TRANSPORT CONSUMPTION INEQUALITIES AND REDISTRIBUTIVE EFFECTS OF TAXES: A COMPARISON OF FRANCE AND THE UK

Akli BERRI, Department of Transport Economics and Sociology (DEST), INRETS (akli.berri@inrets.fr)

Joyce M. DARGAY, Institute of Transport Studies (ITS), University of Leeds (J.M.Dargay@leeds.ac.uk)

ABSTRACT

This paper evaluates household transport consumption inequalities in France and the UK, investigates their temporal dynamics and estimates the redistributive effects of taxes on various commodity categories. A decomposition by expenditure component of the Gini index is applied, using household-level data from repeated cross-sections of expenditure surveys spanning long time periods. The results highlight the effect of car social diffusion. The relative contribution of vehicle use items to total expenditure inequality decreases over time, thus reflecting the more and more widespread use of the car. Moreover, fuel taxes become regressive (i.e. they affect the poor more than the rich), while the progressive character of taxes on the remaining car use commodities weakens with time. Therefore equity issues should not be ignored when designing policies to attenuate the environmental impact of cars. Increasing car use costs, notably fuel prices, through an increase of uniform taxes would be particularly inequitable.

Keywords: Inequality, Transport consumption, Household expenditure surveys, Gini index, Decomposition by component, Redistributive effects of taxes

1. INTRODUCTION

Car taxes are a source of public revenues as well as a policy tool to reduce adverse impacts of road traffic. Most originated in a time when the car was a luxury good (e.g. the French *vignette*, an annual tax on vehicles owned, in 1956). The large social diffusion of this good over the past decades has doubtless lessened the progressivity of these taxes. The protests in several European countries against the rapid increase in fuel prices during autumn 2000 highlighted the sensitivity to the burden of fuel costs, not only of the road transport industry

but also of households, particularly those in rural and suburban areas who are more car-dependent.

In this paper, we evaluate inequalities between households regarding the consumption of transport goods and services in France and the UK, investigate their temporal dynamics and estimate the redistributive effects of taxes on the different commodity categories considered. A comparative analysis is carried out in light of the differences between these countries, most notably in terms of car taxation systems and car ownership levels. Consumption is measured in terms of expenditures collected through budget surveys. As Deaton (1997) puts it, by revealing who buys each good or service and the amounts spent, expenditure surveys tell us who bears the most of the corresponding taxes (notably, according to income level) and thus the potential losers and gainers from possible changes in taxation.

The analysis applies a decomposition of the Gini inequality index by expenditure component. Each component appears through its proper Gini coefficient, its budget share and its degree of association with total expenditure. This method provides a better understanding of the inequality mechanisms, in particular their temporal evolution. Moreover, it allows evaluating the redistributive effect of (a change in) a tax on a good or a service. By *redistributive effect* is meant the impact in terms of inequality increase or reduction. Finally, it furnishes estimates of elasticities with respect to total expenditure (or income) without specifying a functional form for the Engel curves.

The rest of the paper is organised as follows. The next section describes the methodology used. Then, Section 3 presents some of the characteristics of the car taxation systems in the two countries and examines the budget shares allocated to different expenditure groups according to the household's standard of living. Section 4 presents the results of the analyses of inequality and redistributive effects of taxes on the different categories of goods and services considered. The last section summarises the findings and concludes.

2. DECOMPOSITION OF THE GINI COEFFICIENT BY COMPONENT AND REDISTRIBUTIVE EFFECTS OF MARGINAL CHANGES IN COMPONENTS

2.1. The Gini Inequality Index

The Gini coefficient is one of the more widely used indicators to evaluate inequalities (of income, wealth, consumption…). A graphic visualisation of this index is based on the Lorenz curve, shown in Figure 1. The Lorenz curve of income, for instance, is constructed by arranging individuals from the poorest to the richest, and then representing their cumulative share of total income as a function of their cumulative proportion in the population.

If each individual had the same income, the curve would coincide with the main diagonal, the income share of a given group being equal to its weight in the total population. Apart from the case of perfect equality, the groups with the lowest incomes enjoy a share of total income

that is lower than their weight in the population. Consequently, except in the case of perfect equality, every Lorenz curve lies below the main diagonal and its slope increases (in any case, it does not decrease) as one moves towards the highest incomes.

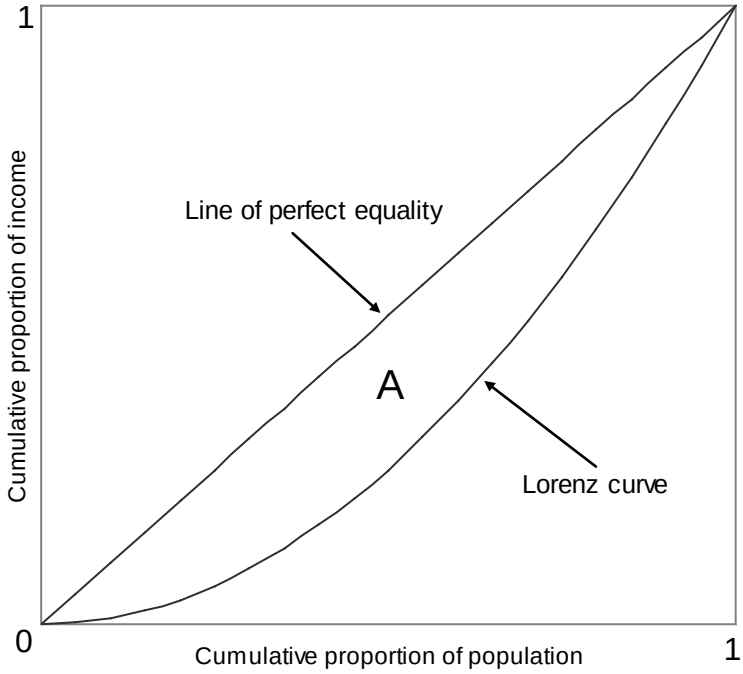

Figure 1 – Illustration of a Lorenz curve

This graphic tool plays an important role in the characterisation of the robustness of inequality measures as to ranking distributions (Atkinson, 1970; Deaton, 1997). Thus, if the Lorenz curve of a distribution Y lies everywhere below that of another distribution X, Y is less egalitarian than X. Indeed, the distribution Y can be transformed by a series of transfers from the richer to the poorer in such a way to obtain the distribution X. Consequently, when two Lorenz curves do not cross, the upper one represents a more egalitarian distribution and will show a lower inequality level provided the inequality measure used satisfies the *principle of transfers*. The *principle of transfers* is stated as follows: if one transfers an amount d from a person having an income y_1 to another person having a lower income y_2 (with $y_2 \leq y_1 - d$, such that the transfer does not reverse their relative positions), then the new distribution should be preferred to the initial one. In the case where two Lorenz curves intersect, it is not possible to rank unambiguously the corresponding distributions as to their degree of inequality, unless restraining choice to specific inequality measures.

The Gini coefficient is defined as the ratio of the area between the Lorenz curve and the main diagonal (designated by A in Figure 1) to the area of the triangle below the diagonal (i.e., $1/2$), that is $G = 2A$. When the distribution is perfectly egalitarian, its Lorenz curve coincides with the diagonal, hence $A = 0$ and $G = 0$. Absolute inequality implies that A is the whole area of the triangle under the diagonal, so $A = 1/2$ and $G = 1$. Thus, the Gini coefficient takes values between 0 and 1.

One of the appeals of the Gini coefficient as a measure of (income) inequality is that it is "*a very direct measure of (income) difference, taking note of differences between* every *pair of (incomes)*" (Sen, 1997, p. 31). Indeed, one of its expressions (the original definition) is based on the *average of absolute differences between pairs of observations*, called *Gini's Mean Difference* (GMD):

$$\frac{1}{N^2}\sum_{i=1}^{N}\sum_{j=1}^{N}\left|y_i - y_j\right|,$$

where y_i is the income of individual i and N is the number of individuals in the population.

The Gini coefficient is defined as the GMD divided by twice the mean (m):

$$G = \frac{1}{2N^2 m}\sum_{i=1}^{N}\sum_{j=1}^{N}\left|y_i - y_j\right|. \qquad (1)$$

Another convenient feature of the Gini coefficient is that it handles negative values, which is in particular useful in its decomposition by income source, where taxes are considered as "negative incomes" (Lerman and Yitzhaki, 1994).

Besides Equation (1), the Gini coefficient has several expressions (Sen, 1997). In the following, we adopt a formulation that is easy to implement directly on individual data. This formulation is used to obtain a decomposition by the constituents of the variable of interest. The decomposition makes explicit the mechanisms by which each component contributes to the global Gini and therefore highlights the temporal patterns of inequalities. In addition, it enables evaluating the redistributive effects of taxes on the different components.

2.2. A Practical Formulation of the Gini Coefficient

Lerman and Yitzhaki (1984) show that the Gini coefficient can be expressed as a function of the covariance between the variable of interest (X) and its cumulative distribution (F_X), and of its mean (m):

$$G(X) = \frac{2\,\mathrm{cov}(X, F_X)}{m}. \qquad (2)$$

Estimation of the Gini coefficient using this formulation is easy to implement on individual survey data. Indeed, one only has to estimate the mean of X and the covariance between X and its empirical cumulative distribution, and to substitute for the corresponding terms in the expressions above. With a random sample (same selection probability for all individuals) of size n, the cumulative distribution is estimated by ranking individuals according to increasing values of X and by dividing their ranks i by the sample size, i.e. $\tilde{F}_X = I/n$, and the mean is estimated by $\tilde{m} = \sum_i x_i \Big/ n$. In the case of a non-random sample (selection probability varying from one individual to another), the observations have to be weighted by the respective individual survey weights, w_i. The cumulative distribution and the mean of X are estimated as follows:

$$\hat{F}_i(x) = \sum_{j=0}^{i-1} \pi_j + \frac{\pi_i}{2}, \text{ with } \pi_0 = 0, \text{ and}$$

$$\hat{m} = \sum_{i=1}^{n} \pi_i x_i ,$$

where $\pi_j = w_j \Big/ \sum_{i=1}^{n} w_i$.[1]

By avoiding the usual practice of grouping data prior to estimation, this approach yields estimates that are more accurate and free of the (downward) bias due to aggregation. Lerman and Yitzhaki (1989) show that this bias increases with the aggregation level and with the value of the Gini coefficient.

2.3. Decomposition of the Gini Coefficient by Component

The covariance-based formulation is used by Lerman and Yitzhaki (1985) to obtain a decomposition of the Gini coefficient by the constituents of *X* and apply it to the analysis of the effects of income sources on total income inequality. This decomposition is also applied to the analysis of inequalities in terms of expenditures (Garner, 1993; Yitzhaki, 1994).

Consider the case where X is household's total expenditure. Let $x_1, x_2, ..., x_k, ..., x_K$ be the amounts spent on the K budget components, such that:

$$X = \sum_{k=1}^{K} x_k . \tag{3}$$

Then, using the additivity property of covariance, the Gini coefficient of X can be written:

$$G(X) = 2\sum_{k=1}^{K} \frac{\text{cov}(x_k, F_X)}{m} . \tag{4}$$

Let F_k and m_k be the cumulative distribution and the mean of x_k, respectively. Multiplying and dividing each term in k in Equation (4) by $\text{cov}(x_k, F_k)$ and by m_k, one obtains the decomposition by component:

$$G(X) = \sum_{k=1}^{K} \left[\frac{\text{cov}(x_k, F_X)}{\text{cov}(x_k, F_k)} \right] \times \left[\frac{2\,\text{cov}(x_k, F_k)}{m_k} \right] \times \left[\frac{m_k}{m} \right]. \tag{5}$$

Denoting the first term of the sum by R_k, the second by G_k, and the third by S_k, the Gini coefficient can be written:

$$G(X) = \sum_{k=1}^{K} R_k G_k S_k , \tag{6}$$

[1] A derivation of $\hat{F}_x$ can be found in Berri (2005), pp. 246-248.

where R_k is the *Gini correlation coefficient* between expenditure *k* and total expenditure, G_k is the Gini coefficient of component k, and S_k is its budget share. A high Gini correlation for a category of goods and services means that expenditure devoted to this category is higher the higher the total budget. Gini correlation is a measure of association based on Gini's Mean Difference (Schechtman and Yitzhaki, 1987). The Gini correlation between two variables takes values between –1 and 1. It is equal to zero if the two variables are independent. For example, if one of the variables is a monotonously increasing function of the other, their Gini correlation will be equal to 1. Further details can be found in the Annex.

Thus, the contribution of an expenditure category to total inequality is determined by three terms: its proper Gini coefficient, its average budget share and the degree of its association with total expenditure (measured by their Gini correlation). The higher the value of each of the factors, the stronger is the contribution of the category to total inequality. The expression of the contribution also means that a high Gini coefficient does not guarantee a large contribution to total inequality. As will be seen below, because of a very low budget share the contribution of the item "two-wheeler purchases" is the lowest among the categories considered, though its Gini coefficient is the highest.

This approach is advantageous in that it furnishes a decomposition of inequalities into elements easily interpretable and helps understanding their temporal change by examining the change of the elements involved in the contribution of each component. Moreover, it avoids a major shortcoming of the usual method called *before-after*. The latter consists in calculating an inequality index after excluding a particular component and comparing it with the value of the index when this component is included. The results of this method may depend on the order in which the components are considered. For instance, in the case of two income sources, Lerman (1999) shows that a component will appear reducing inequalities or, on the contrary, increasing them according to whether one accounts for it before or after the other component.

2.4. Redistributive Effects of Marginal Changes in the Components

Another advantage of this decomposition is that it allows evaluating the redistributive effects of marginal changes in the different expenditure categories. It has to be noted that no explicit income transfer is considered here. The expression 'redistributive effect' refers to the impact in terms of increase or reduction of inequality.

Suppose that the expenditure on a particular item k undergoes a small percentage variation, e_k, identical for all households (e.g. a tax), such that $x_k\left(e_k\right)=\left(1+e_k\right)x_k$, $e_k>0$. In terms of variation of a tax t_k on expenditure k, one has $x_k\left(dt_k\right)=\left(1+dt_k\right)x_k$. The initial rate t_k does not appear, its effect being incorporated in the observation on x_k. The tax change is imposed on the expenditure made, x_k, which is equivalent to a tax proportional to the price paid by the consumer. The effect on the global Gini is (Stark *et al.*, 1986):

$$\frac{\partial G}{\partial e_k} = S_k \left(R_k G_k - G \right), \tag{7}$$

the terms S_k, R_k, G_k and G being evaluated before the marginal variation in component k takes place. Dividing by G, one obtains

$$\frac{\partial G / \partial e_k}{G} = \frac{R_k G_k S_k}{G} - S_k . \tag{8}$$

Equation (8) shows that the relative variation of the global Gini due to a small variation in expenditure on component *k* is equal to the relative contribution of the component to overall inequality minus its contribution to total expenditure. The sum of all relative marginal effects equals 0. Multiplication by $1+e$ of all components leaves the overall Gini unchanged. It can also be seen that, as long as the budget share S_k is not zero:

A. the relative marginal effect is *negative* if the Gini correlation between expenditure k and total expenditure is negative or null ($R_k \leq 0$);

B. if the Gini correlation is positive, the impact on inequality depends on the sign of ($R_k G_k - G$). A necessary condition for this term to be positive is that the inequality of component k exceeds that of total expenditure: $G_k > G$ (since $R_k \leq 1$).

Equation (8) defines the concept of *progressivity* used here (Yitzhaki, 1997). A tax will be called *progressive* if an increase in this tax (or its imposition if it does not exist yet) reduces inequality of total expenditure (after taxes). A tax will be called *regressive* if it increases total inequality. This definition can also be justified as follows. Consider the compensation that is necessary to preserve the level of well-being enjoyed by each household before the modification in taxation. If the compensation is progressive (i.e. its share increases with total expenditure or income), the change in the tax affects the rich more than the poor. The tax is then progressive and its increase (or its imposition) will yield a decrease in inequalities. Conversely, if the compensation is regressive (i.e. its share decreases when total expenditure increases), the modification in the tax affects the poor more than the rich. The tax is therefore regressive and its increase (or its imposition) will induce an increase in inequalities.

If the expenditure component is a *decreasing* function of total expenditure (or income), as is the case of a *regressive* tax paid by all households, then its Gini correlation with total expenditure is -1 and the relative marginal effect is *negative*. Consequently, when the relative marginal effect is negative, the taxation would increase inequalities, as would a regressive tax. If the component is an *increasing* function of total expenditure, as for a *progressive* or *proportional* tax, then its Gini correlation with total expenditure is +1. One is then in the configuration B above, and the sign of the relative marginal effect depends on the quantities R_k, G_k and G.

Hence, the interpretation of Equation (8) in terms of the impact on total inequality of (an increase of) a tax on an expenditure category k is as follows: when the relative marginal

effect is positive (negative) the taxation should reduce (increase) global inequality. Such a tax would be progressive (regressive).

In addition, the decomposition described above provides estimates of elasticities (called *Gini elasticities*) with respect to total expenditure without specifying a functional form for the Engel curves. The term

$$\eta_k = \frac{R_k G_k}{G} = \frac{\mathrm{cov}\left(x_k, F_X\right)}{\mathrm{cov}\left(X, F_X\right)} \times \frac{m}{m_k} \tag{9}$$

can be interpreted as the elasticity of expenditure k with respect to total expenditure. Indeed,

$$\beta_k = \frac{\mathrm{cov}\left(x_k, F_X\right)}{\mathrm{cov}\left(X, F_X\right)} \tag{10}$$

can be seen as a non-parametric estimator of the marginal propensity to spend on the category of goods and services k (Olkin and Yitzhaki, 1992; Yitzhaki, 1994).

Notice that the relative marginal effect in Equation (8) can also be written as:

$$\frac{\partial G / \partial e_k}{G} = S_k(\eta_k - 1)\,. \tag{11}$$

Equation (11) makes even more immediate the interpretation of the relative marginal effect, in agreement with the usual classification of taxes according to elasticities with respect to income. A tax is progressive if it is imposed on a luxury commodity (η_k >1), in which case the relative marginal effect is positive. It is regressive if it is imposed on a necessary or inferior good (η_k <1); in this case, the relative marginal effect is negative. However, the extent of the relative marginal effect depends on the magnitude of the component's budget share (S_k). Finally, the tax is neutral if the elasticity is equal to 1 (the relative marginal effect is zero).

3. TRANSPORT EXPENDITURES IN THE HOUSEHOLD BUDGET

3.1. The Data

The data are from repeated cross-sections of household expenditure surveys. Three survey periods more than 10 years apart are selected in each country: 1978-79, 1994-95 and 2005-06 for France; 1979, 1995 and 2006 for the UK. The number of surveyed French households in the *Budget de Famille* survey is of 10,645 in 1978-79, 9,606 in 1994-95 and 10,240 in 2005-06. In the UK, the *Family Expenditure Survey* sample is comprised of 6,776 households in 1979, 6,853 in 1995, and 6,645 in 2006.

Private transport expenditures include purchases of cars and two-wheelers, insurance costs for cars and two-wheelers, purchases of fuels, lubricants, tyres and accessories,

maintenance and repair costs, parking costs, lock-up garage or parking-lot rental costs, car licence and annual registration taxes, and vehicle-use-related fines.

Regarding public transport, in general it is not possible to distinguish between local trips and long distance trips in the data files at our disposal, the exception being the first two French surveys (1979 and 1995). Also, for France expenditures on lubricants cannot be separated from fuels in the 2006 survey data.

3.2. Elements on Car Taxation Schemes

To understand some of the differences between the two countries as regards transport expenditures and their effect on inequality, some background information about vehicle taxation systems in each country may be useful[2].

In France, the VAT rate on automobile purchases was as high as 33.33% until 1987. It then gradually decreased: 28% in Sept. 1987, 25% in Sept. 1989, 22% in Sept. 1990, and 18.6% (rate imposed on the majority of commodities) in April 1991. As for most products, the rate increased to 20.6% in August 1995, then decreased to 19.6% since April 2000. A car registration tax is paid when a vehicle is bought, whether new or second-hand; it is also paid when changing residential location from a prefecture to another. The tax is calculated on the basis of engine size expressed in fiscal horsepower. The tax rate per horsepower is fixed at the province level. In 1995, this rate varied between 95 FF (about 14.5 EUR) and 195 FF (about 19.7 EUR). In 2008, it ranged from 27 EUR to 46.15 EUR. Besides, there is an annual tax on ownership of a vehicle (this tax is no more imposed on households from 2001 on) and taxes on insurance. As for fuels, an excise tax (the domestic tax on petroleum products, TIPP) and VAT (19.6%) apply.

In the UK, in 1973, the 25% purchase tax on new cars was replaced by VAT at 10% plus an additional car tax of 10% (with VAT charged on the price including the car tax). The VAT rate imposed on cars and the majority of other commodities was increased to 15% in 1979 and 17.5% in 1991. In 1992, the additional car tax of 10% was abolished, so that from this date new car purchases are taxed at the VAT rate of 17.5%. In 1998 a “first registration fee” of £25 was imposed on new cars sales, which was increased to £38 in 2004 and currently stands at £55. An annual tax, the Vehicle Excise Duty (VED), is also payable on most passenger cars. In 1979, the VED was £50 per year for all cars. This increased in nominal terms over the following years, to reach £140 in 1995. By 1999 the tax had increased to £155, and a lower rate of £100 was introduced for cars with engines up to 1100 cc. VED bands based on CO2 emissions were introduced in 2001. For cars first registered after March 2001, the tax ranged from £0 to £400 in 2006 and from £0 to £435 in 2010. The rates for cars first registered prior to this, the VED rate depends on engine size, currently, £125 up to 1549 cc and £205 above this. The tax on fuels is comprised of the hydrocarbon duty and VAT (which is also levied on the duty). The tax has increased more-or-less annually over the

[2] More detailed descriptions of the tax systems regarding passenger transport in the two countries are provided, for example, by Bückman and Rienstra (1998).

past decades. In 1979, it was 10.15 pence per litre, in 1995, 45.35 p per litre and in 2006 63.19 p per litre, all in nominal terms.

3.3. Patterns of Transport Budget Shares by Standard of Living

Households are grouped into quintiles of total expenditure, deflated by the number of consumption units (CU) to account for their composition. The number of CUs in a household is determined according to the Oxford scale: 1 for the reference person (or head), 0.7 for any other member older than 14 years, and 0.5 for each child of up to 14 years of age. The choice of total expenditure as a classifying variable is justified by the fact that expenditure data are more reliable than income data in budget surveys. Besides, a measure based on consumption (more precisely, expenditures) is more relevant than a measure based on income to give an account of the level of material well-being, because households tend to *smooth* their consumption so as to maintain a stable standard of living over time (Rogers and Gray, 1994; Slesnick, 2001).

The average expenditure devoted by French households to private transport (mainly car acquisition and use expenses) accounted for about 14% of their total budget in the late 1970s (Table 1). It decreased slightly since the mid-1990s to reach 11% in 2006. A decrease is observed for each quintile, except the lowest which recorded a higher average share in 1995 probably because of higher car purchases stimulated by a governmental car scrapping incentive (the *Balladurette*, in force from Feb. 1994 to June 1995). The budget share differs according to the standard of living and grows with income: the gap between the first and last quintiles is of 4 to 5 percentage points (up to 8 points in 1979). This reflects the differences of car ownership by income level, as shown in Table 2.

Table 1 – Budget shares of private transport

Quintile ∗	France			UK		
	1979	1995	2006	1979	1995	2006
1	7.2 [6.8; 7.6]	8.7 [8.2 ; 9.1]	6.9 [6.5 ; 7.3]	3.3 [2.9 ; 3.6]	4.2 [3.8 ; 4.7]	5.4 [4.1 ; 6.7]
2	10.9 [10.4; 11.5]	10.7 [10.2 ; 11.2]	8.7 [8.3 ; 9.2]	6.2 [5.7 ; 6.6]	8.8 [8.3 ; 9.3]	9.4 [8.9 ; 10.0]
3	12.5 [11.9; 13.1]	12.1 [11.6 ; 12.7]	10.6 [10.1 ; 11.1]	9.4 [8.9 ; 10.0]	11.6 [11.1 ; 12.1]	12.1 [11.4 ; 12.7]
4	15.2 [14.5; 15.8]	14.1 [13.4 ; 14.8]	12.9 [12.4 ; 13.5]	12.8 [12.1 ; 13.5]	12.7 [12.1 ; 13.2]	13.7 [13.1 ; 14.4]
5	15.1 [14.4; 15.7]	13.4 [12.8 ; 14.1]	11.5 [11.0 ; 12.1]	15.2 [14.4 ; 16.0]	14.3 [13.5 ; 15.2]	15.6 [14.7 ; 16.4]
All hhs.	**13.5 [13.2; 13.8]**	**12.6 [12.3 ; 12.9]**	**11.1 [10.8 ; 11.4]**	**9.4 [9.1 ; 9.7]**	**10.3 [10.0 ; 10.6]**	**11.2 [10.8 ; 11.6]**

Sources: Household expenditure surveys.
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given in square brackets.

The budget shares of British households are generally lower and show different temporal patterns. Thus, they increased for the three lower quintiles, while they remained stable for the upper two. This resulted in a slight increase for the whole population of households. The differences according to income are larger among British households than among French households: the gap between the first and last quintiles is of 10 to 12 percentage points. This is attributable to larger differences in terms of car ownership: households in the upper quintile have on average around one vehicle more than those in the lower quintile (the gap is of about 0.7 vehicle in France).

In general, the levels of car ownership in the UK are lower than in France. The average for all British households in 2006 was the same as that of French households a decade before (1.14 vehicles per household). The lag is even more important when focusing on the least wealthy: the car ownership levels of British households in 2006 were lower than those of their French "homologues" in 1995 (0.57 against 0.75 for the first quintile, and 0.95 against 1.06 for the second quintile). On the other hand, for the wealthiest quintile, car ownership was higher in the UK than in France for all periods.

Both countries witnessed a progression of the social diffusion of the car: the number of cars per household increased more strongly for the least wealthy. However, the increases were higher in the UK than in France. Thus, from 1979 to 2006 the car ownership level increased by about one third for the upper quintile and doubled in the case of the lowest quintile of British households (respectively one third and 80% in France).

Table 2 – Number of vehicles per household

Quintile ∗	France			UK		
	1979	1995	2006	1979	1995	2006
1	0.43	0.75	0.77	0.28	0.30	0.57
2	0.75	1.06	1.11	0.53	0.75	0.95
3	0.93	1.20	1.29	0.76	1.08	1.25
4	1.07	1.29	1.48	0.97	1.29	1.39
5	1.13	1.37	1.52	1.17	1.49	1.55
All hhs.	**0.86**	**1.14**	**1.23**	**0.74**	**0.98**	**1.14**

Sources: Household expenditure surveys.
∗ Quintiles of total expenditure by consumption unit (Oxford scale).

Regarding the budget share of public transport, it is very low, particularly in France (Table 3). In general, there is no regular pattern related to income level, probably because of the diversity of modes included and the varying contexts in terms of urbanisation and population density, and hence the availability of local public transport means. This diversity also makes it difficult to interpret the temporal variation noted in the table.

Table 3 – Budget shares of public transport

Quintile ∗	France			UK		
	1979	1995	2006	1979	1995	2006
1	0.78 [0.74 ; 0.82]	1.34 [1.27 ; 1.41]	1.03 [0.98 ; 1.08]	1.51 [1.36 ; 1.65]	2.02 [1.82 ; 2.23}	1.87 [1.59 ; 2.14]
2	0.91 [0.87 ; 0.95]	1.46 [1.39 ; 1.53]	1.33 [1.27 ; 1.39]	1.76 [1.62 ; 1.91]	1.71 [1.52 ; 1.89]	1.95 [1.68 ; 2.21]
3	0.99 [0.99 ; 1.03]	1.50 [1.43 ; 1.57]	1.05 [1.00 ; 1.10]	2.05 [1.86 ; 2.24]	1.75 [1.56 ; 1.94]	2.06 [1.80 ; 2.31]
4	1.10 [1.05 ; 1.15]	1.66 [1.58 ; 1.74]	1.15 [1.10 ; 1.20]	1.76 [1.60 ; 1.92]	1.61 [1.43 ; 1.79]	1.99 [1.75 ; 2.22]
5	1.39 [1.33 ; 1.45]	1.70 [1.61 ; 1.79]	1.29 [1.23 ; 1.35]	1.95 [1.67 ; 2.23]	2.33 [2.03 ; 2.64]	2.96 [2.54 ; 3.39}
All hhs.	**1.14 [1.11 ; 1.17]**	**1.59 [1.55 ; 1.63]**	**1.20 [1.17 ; 1.23]**	**1.81 [1.72 ; 1.89]**	**1.88 [1.79 ; 1.98]**	**2.16 [2.03 ; 2.30]**

Sources: Household expenditure surveys.
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given in square brackets.

4. CONSUMPTION INEQUALITIES AND REDISTRIBUTIVE EFFECTS OF TAXES

Transport expenditures are grouped into sufficiently homogeneous categories: automobile purchases, two-wheeler purchases, fuels, other vehicle use items, and public transport. The results in this section are presented for these categories as well as for broader aggregates. To account for household composition, all estimations were carried out on the basis of expenditures per consumption unit (Oxford scale). In the estimations, the data were weighted by the respective survey weights of the households.

The estimations were made with Jackknife1612 (version of August 22, 2001), a programme for Gini decomposition devised by Prof. Shlomo Yitzhaki (Hebrew University of Jerusalem and Central Bureau of Statistics, Israel). For each component, Jackknife1612 gives its covariance with the cumulative distribution of the variable of interest and its standard error, its pseudo-Gini ($R_k G_k$) and its standard error, its (Gini) elasticity with respect to the variable of interest and its standard error, its mean and its sum. The estimators of all the parameters of the decomposition of the Gini coefficient are efficient (i.e., asymptotically unbiased), and their distributions converge to a normal distribution (Schechtman and Yitzhaki, 1987). Thus, estimation of their standard errors allows constructing confidence intervals according to values of a normal distribution. Standard errors are estimated with the *jackknife* method.

In interpreting the estimation results, one has to bear in mind certain characteristics of the data. First, the observed expenditures are the result of choices made under income and price constraints. Moreover, by their nature, some goods and services are not purchased in a frequent and regular manner (e.g. durables). Likewise, some expenditures are conditional on

others or on the existence of a stock of durables, as is the case with vehicle use expenditures. Finally, at household level certain expenditures may be insufficiently recorded because of the survey method and/or the observation period. The effect of these aspects on the estimations appears, notably, through the more or less large frequency of zero expenditures in the sample. The level of a Gini coefficient indicates the degree of disparities between households in terms of expenditures on a category of goods and/or services. These disparities reflect differences in terms of amounts spent as well as how widespread these expenditures are among households. In general, as Garner (1993, p. 137) points out, the greater is the proportion of zero expenditures, whether as a result of the consumer's choice or due to the method of observation, the higher is the corresponding Gini index.

4.1. Inequalities by Expenditure Item and their Contribution to Overall Inequality

The lowest Gini coefficients are observed in the categories of expenditures on vehicle use (fuels and other items). This is not surprising because vehicle use expenditures are increasingly widespread in the population with rising car ownership over the years.

Table 4 – Gini coefficients by expenditure item

Expenditure	France			UK		
Item	1979	1995	2006	1979 (**)	1995	2006
Private transport	0.671 [0.664; 0.679]	0.645 [0.639 ; 0.652]	0.662 [0.655; 0.669]	0.700 [0.692 ; 0.709]	0.706 [0.691; 0.721]	0.658 [0.647; 0.670]
Veh. purchases	0.897 [0.892; 0.902]	0.891 [0.886 ; 0.896]	0.900 [0.895; 0.905]	0.866 [0.859; 0.873]	0.945 [0.940; 0.950]	0.893 [0.882; 0.904]
Automobiles	0.905 [0.900; 0.910]	0.896 [0.891 ; 0.901]	0.908 [0.904 ; 0.913]	-	0.946 [0.941; 0.951]	0.896 [0.885; 0.908]
2-wheelers	0.956 [0.949; 0.962]	0.990 [0.988 ; 0.992]	0.970 [0.967 ; 0.973]	-	0.998 [0.996; 0.999]	0.994 [0.992; 0.996]
Fuels	0.645 [0.635 ; 0.654]	0.554 [0.546 ; 0.561]	0.605 (*) [0.597 ; 0.613]	0.688 [0.680 ; 0.697]	0.610 [0.601; 0.619]	0.590 [0.581; 0.599]
Other use exp.	0.690 [0.676 ; 0.704]	0.649 [0.638 ; 0.659]	0.627 [0.610 ; 0.644]	0.737 [0.727 ; 0.748]	0.594 [0.583; 0.604]	0.783 [0.774; 0.791]
Public transport	0.889 [0.881 ; 0.897]	0.781 [0.773 ; 0.789]	0.880 [0.873 ; 0.887]	0.786 [0.771 ; 0.801]	0.833 [0.822; 0.845]	0.871 [0.860; 0.882]
All transport	*0.644 [0.637 ; 0.652]*	*0.602 [0.596 ; 0.609]*	*0.627 [0.620 ; 0.634]*	*0.637 [0.629 ; 0.646]*	*0.664 [0.649 ; 0.679]*	*0.621 [0.610 ; 0.633]*
Total expend.	**0.338 [0.333 ; 0.344]**	**0.328 [0.321 ; 0.335]**	**0.366 [0.357 ; 0.375]**	**0.302 [0.296 ; 0.309]**	**0.345 [0.338 ; 0.352]**	**0.341 [0.333 ; 0.348]**

Sources: Household expenditure surveys.
Note: Confidence intervals at 95% are given in square brackets.
(*) Expenditures on fuels and lubricants cannot be separated in the 2006 *Budget de Famille* survey.
(**) Expenditures on automobiles and two-wheelers cannot be separated in the 1979 *Family Expenditure Survey*.

Then come, in ascending order, the Gini indices of expenditures on public transport and on car purchases. Finally, two-wheeler purchases exhibit the highest concentration. This can be

explained by the relative scarcity of these purchases. For instance, they represent on average about 1% of the transport budget among French households, and 0.2% of their total budget.

Table 4 also shows that concentration of expenditures has generally decreased for vehicle use items, particularly fuels. In the case of French households, the slight increase of the Gini coefficient for fuels in 2006 is probably due to the fact that for this period this category includes lubricants which are less frequently purchased. There is no regular temporal pattern in the case of vehicle purchases probably because purchases of durables are not made frequently. As for public transport (local and long distance trips together), the concentration is rather stable over the whole observation period in France (despite a decrease in 1995), while it consistently increased in the UK.

The contribution of each transport expenditure category to the overall inequality is displayed in Table 5. As Equation (6) shows, the contribution of a component to overall inequality is determined by three factors: the proper inequality of the component (measured by its Gini coefficient), its degree of association with total expenditure (measured by their Gini correlation), and its share in the total budget. Thus, despite a very high Gini coefficient (close to 1), the relative contribution of two-wheeler purchases to overall inequality is insignificant in both countries, due to their small budget share and their weak association with total expenditure.

Table 5 – Relative contribution to overall inequality (%)

Expenditure item	France			UK		
	1979	1995	2006	1979 (**)	1995	2006
Private transport	16.5 (0.41)	14.7 (0.42)	12.3 (0.40)	18.4 (0.54)	24.3 (1.15)	17.9 (0.60)
Vehicle purchases	7.7 (0.28)	9.0 (0.35)	7.7 (0.31)	9.1 (0.43)	15.4 (1.15)	10.7 (0.57)
Automobiles	7.6 (0.28)	8.7 (0.34)	7.5 (0.30)	-	15.3 (1.15)	10.5 (0.57)
Two-wheelers	0.1 (0.03)	0.3 (0.06)	0.3 (0.03)	-	0.1 (0.06)	0.2 (0.05)
Fuels	3.9 (0.12)	1.9 (0.06)	1.7 (*) (0.06)	4.0 (0.11)	3.7 (0.10)	4.1 (0.13)
Other use exp.	4.9 (0.26)	3.8 (0.17)	2.9 (0.20)	5.3 (0.24)	5.2 (0.17)	3.1 (0.16)
Public transport	1.7 (0.13)	1.8 (0.09)	1.3 (0.09)	2.0 (0.22)	2.3 (0.21)	3.2 (0.33)
All transport	*18.2 (0.42)*	*16.5 (0.42)*	*13.6 (0.41)*	*20.4 (0.56)*	*26.6 (1.15)*	*21.1 (0.65)*

Sources: Household expenditure surveys.
Note: Standard errors are given in brackets.
(*) Expenditures on fuels and lubricants cannot be separated in the 2006 *Budget de Famille* survey.
(**) Expenditures on automobiles and two-wheelers cannot be separated in the 1979 *Family Expenditure Survey*.

By contrast, the relative contribution of car purchases is much more important (around 8% in France; 10% to 15% in the UK) despite slightly lower Gini coefficients; this is due to greater budget shares and stronger correlation with total expenditure. In terms of significance for overall inequality, this component is followed by vehicle use expenditures other than fuels, then by fuels, and finally by expenditures on public transport. Interestingly, the relative contributions of vehicle use items is slightly higher in the UK than in France, reflecting the differences mentioned above regarding car ownership levels.

Over the whole observation period, the contribution to overall inequality among French households declines in the case of fuels and of the remaining vehicle use expenditures. It also declines slightly for public transport. In the UK, the contribution of fuels remains stable, and for the remaining vehicle use items the decrease only shows up in the last survey period. Also, unlike in France, the relative contribution of public transport (though low) shows an increasing tendency.

4.2. Redistributive Effects of Taxes by Expenditure Item

Table 6 displays the estimated effect on overall inequality of a marginal change in each transport expenditure item. In both countries, taxes on transport as a whole are progressive, but are comparatively more progressive in the UK. Also, in both countries progressivity appears to have decreased over time. In the case of France, a 1% proportional increase of transport expenditures would have reduced global inequality by less than 2% in the mid-2000's compared to 3-4% previously. For the UK, the comparable figures are 5.4% and 7%.

Table 6 – Change in overall inequality due to a marginal change in a component (%)

Expenditure item	France			UK		
	1979	1995	2006	1979 (**)	1995	2006
Individual transport	4.0	2.8	1.8	7.0	7.5	4.6
Vehicle purchases	3.0	3.7	2.9	4.4	7.4	4.8
Automobiles	3.0	3.6	2.9	-	7.4	4.7
Two-wheelers	0.0	0.1	0.0	-	0.0	0.0
Fuels	0.1	-0.9	-0.8 (*)	0.9	0.0	-0.6
Other use exp.	0.9	0.1	-0.3	1.7	0.0	0.4
Public transport	0.4	0.2	0.1	0.1	0.3	0.8
All transport	*4.4*	*3.0*	*1.8*	*7.2*	*7.8*	*5.4*

Sources: Household expenditure surveys.
(*) Expenditures on fuels and lubricants cannot be separated in the 2006 *Budget de Famille* survey.
(**) Expenditures on automobiles and two-wheelers cannot be separated in the 1979 *Family Expenditure Survey*.

The progressivity of taxes on transport as a whole is mainly due to the progressive character of taxes on car purchases, strongly linked to income and with a higher budget share than for the other expenditure items. However, with the diffusion of the automobile and of its use, taxes on vehicle use items are less and less progressive and become even regressive in the case of fuels. Though the extent of the induced variations is very small (the relative marginal effect decreased from 0.1% to -1% in France and from 0.9 to -0.6 in the UK), the trend is important: it reflects a gradual transformation of the distributions of these expenditures with the growing penetration of cars in the population. Note that for France in 2006 the effect of a change in fuel expenditures is obscured by the inclusion of lubricants, and is probably underestimated (in absolute value). The differences between the two countries reflect the above-mentioned gaps in terms of car ownership. Thus, taxes on car purchases in particular are more progressive in the UK. Also, for vehicle use items the same tendency as in France seems to take place but with a time lag.

The slightly progressive character of taxes on public transport services in France is to be attributed to long distance trips. Indeed, as shown in Berri (2005), taxes on local public transport appear to be neutral at national level (i.e. neither progressive nor regressive). However, this result conceals a diversity of local conditions in terms of supply of these transport means according to the degree of urbanization and population density. Effectively, these taxes prove to be regressive when focusing on the Greater Paris region, a large urban area very well endowed with public transport infrastructure. Over time, a dissimilar trend shows up in the UK: unlike in France, taxes on public transport expenditures seem to become more progressive. As shown in Dargay (2005), taxes on bus use in the UK have regressive effects while those on rail have progressive effects. This, in combination with an increasing use of rail relative to bus, may explain the increased progressivity of taxes on public transport.

As regards purchases of two-wheelers, which are rare, there seems to be no effect whatsoever on global inequalities.

The (Gini) elasticities with respect to total expenditure, as shown in Table 7, confirm the above conclusions as to the regressive (elasticity < 1) or progressive (elasticity > 1) character of a tax on a category of expenditures.

In France, for example, the luxury character of transport commodities as a whole is obvious (with an elasticity of 1.32 in 1979, 1.22 in 1995 and 1.16 in 2006), because of the predominance of car purchases (the elasticity of which is of the order 1.6-1.7). Vehicle use expenditures show decreasing elasticities (from 1 to 0.7 for fuels and from 1.2 to 0.9 for the remaining vehicle use items), thus confirming the more and more necessary character of the car. The same decreasing tendency is observed for the elasticity of public transport (from 1.4 to 1.1). However, as mentioned previously, these elasticities give information on the *sign* of the relative marginal effect, but not on its *magnitude*. The results for the UK show similar patterns, but there are some differences in magnitudes. Again, public transport shows a different time trend: its elasticity is increasing.

Table 7 – Total expenditure (Gini) elasticities

Expenditure item	France			UK		
	1979	1995	2006	1979 (**)	1995	2006
Private transport	1.32 [1.28 ; 1.36]	1.23 [1.19 ; 1.28]	1.17 [1.12 ; 1.21]	1.61 [1.56 ; 1.67]	1.44 [1.38 ; 1.51]	1.35 [1.30 ; 1.40]
Vehicle purchases	1.64 [1.58 ; 1.69]	1.69 [1.63 ; 1.76]	1.61 [1.55 ; 1.67]	1.94 [1.86 ; 2.02]	1.93 [1.83 ; 2.03]	1.81 [1.73 ; 1.89]
Automobiles	1.67 [1.61 ; 1.73]	1.71 [1.64 ; 1.78]	1.63 [1.57 ; 1.69]	-	1.93 [1.83 ; 2.03]	1.82 [1.74 ; 1.90]
Two-wheelers	0.81 [0.53 ; 1.08]	1.32 [1.04 ; 1.61]	1.18 [1.03 ; 1.33]	-	1.67 [0.70 ; 2.64]	1.31 [0.85 ; 1.77]
Fuels	1.02 [0.98 ; 1.06]	0.67 [0.63 ; 0.70]	0.67 (*) [0.63 ; 0.71]	1.29 [1.24 ; 1.35]	1.00 [0.96 ; 1.04]	0.88 [0.84 ; 0.92]
Other use exp.	1.23 [1.15 ; 1.30]	1.02 [0.96 ; 1.08]	0.90 [0.81 ; 0.98]	1.46 [1.39 ; 1.54]	1.00 [0.96 ; 1.05]	1.15 [1.07 ; 1.22]
Public transport	1.36 [1.24 ; 1.49]	1.13 [1.06 ; 1.21]	1.06 [0.97 ; 1.16]	1.08 [0.92 ; 1.23]	1.16 [1.03 ; 1.29]	1.32 [1.17 ; 1.46]
All transport	*1.32* *[1.29 ; 1.36]*	*1.22* *[1.18 ; 1.26]*	*1.16* [1.11 ; 1.20]	*1.54* [1.49 ; 1.59]	*1.41* [1.35 ; 1.47]	*1.34* [1.30 ; 1.39]

Sources: Household expenditure surveys.
Note: Confidence intervals at 95% are given in square brackets.
(*) Expenditures on fuels and lubricants cannot be separated in the 2006 *Budget de Famille* survey.
(**) Expenditures on automobiles and two-wheelers cannot be separated in the 1979 *Family Expenditure Survey*.

5. SUMMARY AND CONCLUSIONS

Household inequalities as regards the consumption of transport goods and services as well as the redistributive effects of taxes on various expenditure categories have been evaluated for France and the UK. A decomposition by expenditure component of the Gini inequality index was applied, using individual-level data from repeated cross-sections of expenditure surveys spanning long time periods. The results highlight the effect of the gradual diffusion of cars in the last decades.

Inequality regarding transport is mainly attributable to automobile purchases, followed by vehicle use items other than fuels, and fuels. The relative contribution of public transport is very small, due to a small budget share. The relative contribution of car use items decreased over time, thus reflecting the increasingly widespread use of the car.

Taxes on transport goods and services as a whole are progressive, i.e. they affect the rich more than the poor. However, this is principally due to the progressivity of taxes on automobile purchases, strongly linked to income and with a high budget share as compared to the remaining types of expenditures. On the contrary, taxes on fuels become regressive (i.e., they affect the poor more than the rich), whereas the progressive character of taxes on the other vehicle use goods and services has become weaker over the years. This, again, is

an evidence of the effect of the diffusion of the car, becoming more and more of a necessity rather than a luxury.

These findings suggest that equity issues should not be ignored when considering measures to attenuate the environmental impact of cars (pollutant emissions, congestion and noise) in order not to worsen social inequalities. Increasing car use costs, notably fuel prices, through an increase of uniform taxes would be particularly inequitable. In particular, the least wealthy of car-dependent households living in low-densely populated zones would face a heavy burden that they cannot avoid. Indeed, as shown by the example of the Greater Paris region (Berri, 2007), the peripheral location of modest income households, because of high property prices in the centre of the urban area, involves transport expenditures (mainly car purchase and running costs) that increase with distance from the centre. These expenditure levels are not necessarily chosen, but are induced by the absence of a credible alternative to the car. The drift towards remote areas is in particular favoured by the fact that mortgage lenders do not take account of transport expenditures when awarding home purchase loans (Bardy, 2001). By so doing, they consider that life in the outskirts (where land and property prices are lower, but badly served by public transport) is more affordable than in the centre.

Area-specific measures may be more appropriate. In the case of dense urban areas, urban tolls and restrictions of access are examples of such measures. In parallel, public transport supply has to be improved in terms of lines of service, speed, punctuality, comfort, etc. In addition, a global approach should include actions on the housing sector so as to increase the density of the urban fabric and attenuate the sprawl tendency. Besides the necessity of taking into account transport costs in the evaluation of solvency, measures improving the housing market conditions may consist of stimulating construction and promoting low-cost accommodation in most accessible zones by public transport.

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ANNEX

Gini Correlation

The Gini correlation between two random variables X and Y is a measure of their degree of association, based on the Gini Mean Difference (Schechtman and Yitzhaki, 1987). The Gini correlation coefficient is intermediate between the (usual) Pearson correlation coefficient and the rank-based Spearman correlation coefficient, the expressions of which are respectively

$$\rho(X,Y) = \operatorname{cov}(X,Y) \Big/ \sqrt{\operatorname{var}(X)\operatorname{var}(Y)} \text{ and}$$

$$r_S(X,Y) = \operatorname{cov}(R_X,R_Y) \Big/ \sqrt{\operatorname{var}(R_X)\operatorname{var}(R_Y)}\,.$$

R_X and R_Y represent the ranks according to the values of X and Y, respectively. Divided by the size of the population or sample, they give the (empirical) cumulative distributions of the corresponding variables. Pearson correlation is based on the covariance of the two variables, whereas Spearman correlation is based on the covariance of their cumulative distributions. Gini correlation is a compromise between the two: it uses the covariance between one of the two variables and the cumulative distribution of the other. It is a non-symmetric measure and can take the two following forms:

$$R(X,Y) = \operatorname{cov}\left(X, G_Y(Y)\right) \Big/ \operatorname{cov}\left(X, F_X(X)\right),$$

$$R(Y,X) = \operatorname{cov}\left(Y, F_X(X)\right) \Big/ \operatorname{cov}\left(Y, G_Y(Y)\right).$$

In general, the two correlations $R(X,Y)$ and $R(Y,X)$ are not equal.

The properties of the Gini correlation coefficient combine properties of the Pearson and Spearman coefficients (Schechtman and Yitzhaki, 1987). Among these properties:

- for every (X,Y), $-1 \le R(X,Y) \le 1$;
- if X and Y are independent, $R(X,Y) = R(Y,X) = 0$;
- if Y is an increasing (resp. decreasing) monotone function of X, not necessarily linear, $R(X,Y)$ and $R(Y,X)$ will be equal to +1 (resp., -1); and
- if (X,Y) has a bivariate normal distribution with parameters μ_X, μ_Y, σ_X^2, σ_Y^2 and ρ, then $R(X,Y) = R(Y,X) = \rho$.