**Does the income elasticity of road traffic depend on the source of income?**

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**Abstract**

An extensive body of literature addresses the income elasticity of road traffic, in which income is typically treated as a homogenous quantity. Here we report evidence of heterogeneity in cross-sectional estimates of the elasticity of vehicle-kilometres of travel (VKT) with respect to income, when household income is disaggregated on the basis of income source.

The results are generally intuitive, and show that the income elasticity of road traffic is not homogeneous as is typically specified in transport planning models. We show that in a number of circumstances the elasticity with respect to aggregate household income is of the opposite sign in comparison to more refined estimates of elasticity disaggregated by income source. Neglecting the elemental effects could result in misleading results affecting practical infrastructure-investment and policy decisions, particularly as the mix of income sources shifts (e.g. if, as society ages, pension income increases as a share of all income).

These results are of interest to both researchers of travel demand and designers of future travel survey instruments; the latter group must decide how to generate data about respondents' income. Current expert guidance is to collect a single estimate of aggregate income at the household level. Future travel survey design choices will bound the analyses that can be supported by the resulting survey data, and therefore methodological research to re-visit the trade-offs associated with such choices is warranted.

Keywords: Income elasticity, road traffic, income source, travel survey methods

## 1 Introduction

Road traffic has historically been linked positively with real income, both in cross-sectional and longitudinal studies. Indeed, a transport planning model for which a negatively-signed *ceteris paribus* income elasticity is estimated would be challenged on precisely those grounds. Some recent evidence suggests that the positive link may be weakening (cf. Goodwin and Van Dender 2013), but there is no credible argument that it has switched signs to become negative.

In large measure the typical result (a strong positive effect) reflects people choosing to use higher incomes to purchase faster speeds, and personal car travel being, in general and relative to the alternatives, a high-speed form of mobility. This standard empirical result is in keeping with the body of theory addressing the linked expenditure decisions of money and time (Becker 1965).

A wide set of issues associated with income and road traffic have been addressed. There is a gap, however, in understanding how road traffic levels relate with income of various sources. It is not obvious, for instance, that wage income from a job will relate with personal mobility in the same way as pension income, or in the same way as income from benefit schemes.

The reason that this issue has yet to be addressed is at least in part due to data limitations. Household travel surveys typically collect income information at a very aggregate level, and this design choice bounds all analyses that subsequently use the data that are generated. On the basis of the findings from this study, which arise from analysing a large-scale household travel survey with a very-detailed set of income descriptors, we suggest that travel survey designers consider collecting more-detailed income information from respondents. This will entail a line of methodological research to more fully understand the trade-offs of such changes.

The rest of this paper is structured as follows. Section 2 discusses the previous literature, and Section 3 presents the empirical data resource employed in this study. Section 4 outlines the methodology, with the findings and conclusions presented in Sections 5 and 6 respectively.

## 2 Background

Beginning with early landmark traffic studies (e.g. CATS 1959), researchers have generally found a positive relationship between income and road traffic levels. This pertains both to cross-sectional analyses (richer people driving more vehicle-kilometres of travel [VKT] than less-well-off people) and longitudinal ones (overall levels of VKT rising as real incomes rise over time).

Most studies of road traffic levels incorporate income at either the household-level or person-level; when both of these are available researchers may test which of these characterisations provides better statistical fit (e.g. Ramjerdi et al. 1997 cited in Wardman 2001, Cao and Mokhtarian 2005, Choo and Mokhtarian 2004) or include both types of descriptors in a single model specification (e.g. Kitamura et al. 1997). In disaggregate analyses income is observed for each specific unit (either a person or a household), whereas in aggregate analyses these quantities may be proxied by dividing Gross Domestic Product (or similar measures) by the number of people or households (Wheaton 1982, Hymel et al. 2010, Su 2010, Su 2011). The typical empirical finding is that road traffic is positively associated with income but that this is an inelastic relationship – i.e. estimated elasticities are positive but generally smaller than 1.0 (Graham and Glaister 2004, Goodwin et al. 2004, Litman 2013).

## 3 Data

Scottish Household Survey (SHS) collected on behalf of the Scottish Executive are used in this study, from years 2007/8. It is a uniquely appropriate dataset for this analysis, as both travel-diary information and detailed income-source information are collected. (Hope, undated) contains a detailed description of the SHS instrument and protocol.

One randomly-selected member of [a subset of] respondent households is asked to complete a one-day travel diary; the unweighted sample size of diary-eligible households is 16,183 and for the analyses reported here the sample is weighted to be representative of the Scottish adult population.

SHS respondents are asked whether they receive any income from a set of 37 categories, and then the net income (net after tax and other deductions) from each source. For the purposes of this analysis these elemental categories are aggregated into the following 5 broader classes. The percentage that follows each source of income is the percent of all observed income in the sample that the source accounts for:

- **Income from benefits (10%):** Child benefit (2%), Child tax credit (1%), Disability living allowance (care component) (1%), Disability living allowance (mobility component) (1%), Housing benefit (1%), Incapacity benefit (1%), Income support (1%), Working tax credit (1%), Job seekers allowance (income based) (<0.5%), Job seekers allowance (contribution based) (<0.5%), Council tax benefit(<0.5%), Maternity allowance(<0.5%), Maternity pay (<0.5%), Accident/sick scheme (<0.5%), Industrial injury/disablement benefit (<0.5%), Invalid care allowance (<0.5%), Severe disablement benefit (<0.5%), Statutory sick pay (<0.5%), War disablement benefit (<0.5%), Income support/housing benefit disablement premium (<0.5%), Attendance allowance (<0.5%), Other disability benefit (<0.5%), Other [non-disability] state benefit (<0.5%)

- **Income from pensions/annuities (14%):** State retirement pension (7%), Non-state pension (6%), Pension credit (<0.5%), Widows pension (<0.5%), Annuity (<0.5%)

- **Individual's wage income (42%):** Wages from one's own main job (41%), wages from one's other jobs (<0.5%)

- **Spouse's wage income (33%):** Wages from spouse's main job (33%), wages from spouse's other jobs (<0.5%)

- **Other income (2%):** Incomings from rent (1%), investments (1%), maintenance payments (<0.5%), 'dig money' transfers (<0.5%), student loan incomings (<0.5%), grants (<0.5%), other miscellaneous income (<0.5%)

Wage income is the only income source which is observed at the person-level. All other income is known at the household-level; the data do not identify which household member the income accrues to.

Table 1 shows descriptive statistics for the estimation sample, including both the income-source data and control variables.

# Table 1: Descriptive statistics of variables employed in this analysis

| Variable | Percentage / Mean |
|---|---|
| Presence of cars in household (Dummy) | 76% |
| Male (Dummy) | 47% |
| Age 34 or under (Dummy) | 21% |
| Age 35 to 59 (Dummy) | 49% |
| Age 60 or older (Dummy) | 29% |
| Presence of children in household (Dummy) | 30% |
| Residence is a house (Dummy) | 70% |
| Resides in Large Urban Areas spatial class | 39% |
| Resides in Other Urban Areas spatial class | 30% |
| Resides in Accessible Small Towns spatial class | 9% |
| Resides in Remote Small Towns spatial class | 4% |
| Resides in Accessible Rural Areas spatial class | 12% |
| Resides in Remote Rural spatial class | 6% |
| Household is recipient of any benefit income (Dummy) | 50% |
| Household is recipient of any pension/annuity income (Dummy) | 31% |
| Individual is recipient of any wage income (Dummy) | 60% |
| Spouse is recipient of any wage income (Dummy) | 47% |
| Household is recipient of any income from other sources (Dummy) | 16% |

| | |
|---|---|
| Amount of benefit income household receives, GBP/year | £2,390 (std. dev. £4,297) |
| Amount of pension/annuity income household receives, GBP/year | £3,371 (£6,518) |
| Amount of wage income individual receives, GBP/year | £10,525 (£13,241) |
| Amount of wage income spouse receives, GBP/year | £8,342 (£11,959) |
| Amount of income household receives from other sources, GBP/year | £509 (2,696) |
| Amount of income household receives from all sources, GBP/year | £25,136 (£17,819) |
| Car/van driving distance (kms) per day, work purposes | 6.1 (21.8) |
| Car/van driving distance (kms) per day, non-work purposes | 7.3 (23.4) |

Table 2 shows the correlation matrix for income from each of the 5 above-listed classes.

# Table 2: Correlations amongst income sources. All correlations are significant at $p<0.05$

| | Benefits | Pension/annuity | Wage (own) | Wage (spouse) | Other income |
|---|---|---|---|---|---|
| **Benefits** | 1.0 | -0.13 | -0.18 | -0.16 | -0.04 |
| **Pension/annuity** | | 1.0 | -0.33 | -0.29 | +0.06 |
| **Wage (own)** | | | 1.0 | +0.23 | +0.02 |
| **Wage (spouse)** | | | | 1.0 | +0.02 |
| **Other income** | | | | | 1.0 |

12,218 and 3,965 of the diaries took place on weekdays and weekend days respectively. Somewhat less than half (45%) of the observed VKT driven by the sample on their diary days was for work purposes (commuting and in-the-course-of-work), with other journey purposes accounting for the remaining 55%.

## 4 Methodology

Cross-sectional income elasticities were estimated, with car/van driving kilometres per day the quantity modelled. Socio-economic and spatial control variables were included in the specification to account for confounding effects. A log-log functional form was employed, therefore the estimated parameters for marginal income from each source can be interpreted as elasticities (i.e. a 1% change in an independent variable is associated with an X% change in the dependent variable, where X is the corresponding estimated marginal parameter).

Beyond the socio-economic and spatial control variables, parameters were estimated for dummy variables that each indicate whether a person receives *any* income from a given source, as well as marginal parameters that apply to the continuously-varying level of income (in British pounds)from each source. For instance, one parameter captures the effect of being a pension-recipient, so that therefore the separate parameter for the amount of pension income can be interpreted as a strictly marginal effect.

Separate models were estimated for work and non-work journey purposes, and for weekdays and weekends.

In addition to the fully-specified models (with separate parameters for each income source), restricted model forms were estimated, for comparison purposes, in which a single marginal income effect was estimated.

## 5 Findings

Estimation results from 8 models (work/non-work, weekday/weekend-day, restricted/full-specification) are shown in Tables 3 and 4. The models for work-related VKT are in Table 3and the non-work-related VKT models are in Table 4. Goodness-of-fit ($r^2$) ranges from a low of 0.07 (for work-related VKT on weekend days) to 0.25 (for work-VKT on weekdays).

In all cases, the adjusted $r^2$ of the full specifications are improvements on the corresponding restricted specifications (each having a single marginal-income parameter) and we therefore reject the restricted forms in favour of the full models.

A general point from this analysis is that the VKT elasticities we calculate with respect to various income sources are all quite inelastic, with no estimate larger in absolute value than 0.30. We do not comment here on the estimated parameters for the control variables, except to note that they are generally in line with *a priori* expectations.

**Table 3: Parameter estimates, models of work-related vehicle-kilometres of travel. B = mean parameter estimate; p = p-value**

| Dependent variable | Natural log of work-related distance, kms/day, weekdays (restricted specification) | | Natural log of work-related distance, kms/day, weekdays (full specification) | | Natural log of work-related distance, kms/day, weekend days (restricted specification) | | Natural log of work-related distance, kms/day, weekend days (full specification) | |
|---|---|---|---|---|---|---|---|---|
| Sample size (unweighted) | 12,218 | | | | 3,965 | | | |
| $r^2$ | 0.238 | | 0.253 | | 0.073 | | 0.075 | |
| Adjusted-$r^2$ | 0.237 | | 0.252 | | 0.069 | | 0.070 | |
| | β | p | β | p | β | p | β | p |
| Constant | -1.879 | <0.001 | -0.390 | <0.001 | 0.167 | 0.525 | -0.132 | 0.124 |
| Presence of cars in household (Dummy) | 0.413 | <0.001 | 0.428 | <0.001 | 0.091 | 0.011 | 0.083 | 0.019 |
| Male (Dummy) | 0.305 | <0.001 | 0.236 | <0.001 | 0.135 | <0.001 | 0.112 | <0.001 |
| Age 34 or under (Dummy) | 0.040 | 0.459 | 0.012 | 0.821 | 0.023 | 0.708 | 0.028 | 0.652 |
| Age 35 to 59 (Dummy) | 0.108 | 0.024 | 0.072 | 0.135 | 0.040 | 0.448 | 0.040 | 0.456 |
| Age 60 or older (Dummy) | Fixed at zero | | Fixed at zero | | Fixed at zero | | Fixed at zero | |
| Presence of children in household (Dummy) | -0.006 | 0.855 | 0.019 | 0.581 | -0.018 | 0.656 | -0.021 | 0.614 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Residence is a house (Dummy) | 0.084 | 0.004 | 0.082 | 0.005 | 0.050 | 0.129 | 0.048 | 0.143 |
| Resides in Large Urban Areas spatial class | -0.062 | 0.200 | -0.088 | 0.068 | -0.062 | 0.292 | -0.064 | 0.276 |
| Resides in Other Urban Areas spatial class | 0.038 | 0.428 | 0.013 | 0.792 | 0.001 | 0.981 | 0.002 | 0.977 |
| Resides in Accessible Small Towns spatial class | 0.145 | 0.012 | 0.118 | 0.039 | 0.033 | 0.626 | 0.032 | 0.632 |
| Resides in Remote Small Towns spatial class | -0.118 | 0.086 | -0.130 | 0.055 | 0.080 | 0.353 | 0.077 | 0.369 |
| Resides in Accessible Rural Areas spatial class | 0.126 | 0.020 | 0.103 | 0.055 | 0.253 | <0.001 | 0.251 | <0.001 |
| Resides in Remote Rural spatial class | Fixed at zero | | Fixed at zero | | Fixed at zero | | Fixed at zero | |
| Household is recipient of any benefit income (Dummy) | -0.024 | 0.434 | -0.102 | 0.451 | 0.034 | 0.323 | 0.122 | 0.433 |
| Household is recipient of any pension/annuity income (Dummy) | -0.050 | 0.292 | 0.729 | 0.001 | -0.002 | 0.972 | 0.134 | 0.638 |
| Individual is recipient of any wage income (Dummy) | 0.826 | <0.001 | -1.873 | <0.001 | 0.255 | <0.001 | -0.083 | 0.707 |
| Spouse is recipient of any wage income (Dummy) | -0.045 | 0.151 | -0.024 | 0.894 | 0.057 | 0.123 | 0.647 | 0.006 |
| Household is recipient of any income from other sources (Dummy) | -0.060 | 0.053 | 0.143 | 0.199 | 0.019 | 0.595 | 0.142 | 0.262 |
| Natural log(Amount of benefit income household receives, GBP/year) | N/A | | 0.013 | 0.464 | N/A | | -0.012 | 0.543 |
| Natural log(Amount of pension/annuity income household receives, GBP/year) | N/A | | -0.079 | 0.002 | N/A | | -0.017 | 0.600 |
| Natural log(Amount of wage income individual receives, GBP/year) | N/A | | 0.297 | <0.001 | N/A | | 0.033 | 0.160 |
| Natural log(Amount of wage income spouse receives, GBP/year) | N/A | | 0.008 | 0.657 | N/A | | -0.064 | 0.008 |
| Natural log(Amount of income household receives from other sources, GBP/year) | N/A | | -0.025 | 0.104 | N/A | | -0.018 | 0.311 |
| Natural log(Amount of income | 0.160 | <0.001 | N/A | | -0.036 | 0.207 | N/A | |

| | | | | |
|---|---|---|---|---|
| household receives from all sources, GBP/year) | | | | |

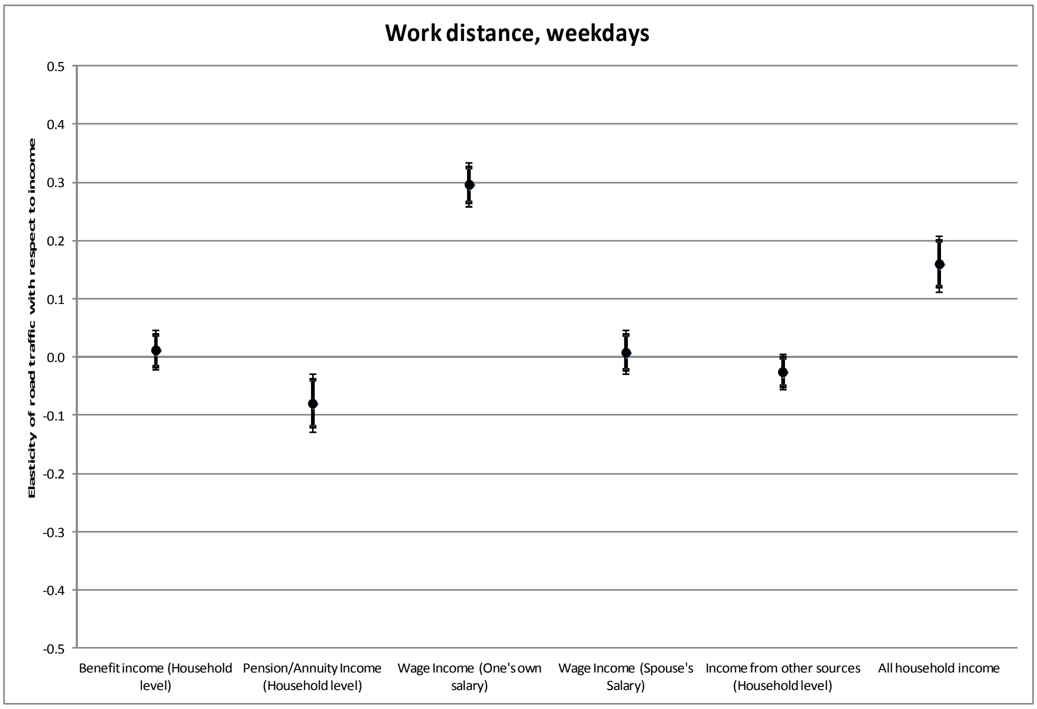
**Table 1: Parameter estimates, models of non-work-related vehicle-kilometres of travel. B = mean parameter estimate; p = p-value**

| Dependent variable | Natural log of non-work-related distance, kms/day, weekdays (restricted specification) | | Natural log of non-work-related distance, kms/day, weekdays (full specification) | | Natural log of non-work-related distance, kms/day, weekend days (restricted specification) | | Natural log of non-work-related distance, kms/day, weekend days (full specification) | |
|---|---|---|---|---|---|---|---|---|
| Sample size (unweighted) | 12,218 | | | | 3,965 | | | |
| $r^2$ | 0.127 | | 0.128 | | 0.161 | | 0.165 | |
| Adjusted-$r^2$ | 0.125 | | 0.126 | | 0.157 | | 0.160 | |
| | β | p | β | p | β | p | β | p |
| Constant | -0.655 | 0.005 | -0.012 | 0.877 | -1.154 | 0.011 | -0.185 | 0.210 |
| Presence of cars in household (Dummy) | 0.925 | <0.001 | 0.931 | <0.001 | 0.878 | <0.001 | 0.876 | <0.001 |
| Male (Dummy) | 0.149 | <0.001 | 0.177 | <0.001 | 0.416 | <0.001 | 0.385 | <0.001 |
| Age 34 or under (Dummy) | 0.135 | 0.016 | 0.169 | 0.003 | -0.030 | 0.779 | -0.026 | 0.810 |
| Age 35 to 59 (Dummy) | 0.141 | 0.004 | 0.180 | <0.001 | 0.009 | 0.926 | 0.006 | 0.951 |
| Age 60 or older (Dummy) | Fixed at zero | | Fixed at zero | | Fixed at zero | | Fixed at zero | |
| Presence of children in household (Dummy) | 0.162 | <0.001 | 0.170 | <0.001 | 0.094 | 0.183 | 0.101 | 0.153 |
| Residence is a house (Dummy) | 0.068 | 0.024 | 0.070 | 0.019 | 0.072 | 0.208 | 0.072 | 0.206 |
| Resides in Large Urban Areas spatial class | -0.229 | <0.001 | -0.223 | <0.001 | -0.040 | 0.695 | -0.051 | 0.615 |
| Resides in Other Urban Areas spatial class | -0.156 | 0.002 | -0.151 | 0.002 | 0.089 | 0.378 | 0.083 | 0.406 |
| Resides in Accessible Small Towns spatial class | -0.153 | 0.010 | -0.150 | 0.011 | 0.107 | 0.358 | 0.094 | 0.418 |
| Resides in Remote Small Towns spatial class | -0.248 | <0.001 | -0.248 | <0.001 | -0.014 | 0.923 | -0.019 | 0.896 |
| Resides in Accessible Rural Areas spatial class | 0.085 | 0.126 | 0.093 | 0.094 | 0.319 | 0.004 | 0.313 | 0.005 |
| Resides in Remote Rural spatial class | Fixed at zero | | Fixed at zero | | Fixed at zero | | Fixed at zero | |
| Household is recipient of any benefit income (Dummy) | -0.003 | 0.934 | 0.320 | 0.023 | -0.042 | 0.485 | 0.232 | 0.386 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Household is recipient of any pension/annuity income (Dummy) | 0.085 | 0.082 | -0.444 | 0.059 | -0.105 | 0.256 | -0.188 | 0.704 |
| Individual is recipient of any wage income (Dummy) | -0.178 | <0.001 | 0.342 | 0.064 | 0.192 | 0.003 | -1.350 | <0.001 |
| Spouse is recipient of any wage income (Dummy) | -0.201 | <0.001 | -0.726 | <0.001 | -0.113 | 0.076 | -0.447 | 0.272 |
| Household is recipient of any income from other sources (Dummy) | 0.191 | <0.001 | 0.310 | 0.007 | 0.199 | 0.001 | 0.073 | 0.737 |
| Natural log(Amount of benefit income household receives, GBP/year) | N/A | | -0.040 | 0.023 | N/A | | -0.033 | 0.323 |
| Natural log(Amount of pension/annuity income household receives, GBP/year) | N/A | | 0.061 | 0.021 | N/A | | 0.013 | 0.814 |
| Natural log(Amount of wage income individual receives, GBP/year) | N/A | | -0.053 | 0.007 | N/A | | 0.168 | <0.001 |
| Natural log(Amount of wage income spouse receives, GBP/year) | N/A | | 0.059 | 0.003 | N/A | | 0.041 | 0.328 |
| Natural log(Amount of income household receives from other sources, GBP/year) | N/A | | -0.016 | 0.304 | N/A | | 0.021 | 0.488 |
| Natural log(Amount of income household receives from all sources, GBP/year) | 0.074 | 0.004 | N/A | | 0.104 | 0.034 | N/A | |

For ease of interpretation, Figures 1 through 4 show graphically the marginal parameters in which we are primarily interested. Each figure shows both the results from a full specification and the corresponding restricted one. We now consider each set of results in turn.

**Figure 1: Estimates of elasticities in WEEKDAY WORK-RELATED road traffic VKT with respect to income of various sources. Bold and non-bold error bars are the 90% and 95% confidence intervals, respectively**




**Weekday work-related VKT:** From Figure 1, it can be seen that the elasticity of weekday work-related VKT is +0.30 with respect to one's own salary income, meaning that a 1% increase in one's own salary is associated with a +0.30% increase in work-related weekday VKT. This effect is stronger than the estimated effect when, as is commonly the case in the literature, all household income is taken into account as a homogeneous quantity (+0.16); this difference is statistically significant. It is the largest-magnitude elasticity of all those we report in this study, which is quite plausible as there are clear mechanisms for this effect (e.g. the increasing depth of labour markets if one is prepared to travel further). It is also intuitive that the effect becomes attenuated when it is proxied for by aggregate household income (+0.16 v. +0.30).

The estimated effects are not statistically distinguishable from zero for other sources of income, with pension/annuity income the only exception – it is estimated that a 1% increase in pension income is associated *ceteris paribus* with a -0.08% decrease in work-related VKT, which is an effect that is independent of one's salary income.

**Figure 1: Estimates of elasticities in WEEKEND WORK-RELATED road traffic VKT with respect to income of various sources. Bold and non-bold error bars are the 90% and 95% confidence intervals, respectively**

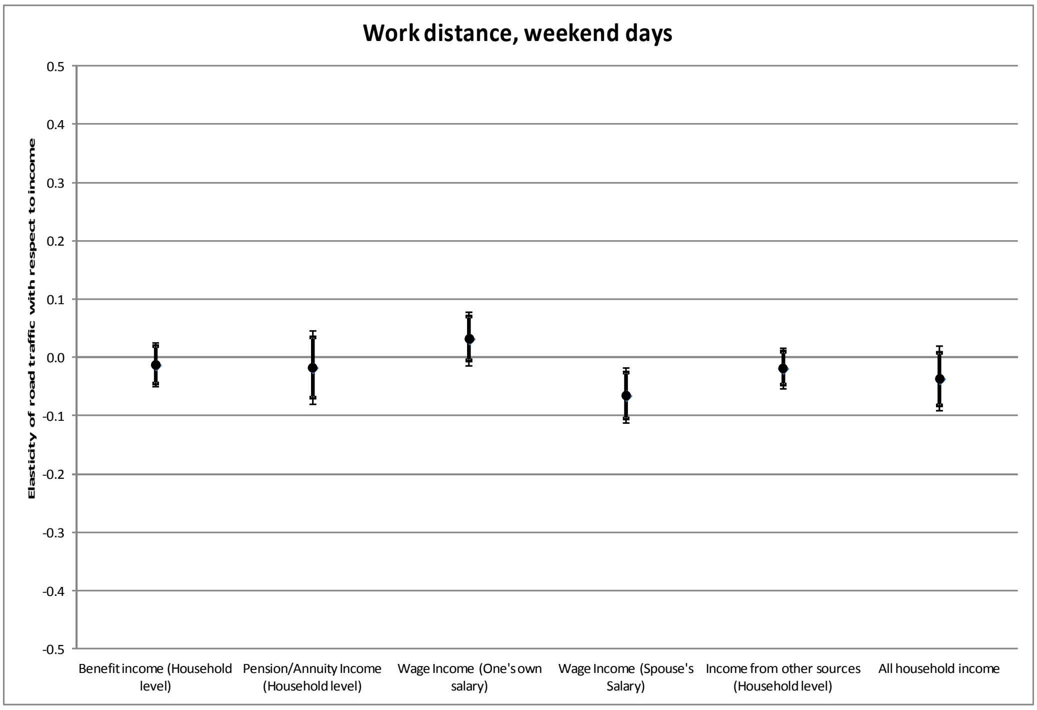



**Figure 2: Estimates of elasticities in WEEKDAY NON-WORK-RELATED road traffic VKT with respect to income of various sources. Bold and non-bold error bars are the 90% and 95% confidence intervals, respectively**

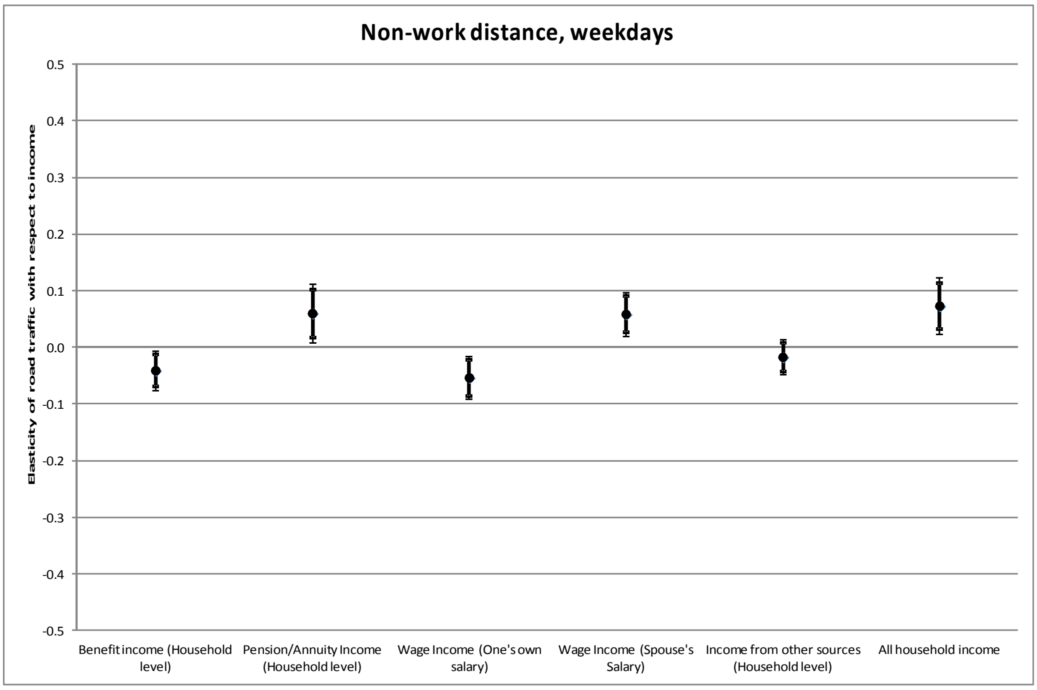
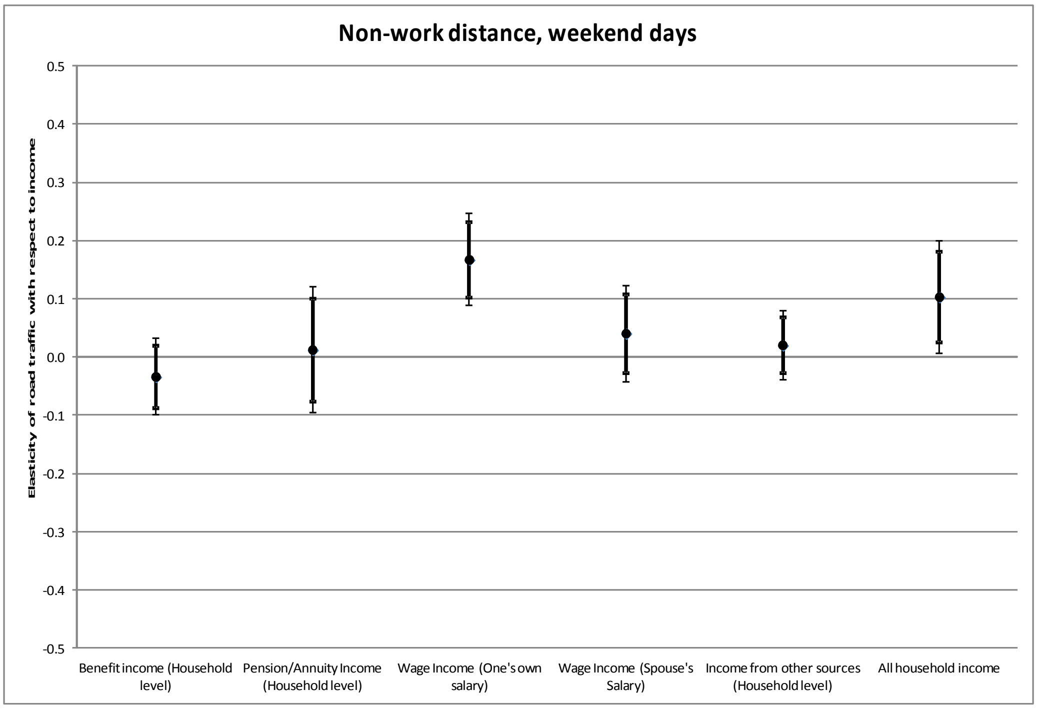



**Figure 3: Estimates of elasticities in WEEKEND NON-WORK-RELATED road traffic VKT with respect to income of various sources. Bold and non-bold error bars are the 90% and 95% confidence intervals, respectively**




**Weekend work-related VKT:** Comparing Figure 2 to Figure 1, it can be seen clearly that the elasticities are very different on weekdays versus weekend days. No positive significant effects are estimated, even for one's own income or when all household income is treated as a single aggregate quantity. A negative elasticity is found with respect to one's spouse's salary – a 1% increase in one's spouse's salary is associated, all else equal, with a -0.06% decrease in weekend work-related driving mileage.

**Weekday non-work-related VKT:** We see in Figure 3 that one's own salary is associated negatively with non-work-related weekday VKT. This effect is negative whereas the effect on work-related VKTis *positive*. The implication is that, all else equal, a higher-salary person is likely to drive more on weekdays for work reasons (elasticity of +0.30) but less on weekdays for non-work purposes (elasticity of -0.05), a set of results that is consistent with intuition.

We find precisely the opposite with respect to pension/annuity income. Marginal pension/annuity income is negatively linked with work-related VKT (elasticity of -0.08) on weekdays, but it is associated [quite plausibly] *positively* with non-work-related VKT on weekdays (elasticity of +0.06).

The elasticity of weekday non-work-related VKT with respect to benefit income is negative (-0.04), implying that people receiving higher benefit incomes are less mobile (in terms of driving) on weekdays for non-work purposes. This was the only one of the four estimated elasticities of benefit income (work/weekday, work/weekend, non-work/weekday, non-work/weekend) found to be statistically significant.

Finally, we see in Figure 3 that the elasticity of weekday non-work-related VKT with respect to one's spouse's income is positive (+0.06), meaning that a person having a high-income spouse is associated, net of other effects, with them (not the high-income spouse) driving more VKT on weekdays for non-work purposes. This suggests intra-household dynamics (which we speculate are likely to be gendered) that are broadly plausible.

**Weekend non-work-related VKT:** In Figure 4 we see that non-work-related VKT on weekends is positively-linked with one's salary (elasticity of +0.17), but not with marginal income from the other classes.

So, one's own salary was found to have a strong positive association with weekday work-related VKT and a somewhat weaker positive link with weekend non-work-related VKT. As with many of the other findings, this relationship is in line with *a priori* intuition.

## 6 Conclusions

This study shows quite clearly that income elasticities of road traffic are not homogeneous across different sources of income. Indeed, we show that in a number of circumstances the elasticity with respect to aggregate household income is of *the opposite sign* in comparison to more refined estimates of elasticity disaggregated by income source.

Neglecting the elemental effects could result in misleading results affecting practical infrastructure-investment and policy decisions, which would be especially problematic as the distribution of income by source shifts over time. For instance, in aging societies the share of income that is in the form of pensions is expected to increase. Other possibilities are that income from benefits could become either more or less prevalent, depending on overall economic trajectory and public policy decisions. Our results suggest that shifts such as these will likely have impacts on traffic levels, but at the moment they are not in general taken into account.

Travel surveys in general collect income-source information at a relatively coarse level of granularity. Current expert guidance (Stopher et al. 2008) to agencies undertaking such surveys in the United States, for instance, recommends collecting aggregate pre-tax income at the household level. This study suggests that collecting additional data points regarding income may be worthwhile, though there are trade-offs to be considered (e.g. increases in non-response bias, imprecision in self-reporting, etc). Another possibility is, subject to respondents' consent, to link self-reported travel survey data with administrative data which can include information on sources and levels of income with potentially much less measurement error (cf. McKay 2012, Taylor et al. 2012).

This paper shows that, when analysing policy-relevant travel behaviour, there are real benefits to having access to richer-than-usual income-source data. But without weighing the trade-offs involved in collecting data of this sort it is not possible to pass judgment on whether changes should be made to standard protocols. Further research is urgently required to properly understand such trade-offs, and is also clearly warranted to more fully establish the causal mechanisms for the systematic variability in income elasticities reported here.

## 7 Acknowledgments

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