from one-way ANOVA is a useful way of summarising the overall pattern of social variation in household CO_2 emissions. The estimated effect size, which varies between 0 and 1, describes the proportion of overall variation in CO_2 emissions attributable to each predictor variable (e.g. income, tenure etc.). Predictor variables with an effect size of 0.1 and above for each CO_2 emissions source are shown below. With regard to public transport emissions, none of the predictors analysed here accounts individually for more than 10 per cent of variation in emissions from this source. Government Office Region and car ownership appeared the strongest predictors of public transport emissions (both having an effect size of 0.06).

Table A: Estimates of univariate effect size for selected respondent and household predictors of mean annual CO_2 emissions (predictors with an effect size of >= 0.1 shown)

Domestic fuel	Aviation	Private vehicles	Total CO_2 (All sources)
Number of bedrooms (0.17)	Equiv. household income (0.15)	Number of cars in household (0.9)	Number of cars in household (0.21)
Household type (composition) (0.12)	NS-Sec of HRP (0.1)	Equiv. household income (0.19)	Household type (0.17)
Household size (number of occupants) (0.12)		Household type (0.18)	Number of bedrooms (0.15)
Dwelling type (0.1)		Tenure status (0.17)	Number of workers in hhld. (0.14)
		Number of workers in hhld. (0.16)	Household size (0.14)
		NS-Sec of HRP (0.15)	Equiv. household income (0.12)
		Household size (0.13)	NS-Sec of HRP (0.1)
		Employment status of HRP (0.12)	Tenure status (0.1)
		Number of bedrooms (0.11)	
		Dwelling type (0.11)	

Table A above suggests the social 'patterning' of variation in household CO_2 emissions arising from **domestic fuel** usage is primarily attributable to differences in the size (number of bedrooms and number of occupants), composition and physical construction (dwelling type) of the household. By contrast, only two variables appear to account for over 10 per cent of variation in household aviation emissions, income appearing the strongest individual predictor.

The social 'patterning' of private vehicle emissions appears very similar to that pertaining to total emissions from all sources (although the magnitude of effects sizes varies somewhat). Level of car ownership not surprisingly shows a strong association with emissions from private vehicles, but also individually accounts for over 20 per cent of the variation in total CO_2 emissions from all sources. In addition, household type (composition), dwelling size (number of bedrooms), the number of workers in the household, household size (number of occupants), equivalised income, occupational class (NS-SEC), and housing tenure appear strong determinants of variations in emissions from all sources and private vehicles.

The effect sizes shown above are based on univariate analysis only. The earlier discussion of distributional analysis of emissions by socio-demographics showed that while some factors do not necessarily appear strong predictors in themselves (i.e. do not appear in table A above) there are still significant differences in average household emissions between groups. For example, rural households have significantly higher emissions on average that their urban counterparts (Fig. G), but settlement type appears to account for only 1 per cent of the overall variation in total CO_2 emissions. It is likely that a number of factors influence this phenomenon – for example, reliance on more carbon-intensive heating fuel in rural areas; increased private road travel; and housing stock characteristics e.g. typically older properties. Thus the effect of settlement type is diluted in a univariate analysis where such higher-order interactions are not accounted for. Multi-factorial analysis will help in understanding these interrelated factors.

Key implications of the findings to date

The analysis presented in this report has some important implications in the context of designing and delivering socially equitable carbon emission reduction policies, summarised below.

There are significant differences in mean total household emissions along the following dimensions:

- Income;
- household type;
- Age of Household Reference Person;
- Employment status of Household Reference Person;
- Dwelling size (number of bedrooms);
- Main heating fuel;
- Tenure;
- Car ownership.

These patterns tend to support the observation that, in general, those groups most likely to be vulnerable and/or socially excluded tend to have lower than average CO_2 emissions.

The relative inelasticity of domestic fuel use (cf transport) is likely to mean that policies which increase the cost of domestic fuels will be regressive.

Domestic fuel accounts for approximately 60 per cent of the total direct household emissions, but transport (specifically private cars and international aviation) accounts for the majority of the social variation in these emissions.

The increasingly strong association between household emissions and income when transport emissions are included means that treating total direct carbon emissions in an integrated way may offer the best approach to minimising regressive impacts from carbon reduction policies. Put another way – if household carbon reduction policies addressed all transport emissions as well as those from household fuel use, there would be far fewer low-income/high-carbon households, and policies which placed a cost on carbon itself would be likely to be more progressive.

Although beyond the scope of this report, it would also be interesting to investigate the use of 'Minimum Income Standards' approaches to equivalising carbon emissions. This could enable an understanding of the levels of carbon emissions required to meet acceptable living standards.

Next steps

The analysis presented in this report has focused on the distribution of average CO_2 emissions by different socio-demographics. While ANOVA has shown significant differences between groups (based on income, etc.), the issue of variation in emissions within e.g. income groups still needs to be considered. For example, previous research has suggested a subset of low income households have above average energy consumption. Further analysis is required to establish that such policies can be designed to avoid penalising this minority of vulnerable households who may have higher than average emissions.

While this report shows clearly discernable and comprehensible patterns (not least that affluent households have higher consumption lifestyles and thus higher emissions) what is not clear from this LCF-based analysis is the extent to which these consumption patterns are driven by 'necessity' over lifestyle choices. For example, in the context of a householders response to climate change policies, to what extent do the high emitting rural households have access to alternative transport measures; opportunities to improve the thermal efficiency of their home; or to switch to less carbon-intensive energy sources? Similarly, how much of the apparent low consumption amongst low income households is actually poverty driven, rather than associated with actual lower levels of energy need e.g. smaller housing?

The next phase of the project will build on the analysis presented in this paper to explore:

1. the social distributional impacts of existing and potential new UK Government climate change policies;

2. the distribution of carbon emission abatement opportunities in English households;

The work will assess the distributional impacts, and attempt to answer questions of the following nature:

- Feed-in Tariffs: do higher income households tend to benefit at the expense of lower income households?

- The Renewable Heat Incentive (RHI): is the policy more progressive as a result of being funded from general taxation?

- Would a carbon tax be progressive, and is it possible to avoid penalising low income/high consumers?

- Personal carbon trading: are the abatement opportunities sufficient to allow low income households to benefit from a downstream trading mechanism?

- Green Deal: are the actual energy savings high enough to repay the finance, and does this vary with income?

1. Introduction

While several studies examine the distributional impacts of carbon reduction policies at an international scale, far fewer have focused on the equity of distributional impacts within countries. Of these, most consider the impact of a carbon tax on fuels, rather than the more complex range of policies that already exist or have been proposed for the UK, and few have investigated the distributional effects of such policies between households.

In recent years analysts have begun to model the potential distributional implications for households of carbon taxes, whether direct (Speck, 1999, Tiezzi, 2005) or indirect (Symons, et al., 1994; Gough, et al., 2011). Other researchers have developed this approach to examine the potential for redistribution in mitigating the regressivity of potential carbon reduction policies in China (Brenner, et al., 2007) and the United States (DeCanio, 2007). Work by Callan et al. (2008) in Ireland and Dresner and Ekins (2004) in the UK are especially relevant in examining the potential distributional impacts of carbon mitigation policies. However, Dresner and Ekins' analyses are not based on housing condition data and as a result focus on the potential for *aggregate* carbon savings. Opportunities for modelling the distributional impacts for individual households were restricted to carbon emissions from household fuel consumption.

Druckman and Jackson (2007, 2008) use expenditure and 2001 UK census data to estimate spatially disaggregated models of carbon emissions. The synthetic estimation approach taken by Druckman and Jackson provides very useful small-area estimates of carbon emissions, although improvements in the reliability of small-area models are possible as a result of further model validation and data harmonisation. Nevertheless, few existing studies have focused specifically upon mitigation opportunities at a household level in examining distributional impacts of climate change policies, nor has existing work sought to encompass the range of sources necessary to understanding households' carbon footprint.

Gough et al.'s (2011) innovative work is therefore especially significant in this respect. These authors' analyses model the distribution of total embodied greenhouse gas emissions using UK Expenditure and Food Survey data. These authors' analyses identify equivalised household income as the main driver of household emissions along with household composition and employment status. However, they conclude that the effects of current policy in raising domestic energy process are highly regressive and call for further research to model the potential distributional effects of alternative policies such as personal carbon allowances.

This project builds upon this earlier work. It defines a narrower scope of emissions – excluding carbon embodied in goods and services – but uses more precise approaches to estimating direct emissions from household fuel and transport energy services. Precision is important in this context, because the dataset is being developed specifically for the purpose of modelling the social distribution impacts of UK energy and climate policy, with the objective of influencing future policy development.

Consumption and emissions are all calculated directly in nationally representative surveys, and these surveys are then combined to create a synthetic but representative dataset covering emissions from: household fuel consumption; private road travel; public transport usage; and domestic and international aviation. In the absence of a comprehensive national carbon emissions survey, this approach gives us the best available representation of the distribution of the emissions covered by the work.

The project aims to fill in some key research gaps in advancing our understanding of the way that CO_2 emissions are distributed across UK households, and in using these data to inform analysis of the likely social distributional consequences of possible UK energy and climate policies. In this interim report we summarise the social distribution of direct household carbon emissions from private usage of domestic fuel, private vehicles, public transport and aviation. This report summarises some initial findings from the analysis of this dataset with regard to the relationship between emissions and selected household, respondent and area characteristics.

2. Data and methods

In this section we summarise the data and methods used in generating UK household level CO_2 estimates. Perhaps surprisingly, there remains no single representative dataset describing the distribution of domestic emissions in the UK. As a result, it was necessary to create such a dataset synthetically, by using multiple imputation methods in order to merge data for the 2002–2008 period drawn from the Expenditure and Food Survey, the English House Condition Survey, the Annual Passenger Survey, and the National Travel Survey. In order to do so, extensive harmonisation of sources was first necessary to ensure that data from different sources use a comparable measurement framework prior to data merging (see Patsios, et al., 2011).

The resultant dataset comprises observations for 24,207 private households drawn from the Expenditure and Food Survey (EFS) for the period 2004–2007. The data itself comprises original EFS data for the 2004–2007 period (the ‘host’ survey) as well as additional data drawn from a range of ‘donor’ surveys, namely the Annual Passenger Survey, and the National Travel Survey. For each respondent, the resultant dataset comprises the original source data and a series of estimates based upon multiple imputation. Multiple imputation is a technique for replacing missing data values with $m>1$ simulated versions using the Markov chain Monte Carlo method in order to derive estimates and confidence intervals which incorporate missing-data uncertainty (see Rubin, 1988; Schafer, 1999; Little and Rubin, 2002).

In most cases the relative efficiency of estimates does not increase substantially beyond five imputations (Rubin, 1987), and these analyses are therefore based upon the original data and five separate imputations derived from multiple imputation. The results described below refer to the pooled estimates derived by multiple imputation unless stated otherwise. In this interim report we summarise the social distribution of emissions from all sources with regard to selected household, respondent and area characteristics as detailed in Table 1 (*below*). We also briefly summarise the pattern of association for emissions from aviation, private vehicles, public transport, and domestic fuel with regard to selected household, respondent and area characteristics. The estimated marginal means together with their standard errors and 95 per cent confidence intervals for all emissions sources are tabulated in full in the Appendix (*Tables A1-A5*).

Table 1: Summary of CO_2 measurement and analysis variables

Dependent measures	Domestic fuel emissions Private vehicle emissions Public transport emissions Aviation emissions Total household CO_2 emissions
Dwelling and area variables	Government Office Region Urban-rural classification (England & Wales only) Dwelling type Heating fuel type Number of bedrooms
Household variables	Household size Household composition Number of dependent children in household Number of workers in household Net annual disposable household income (decile) OECD equivalised net annual disposable household income (decile) Tenure status Number of cars in household
Household Respondent variables	Age of Household Respondent Person (HRP) Employment status of Household Respondent Person NS-Sec of Household Respondent Person SEG of Household Respondent Person

Section 2 of this report describes the composition of total mean CO_2 emissions by source and selected household, respondent and area characteristics for the sample. It also illustrates the estimated marginal means and confidence intervals for total household CO_2 emissions from all sources. Section 3 of this report summarises the pattern of association between total direct household CO_2 emissions by source for selected household, respondent and area characteristics based upon one-way analysis of variance. The potential implications of these analyses for policies to mitigate carbon emissions in Britain are briefly discussed in Section 4.

3. The composition of mean total CO_2 emissions from all sources

In this section, we describe the composition of total mean direct household CO_2 emissions from all sources amongst resident private households in Britain. To do so, we first compare total CO_2 utilisation by source for different sample groups in order to establish which sample groups have the highest and lowest total emissions by source (*Fig. 1a to 12a, below*). We also consider the extent to which differences in sample mean total emissions from all sources reflect underlying differences in the wider GB population. Figures 1b to 12b (*below*) illustrate estimated marginal means for total CO_2 emissions from all sources for different sample sub-groups based upon pooled estimates obtained across all five multiple imputations data sets. In the interests of clarity of presentation, we do not illustrate the social distribution of mean total CO_2 emissions arising from aviation, private vehicles, public transport, and domestic fuel but estimated marginal means together with their standard errors and associated confidence intervals for the individual components of total household CO_2 emissions are tabulated in the Appendix (*see Tables A1-A5*).

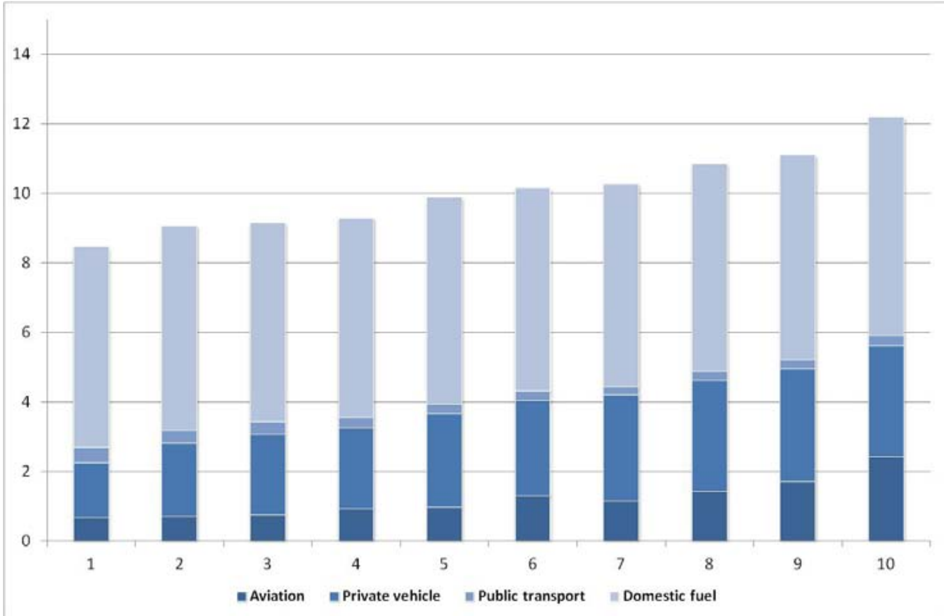
Since we are interested here in the social distribution of emissions (rather than in their absolute values) these estimates have been rescaled so that the sample mean equals 1. This makes it easier to compare sample means across groups. For example, a mean estimate of 1.5 for group *x* indicates that average household emissions for this group are 50 per cent higher than for all sample households. Similarly, a mean estimate of 0.4 for group *y* indicates average household emissions for this group are only 40 per cent of those found in the sample as a whole.

Figures 1b to 11b (*below*) show sample means along with confidence intervals for the pooled estimates based on multiple imputation. Confidence intervals indicate the range of plausible values for group means within the wider population of interest, in this case all private resident households in Britain. A 95 per cent confidence interval denotes the estimated range of predicted values for the population mean which can be specified with 95 per cent certainty. Where the confidence interval for groups *x* and *y* do not overlap we can therefore be at least 95 per cent confident that a real difference in means also exists in the wider population.

Income

Figure 2.1a (*below*) describes the distribution of mean CO_2 emissions from all sources in metric tons by net household disposable income decile. These data show that mean total emissions from all sources increase with income decile. For all income deciles, domestic fuel accounts for the majority of mean total emissions. Nevertheless, the income differential in mean total emissions arises primarily as a result of increasing aviation and private vehicles associated with rising disposable incomes. For example, in comparison with the lowest income decile, mean aviation emissions are *three and a half* times higher, and mean private vehicle emissions *twice* as high, as those for households in the highest income decile.

Fig. 2.1a: Mean annual total CO_2 emissions from all sources by net household disposable income decile *(metric tons)*



However, net disposable income is a relatively imprecise measure of households' command over resources since this will also depend upon the size and composition of households. For example, households comprising two adults and two children will clearly require a higher level of income in order to achieve the same command over resources as households comprising a single working age adult. It is therefore best practice in income measurement to adjust incomes to take account of differences in household size and composition in order to provide a more precise estimate of households' command over resources – a technique known as income equivalisation (e.g. Canberra Group, 2001).

Figure 2.2a (*below*) therefore describes the distribution of mean CO_2 emissions from all sources in metric tons by OECD equivalised net household disposable income decile. After adjusting for differences in household size and composition, the relationship between mean CO_2 emissions and household income is especially strong. A clear, positive and consistent relationship is evident between equivalised income and total mean CO_2 emissions – emissions increase dramatically with rising household incomes. For example, households within the highest income decile have mean total CO_2 emissions which are more than twice as high as households within the lowest decile of the equivalised income distribution (14.4 tons compared with 6.7 tons). As with net disposable income (*Fig. 2.1a, above*), the income differential in mean total CO_2 emissions is mostly accounted for by dramatic differences in emissions from aviation and private vehicles. Compared with households in the lowest income decile, households in the highest income decile have aviation emissions which are more than *six times* higher and private vehicle emissions which are more than *four times* higher.

Fig. 2.2a: Mean annual total CO_2 emissions from all sources by equivalised household income decile *(metric tons)*

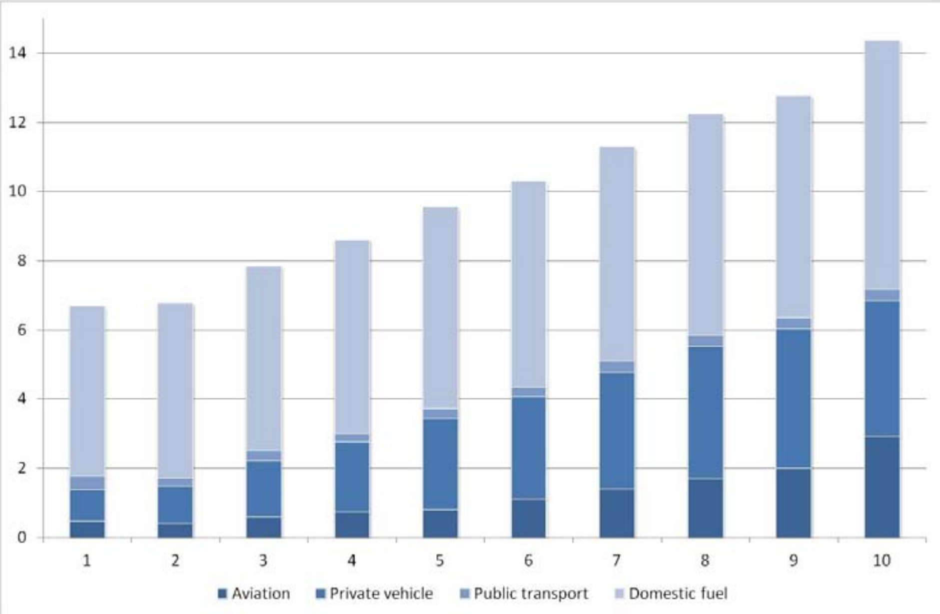
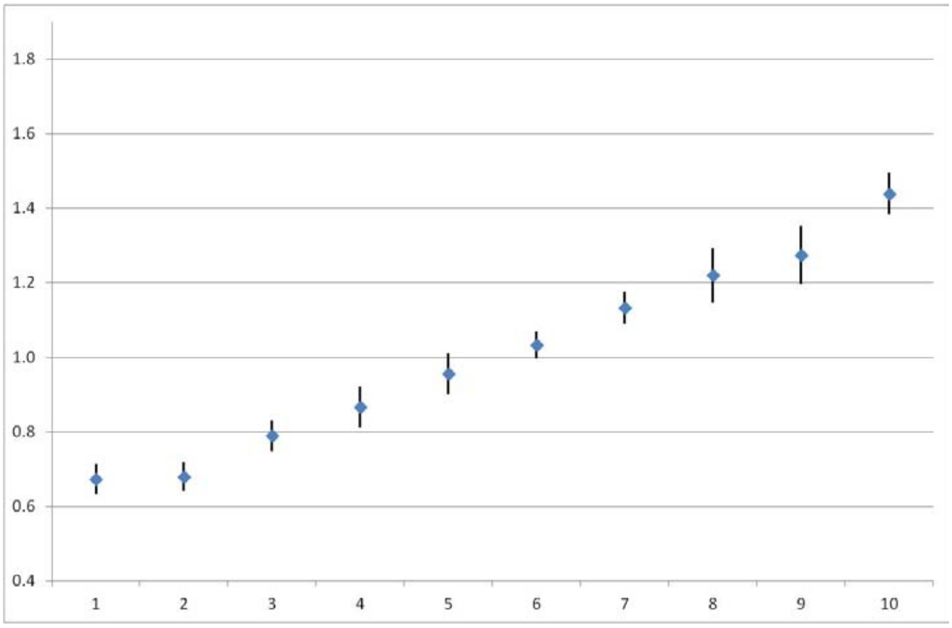


Figure 2.2b (*below*) shows estimated marginal means and confidence intervals for total emissions from all sources by net disposable equivalised household income decile. These data confirm that social differences in mean total CO_2 emissions from all sources by equivalised income exist not only for the sample under consideration but also for the wider population of interest. While little is known about the social distribution of emission at a household level, these results confirm the findings of earlier work conducted by Gough et al. (2011) which suggest a strong and broadly linear relationship between embodied greenhouse gas emissions and (equivalised) income. These income differences in emissions are likely to reflect social differences associated with income in households' command over resources and the patterns of consumption associated with income differences. It is also possible that such trends may reflect compositional differences between households (for example, associated with household type) as well as other lifestyle differences (for example, associated with differences in employment patterns and household work intensity).

Fig. 2.2b: Mean annual CO_2 emissions from all sources by equivalised household income decile *(rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Household type

Figure 2.3a (*below*) describes the distribution of sample mean CO_2 emissions from all sources in metric tons by household type. These data show that mean total CO_2 emissions are highest amongst households comprising three or more adults and amongst couple households (with or without dependent children). Total mean CO_2 emissions are substantially lower amongst single person households (single pensioners and single working age people), and to a lesser extent amongst pensioner couples and single parents with dependent children. As with income, these differences are largely associated with social variations in aviation and private vehicle emissions. For example, compared with single pensioners, households comprising three or more adults have mean total aviation and private vehicle emissions which are more than *five times* higher.

Fig. 2.3a: Mean annual total CO_2 emissions from all sources by household type *(metric tons)*

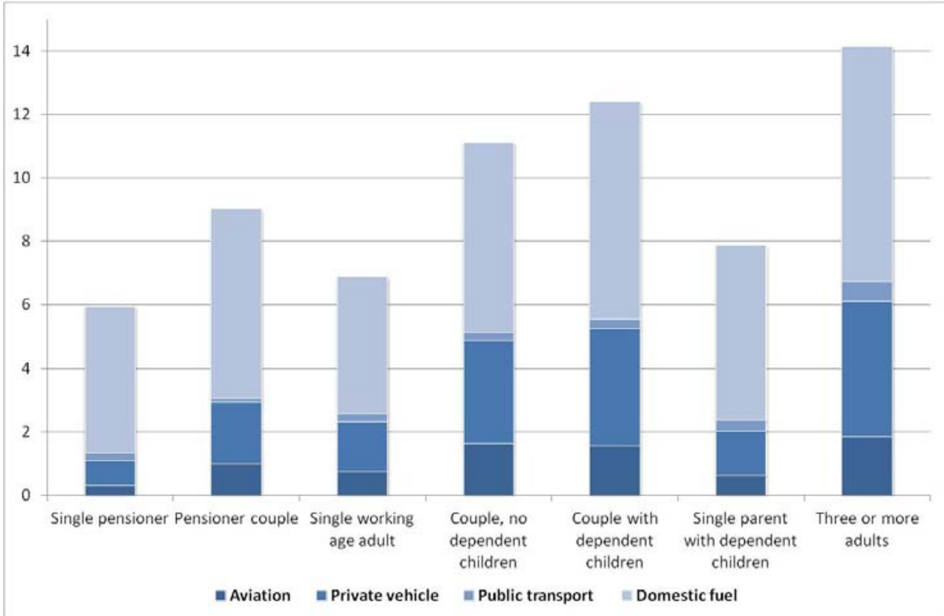
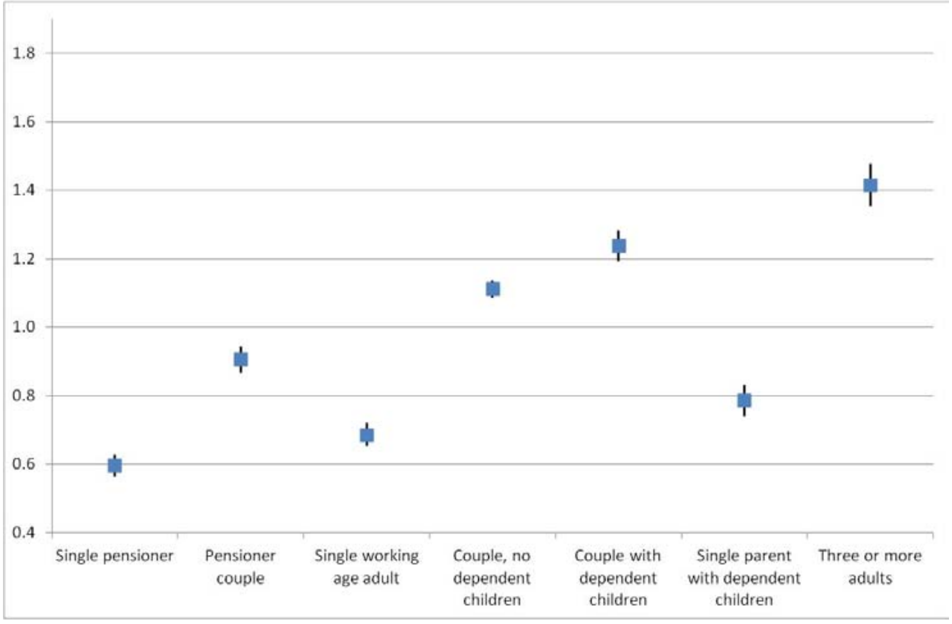


Figure 2.3b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by household type. These data confirm that social differences in mean total CO_2 emissions from all sources by household type exist not only for the sample under consideration but also for the wider population of interest. Variations in emissions by household type are likely to reflect variations in the size and age profile of household and associated differences in levels and patterns of consumption. To this extent, it would in future be desirable in principle to take account of such differences in household size and composition in estimating household CO_2 emissions. However, since household type is also known to vary consistently with income and standard of living, it may also be that these differences reflect underlying differences in income and income adequacy across households of different types given the strong association between equivalised income and emissions reviewed above.

Fig. 2.3b: Mean annual total CO_2 emissions from all sources by household type *(rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Housing tenure

Figure 2.4a (*below*) describes the distribution of sample mean CO_2 emissions from all sources in metric tons by housing tenure. These data show that mean total CO_2 emissions are highest amongst mortgage holders and lowest amongst renters. In comparison with renters, mean total CO_2 emissions amongst mortgage holders are *two thirds* higher. Again, these social variations are primarily a result of differences in mean total emissions from aviation and private vehicle transport. In comparison with renters, mean totals for mortgage holders are approximately *two and a half times* higher for both aviation and private vehicle emissions.

Fig. 2.4a: Mean annual CO_2 emissions from all sources by housing tenure *(metric tons)*

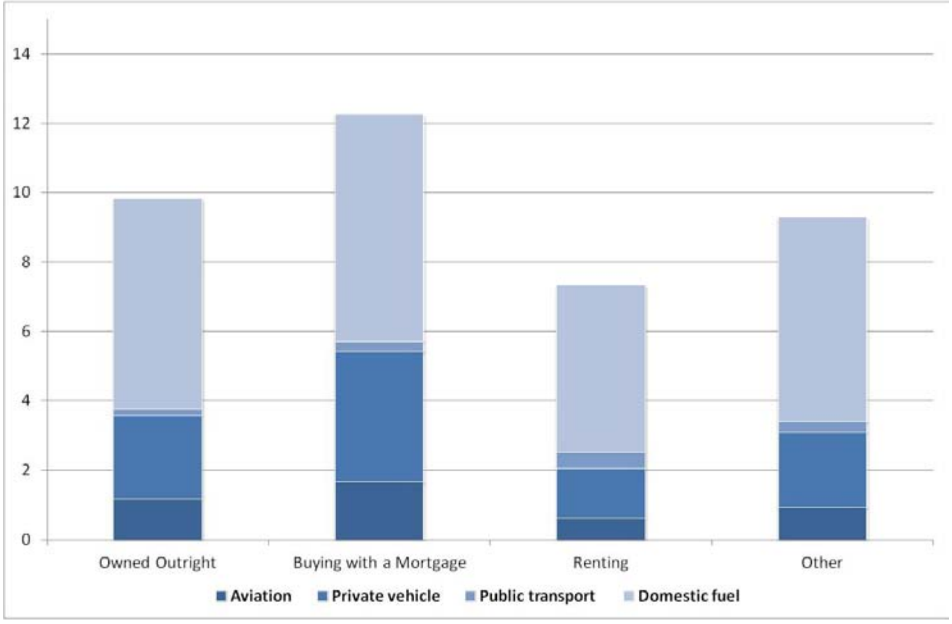
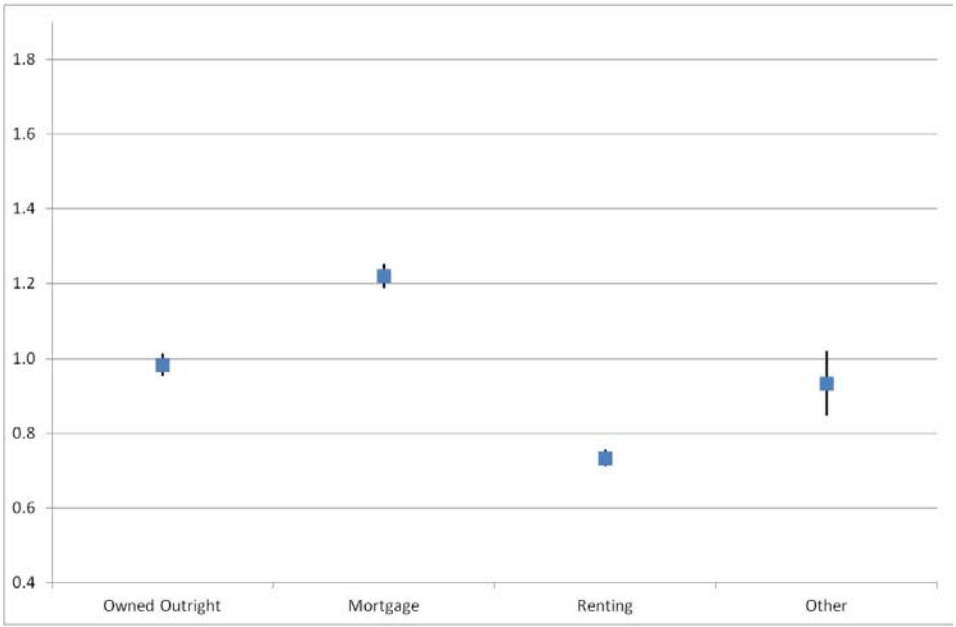


Figure 2.4b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by tenure status. These data confirm that social differences in mean total CO_2 emissions from all sources by housing tenure exist not only for the sample under consideration but also in most cases for the wider population of interest. Further work is needed to better understand the underlying drivers of differences in household CO_2 emissions by housing tenure. However, it is likely that such effects reflect both underlying socio-economic differences between households in their command over resources, as well as (associated) differences in the size, location and built structure of dwellings occupied on a rental basis in comparison with the owner-occupier sector. At the same time it should also be acknowledged that the private rental sector is itself highly heterogeneous in its social composition and further disaggregation would be desirable in this respect.

***Fig. 2.4b: Mean annual total CO_2 emissions from all sources by tenure** (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Number of workers in household

Figure 2.5a (*below*) describes the distribution of sample mean CO_2 emissions from all sources in metric tons by the number of workers in the household. These data show a strong, positive and consistent relationship between mean total CO_2 emissions from all sources and the number of workers in the household. In comparison with households where no-one is in paid work, mean totals CO_2 emissions from all sources for households comprising four or more workers are approximately *two and a half times* higher. Again, differences in mean total emissions from all sources are largely attributable to social variations in emissions from aviation and private vehicles. Compared with workless households, mean total emissions from aviation are *nearly four times* higher, and mean total emissions from private vehicles are *nearly six times* higher for households comprising four or more workers.

Fig. 2.5a: Mean annual CO_2 emissions from all sources by number of workers in household *(metric tons)*

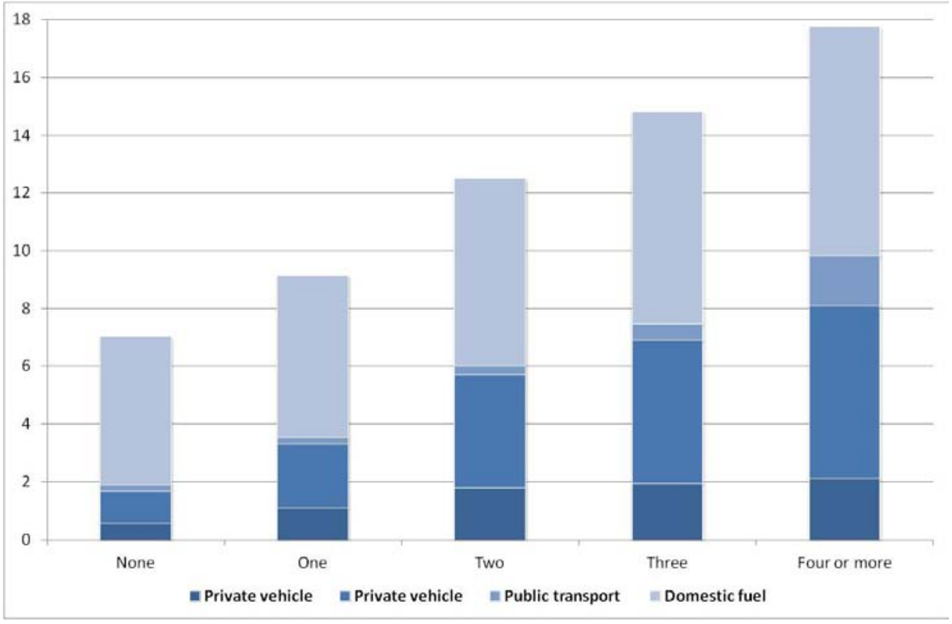
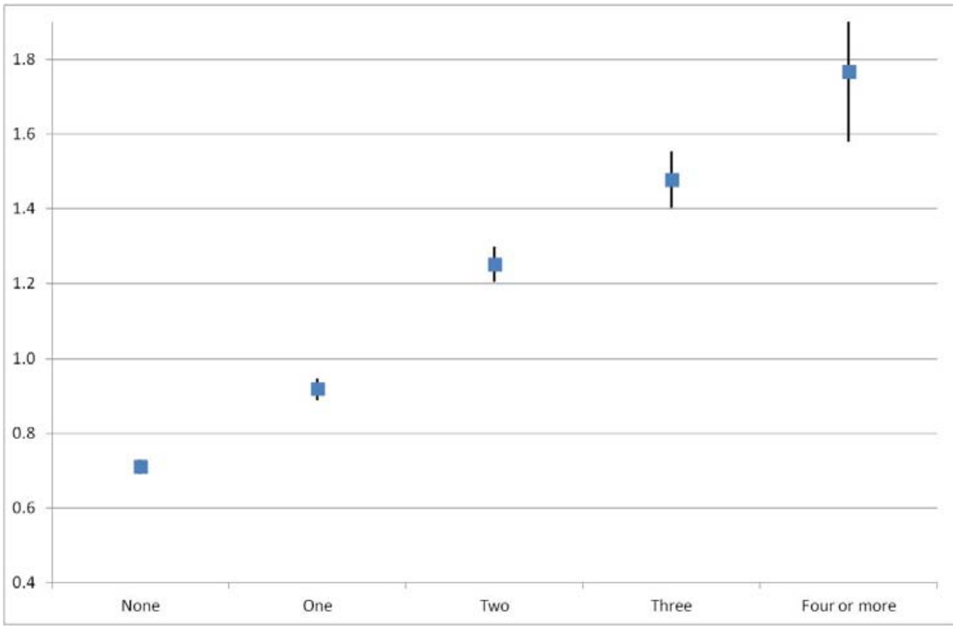


Figure 2.5b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by the number of workers resident in the household. These data confirm that social differences in mean total CO_2 emissions from all sources by number of workers resident in the household exist not only for the sample under consideration but also for the wider population of interest. Substantial variations in mean household emissions according to the number of workers within the household are likely to reflect differences in household size. To this extent, as noted above, it would in future be desirable in principle to take account of such differences in household size and composition in estimating household CO_2 emissions. Nevertheless, it is also likely that such variation is partly accounted for indirectly by differences in total household income arising from different levels of participation in paid work and associated differences in consumption patterns including but by no means not limited to the emissions directly associated with labour market participation, for example, as a result of commuting to work.

***Fig. 2.5b: Mean annual total CO_2 emissions from all sources by number of workers in household** (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Employment status of HRP

Figure 2.6a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by the employment status of the Household Reference Person (HRP – The Household Reference Person – typically responds to household survey interview questions on behalf of the household as a whole defined. In the EFS the HRP is defined as the householder with the highest income or the oldest of two or more householders with the same income). These data show that mean total CO_2 emissions are highest amongst households where the HRP is in employment and substantially lower amongst households where the HRP is economically inactive or unemployed. Again social variations in mean total emissions are primarily attributable to variation in mean total emissions from private vehicles and to a lesser extent as a result of aviation emissions. For example, in comparison with households where the HRP is unemployed or retired, mean total emissions from private vehicles are at least *two and a half* times higher for households where the HRP is a full-time employee.

Fig. 2.6a: Mean annual CO_2 emissions from all sources by employment status of HRP *(metric tons)*

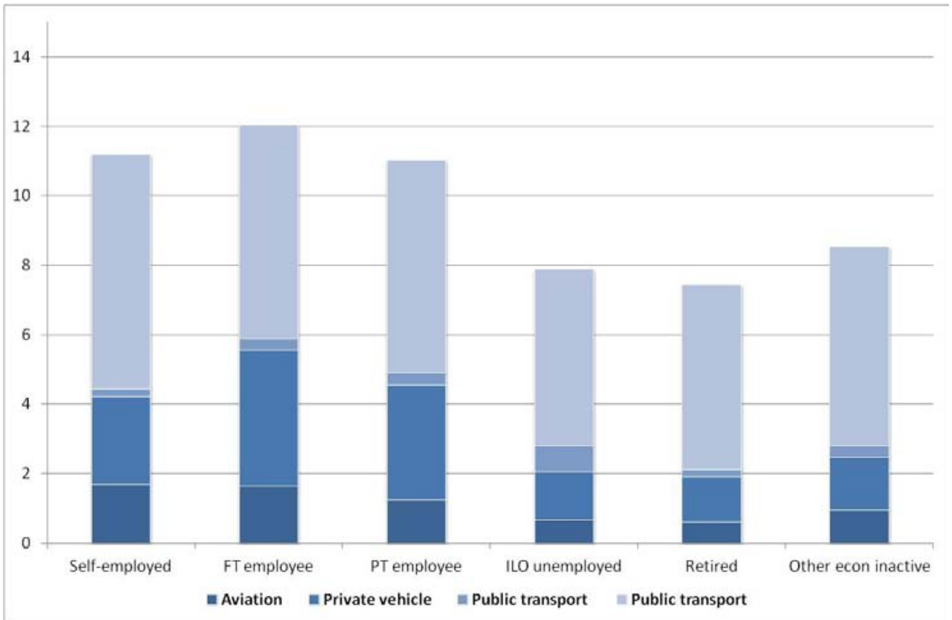
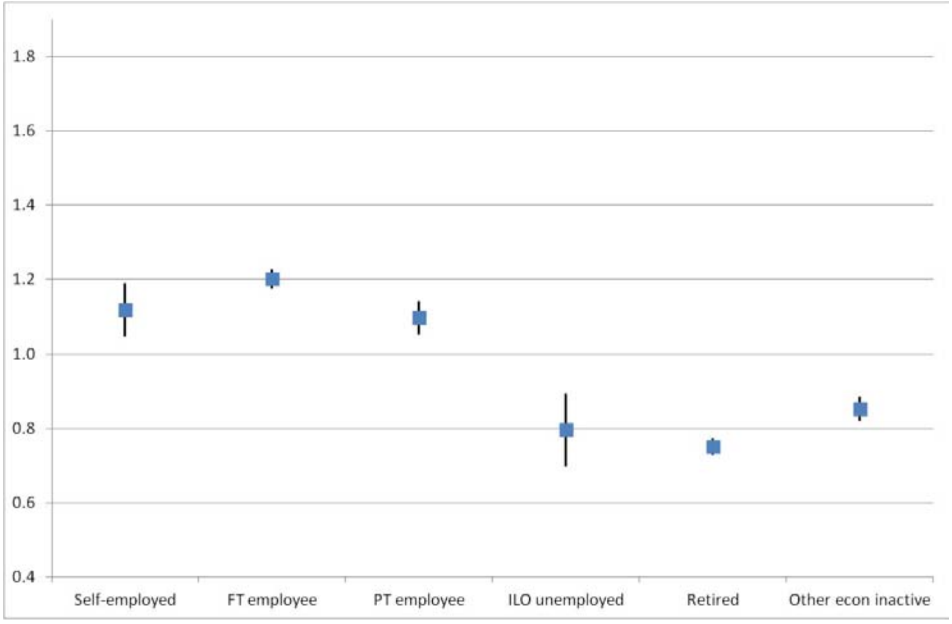


Figure 2.6b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by the employment status of the HRP. These data confirm that social differences in mean total CO_2 emissions from all sources by employment status exist not only for the sample under consideration but also for the wider population of interest. These trends are likely to reflect the effects of substantial inequalities in household disposable income arising from different sources of income and therefore inequalities in command over resources and levels of consumption to which this gives rise. However, it is likely that such differences are also at least partly explained by differences in household composition and size associated with HRP employment status – for example in comparing the retired population and those in full-time employment.

Fig. 2.6b: Mean annual total CO_2 emissions from all sources by employment status of HRP *(rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Age of HRP

Figure 2.7a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by the age of the HRP. These data reveal a curvilinear relationship between mean total emissions and the age of the HRP – household mean total emissions rise with age peaking in the middle years (35-60 years) before declining quite steeply in older age. For example, mean total emissions for the 45-55 age group are approximately 20 per cent higher than those for the sample as a whole. In contrast, for those HRPs aged 75 or more mean total emissions are less than 70 per cent of those for the sample as a whole.

Fig. 2.7a: Mean annual CO_2 emissions from all sources by age of HRP *(metric tons)*

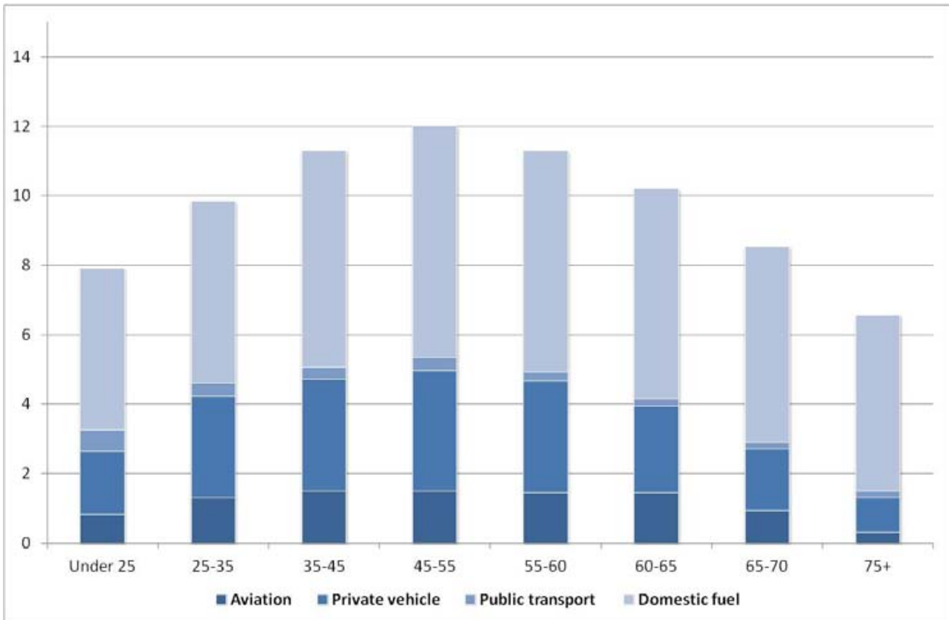
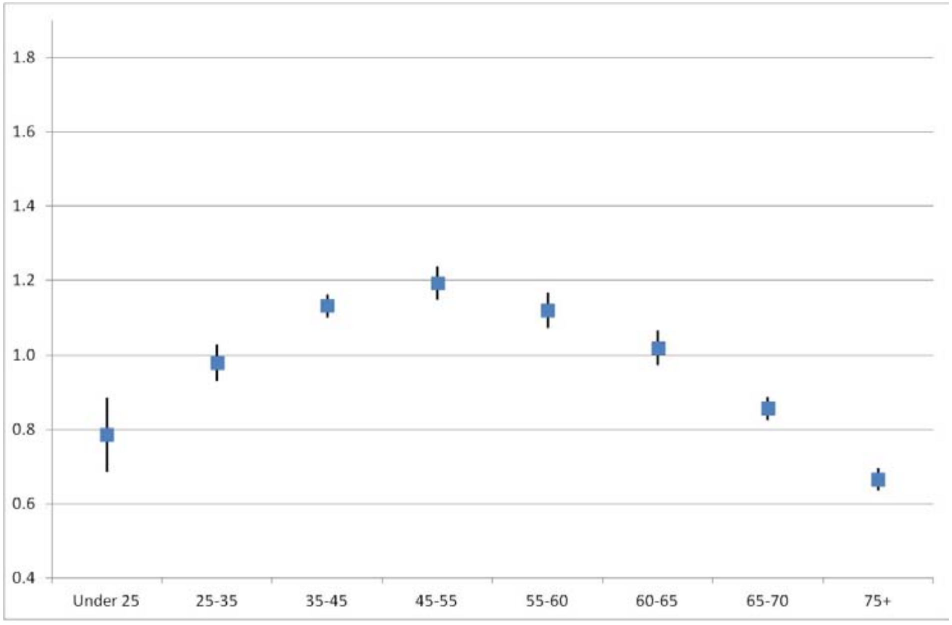


Figure 2.7b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by the age group of the HRP. These data confirm that social differences in mean total CO_2 emissions from all sources by the age of the HRP exist not only for the sample under consideration but also for the wider population of interest. These trends in household CO_2 emissions across the life course are likely to reflect underlying differences in income and command over resources associated with age, with average (equivalised) incomes for the young and older people typically being substantially lower than those for people in their 'middle years'. At the same time, such trends are also likely to reflect social differences in household size and composition across the life course (for example, associated with child rearing) and the associated additional consumption of these households.

Fig. 2.7b: Mean annual total CO_2 emissions from all sources by age of HRP *(rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Socio-Economic Group of HRP

Figure 2.8a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by the Socio-Economic Group (SEG) of the HRP. These data show that mean total CO_2 emissions vary with the Socio-Economic Group of the HRP with higher status groups having substantially higher mean total CO_2 emissions than lower status groups. Again, these social variations in mean total CO_2 emissions are primarily associated with social differences in mean total aviation and private vehicle emissions. For example, compared with semi and unskilled manual workers (SEG DE), mean total aviation emissions are approximately *two and a half* times higher, and private vehicle emissions 50 per cent higher, for higher professional and managerial groups (SEG A).

Fig. 2.8a: Mean annual CO_2 emissions from all sources by Socio-Economic Group of HRP *(metric tons)*

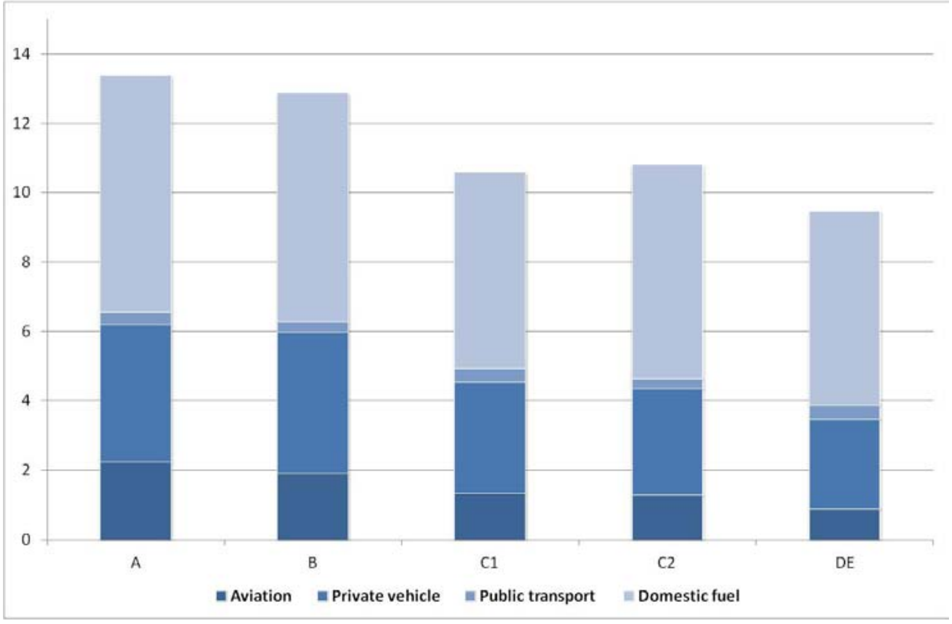
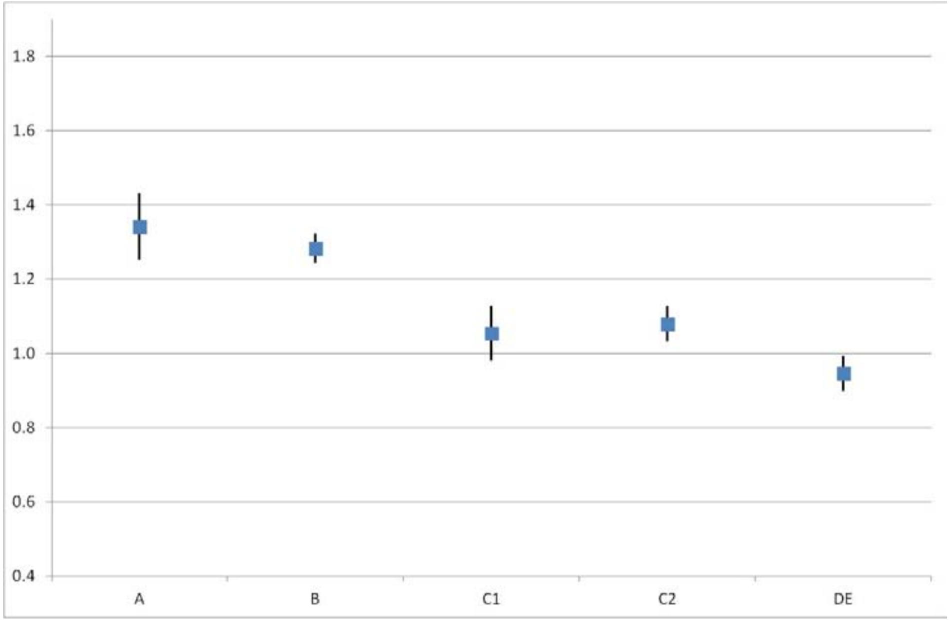


Figure 2.8b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by the Socio-Economic Group (SEG) of the HRP. These data confirm that social differences in mean total CO_2 emissions from all sources by Socio-Economic Group of the HRP exist not only for the sample under consideration but also for the wider population of interest. Occupational class differences in total household emissions from all sources are likely to reflect underlying inequalities in (equivalised) household incomes between occupational groups and related inequalities in command over resources and associated consumption levels.

***Fig. 2.8b: Mean annual total CO_2 emissions from all sources by Socio-Economic Group of HRP** (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Settlement type

Figure 2.9a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by the settlement type. In comparison with other social variations in mean total emissions, variation by settlement type is comparatively modest. Nevertheless, these data show that mean total emissions from all sources are highest amongst households living in ‘rural’ areas (villages, hamlets and isolated locations). Thus, compared with households in urban areas, households living in ‘rural’ areas have mean total emissions which are approximately *one fifth* higher. In contrast with other social differences in emissions, social variations in emissions by settlement type are primarily a consequence of social differences in domestic dwelling emissions. Households living in ‘rural’ areas have mean total emissions from domestic fuel use which are approximately *one quarter* higher than for households living in more ‘urban’ environments.

Fig. 2.9a: Mean annual CO_2 emissions from all sources by settlement type *(England and Wales only) (metric tons)*

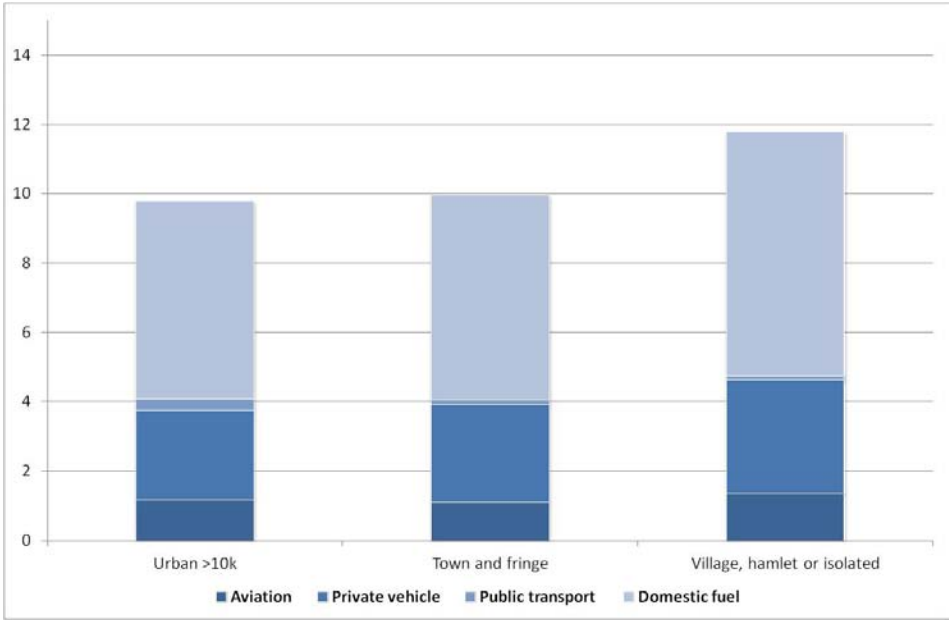
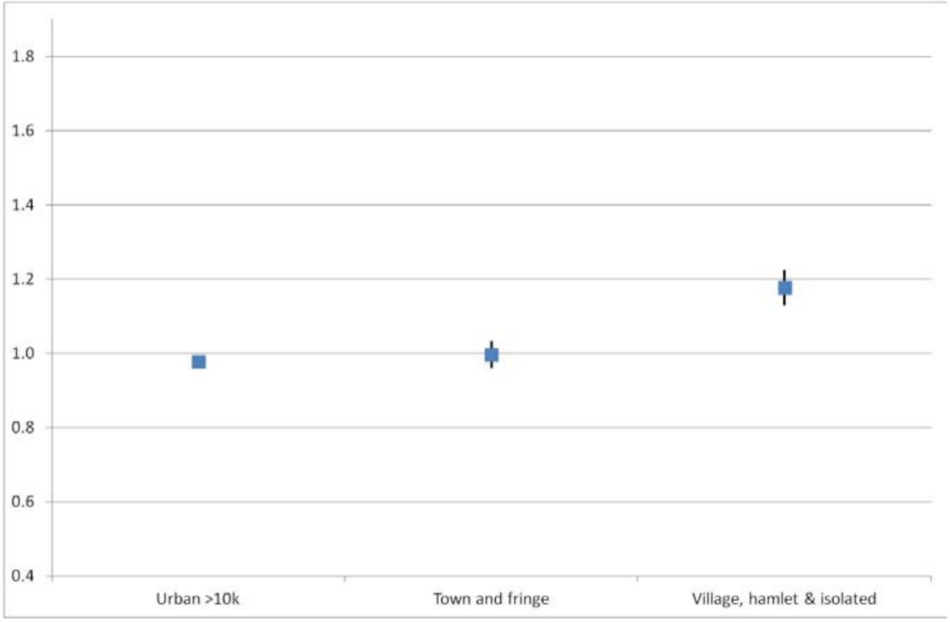


Figure 2.9b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by settlement type. These data confirm that social differences in mean total CO_2 emissions from all sources by settlement type exist not only for the sample under consideration but also for the wider population of interest. Differences in total household emissions from all sources between urban and rural areas are likely to reflect a wide variety of compositional differences in the populations of urban and rural areas. However, inequalities in (equivalised) income and associated command over resources between urban and rural areas are likely to be a key driver. It is possible that differences in domestic fuel emissions between urban and rural areas may reflect differences in required heating regimes and climatic conditions, though it is equally likely that such differences are at least partially accounted for by differences in dwelling construction and size. Similarly, higher private vehicle emissions in rural areas are likely to reflect both higher rates of vehicle ownership and reduced availability of accessible public transport in many rural communities.

Fig. 2.9b: Mean annual total CO_2 emissions from all sources by settlement type *(England and Wales only) (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Number of cars in household

Figure 2.10a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by the number of cars available to the household. These data reveal a strong and linear relationship between mean total CO_2 emissions from all sources and the number of cars available to the household. Mean total CO_2 emissions from all sources rise with rising levels of car ownership with households owning three or more vehicles having mean total emissions which are nearly *three times* those of households who do not own a private vehicle. As one might expect these social differences in mean total emissions are mainly attributable to emissions from private vehicles. Nevertheless, these data also show that car ownership is also associated with social differences in emissions from other sources, notably aviation and domestic fuel.

Fig. 2.10a: Mean annual CO_2 emissions from all sources by number of cars in household *(metric tons)*

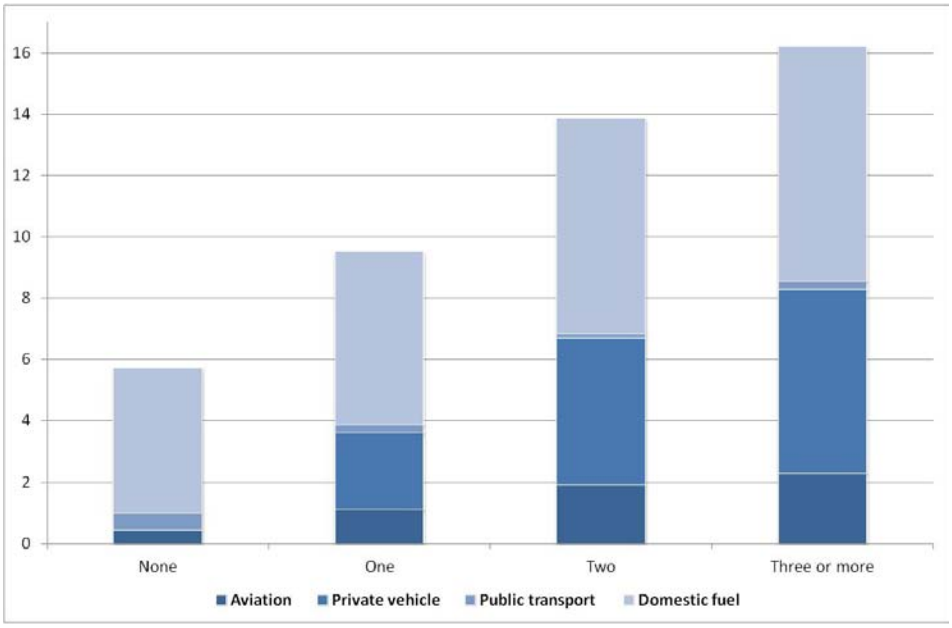
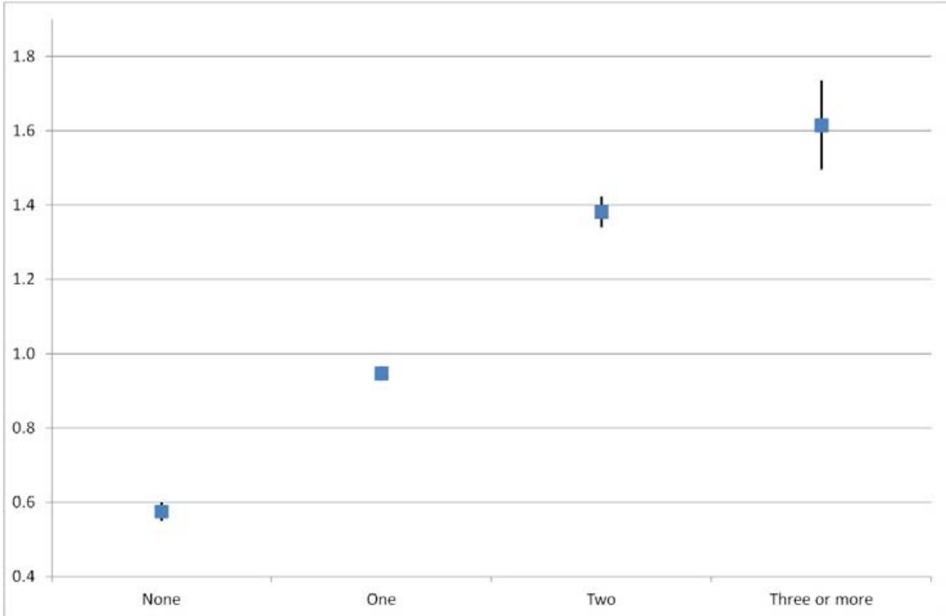


Figure 2.10b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by the number of cars to which the household has access. These data confirm that social differences in mean total CO_2 emissions from all sources by levels of household car ownership exist not only for the sample under consideration but also for the wider population of interest. As discussed above, variations in private vehicle emissions are a key driver of variation in total household emissions from all sources and a direct association between levels of car ownership and private vehicle emissions is therefore to be expected. However, variation in other emissions sources associated with levels of car ownership is likely to reflect the indirect impacts of other socio-economic differences (and especially inequalities in equivalised household income) which are also associated with car ownership.

Fig. 2.10b: Mean annual aggregate CO_2 emissions from all sources by number of cars in household *(rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Domestic fuel type

Figure 2.11a (*below*) describes the distribution of sample mean total CO_2 emissions from all sources in metric tons by domestic fuel type. These data show that mean total CO_2 emissions are highest amongst households using oil-based domestic fuel systems and lowest amongst households using electric-based heating systems, with mean total CO_2 emissions from all sources being approximately *twice* as high amongst the households using oil-based systems in comparison with those using electric based systems. As might be expected, these differences are primarily associated with social variations in mean total CO_2 emissions from domestic fuel itself. Nevertheless, these data also show that fuel type is also associated with other social differences in emissions from other sources, notably from aviation and private vehicles.

Fig. 2.11a: Mean annual CO_2 emissions from all sources by domestic fuel type *(metric tons)*

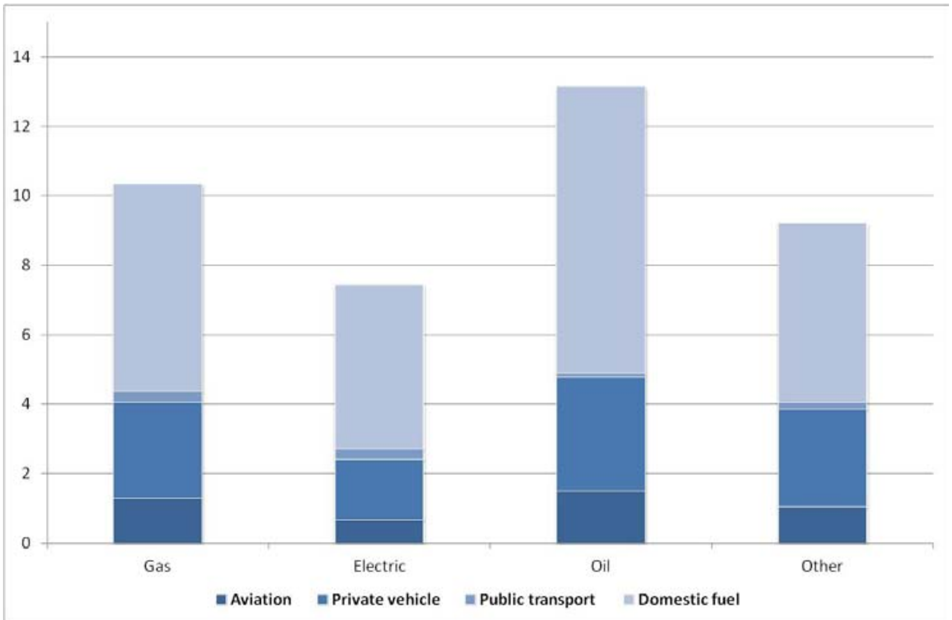
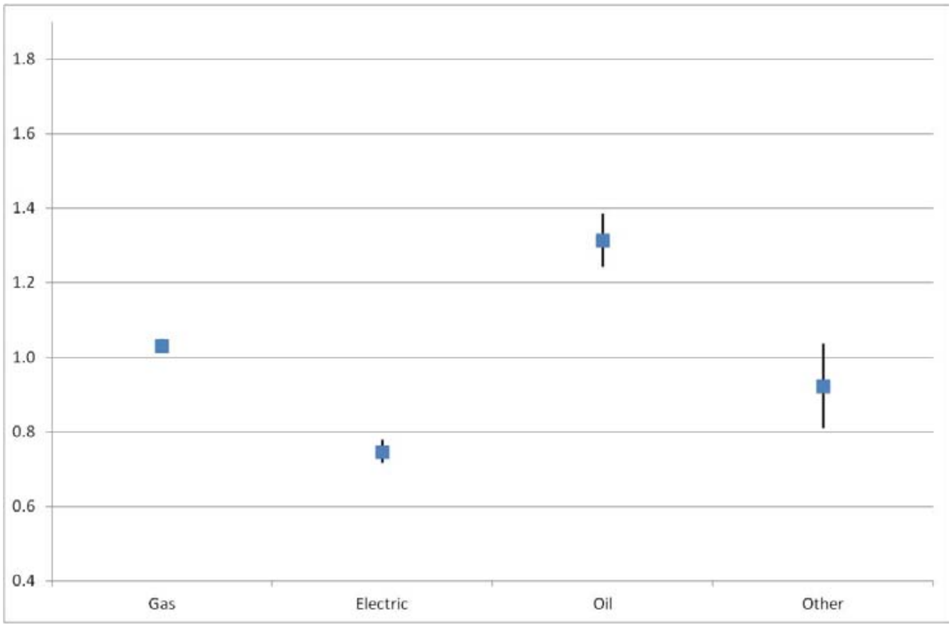


Figure 2.11b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by domestic fuel type. These data confirm that social differences in mean total CO_2 emissions from all sources by domestic fuel type exist not only for this sample but also for the wider population of interest. The direct effects of domestic fuel type upon household emissions are of course limited to domestic fuel emissions and are likely to reflect differences in the energy efficiency of different sources and, more importantly, wider social differences in the size and type of private dwellings. However, it is also likely that domestic fuel type is a proxy for a wide range of socio-economic inequalities within the population, including income inequalities, which affect households' command over resources and therefore their patterns of consumption.

***Fig. 2.11b: Mean annual total CO_2 emissions from all sources by domestic fuel type** (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

Government Office Region

Figure 2.12a (*below*) describes the distribution of sample mean CO_2 emissions from all sources in metric tons by Government Office Region. These data show that there is comparatively little social variation in mean total CO_2 emissions by region. Nevertheless, there are some interesting regional differences in the composition of total emissions. For example, compared with most other regions mean total emissions from public transport and aviation are higher in London and emissions from private vehicles and domestic fuel are lower.

Fig. 2.12a: Mean annual CO_2 emissions from all sources by Government Office Region *(metric tons)*

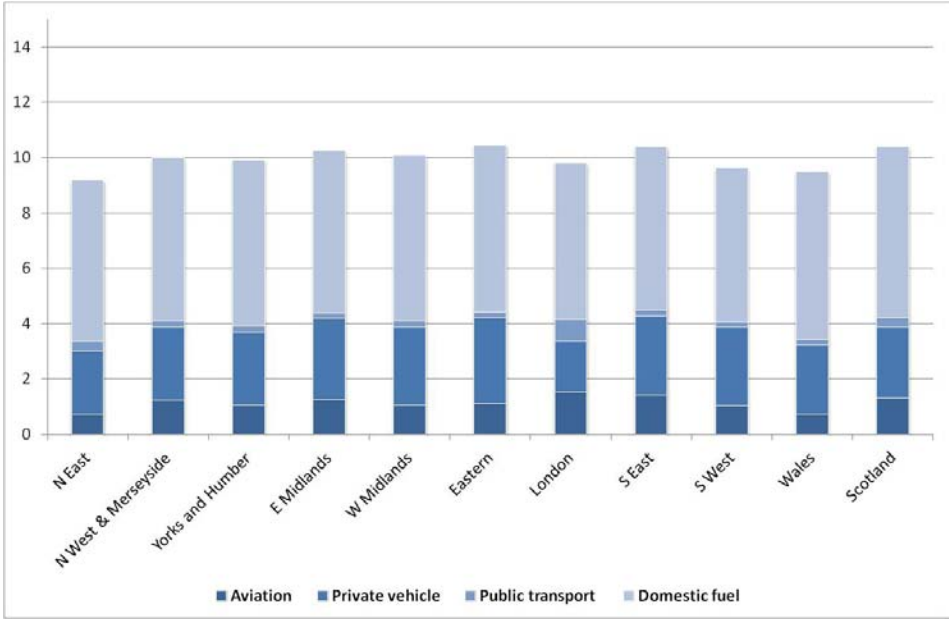
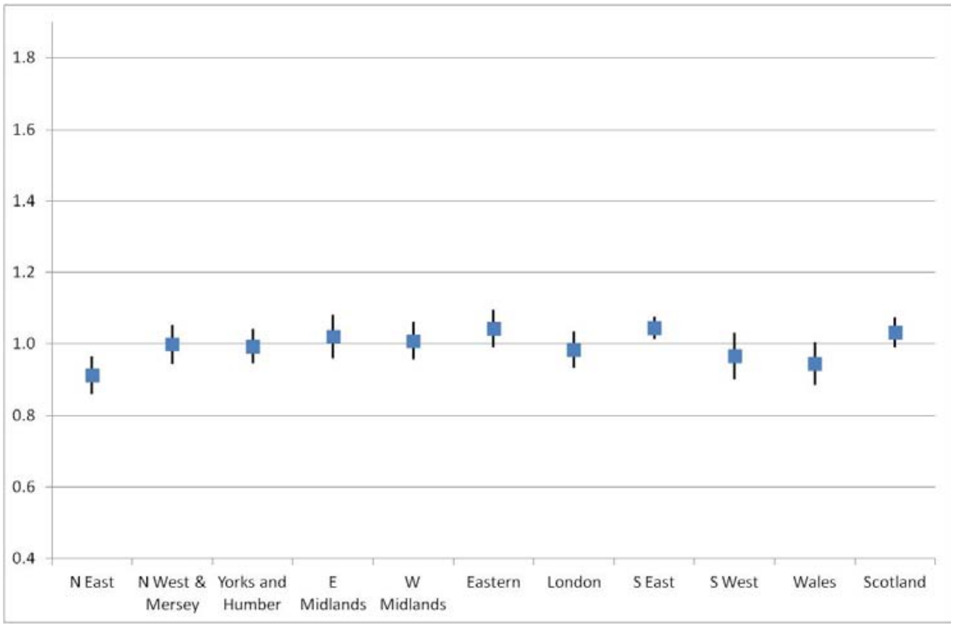


Figure 2.12b (*below*) shows estimated marginal means and 95 per cent confidence intervals for total emissions from all sources by Government Office Region. These data confirm that social differences in mean total CO_2 emissions from all sources by region exist not only for this sample but also for the wider population of interest. The drivers of regional differences in total household emissions are complex and likely to reflect the influence of a wide range of compositional effects with regard to demographic and socio-economic distinctions within the British population. Considerable further work would be needed to disentangle these complex effects but it worth noting that in most cases there is no statistically significant difference in total emissions from all sources.

***Fig. 2.12b: Mean annual total CO_2 emissions from all sources by Government Office Region** (rescaled)*



NOTE: Central estimates are means rescaled to a sample mean of 1. A group mean of 1.5 indicates that household emissions for this sample group are 50 per cent higher than for the sample as a whole. Error bars show the range of plausible population means at the 95 per cent confidence interval (95 per cent CI).

4. Summarising the social distribution of emissions – estimated effect sizes

Table 2 (*below*) summarises the pattern of association for each predictor reviewed in Section 2 with regard to mean annual total CO_2 emissions from all sources based on analysis of variance (ANOVA) methods. Analysis of variance is a parametric statistical method which can be used to compare within and between group variation in CO_2 estimates in order to estimate the extent to which variation in scores arises as a result of differences between groups (e.g. by tenure, income decile, etc.) rather than as a result of within group differences. The resulting test statistic (F ratio) offers a formal test of the null hypothesis of no between-group difference within the wider population.

In this section we report estimated effect sizes (partial eta squared) derived from one-way analysis of variance. The estimated effect size varies between 0 and 1 and describes the proportion of total variation in CO_2 emissions scores attributable to the predictor variable. As such it is useful way of summarising the overall pattern of social variation in our measures of interest attributable to a range of household, respondent and area characteristics as detailed in Table 2 (*below*).

Table 2: Estimates of univariate effect size for selected respondent and household predictors of mean annual CO_2 emissions

Predictor	Aviation	Private vehicles	Public transport	Domestic fuel	ALL SOURCES
Number of cars in household	.08	.90	.06	.09	.21
Household type	.06	.18	.04	.12	.17
Number of bedrooms	.04	.11	<.01	.17	.15
Household size	.02	.13	.02	.12	.14
Number of workers in hhld.	.08	.16	.05	.06	.14
Equiv. household income	.15	.19	<.01	.05	.12
NS-Sec of HRP	.10	.15	.03	.04	.10
Tenure status	.05	.17	.03	.06	.10
Dwelling type	.02	.11	.03	.10	.09
Employment status of HRP	.07	.12	.03	.02	.07
Age of HRP (banded)	.04	.08	.03	.04	.06
Heating fuel type	.01	.03	.01	.04	.04
SEG of HRP	.04	.04	<.01	.02	.03
Number of dep. children	<.01	.02	.01	.04	.03
Net household income	.09	.05	<.01	<.01	.02
Settlement type	<.01	.02	.03	.01	.01
Government Office Region	.01	.02	.06	<.01	<.01

NOTE: Effect estimates are one-way ANOVA partial eta squared values (based upon data iteration 1). Estimates vary between 0 and 1 and indicate the proportion of total variation in total CO_2 emissions attributable to the predictor variable. All effects are significant at the 95 per cent confidence level. All analyses performed on the natural log of the dependent variables.

For ease of interpretation, effect sizes greater than or equal to 0.1 are highlighted in Table 2 (*above*) in order to indicate those variables which have the strongest direct association with variation in total CO_2 emissions. In effect, (and leaving aside the influence of other variables) an effect size of 0.1 indicates that 10 per cent of the variation in our dependent measure can be 'explained' (or accounted for) by the predictor of interest. Considering firstly total CO_2 emissions from all sources (data column 5), levels of car ownership, household type, dwelling size (number of bedrooms), household size (number of occupants), the number of workers in the household, equivalised income, occupational class (NS-SEC), and housing tenure appear to be the most 'important' determinants of variations in emissions from all sources. Each of these variables accounts individually for between 10 per cent and 21 per cent of the variation in total emissions from all sources.

Considering the individual components of total household CO_2 emissions (data columns 1-4), it is evident that the extent and nature of social 'patterning' of emissions varies considerably by source. With regard to **public transport** emissions (data column 3), none of the predictors analysed here accounts individually for more than 10 per cent of the variation in total household emissions from this source, though levels of car ownership and the number of workers in a household account for 6 per cent and 5 per cent respectively of the total variance in public transport emissions.

With regard to **private vehicle emissions** (data column 2), the social structure of emissions is very similar to that pertaining to total emissions though the magnitude of effects sizes varies somewhat. Again, household type, dwelling size (number of bedrooms), household size, the number of workers in the household, equivalised income, occupational class (NS-SEC), housing tenure along with dwelling type and HRP employment status appear to be the primary determinants of variations in household emissions attributable to private vehicles. Naturally, we would also expect to find a very strong association between levels of household car ownership and household emissions attributable to private vehicles.

The social ‘patterning’ of households’ emissions attributable to **aviation** is in some respects similar to that associated with total household CO_2 emissions and emissions attributable to private vehicles. However, in most cases the pattern of association appears to be considerably weaker. With the exceptions of equivalised income and occupational class (NS-SEC) none of the predictors analysed here individually account for more than 10 per cent of the total variance in household aviation emissions. Nevertheless, equivalised household income and occupational class (NS-SEC) ‘explain’ respectively 15 per cent and 10 per cent of the total variance in households’ emissions from aviation (for non-business purposes).

As one might expect, the social ‘patterning’ of variation in households’ CO_2 emissions arising from **domestic fuel** usage is primarily attributable to differences in the size and composition of households, and the size and construction of dwellings themselves. Dwelling size (number of bedrooms), household size and type, and dwelling type each individually account for at least 10 per cent of the total variance in households’ domestic fuel emissions. In comparison, other socio-demographic and area-based differences within the population appear to ‘explain’ relatively little of the variation in household CO_2 emissions associated with domestic fuel use.

In summary, it is evident that a wide range of demographic and socio-economic characteristics are associated with variation in total household CO_2 emissions. In general terms, these reflect underlying differences in households’ size and structure, their social status and command over resources, and (associated with these) differences in the size and built structure of the dwellings households occupy. As one would expect given the implications of dwelling size and structure for thermal efficiency and heat requirement, CO_2 utilisation as a result of domestic fuel use is most strongly associated with the size and built structure of dwellings. In particular, it is noticeable that regional differences in household emissions attributable to domestic fuel usage, and those associated with settlement type, are trivial in comparison. The findings suggest that variation in emissions associated with domestic fuel use is driven by socio-economic and demographic factors rather than reflecting climatic conditions and the physical environment.

In comparison, emissions from aviation and private vehicle use reflect the influence of a much wider range of socio-economic factors associated with social status and command over resources (i.e. income-related). This is to be expected since consumption patterns relating to aviation and private vehicle use (and therefore also the associated CO_2 utilisation) are inherently more elastic with regard to the resources available to households in comparison with emissions associated with domestic fuel. Since the above analyses describe only the direct relationship between each predictor and the outcome of interest it is also likely that many of the predictors of interest will ‘overlap’ in their effects. For example, it may be that the strong association between private vehicle emissions and household type may be attributable to other socio-economic differences between households of different types.

Finally, there is little evidence of any substantial social patterning of household emissions attributable to public transport. This is not entirely surprising since the availability of adequate public transport is likely to be a primary driver of trends in usage and this is largely independent of the characteristics of households themselves. The relationship between region and public transport usage is a case in point here since much of the explanatory power of region in predicting public transport emissions is likely to be an effect of the elevated levels of emissions from this source in London. Unsurprisingly, as the above analyses show, the volume of households’ public transport emissions is inversely proportional to levels of household car ownership. That these emissions are also positively associated with the number of workers in a household is likely to be at least partly attributable to the commuting requirements of these households.

5. Conclusions

The findings described above demonstrate the extent to which households’ domestic CO_2 emissions reflect the influence of a wide range of demographic and socio-economic distinctions. Many of these phenomena are of course highly complex and inter-correlated and further work using multivariate modelling approaches will therefore be needed in order to disentangle these effects and to better understand the underlying drivers of social variation in households’ domestic CO_2 emissions. As a result it would be premature at this stage to seek to draw any firm conclusions regarding the potential distributional impacts of proposed or possible carbon mitigation policies.

However, a number of observations are warranted at this stage which may potentially have a bearing on future carbon mitigation policies. Firstly, while domestic fuel emissions accounts for the majority (approximately 60 per cent) of total household emissions from all sources, as described above much of the social *variation* in households’ domestic carbon emissions arises from private vehicle and (to a lesser extent) aviation emissions. Social variation in domestic energy consumption accounts for rather less of the total variation in household emissions. Emissions associated with public transport usage are also negligible in comparison with these sources and the social patterning of emissions from this source is much less pronounced.

Further improvements in domestic energy efficiency and reduced energy consumption will depend to a significant extent upon relatively long term improvements in housing stock. Moreover, since the energy demand associated with domestic fuel use is relatively *inelastic* with regard to demographic and socio-economic differences within the population (at least in comparison with aviation and private vehicle usage), the distributional consequences of current energy policies focused upon raising domestic energy prices are likely to be highly regressive. More imaginative policy solutions will certainly be required to ensure that the required reductions in CO_2 emissions associated with domestic fuel use are delivered in ways which are socially equitable. More emphasis will also need to be placed on carbon mitigation policies associated with aviation and private vehicle usage if reductions in total carbon emissions are to be achieved in ways which do not exacerbate existing socio-economic inequalities.

Secondly, the above analyses demonstrate the centrality of demographic and socio-economic distinctions in accounting for variation in household CO_2 emissions. In comparison, geo-spatial variations in households' domestic emissions are relatively trivial. However, any assessment of the distributive equity of current patterns of household energy consumption and associated emissions clearly needs to take account of variations in household size and composition. Determining the energy and associated CO_2 emissions required by households of different types in order to meet their material and social needs should therefore be a priority for future research in the area.

Thirdly, these data demonstrate the centrality of socio-economic inequalities, including income inequalities, in determining households' command over resources and therefore their patterns of consumption and associated emissions. In general terms, these data suggest that substantial reductions in carbon emissions could be achieved by reducing energy consumption amongst those groups currently 'over-consuming' relative to the population as a whole. Such a strategy would also appear to be consistent with the pursuit of social equity in the distribution and utilisation of societal resources. However, as noted above the socio-economic and demographic correlates of household carbon emissions are often inter-correlated and therefore require much more detailed analysis of the potential distributive impacts of potential carbon mitigation policies at the household level given the potential for complex, non-linear effects and interactions within these data. Phase Two of this project will therefore seek to provide a detailed assessment of the distributional consequences of existing and potential carbon mitigation policies for households in different circumstances.

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7. Appendices

Table A1: The distribution of total household CO_2 emissions from all sources – means, standard errors and confidence intervals *(metric tons)*

		Mean	SE	95%CI lo	95%CI hi
OECD equivilised net household disposable income	1	.674	.020	.633	.714
	2	.679	.019	.641	.718
	3	.789	.021	.747	.831
	4	.866	.025	.811	.922
	5	.956	.025	.901	1.012
	6	1.033	.018	.997	1.069
	7	1.133	.020	1.091	1.175
	8	1.220	.031	1.147	1.293
	9	1.275	.033	1.196	1.353
	10	1.440	.026	1.384	1.496
Net household disposable income	1	.847	.022	.801	.892
	2	.906	.023	.858	.954
	3	.919	.018	.883	.954
	4	.932	.024	.882	.983
	5	.994	.018	.958	1.029
	6	1.016	.023	.968	1.064
	7	1.026	.019	.989	1.063
	8	1.084	.022	1.037	1.130
	9	1.111	.028	1.049	1.173
	10	1.224	.025	1.170	1.279
Number of children	None	.928	.008	.912	.945
	One	1.121	.021	1.077	1.166
	Two	1.221	.016	1.190	1.253
	Three	1.210	.041	1.120	1.300
	Four or more	1.183	.077	1.011	1.355
Household size	One person	.641	.011	.619	.663
	Two persons	1.020	.010	.999	1.041
	Three persons	1.167	.016	1.134	1.200
	Four persons	1.325	.022	1.277	1.372
	Five persons	1.337	.035	1.261	1.412
	Six or more persons	1.425	.080	1.233	1.617
Age of HRP	Under 25	.785	.045	.685	.885
	25-35	.979	.022	.930	1.028
	35-45	1.133	.015	1.102	1.164
	45-55	1.194	.020	1.149	1.239
	55-60	1.120	.023	1.072	1.168
	60-65	1.019	.023	.972	1.065
	65-70	.856	.016	.825	.887
	75+	.665	.016	.634	.695
Household type	Single pensioner	.597	.016	.565	.629
	Pensioner couple	.906	.019	.868	.944
	Single working age adult	.687	.017	.653	.720
	Couple, no dependent children	1.112	.012	1.087	1.136
	Couple with dependent children	1.238	.020	1.193	1.284
	Single parent with dependent children	.786	.023	.741	.832
	Three or more adults	1.416	.027	1.354	1.478

Table A1: The distribution of total household CO_2 emissions from all sources – means, standard errors and confidence intervals *(metric tons)* ***(continued)***

		Mean	SE	95%CI lo	95%CI hi
Number of bedrooms in dwelling	One	.556	.019	.519	.593
	Two	.810	.012	.787	.833
	Three	1.043	.010	1.022	1.063
	Four	1.359	.024	1.303	1.415
	Five or more	1.700	.033	1.633	1.768
Accommodation type	Detached	1.280	.023	1.225	1.336
	Semi-detached	1.042	.013	1.014	1.070
	Terraced	.923	.015	.890	.956
	Flat	.672	.023	.620	.724
	Other	.879	.029	.820	.939
Tenure	Owned Outright	.983	.014	.953	1.013
	Mortgage	1.221	.014	1.189	1.253
	Renting	.734	.011	.712	.756
	Other	.934	.044	.848	1.020
Number of cars in household	None	.575	.012	.550	.600
	One	.947	.009	.929	.965
	Two	1.382	.018	1.340	1.424
	Three or more	1.616	.049	1.497	1.736
Domestic fuel type	Gas	1.032	.008	1.015	1.049
	Electric	.747	.016	.715	.779
	Oil	1.314	.035	1.242	1.386
	Other	.923	.053	.809	1.037
Government Office Region	N East	.913	.027	.861	.966
	N West & Mersey	.999	.025	.945	1.053
	Yorks and Humber	.994	.023	.948	1.041
	E Midlands	1.021	.028	.960	1.081
	W Midlands	1.009	.025	.957	1.062
	Eastern	1.043	.025	.990	1.097
	London	.984	.024	.933	1.035
	S East	1.045	.016	1.013	1.078
	S West	.966	.029	.902	1.031
	Wales	.946	.029	.886	1.006
	Scotland	1.032	.021	.989	1.076
Settlement type	Urban >10k	.978	.008	.961	.994
	Town and fringe	.996	.019	.960	1.033
	Village, hamlet & isolated	1.178	.023	1.130	1.226
Number of (paid) workers in household	None	.710	.010	.691	.729
	One	.918	.014	.890	.947
	Two	1.251	.020	1.204	1.298
	Three	1.479	.035	1.403	1.556
	Four or more	1.768	.078	1.580	1.956
Employment status of HRP	Self-employed	1.118	.032	1.046	1.190
	FT employee	1.202	.012	1.176	1.229
	PT employee	1.098	.021	1.054	1.142
	ILO unemployed	.796	.047	.698	.893
	Retired	.751	.011	.729	.772
	Other econ inactive	.853	.016	.820	.886

Table A1: The distribution of total household CO_2 emissions from all sources – means, standard errors and confidence intervals** (metric tons) **(continued)

		Mean	SE	95%CI lo	95%CI hi
NS-SEC of HRP	Large employers/higher managerial	1.452	.038	1.369	1.535
	Higher professionals	1.326	.029	1.264	1.388
	Lower managerial/professionals	1.254	.026	1.192	1.315
	Intermediate	1.038	.043	.936	1.140
	Small employers/own account workers	1.071	.029	1.011	1.131
	Lower supervisory/technical	1.092	.029	1.030	1.154
	Semi-Routine	.966	.028	.906	1.026
	Routine	.972	.024	.925	1.018
	HRP retired	.751	.011	.729	.772
	Other econ inactive	.788	.022	.743	.833
	Not classifiable	.770	.036	.697	.843
Socio-Economic Group of HRP	A	1.342	.041	1.253	1.431
	B	1.284	.018	1.244	1.324
	C1	1.054	.033	.981	1.127
	C2	1.079	.022	1.032	1.127
	DE	.947	.024	.899	.994

Table A2: The distribution of total household CO_2 emissions from aviation – means, standard errors and confidence intervals *(metric tons)*

		Mean	SE	95%CI lo	95%CI hi
OECD equivilised net household disposable income	1	0.47	0.09	0.28	0.65
	2	0.42	0.07	0.28	0.55
	3	0.59	0.07	0.46	0.72
	4	0.75	0.07	0.61	0.88
	5	0.82	0.07	0.69	0.95
	6	1.13	0.08	0.96	1.31
	7	1.39	0.08	1.23	1.56
	8	1.72	0.10	1.49	1.94
	9	1.99	0.12	1.71	2.28
	10	2.94	0.12	2.67	3.21
Net household disposable income	1	0.68	0.08	0.50	0.85
	2	0.71	0.07	0.57	0.84
	3	0.77	0.08	0.61	0.93
	4	0.96	0.09	0.78	1.15
	5	1.00	0.07	0.86	1.14
	6	1.31	0.08	1.15	1.47
	7	1.17	0.09	0.98	1.36
	8	1.44	0.10	1.22	1.66
	9	1.74	0.11	1.50	1.98
	10	2.44	0.09	2.24	2.65
Number of children	None	1.13	0.04	1.05	1.21
	One	1.31	0.06	1.20	1.42
	Two	1.55	0.07	1.41	1.69
	Three	1.31	0.13	1.05	1.57
	Four or more	1.13	0.29	0.49	1.77
Household size	One person	0.53	0.04	0.45	0.61
	Two persons	1.37	0.04	1.29	1.45
	Three persons	1.42	0.07	1.27	1.57
	Four persons	1.75	0.06	1.63	1.86
	Five persons	1.58	0.12	1.32	1.85
	Six or more persons	1.50	0.21	1.05	1.94
Age of HRP	Under 25	0.80	0.13	0.54	1.07
	25-35	1.29	0.09	1.08	1.50
	35-45	1.49	0.06	1.38	1.61
	45-55	1.48	0.08	1.31	1.64
	55-60	1.44	0.08	1.29	1.59
	60-65	1.45	0.10	1.23	1.67
	65-70	0.96	0.06	0.85	1.07
	75+	0.34	0.07	0.20	0.47
Household type	Single pensioner	0.34	0.05	0.23	0.44
	Pensioner couple	1.02	0.07	0.87	1.16
	Single working age adult	0.73	0.06	0.62	0.85
	Couple, no dependent children	1.64	0.05	1.53	1.74
	Couple with dependent children	1.55	0.05	1.46	1.65
	Single parent with dependent children	0.63	0.09	0.46	0.79
	Three or more adults	1.84	0.10	1.63	2.06

Table A2: The distribution of total household CO_2 emissions from aviation – means, standard errors and confidence intervals** (metric tons) **(continued)

		Mean	SE	95%CI lo	95%CI hi
Number of bedrooms in dwelling	One	0.54	0.07	0.40	0.68
	Two	0.85	0.04	0.77	0.92
	Three	1.18	0.03	1.11	1.25
	Four	2.05	0.08	1.88	2.22
	Five or more	2.79	0.23	2.24	3.33
Accommodation type	Detached	1.82	0.05	1.71	1.93
	Semi-detached	1.18	0.05	1.07	1.28
	Terraced	0.98	0.05	0.88	1.08
	Flat	0.79	0.05	0.69	0.90
	Other	1.15	0.09	0.97	1.33
Tenure	Owned Outright	1.21	0.07	1.06	1.37
	Mortgage	1.66	0.05	1.53	1.78
	Renting	0.62	0.04	0.55	0.70
	Other	0.91	0.20	0.49	1.33
Number of cars in household	None	0.44	0.05	0.34	0.54
	One	1.10	0.04	1.02	1.18
	Two	1.92	0.09	1.71	2.12
	Three or more	2.31	0.13	2.02	2.61
Domestic fuel type	Gas	1.29	0.03	1.22	1.36
	Electric	0.67	0.06	0.55	0.80
	Oil	1.51	0.11	1.29	1.73
	Other	1.04	0.19	0.64	1.43
Government Office Region	N East	0.73	0.10	0.53	0.92
	N West & Mersey	1.23	0.07	1.10	1.36
	Yorks and Humber	1.09	0.08	0.94	1.25
	E Midlands	1.27	0.09	1.09	1.45
	W Midlands	1.07	0.11	0.83	1.32
	Eastern	1.14	0.07	1.01	1.27
	London	1.56	0.08	1.38	1.74
	S East	1.46	0.09	1.26	1.65
	S West	1.06	0.08	0.90	1.22
	Wales	0.73	0.10	0.53	0.92
	Scotland	1.33	0.08	1.16	1.50
Settlement type	Urban >10k	1.19	0.03	1.12	1.25
	Town and fringe	1.13	0.08	0.97	1.29
	Village, hamlet & isolated	1.37	0.07	1.23	1.52
Number of (paid) workers in household	None	0.58	0.04	0.49	0.67
	One	1.11	0.05	1.01	1.21
	Two	1.78	0.06	1.64	1.92
	Three	1.95	0.14	1.65	2.26
	Four or more	2.03	0.24	1.47	2.58
Employment status of HRP	Self-employed	1.69	0.10	1.49	1.89
	FT employee	1.64	0.05	1.53	1.76
	PT employee	1.24	0.07	1.10	1.39
	ILO unemployed	0.70	0.15	0.40	1.01
	Retired	0.64	0.04	0.55	0.73
	Other econ inactive	0.94	0.07	0.80	1.09

Table A2: The distribution of total household CO_2 emissions from aviation – means, standard errors and confidence intervals** (metric tons) **(continued)

		Mean	SE	95%CI lo	95%CI hi
NS-SEC of HRP	Large employers/higher managerial	2.38	0.12	2.14	2.61
	Higher professionals	2.23	0.11	2.00	2.46
	Lower managerial/professionals	1.79	0.07	1.64	1.94
	Intermediate	1.24	0.10	1.05	1.43
	Small employers/own account workers	1.56	0.08	1.40	1.73
	Lower supervisory/technical	1.18	0.08	1.03	1.34
	Semi-Routine	0.90	0.08	0.74	1.07
	Routine	0.94	0.09	0.75	1.13
	HRP retired	0.64	0.04	0.55	0.73
	Other econ inactive	0.69	0.07	0.55	0.84
	Not classifiable	0.90	0.15	0.60	1.20
Socio-Economic Group of HRP	A	2.27	0.19	1.84	2.71
	B	1.91	0.06	1.78	2.04
	C1	1.31	0.08	1.14	1.48
	C2	1.28	0.06	1.17	1.40
	DE	0.88	0.08	0.71	1.04

Table A3: The distribution of total household CO_2 emissions from private vehicles – means, standard errors and confidence intervals *(metric tons)*

		Mean	SE	95%CI lo	95%CI hi
OECD equivilised net household disposable income	1	0.95	0.15	0.64	1.26
	2	1.09	0.14	0.82	1.36
	3	1.69	0.18	1.32	2.07
	4	2.08	0.20	1.63	2.52
	5	2.66	0.22	2.17	3.14
	6	3.01	0.16	2.68	3.34
	7	3.44	0.19	3.02	3.85
	8	3.81	0.20	3.38	4.25
	9	4.03	0.21	3.56	4.49
	10	3.92	0.18	3.54	4.31
Net household disposable income	1	1.59	0.16	1.27	1.90
	2	2.14	0.18	1.76	2.51
	3	2.39	0.15	2.09	2.69
	4	2.35	0.20	1.90	2.80
	5	2.74	0.14	2.46	3.01
	6	2.76	0.18	2.39	3.13
	7	3.04	0.15	2.75	3.34
	8	3.20	0.15	2.90	3.51
	9	3.24	0.19	2.83	3.65
	10	3.21	0.22	2.70	3.71
Number of children	None	2.36	0.06	2.25	2.48
	One	3.19	0.14	2.90	3.47
	Two	3.57	0.13	3.32	3.82
	Three	3.22	0.39	2.33	4.11
	Four or more	2.57	0.45	1.64	3.50
Household size	One person	1.18	0.08	1.01	1.35
	Two persons	2.71	0.08	2.56	2.87
	Three persons	3.46	0.12	3.20	3.71
	Four persons	4.04	0.18	3.63	4.44
	Five persons	3.73	0.30	3.05	4.40
	Six or more persons	3.58	0.57	2.25	4.92
Age of HRP	Under 25	1.82	0.35	1.05	2.59
	25-35	2.89	0.16	2.53	3.24
	35-45	3.24	0.13	2.98	3.51
	45-55	3.47	0.15	3.13	3.81
	55-60	3.20	0.23	2.70	3.71
	60-65	2.52	0.20	2.11	2.93
	65-70	1.82	0.12	1.58	2.06
	75+	1.05	0.13	0.79	1.30
Household type	Single pensioner	0.80	0.13	0.55	1.06
	Pensioner couple	2.00	0.15	1.69	2.31
	Single working age adult	1.58	0.14	1.30	1.86
	Couple, no dependent children	3.24	0.10	3.03	3.44
	Couple with dependent children	3.73	0.15	3.38	4.07
	Single parent with dependent children	1.41	0.19	1.04	1.79
	Three or more adults	4.29	0.21	3.80	4.77

Table A3: The distribution of total household CO_2 emissions from private vehicles – means, standard errors and confidence intervals *(metric tons)* ***(continued)***

		Mean	SE	95%CI lo	95%CI hi
Number of bedrooms in dwelling	One	0.98	0.15	0.68	1.27
	Two	2.04	0.10	1.85	2.24
	Three	2.88	0.08	2.70	3.06
	Four	3.80	0.22	3.29	4.31
	Five or more	4.17	0.25	3.67	4.66
Accommodation type	Detached	3.56	0.20	3.07	4.05
	Semi-detached	2.96	0.10	2.75	3.17
	Terraced	2.38	0.13	2.08	2.69
	Flat	1.27	0.17	0.91	1.64
	Other	2.01	0.25	1.48	2.55
Tenure	Owned Outright	2.41	0.11	2.17	2.65
	Mortgage	3.76	0.08	3.58	3.93
	Renting	1.44	0.10	1.24	1.64
	Other	2.25	0.42	1.38	3.13
Number of cars in household	None	0.00	0.08	0.00	0.00
	One	2.50	0.07	2.37	2.64
	Two	4.76	0.15	4.40	5.11
	Three or more	5.97	0.39	5.02	6.91
Domestic fuel type	Gas	2.77	0.05	2.67	2.87
	Electric	1.76	0.15	1.44	2.08
	Oil	3.33	0.32	2.60	4.05
	Other	2.83	0.50	1.68	3.98
Government Office Region	N East	2.28	0.20	1.87	2.68
	N West & Mersey	2.66	0.20	2.21	3.12
	Yorks and Humber	2.62	0.16	2.29	2.94
	E Midlands	2.92	0.27	2.31	3.53
	W Midlands	2.82	0.20	2.39	3.24
	Eastern	3.07	0.23	2.55	3.60
	London	1.85	0.16	1.52	2.18
	S East	2.90	0.12	2.65	3.14
	S West	2.88	0.26	2.27	3.49
	Wales	2.48	0.22	2.04	2.93
	Scotland	2.53	0.15	2.22	2.83
Settlement type	Urban >10k	2.57	0.05	2.47	2.67
	Town and fringe	2.81	0.17	2.46	3.16
	Village, hamlet & isolated	3.27	0.19	2.86	3.67
Number of (paid) workers in household	None	1.17	0.07	1.02	1.31
	One	2.22	0.13	1.92	2.53
	Two	3.97	0.14	3.64	4.30
	Three	4.94	0.31	4.21	5.66
	Four or more	6.03	0.73	4.21	7.85
Employment status of HRP	Self-employed	2.53	0.26	1.95	3.12
	FT employee	3.91	0.08	3.75	4.07
	PT employee	3.30	0.13	3.03	3.56
	ILO unemployed	1.39	0.36	0.64	2.13
	Retired	1.36	0.09	1.19	1.53
	Other econ inactive	1.55	0.13	1.27	1.82

Table A3: The distribution of total household CO_2 emissions from private vehicles – means, standard errors and confidence intervals** (metric tons) **(continued)

		Mean	SE	95%CI lo	95%CI hi
NS-SEC of HRP	Large employers/higher managerial	4.59	0.32	3.86	5.32
	Higher professionals	4.00	0.29	3.32	4.67
	Lower managerial/professionals	4.11	0.19	3.65	4.57
	Intermediate	3.12	0.28	2.48	3.76
	Small employers/own account workers	2.30	0.23	1.81	2.79
	Lower supervisory/technical	3.48	0.29	2.81	4.15
	Semi-Routine	2.82	0.20	2.40	3.25
	Routine	2.71	0.20	2.30	3.12
	HRP retired	1.36	0.09	1.19	1.53
	Other econ inactive	1.38	0.18	0.99	1.77
	Not classifiable	1.01	0.23	0.55	1.48
Socio-Economic Group of HRP	A	3.97	0.39	3.07	4.87
	B	4.04	0.13	3.77	4.32
	C1	3.23	0.26	2.63	3.82
	C2	3.08	0.18	2.68	3.48
	DE	2.60	0.19	2.23	2.98

Table A4: The distribution of total household CO_2 emissions from public transport – means, standard errors and confidence intervals *(metric tons)*

		Mean	SE	95%CI lo	95%CI hi
OECD equivilised net household disposable income	1	0.38	0.07	0.21	0.54
	2	0.26	0.05	0.16	0.35
	3	0.28	0.05	0.16	0.39
	4	0.23	0.04	0.15	0.32
	5	0.28	0.07	0.12	0.45
	6	0.26	0.06	0.13	0.40
	7	0.33	0.06	0.19	0.47
	8	0.29	0.06	0.15	0.43
	9	0.29	0.08	0.11	0.47
	10	0.34	0.08	0.14	0.54
Net household disposable income	1	0.44	0.09	0.22	0.66
	2	0.35	0.04	0.26	0.44
	3	0.34	0.05	0.23	0.45
	4	0.30	0.05	0.20	0.40
	5	0.26	0.05	0.16	0.36
	6	0.26	0.08	0.07	0.44
	7	0.23	0.05	0.14	0.33
	8	0.24	0.05	0.12	0.35
	9	0.24	0.07	0.09	0.39
	10	0.28	0.08	0.08	0.48
Number of children	None	0.27	0.02	0.23	0.30
	One	0.40	0.08	0.21	0.59
	Two	0.30	0.05	0.19	0.41
	Three	0.32	0.10	0.09	0.56
	Four or more	0.42	0.20	-0.05	0.88
Household size	One person	0.24	0.03	0.18	0.29
	Two persons	0.23	0.03	0.17	0.28
	Three persons	0.32	0.04	0.22	0.42
	Four persons	0.40	0.06	0.27	0.53
	Five persons	0.52	0.09	0.33	0.71
	Six or more persons	0.92	0.28	0.17	1.66
Age of HRP	Under 25	0.58	0.15	0.21	0.95
	25-35	0.36	0.05	0.24	0.48
	35-45	0.34	0.05	0.23	0.44
	45-55	0.38	0.06	0.23	0.53
	55-60	0.24	0.06	0.10	0.38
	60-65	0.19	0.04	0.11	0.28
	65-70	0.18	0.04	0.11	0.25
	75+	0.18	0.04	0.10	0.26
Household type	Single pensioner	0.23	0.04	0.15	0.32
	Pensioner couple	0.11	0.04	0.04	0.19
	Single working age adult	0.24	0.04	0.17	0.32
	Couple, no dependent children	0.27	0.03	0.20	0.34
	Couple with dependent children	0.28	0.04	0.18	0.37
	Single parent with dependent children	0.32	0.07	0.18	0.46
	Three or more adults	0.66	0.08	0.46	0.85

Table A4: The distribution of total household CO_2 emissions from public transport – means, standard errors and confidence intervals (continued)

		Mean	SE	95%CI lo	95%CI hi
Number of bedrooms in dwelling	One	0.36	0.05	0.27	0.45
	Two	0.28	0.03	0.21	0.35
	Three	0.29	0.02	0.24	0.34
	Four	0.25	0.05	0.13	0.36
	Five or more	0.47	0.15	0.11	0.84
Accommodation type	Detached	0.15	0.03	0.10	0.20
	Semi-detached	0.26	0.02	0.21	0.30
	Terraced	0.34	0.03	0.28	0.40
	Flat	0.45	0.08	0.24	0.65
	Other	0.49	0.11	0.23	0.76
Tenure	Owned Outright	0.18	0.03	0.12	0.23
	Mortgage	0.28	0.04	0.19	0.38
	Renting	0.44	0.03	0.38	0.50
	Other	0.29	0.15	-0.05	0.64
Number of cars in household	None	0.55	0.05	0.43	0.66
	One	0.24	0.02	0.19	0.29
	Two	0.15	0.03	0.08	0.22
	Three or more	0.26	0.08	0.10	0.43
Domestic fuel type	Gas	0.31	0.02	0.27	0.34
	Electric	0.30	0.05	0.20	0.40
	Oil	0.09	0.06	-0.03	0.21
	Other	0.20	0.09	0.02	0.37
Government Office Region	N East	0.36	0.09	0.16	0.55
	N West & Mersey	0.24	0.05	0.15	0.33
	Yorks and Humber	0.24	0.05	0.13	0.35
	E Midlands	0.20	0.07	0.06	0.35
	W Midlands	0.23	0.06	0.11	0.36
	Eastern	0.20	0.04	0.12	0.28
	London	0.79	0.06	0.66	0.92
	S East	0.23	0.05	0.10	0.35
	S West	0.14	0.04	0.06	0.21
	Wales	0.19	0.07	0.04	0.35
	Scotland	0.34	0.07	0.16	0.51
Settlement type	Urban >10k	0.33	0.02	0.30	0.37
	Town and fringe	0.14	0.05	0.03	0.25
	Village, hamlet & isolated	0.11	0.05	0.02	0.20
Number of (paid) workers in household	None	0.20	0.02	0.16	0.25
	One	0.22	0.03	0.17	0.28
	Two	0.30	0.04	0.21	0.38
	Three	0.60	0.09	0.39	0.81
	Four or more	1.77	0.42	0.62	2.91
Employment status of HRP	Self-employed	0.22	0.06	0.08	0.35
	FT employee	0.34	0.04	0.23	0.44
	PT employee	0.35	0.05	0.25	0.45
	ILO unemployed	0.76	0.19	0.29	1.24
	Retired	0.18	0.03	0.13	0.23
	Other econ inactive	0.31	0.04	0.22	0.40

Table A4: The distribution of total household CO_2 emissions from public transport – means, standard errors and confidence intervals (continued)

		Mean	SE	95%CI lo	95%CI hi
NS-SEC of HRP	Large employers/higher managerial	0.33	0.09	0.14	0.53
	Higher professionals	0.33	0.06	0.20	0.46
	Lower managerial/professionals	0.29	0.05	0.17	0.41
	Intermediate	0.39	0.13	0.06	0.71
	Small employers/own account workers	0.22	0.06	0.10	0.35
	Lower supervisory/technical	0.24	0.06	0.12	0.37
	Semi-Routine	0.44	0.11	0.18	0.70
	Routine	0.41	0.11	0.16	0.67
	HRP retired	0.18	0.03	0.13	0.23
	Other econ inactive	0.31	0.07	0.15	0.47
	Not classifiable	0.58	0.14	0.24	0.92
Socio-Economic Group of HRP	A	0.34	0.07	0.20	0.49
	B	0.29	0.04	0.20	0.38
	C1	0.37	0.08	0.17	0.57
	C2	0.29	0.06	0.17	0.42
	DE	0.41	0.06	0.29	0.53

Table A5: The distribution of total household CO_2 emissions from domestic fuel – means, standard errors and confidence intervals *(metric tons)*

		Mean	SE	95%CI lo	95%CI hi
OECD equivilised net household disposable income	1	4.98	0.08	4.81	5.14
	2	5.06	0.07	4.92	5.20
	3	5.37	0.07	5.23	5.51
	4	5.65	0.07	5.52	5.78
	5	5.86	0.07	5.73	5.99
	6	5.98	0.07	5.85	6.11
	7	6.23	0.07	6.10	6.36
	8	6.44	0.07	6.31	6.57
	9	6.50	0.07	6.37	6.63
	10	7.26	0.07	7.13	7.40
Net household disposable income	1	5.80	0.08	5.63	5.98
	2	5.92	0.07	5.79	6.05
	3	5.74	0.07	5.61	5.87
	4	5.75	0.07	5.62	5.88
	5	5.99	0.07	5.86	6.12
	6	5.89	0.07	5.75	6.03
	7	5.87	0.07	5.74	5.99
	8	6.01	0.07	5.88	6.14
	9	5.95	0.07	5.82	6.08
	10	6.38	0.07	6.25	6.51
Number of children	None	5.57	0.03	5.51	5.62
	One	6.37	0.06	6.26	6.48
	Two	6.86	0.06	6.74	6.98
	Three	7.31	0.12	7.07	7.55
	Four or more	7.78	0.18	7.42	8.14
Household size	One person	4.49	0.04	4.42	4.57
	Two persons	5.95	0.03	5.88	6.01
	Three persons	6.53	0.05	6.43	6.64
	Four persons	7.13	0.05	7.03	7.24
	Five persons	7.61	0.10	7.40	7.81
	Six or more persons	8.33	0.16	8.02	8.64
Age of HRP	Under 25	4.69	0.13	4.43	4.95
	25-35	5.30	0.05	5.19	5.41
	35-45	6.31	0.05	6.22	6.40
	45-55	6.68	0.05	6.58	6.78
	55-60	6.38	0.07	6.24	6.51
	60-65	6.08	0.07	5.94	6.22
	65-70	5.64	0.06	5.54	5.75
	75+	5.12	0.06	5.00	5.23
Household type	Single pensioner	4.63	0.05	4.52	4.73
	Pensioner couple	5.98	0.06	5.86	6.10
	Single working age adult	4.35	0.06	4.24	4.46
	Couple, no dependent children	6.03	0.04	5.95	6.12
	Couple with dependent children	6.89	0.05	6.80	6.98
	Single parent with dependent children	5.54	0.09	5.37	5.72
	Three or more adults	7.45	0.06	7.33	7.57

Table A5: The distribution of total household CO_2 emissions from domestic fuel – means, standard errors and confidence intervals (continued)

		Mean	SE	95%CI lo	95%CI hi
Number of bedrooms in dwelling	One	3.71	0.07	3.58	3.84
	Two	4.97	0.04	4.90	5.05
	Three	6.13	0.03	6.07	6.19
	Four	7.56	0.05	7.45	7.67
	Five or more	9.66	0.12	9.43	9.90
Accommodation type	Detached	7.34	0.04	7.25	7.42
	Semi-detached	6.08	0.04	6.01	6.15
	Terraced	5.58	0.04	5.50	5.65
	Flat	4.24	0.06	4.13	4.36
	Other	5.18	0.09	5.01	5.35
Tenure	Owned Outright	6.08	0.04	6.01	6.15
	Mortgage	6.58	0.03	6.51	6.64
	Renting	4.87	0.05	4.78	4.96
	Other	5.93	0.17	5.61	6.26
Number of cars in household	None	4.80	0.05	4.71	4.89
	One	5.67	0.03	5.62	5.73
	Two	7.07	0.04	6.99	7.15
	Three or more	7.70	0.09	7.53	7.87
Domestic fuel type	Gas	6.01	0.02	5.96	6.06
	Electric	4.77	0.06	4.66	4.89
	Oil	8.28	0.11	8.07	8.50
	Other	5.22	0.15	4.93	5.50
Government Office Region	N East	5.82	0.10	5.62	6.02
	N West & Mersey	5.91	0.06	5.78	6.03
	Yorks and Humber	6.05	0.07	5.90	6.19
	E Midlands	5.86	0.08	5.71	6.01
	W Midlands	6.02	0.07	5.88	6.17
	Eastern	6.07	0.07	5.93	6.21
	London	5.69	0.07	5.55	5.82
	S East	5.93	0.06	5.82	6.04
	S West	5.63	0.07	5.50	5.77
	Wales	6.11	0.09	5.93	6.29
	Scotland	6.18	0.07	6.04	6.32
Settlement type	Urban >10k	5.73	0.03	5.68	5.79
	Town and fringe	5.93	0.07	5.80	6.07
	Village, hamlet & isolated	7.09	0.07	6.96	7.22
Number of (paid) workers in household	None	5.18	0.04	5.11	5.26
	One	5.68	0.04	5.60	5.75
	Two	6.53	0.04	6.46	6.60
	Three	7.37	0.09	7.19	7.55
	Four or more	7.95	0.17	7.60	8.29
Employment status of HRP	Self-employed	6.80	0.08	6.64	6.96
	FT employee	6.20	0.03	6.13	6.26
	PT employee	6.14	0.07	6.01	6.28
	ILO unemployed	5.15	0.14	4.87	5.43
	Retired	5.36	0.04	5.28	5.43
	Other econ inactive	5.77	0.06	5.64	5.90

Table A5: The distribution of total household CO_2 emissions from domestic fuel – means, standard errors and confidence intervals (continued)

		Mean	SE	95%CI lo	95%CI hi
NS-SEC of HRP	Large employers/higher managerial	7.29	0.10	7.10	7.48
	Higher professionals	6.77	0.08	6.61	6.92
	Lower managerial/professionals	6.41	0.05	6.31	6.51
	Intermediate	5.68	0.09	5.51	5.86
	Small employers/own account workers	6.68	0.08	6.51	6.84
	Lower supervisory/technical	6.07	0.08	5.91	6.24
	Semi-Routine	5.54	0.09	5.37	5.71
	Routine	5.71	0.09	5.53	5.88
	HRP retired	5.36	0.04	5.28	5.43
	Other econ inactive	5.54	0.08	5.37	5.71
	Not classifiable	5.24	0.14	4.96	5.53
Socio-Economic Group of HRP	A	6.90	0.10	6.71	7.10
	B	6.66	0.04	6.57	6.74
	C1	5.69	0.07	5.56	5.83
	C2	6.20	0.06	6.09	6.31
	DE	5.63	0.08	5.47	5.78

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