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Transport consumption inequalities and redistributive effects of taxes: A repeated cross-sectional evaluation on French household data

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Abstract

This paper evaluates transport consumption inequalities among French households, investigates their temporal dynamics, and estimates the redistributive effects of taxes on different commodity categories. A decomposition by expenditure component of the Gini coefficient is applied, using household-level data from five expenditure surveys conducted between the end of the 1970's and the early 2000's. The results highlight the effect of car social diffusion. Indeed, the relative contribution to global inequality of car use items, especially fuels, decreased regularly over time, 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 over time. Therefore, the design of policy measures to reduce car use and thus attenuate its nuisances for the environment should also account for the imperative of equity. The case of local public transport underlines the necessity of accounting for disparities in terms of availability of alternatives to the car. Taxes on these services appear to be neutral (i.e. neither progressive nor regressive) at national level, but 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. Hence, a distinction by degree of urbanization is to be considered.

Keywords: Inequality, transport consumption, household expenditure surveys, Gini index, decomposition by component, redistributive effects of taxes.
JEL classification: D12, H23, H24, R41.

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1. Introduction

Car taxes are a source of public revenues as well as a policy tool to reduce traffic nuisances. Most of them were instituted in a time where the car was a luxury good (e.g. the French *vignette*, an annual tax on vehicles owned, in 1956). The large automobile social diffusion over the last 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 expenditures, not only of professionals but also of households, particularly those in rural and suburban areas who are more car-dependent.

This paper evaluates inequalities between French households regarding the consumption of transport goods and services, estimates the redistributive effects of taxes on the different categories considered, and examines their temporal dynamics. 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 indicator by expenditure component. Each component appears through its proper Gini coefficient, its budget share and its degree of association with total expenditure. This method allows a better understanding of the inequality mechanisms, in particular their temporal evolution. Moreover, it permits evaluating the redistributive effect of (a change in) a tax on a good or a service. Finally, it furnishes estimates of elasticities with respect to total expenditure (or income) without specifying a functional form for the Engel curves. The data are from five *Household Budget* (*Budget de Famille*) surveys conducted by the National Institute of Statistics and Economic Studies (INSEE) in 1978-79, 1984-85, 1989, 1994-95 and 2000-01. The analysis first considers all surveyed households at national level, and then focuses on those living in the Greater Paris region, a large urban area very well endowed with public transport infrastructure. The number of surveyed households at national level amounts to 10,645 in 1978-79, 11,976 in 1984-85, 9,038 in 1989, 9,606 in 1994-95 and 10,305 in 2000-01. For the Greater Paris region, this number is of 1,997, 2,049, 1,370, 1,706 and 1,609, respectively.

The paper is organised as follows. An exposition of the methodology used is given in the next section. Then, Section 3 examines the budget shares allocated to different expenditure categories, according to households' standard of living. Section 4 presents the results of analyses of inequality and redistributive effects of taxes on the different categories of goods and services considered. Section 5 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 or consumption…). One of its appeals 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):

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

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

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

where m is the mean of the distribution. 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 index has several expressions, and thus lends itself to diverse interpretations.[1] 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 lights up the temporal patterns of inequalities. Besides, it allows evaluating the redistributive effects of taxes on the different components.

2.2. A practical formulation of the Gini coefficient

LERMAN and YITZHAKI (1984)[2] 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 its covariance with its empirical cumulative distribution, and to substitute for the corresponding terms in the expressions above. With a random sample of size n (same selection probability for all individuals), the cumulative distribution is estimated by ranking individuals according to increasing values of X and by dividing theirs 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, respectively, by

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

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

[1] See, for example, SEN (1997, pp. 31-33) and YITZHAKI (1998).
[2] See also SHALIT (1985).

where $\pi_j = w_j \Big/ \sum_{i=1}^{n} w_i$.[3]

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

This 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 the global income inequality. GARNER (1993) applies it to the analysis of inequalities in terms of expenditures.

Consider the case where X represents 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:

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

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 the last equation by $\operatorname{cov}(x_k, F_k)$ and by m_k, one obtains the decomposition by component:

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

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:

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

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. If one of the variables is an increasing (resp., decreasing) monotone function of the other, their Gini correlation will be equal to +1 (resp., -1). Further details can be found in Annex 1.

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

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

the factors, the stronger the contribution of the category to total inequality. The expression of the contribution means also 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 provides a decomposition of inequalities into elements easily interpretable and helps understanding their temporal evolution by examining the evolution 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, worsening 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 is to be noted that no explicit transfer is considered here. The expression *redistributive effect* refers to the impact on distributions in terms of inequality increase or reduction.

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 $x_k(e_k) = (1+e_k)x_k$, $e_k > 0$.[4] The effect on the global Gini is (STARK *et al.*, 1986, pp. 737-738):

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

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 for 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. One can also see that, as long as the budget share S_k is not null,

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

[4] In terms of variation of a tax t_k on expenditure k, one has $x_k(dt_k) = (1+dt_k)x_k$. 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.

(2) 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 said to be *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 said to be *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 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 should increase inequalities, as would a regressive tax do. 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 (2) above. As previously noted, in this case 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 (resp., negative) the taxation should diminish (resp., increase) global inequality. Such a tax would be progressive (resp., regressive).

Besides, the decomposition 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).[5] The estimator is an average of slopes defined between each pair of observations in the sample, weighted by the distance between the two observations (which is the difference in terms of total expenditure or income):

[5] It is to be noted that β_k can also be interpreted as an instrumental variables estimator in a linear model $x_k = a + bX + \varepsilon$, the instrument being the empirical cumulative distribution of total expenditure, F_X. The use of rank as an instrumental variable was suggested by DURBIN (1954) as a solution for the problem of measurement errors in the variables.

$$\beta_k = \sum_{i,j} w_{ij} b_{ij}^k ,$$

where $b_{ij}^k = \left(x_{k;i} - x_{k;j}\right) \Big/ \left(X_i - X_j\right)$ and $w_{ij} = \left|X_i - X_j\right| \Big/ \sum_{l,m} \left|X_l - X_m\right|$, with $\sum_{i,j} w_{ij} = 1$.

The relative marginal effect in equation (8) can also be written:

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

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 ($\eta_k > 1$), in which case the relative marginal effect is positive. It is regressive if it is imposed on a necessary or inferior good ($\eta_k < 1$); 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 null).

3. Transport expenditures in the households' budget

In this section, we examine the budget shares of different transport items by standard of living, and their temporal pattern.[6] Households are grouped into quintiles of total expenditure, deflated by the number of consumption units (CU) to account for their composition. The number of consumption units in a household is determined according to Oxford scale: 1 for the reference person (or head), 0.7 for any other member older than 14, and 0.5 for each child aged 14 years or less. 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).

Private transport expenditures include purchases of cars and two-wheelers, insurance (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, tolls, car licence and annual registration taxes, and fines.

Local public transport expenses are reported by means of a diary. However, expenses on long distance trips by public transport, which are mainly made during holiday travels, are more difficult to measure. The problem is that these expenditures can often not be isolated from other holiday expenditures because of combined travel+stay packages. For example, in 1989, 11.3% of households participated in a conducted tour[7]. The percentage of households who made long distance trips by public transport outside holidays was 3.2% in 1979, 5.9% in 1984, 3.8% in 1989, and 3.7% in 1994. The proportion of those who declared long distance trips for holidays continued to grow over the observation period: 14.8% in 1979, 17% in 1984, 17.9% in 1989 and 44.5% in 1994. When we consider the two purposes together (not mutually exclusive), the proportions are respectively of 17%, 20.6%, 20.2% and 45.7%. The

[6] The average annual expenditures on the main categories considered, at national level as well as for the Greater Paris region, are given in Annex 2.

[7] ENEAU and MOUTARDIER (1992), p. 129.

very strong increase between 1989 and 1994 can be explained by a change of methodology concerning the holiday section of the survey. The 1989 survey considered the totality of stays made during the last 12 months. A quarter of the stays made more than 6 months before were omitted (leading to an under-estimation of the holiday expenditure of about 13%). Among the omitted stays were the shortest ones made beyond the 6 preceding months. In the 1994-95 survey the reference period is reduced to 6 months and a more detailed description of the nature of expenditure for the last two stays is made. The different components of the item "holiday", of which transport is one, are hence better described in the latter survey (INSEE, 1997, p. 18).

Notice that regarding the 2000-01 survey, the data files available to us do not allow distinguishing between local and long distance trips by public transport, and between fuels and lubricants.

3.1. Temporal patterns of budget shares at national level

The average share of total expenditure devoted to transport was of about 15%, and remained globally stable except a small decrease by the end of the period (Table 1). However, this share differs greatly according to the standard of living and grows with income (the gap between the first and last quintiles is up to 9 percentage points). The temporal patterns were contrasting: slight increases for the poorest and slight decreases for the richest.

Table 1. *Budget shares of total transport – Whole France*

Quintile ∗	1979	1984	1989	1994	2000
1	8.0 [7.5 ; 8.4]	9.8 [9.3 ; 10.2]	9.3 [8.8 ; 9.8]	10.0 [9.5 ; 10.5]	9.0 [8.5 ; 9.4]
2	11.9 [11.3 ; 12.4]	12.3 [11.8 ; 12.9]	11.5 [10.9 ; 12.1]	12.1 [11.5 ; 12.7]	10.7 [10.2 ; 11.2]
3	13.5 [12.9 ; 14.1]	14.6 [13.9 ; 15.2]	13.9 [13.2 ; 14.6]	13.6 [13.0 ; 14.3]	12.8 [12.2 ; 13.4]
4	16.3 [15.6 ; 17.0]	16.5 [15.8 ; 17.2]	16.7 [15.9 ; 17.6]	15.8 [15.0 ; 16.5]	15.1 [14.4 ; 15.8]
5	16.5 [15.7 ; 17.2]	18.0 [17.2 ; 18.8]	18.3 [17.3 ; 19.2]	15.2 [14.4 ; 15.9]	13.4 [12.7 ; 14.1]
All hhs.	**14.6 [14.3 ; 15.0]**	**15.5 [15.2 ; 15.8]**	**15.5 [15.1 ; 15.9]**	**14.2 [13.8 ; 14.5]**	**13.0 [12.7 ; 13.4]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given between square brackets.

One observes the same configuration for the most important group: individual transport, constituted essentially by automobile acquisition and use expenditures (Table 2). This reflects the structuring of household automobile equipment by their income level, even though car diffusion progressed over the period: the number of cars per household increased more strongly for the lowest incomes (Table 3).

Table 2. *Budget shares of private transport – Whole France*

Quintile ∗	1979	1984	1989	1994	2000
1	7.2 [6.8 ; 7.6]	8.9 [8.5 ; 9.4]	8.3 [7.8 ; 8.7]	8.7 [8.2 ; 9.1]	8.1 [7.7 ; 8.5]
2	10.9 [10.4 ; 11.5]	11.4 [10.9 ; 11.9]	10.7 [10.2 ; 11.2]	10.7 [10.2 ; 11.2]	9.9 [9.4 ; 10.3]
3	12.5 [11.9 ; 13.1]	13.6 [13.0 ; 14.2]	13.0 [12.3 ; 13.6]	12.1 [11.6 ; 12.7]	11.8 [11.3 ; 12.4]
4	15.2 [14.5 ; 15.8]	15.4 [14.7 ; 16.0]	15.7 [14.9 ; 16.4]	14.1 [13.4 ; 14.8]	14.0 [13.4 ; 14.6]
5	15.1 [14.4 ; 15.7]	16.6 [15.8 ; 17.3]	16.9 [16.0 ; 17.8]	13.4 [12.8 ; 14.1]	12.2 [11.6 ; 12.8]
All hhs.	**13.5 [13.2 ; 13.8]**	**14.4 [14.0 ; 14.7]**	**14.4 [14.0 ; 14.7]**	**12.6 [12.3 ; 12.9]**	**11.9 [11.6 ; 12.3]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given between square brackets.

Table 3. *Automobile equipment – Whole France*

Quintile ∗	Number of vehicles per household				
	1979	1984	1989	1994	2000
1	0.43	0.59	0.60	0.75	0.72
2	0.75	0.89	0.93	1.06	1.08
3	0.93	1.05	1.08	1.20	1.23
4	1.07	1.15	1.18	1.29	1.36
5	1.13	1.26	1.29	1.37	1.42
All hhs.	**0.86**	**0.99**	**1.02**	**1.14**	**1.16**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).

As for public transport, the largest change in its budget share occurred between 1989 and 1994 (Table 4). The increase is essentially due to long distance trips. This is attributable in part to the differences noted above between the two surveys regarding the coverage of these trips, particularly in the “holiday” section. The budget share of public transport also grows with income level, but the link is to be attributed to long distance trips.

Table 4. *Budget shares of public transport – Whole France*

Quintile ∗	1979	1984	1989	1994	2000
1	0.78 [0.74 ; 0.82]	0.83 [0.79 ; 0.87]	0.98 [0.93 ; 1.03]	1.34 [1.27 ; 1.41]	0.85 [0.81 ; 0.89]
2	0.91 [0.87 ; 0.95]	0.92 [0.88 ; 0.96]	0.81 [0.77 ; 0.85]	1.46 [1.39 ; 1.53]	0.84 [0.80 ; 0.88]
3	0.99 [0.95 ; 1.03]	0.94 [0.90 ; 0.98]	0.93 [0.88 ; 0.98]	1.50 [1.43 ; 1.57]	0.94 [0.90 ; 0.98]
4	1.10 [1.05 ; 1.15]	1.09 [1.04 ; 1.14]	1.07 [1.02 ; 1.12]	1.66 [1.58 ; 1.74]	1.13 [1.08 ; 1.18]
5	1.39 [1.33 ; 1.45]	1.41 [1.35 ; 1.47]	1.35 [1.28 ; 1.42]	1.70 [1.61 ; 1.79]	1.18 [1.12 ; 1.24]
All hhs.	**1.14 [1.11 ; 1.17]**	**1.13 [1.11 ; 1.15]**	**1.10 [1.07 ; 1.13]**	**1.59 [1.55 ; 1.63]**	**1.06 [1.03 ; 1.09]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given between square brackets.

The budget share of local public transport is very low. It slightly increased for the bottom of the income distribution and slightly decreased for the richest households. However, there is no regular pattern related to income level, probably because of a diversity of contexts in terms of urbanisation and hence as to the availability of local public transport means (Table 5).

Table 5. *Budget shares of local public transport – Whole France*

Quintile ∗	1979	1984	1989	1994	2000 **
1	0.51 [0.48 ; 0.54]	0.46 [0.44 ; 0.48]	0.60 [0.57 ; 0.63]	0.64 [0.61 ; 0.67]	–
2	0.50 [0.48 ; 0.52]	0.49 [0.47 ; 0.51]	0.46 [0.44 ; 0.48]	0.68 [0.65 ; 0.71]	–
3	0.58 [0.55 ; 0.61]	0.51 [0.49 ; 0.53]	0.52 [0.49 ; 0.55]	0.58 [0.55 ; 0.61]	–
4	0.59 [0.56 ; 0.62]	0.50 [0.48 ; 0.52]	0.56 [0.53 ; 0.59]	0.54 [0.51 ; 0.57]	–
5	0.67 [0.64 ; 0.70]	0.43 [0.41 ; 0.45]	0.43 [0.41 ; 0.45]	0.45 [0.43 ; 0.47]	–
All hhs.	**0.60 [0.59 ; 0.61]**	**0.47 [0.46 ; 0.48]**	**0.49 [0.48 ; 0.50]**	**0.54 [0.53 ; 0.55]**	–

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989 and 1994).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
** It has not been possible to distinguish between local and long distance trips.
Note: Confidence intervals at 95% are given between square brackets.

3.2. Temporal patterns of the budget shares in the Greater Paris region

The Greater Paris region presents similar patterns, though with higher levels of total expenditure, reflecting in particular the fact that the capital region is wealthier in comparison with the rest of the country. The notable differences relate to expenditures on private transport and local public transport, in levels as well as in budget shares.[8]

[8] The expenditure amounts are given in Annex 2.

Due to a higher degree of urbanisation and a greater supply of public transport, household car equipment levels are lower than at national level (Table 6). It follows that the amounts of expenditures for individual transport, consisting essentially of car expenditures, and their shares in the budget are in general lower for households of the region (Table 7).

Table 6. *Automobile equipment – Greater Paris region*

Quintile ∗	Number of vehicles per household				
	1979	1984	1989	1994	2000
1	0.43	0.43	0.44	0.59	0.61
2	0.74	0.71	0.77	0.91	0.91
3	0.88	0.89	0.92	1.04	1.11
4	0.95	1.02	1.06	1.09	1.12
5	1.08	1.11	1.13	1.21	1.31
All hhs.	**0.82**	**0.83**	**0.86**	**0.97**	**1.01**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).

Table 7. *Budget shares of private transport – Greater Paris region*

Quintile ∗	1979	1984	1989	1994	2000
1	6.7 [5.9 ; 7.6]	6.6 [5.9 ; 7.4]	6.0 [5.2 ; 6.8]	6.7 [5.9 ; 7.5]	5.5 [4.8 ; 6.2]
2	10.0 [8.9 ; 11.1]	8.8 [7.9 ; 9.7]	9.0 [7.9 ; 10.1]	9.1 [8.1 ; 10.1]	8.2 [7.2 ; 9.2]
3	11.9 [10.7 ; 13.2]	10.6 [9.5 ; 11.6]	12.3 [10.7 ; 13.8]	10.5 [9.3 ; 11.7]	9.6 [8.5 ; 10.7]
4	12.3 [11.1 ; 13.5]	12.8 [11.5 ; 14.1]	13.1 [11.5 ; 14.7]	10.2 [9.0 ; 11.3]	11.3 [9.9 ; 12.6]
5	13.5 [12.1 ; 14.8]	13.6 [12.1 ; 15.0]	12.3 [10.6 ; 13.9]	9.4 [8.2 ; 10.5]	7.6 [6.5 ; 8.6]
All hhs.	**11.9 [11.3 ; 12.5]**	**11.5 [10.9 ; 12.1]**	**11.5 [10.7 ; 12.2]**	**9.5 [8.9 ; 10.0]**	**8.6 [8.0 ; 9.2]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
∗ Quintiles of total expenditure by consumption unit (Oxford scale).
Note: Confidence intervals at 95% are given between square brackets.

On the contrary, expenditures for local public transport are higher, whatever the standard of living. The corresponding budget shares are higher than those recorded at national level (often more than the double), even though their level remains very low (Table 8). It is also to be noted that the budget share of this item tends to diminish as income increases.

Table 8. *Budget shares of local public transport – Greater Paris region*

Quintile *	1979	1984	1989	1994	2000 **
1	1.19 [1.04 ; 1.34]	1.23 [1.09 ; 1.37]	1.58 [1.36 ; 1.80]	1.71 [1.51 ; 1.91]	_
2	1.35 [1.20 ; 1.50]	1.30 [1.17 ; 1.43]	1.25 [1.09 ; 1.41]	1.55 [1.37 ; 1.73]	_
3	1.26 [1.13 ; 1.39]	1.16 [1.04 ; 1.28]	1.24 [1.08 ; 1.40]	1.33 [1.18 ; 1.48]	_
4	1.32 [1.19 ; 1.45]	1.01 [0.91 ; 1.11]	1.13 [0.99 ; 1.27]	1.16 [1.03 ; 1.29]	_
5	0.91 [0.82 ; 1.00]	0.75 [0.67 ; 0.83]	0.59 [0.51 ; 0.67]	0.70 [0.61 ; 0.79]	_
All hhs.	**1.16 [1.10 ; 1.22]**	**1.01 [0.96 ; 1.06]**	**1.00 [0.93 ; 1.07]**	**1.12 [1.05 ; 1.19]**	_

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989 and 1994).
* Quintiles of total expenditure by consumption unit (Oxford scale).
** It has not been possible to distinguish between local and long distance trips.
Note: Confidence intervals at 95% are given between square brackets.

4. Transport 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, local public transport and long distance public transport. Notice that for the last survey period it has not been possible to make the distinction between local and long distance trips by public transport. So is the also the case for expenditures on fuels and lubricants.

To account for household composition, estimations are carried out on expenditures per consumption unit (Oxford scale). The results are presented for the finest categories considered as well as for the large groups they constitute.

In the estimations, the data are weighted by the respective survey weights of the households. The estimations are performed with Jackknife1612,[9] a Fortran programme written by Professor Shlomo Yitzhaki (Hebrew University of Jerusalem) to estimate the Gini coefficient of the variable of interest (e.g. income or total expenditure) and its decomposition by component. 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 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.[10]

Before examining the results, it is worth noting certain characteristics of the data used. 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 to others or to 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

[9] Version of August 2001.
[10] The algorithms of estimation by *jackknife* of variances of the parameters of the Gini decomposition are described in YITZHAKI (1991).

survey method and/or of the observation period (e.g., the case of long distance trips by public transport pointed out above).

The effect on estimations appears, notably, through the more or less large frequency of zero expenditures (no purchase) 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, the greater is the proportion of zero expenditures, whether the result of choice or due to the method of observation, the higher is the corresponding Gini coefficient (GARNER, 1993, p. 137).

4.1. Inequalities and redistributive effects at national level

4.1.1. Inequalities by expenditure item and their contribution to global inequality

As expected, the lowest Gini coefficients are recorded by fuel expenses, followed by expenditures on other vehicle use items (Table 9). Vehicle use expenditures are more and more widespread with the diffusion of the car, those on fuels being made with more frequency and regularity.

Table 9. *Gini coefficients by expenditure item – Whole France*

Expenditure item	1979	1984	1989	1994	2000
Private transport	0.671 [0.664 ; 0.679]	0.646 [0.640 ; 0.652]	0.668 [0.662 ; 0.675]	0.645 [0.639 ; 0.652]	0.643 [0.636; 0.650]
Vehicle purchases	0.897 [0.892 ; 0.902]	0.890 [0.885 ; 0.895]	0.883 [0.878 ; 0.888]	0.891 [0.886 ; 0.896]	0.895 [0.890; 0.900]
Automobiles	0.905 [0.900 ; 0.910]	0.896 [0.891 ; 0.900]	0.888 [0.883 ; 0.894]	0.896 [0.891 ; 0.901]	0.902 [0.897; 0.907]
Two-wheelers	0.956 [0.949 ; 0.962]	0.970 [0.967 ; 0.973]	0.977 [0.973 ; 0.980]	0.990 [0.988 ; 0.992]	0.972 [0.968; 0.975]
Fuels	0.645 [0.635 ; 0.654]	0.586 [0.580 ; 0.593]	0.579 [0.571 ; 0.587]	0.554 [0.546 ; 0.561]	0.571 [0.563; 0.579]
Other use exp.	0.690 [0.676 ; 0.704]	0.642 [0.632 ; 0.652]	0.648 [0.636 ; 0.660]	0.649 [0.638 ; 0.659]	0.644 [0.628; 0.659]
Public transport	0.889 [0.881 ; 0.897]	0.881 [0.874 ; 0.888]	0.882 [0.870 ; 0.894]	0.781 [0.773 ; 0.789]	0.862 [0.851; 0.873]
Local PT	0.912 [0.903 ; 0.922]	0.896 [0.891 ; 0.900]	0.902 [0.896 ; 0.907]	0.893 [0.888 ; 0.898]	–
Long dist. PT	0.949 [0.943 ; 0.954]	0.941 [0.936 ; 0.946]	0.942 [0.933 ; 0.952]	0.824 [0.815 ; 0.832]	–
All transport	*0.644* *[0.637 ; 0.652]*	*0.616* *[0.610 ; 0.623]*	*0.638* *[0.631 ; 0.645]*	*0.602* *[0.596 ; 0.609]*	*0.617* *[0.610; 0.625]*
Total expenditure	**0.338** **[0.333 ; 0.344]**	**0.315** **[0.310 ; 0.320]**	**0.336** **[0.329 ; 0.343]**	**0.328** **[0.321 ; 0.335]**	**0.356** **[0.348; 0.365]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Confidence intervals at 95% are given between square brackets.

Then come, in ascending order, the Gini indices of car purchases, local public transport (available according to the degree of urbanisation) and long distance public transport. Finally, two-wheeler purchases show the highest concentration. This can be explained by the relative scarcity of these purchases (on average, 0.2% of the total budget; about 1% of the transport budget). Except a slight decrease between the last two surveys, the Gini index of this item increased over time. This tendency reflects changes in the product range of these goods and in the needs they satisfy. Two-wheelers, particularly motorised ones, witnessed a shift to higher quality and prices, [11] and the customers are rather urban.

Except the case of two-wheelers, inequalities decreased in general. The decrease was regular in the case of fuels and public transport. The slight increase of the Gini of fuels between 1994 and 2000 is probably due to the fact in the last survey period this expenditure category includes also lubricants (in general not purchased as frequently as are fuels). For long distance trips, the sharp decrease between 1989 and 1994 reflects a better coverage of these expenditures following a change in methodology in the latter survey. The decrease was not monotonic in the case of car purchases and other car use expenses: these components contain durable and semi-durable goods the purchase of which is less frequent and regular. Because of their large budget shares (resp., 35% to 44%, and 26% to 29% of transport expenditures), this has repercussions on the temporal patterns of the Gini coefficients of the groups which include them (private transport and transport as a whole).

As shown in the methodological section, 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 weight in the total budget.

Table 10. *Relative contribution to total inequality (%) – Whole France*

Expenditure item	1979	1984	1989	1994	2000
Private transport	16.5 (0.41)	18.4 (0.40)	18.4 (0.50)	14.7 (0.42)	13.4 (0.42)
Vehicle purchases	7.7 (0.28)	9.9 (0.33)	11.7 (0.42)	9.0 (0.35)	7.9 (0.32)
Automobiles	7.6 (0.28)	9.8 (0.32)	11.4 (0.42)	8.7 (0.34)	7.8 (0.32)
Two-wheelers	0.1 (0.03)	0.1 (0.02)	0.2 (0.04)	0.3 (0.06)	0.2 (0.03)
Fuels	3.9 (0.12)	3.7 (0.09)	2.6 (0.07)	1.9 (0.06)	2.1 (0.07)
Other use exp.	4.9 (0.26)	4.7 (0.18)	4.2 (0.19)	3.8 (0.17)	3.3 (0.21)
Public transport	1.7 (0.13)	1.7 (0.12)	1.6 (0.18)	1.8 (0.09)	1.4 (0.13)
Local PT	0.7 (0.09)	0.4 (0.03)	0.5 (0.04)	0.4 (0.03)	–
Long dist. PT	1.0 (0.10)	1.2 (0.11)	1.2 (0.18)	1.4 (0.08)	–
All transport	*18.2 (0.42)*	*20.1 (0.41)*	*20.1 (0.50)*	*16.5 (0.42)*	*14.7 (0.45)*

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Standard errors are given between brackets.

[11] The price index of two-wheelers increased faster than the general price index: 9 percentage points more between the first and the fourth survey periods (BERRI, 2005, Table 1, p. 121).

Thus, despite a very high Gini coefficient (near 1), the relative contribution of two-wheeler purchases is insignificant (Table 10), due to their small budget share and their weak association with total expenditure (with a Gini correlation of about 0.3 at the beginning of the period and 0.4 from 1989 on).

By contrast, the relative contribution of car purchases is much more important (around 10%) despite a slightly lower Gini coefficient; this is due to a greater budget share (about 6%) and a stronger correlation with total expenditure (more than 0.6). This component is followed by vehicle use expenditures other than fuels, then by fuels, and finally by public transport means (with an even lower contribution by local trips).

Inequalities regarding transport as a whole are essentially attributable to automobile purchases (44 to 58% according to the period), followed by vehicle use expenditures other than fuels (21 to 26%) and fuels (13 to 22%). The contribution of public transport is more modest (6 to 8%). That of two-wheelers expenditures is even lower (less than 2%).

Over the whole observation period, the contribution to overall inequality declines in the case of fuels and of the remaining vehicle use expenditures. It is globally stable for public transport. The contribution of two-wheelers purchases remains negligible. The contribution of transport as a whole decreases at the end of the period after a slight increase, thus following that of the most important of its components (car purchases).

4.1.2. Redistributive effects of taxes by expenditure item

The relative marginal effect on overall inequality (i.e., total expenditure inequality) shows that taxes on transport commodities as a whole remain progressive, though to a lesser extent at the end of the period (Table 11). A 1% proportional increase of transport expenditures would have reduced global inequality by 2% to 3% since the mid-1990's (by 5% previously).

Table 11. *Relative marginal effect on total inequality (%) – Whole France*

Expenditure item	1979	1984	1989	1994	2000
Private transport	4.0	4.8	4.9	2.8	1.9
Vehicle purchases	3.0	4.4	5.1	3.7	2.9
Automobiles	3.0	4.5	5.1	3.6	3.0
Two-wheelers	0.0	0.0	0.0	0.1	0.0
Fuels	0.1	-0.2	-0.6	-0.9	-1.0
Other use exp.	0.9	0.6	0.3	0.1	-0.1
Public transport	0.4	0.5	0.4	0.2	0.2
Local PT	0.1	0.0	0.0	-0.1	_
Long dist. PT	0.4	0.5	0.5	0.3	_
All transport	*4.4*	*5.3*	*5.3*	*3.0*	*2.1*

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).

The progressivity of taxes on transport as a whole is mainly due to the progressive character of taxes on car purchases. 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 trend is important: it reflects a gradual transformation of the distributions of these expenditures with the growing diffusion of the car. The slightly progressive character of taxes on public transport services is to be attributed to long distance trips. As to local public transport trips and purchases of two-wheelers, the effect on global inequalities is almost null.

The (Gini) elasticities with respect to total expenditure confirm the above conclusions as to the regressive (elasticity < 1) or progressive (elasticity > 1) character of a tax on a category of expenditures (Table 12). However, as mentioned previously, these elasticities give information on the *sign* of the relative marginal effect, but not on its *extent*.

Thus, we find again the luxury character of transport commodities as a whole (which also appeared in the analysis of budget shares by total expenditure quintile), because of the predominance of car purchases. Vehicle use expenditures show continuously decreasing elasticities (from 1 to 0.7 for fuels and from 1.2 to 1 for the remaining vehicle use items), thus confirming the more and more necessary character of the car. One observes the same decreasing tendency for the elasticity of local public transport (from 1.2 to 0.8). Public transport long distance trips remain of a luxury character. However, the elasticity estimates are somewhat "fragile" in view of the insufficient coverage of these trips, mainly occasioned by holidays.

Table 12. *Total expenditure (Gini) elasticities – Whole France*

Expenditure item	1979	1984	1989	1994	2000
Private transport	1.318 [1.280 ; 1.356]	1.357 [1.322 ; 1.392]	1.358 [1.317 ; 1.399]	1.234 [1.192 ; 1.277]	1.165 [1.122; 1.208]
Vehicle purchases	1.635 [1.577 ; 1.692]	1.801 [1.745 ; 1.857]	1.779 [1.720 ; 1.839]	1.693 [1.627 ; 1.759]	1.588 [1.526; 1.650]
Automobiles	1.668 [1.609 ; 1.727]	1.829 [1.772 ; 1.886]	1.797 [1.737 ; 1.857]	1.709 [1.642 ; 1.776]	1.616 [1.553 ; 1.680]
Two-wheelers	0.809 [0.534 ; 1.084]	0.765 [0.518 ; 1.011]	1.155 [0.920 ; 1.389]	1.324 [1.038 ; 1.609]	0.860 [0.684 ; 1.036]
Fuels	1.020 [0.977 ; 1.062]	0.942 [0.909 ; 0.976]	0.817 [0.780 ; 0.854]	0.667 [0.631 ; 0.703]	0.688 [0.651 ; 0.725]
Other use exp.	1.228 [1.154 ; 1.301]	1.159 [1.104 ; 1.214]	1.083 [1.023 ; 1.143]	1.017 [0.957 ; 1.077]	0.975 [0.898 ; 1.055]
Public transport	1.364 [1.243 ; 1.485]	1.376 [1.267 ; 1.485]	1.346 [1.179 ; 1.513]	1.133 [1.060 ; 1.207]	1.215 [1.088 ; 1.342]
Local PT	1.152 [0.982 ; 1.323]	0.937 [0.840 ; 1.033]	0.910 [0.794 ; 1.027]	0.772 [0.673 ; 0.871]	–
Long dist. PT	1.581 [1.415 ; 1.746]	1.650 [1.507 ; 1.793]	1.657 [1.429 ; 1.884]	1.309 [1.219 ; 1.399]	–
All transport	*1.322* *[1.287 ; 1.357]*	*1.358* *[1.326 ; 1.391]*	*1.357* *[1.318 ; 1.395]*	*1.222* *[1.184 ; 1.261]*	*1.169* *[1.127 ; 1.212]*

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Confidence intervals at 95% are given between square brackets.

The temporal pattern of the elasticity of two-wheelers purchases is atypical. It increased (from 0.8 in the late 1970's) and became greater than 1 from 1989 to the mid-1990s. Thus, this item was a necessity and became a "luxury" good by the end of the 1980s! Though this conclusion seems counterintuitive, it is coherent with the transformation of two-wheelers (particularly, the motorised ones) into a practical means of transport in urban areas (and not as a cheap substitute to the car) and the shift of its market towards higher quality ranges at higher prices. The increase in the Gini correlation of the component with total expenditure (0.29 in 1978-79 and 0.44 in 1994-95) reflects this change. Combined with the continuous increase of its Gini coefficient and the stability of the Gini coefficient of total expenditure, this explains the temporal pattern of this elasticity (see equation (9) above).

4.2. Inequalities and redistributive effects at the Greater Paris region level

4.2.1. Inequalities by expenditure item and their contribution to global inequality

As at national level, the lowest concentrations are recorded by fuels. Then come, in ascending order, those of vehicle use items other than fuels, public transport, car purchases, and finally those of two-wheelers purchases (Table 13).

Table 13. *Gini coefficients by expenditure item – Greater Paris region*

Expenditure item	1979	1984	1989	1994	2000
Private transport	0.678 [0.660 ; 0.695]	0.682 [0.667 ; 0.697]	0.693 [0.677 ; 0.710]	0.680 [0.664 ; 0.696]	0.683 [0.666 ; 0.700]
Vehicle purchases	0.883 [0.871 ; 0.895]	0.902 [0.892 ; 0.912]	0.886 [0.872 ; 0.899]	0.902 [0.891 ; 0.913]	0.904 [0.892 ; 0.916]
Automobiles	0.891 [0.879 ; 0.903]	0.908 [0.898 ; 0.918]	0.890 [0.877 ; 0.904]	0.906 [0.895 ; 0.917]	0.910 [0.898 ; 0.922]
Two-wheelers	0.964 [0.946 ; 0.983]	0.980 [0.976 ; 0.985]	0.983 [0.979 ; 0.987]	0.991 [0.988 ; 0.994]	0.976 [0.965 ; 0.988]
Fuels	0.686 [0.663 ; 0.709]	0.648 [0.631 ; 0.665]	0.644 [0.624 ; 0.664]	0.648 [0.630 ; 0.666]	0.653 [0.632 ; 0.674]
Other use exp.	0.692 [0.657 ; 0.727]	0.676 [0.653 ; 0.700]	0.671 [0.647 ; 0.696]	0.669 [0.642 ; 0.697]	0.670 [0.627 ; 0.713]
Public transport	0.771 [0.752 ; 0.790]	0.762 [0.742 ; 0.783]	0.778 [0.737 ; 0.820]	0.645 [0.629 ; 0.662]	0.774 [0.742 ; 0.806]
Local PT	0.796 [0.778 ; 0.814]	0.770 [0.757 ; 0.784]	0.777 [0.761 ; 0.794]	0.786 [0.771 ; 0.801]	–
Long dist. PT	0.895 [0.880 ; 0.909]	0.886 [0.871 ; 0.901]	0.899 [0.867 ; 0.930]	0.724 [0.706 ; 0.743]	–
All transport	*0.609 [0.592 ; 0.627]*	*0.612 [0.596 ; 0.628]*	*0.623 [0.604 ; 0.642]*	*0.576 [0.559 ; 0.593]*	*0.619 [0.596 ; 0.641]*
Total expenditure	**0.324 [0.312 ; 0.337]**	**0.308 [0.295 ; 0.321]**	**0.334 [0.319 ; 0.350]**	**0.332 [0.314 ; 0.350]**	**0.378 [0.355 ; 0.401]**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Confidence intervals at 95% are given between square brackets.

The noteworthy differences are linked to the particularity of the region as a large urban area very well endowed with local public transport infrastructure. The use of the car for local trips is more differentiated, determined at least in part by the relative accessibility to public transport depending on residential location. Consequently, the Gini coefficients of vehicle use expenditures are higher than at national level, particularly for fuels. On the contrary, the use of local public transport is more widespread, even if it varies according to the zone of residence. On that account, the corresponding Gini index is lower than at national level.

In general, inequalities were stabilising, if not decreasing, except for two-wheelers. They decreased in the case of fuels and other vehicle use items. However, these decreases are less marked than at national level and the estimates are less accurate because of smaller samples. The Gini index of local public transport expenditures remained stable (around 0.8). That of automobile purchases fluctuated around 0.9.

Table 14. *Relative contribution to total inequality (%) – Greater Paris region*

Expenditure item	1979	1984	1989	1994	2000
Private transport	14.2 (0.90)	15.6 (0.88)	13.5 (0.97)	10.1 (0.80)	8.4 (0.76)
Vehicle purchases	6.3 (0.55)	7.9 (0.71)	8.5 (0.85)	5.6 (0.61)	4.6 (0.53)
Automobiles	6.2 (0.54)	7.8 (0.71)	8.2 (0.84)	5.6 (0.61)	4.5 (0.52)
Two-wheelers	0.2 (0.10)	0.1 (0.04)	0.2 (0.07)	0.0 (0.02)	0.1 (0.05)
Fuels	3.3 (0.26)	3.1 (0.18)	1.9 (0.14)	1.5 (0.13)	1.5 (0.14)
Other use exp.	4.5 (0.60)	4.6 (0.42)	3.2 (0.31)	3.0 (0.36)	2.4 (0.43)
Public transport	2.5 (0.31)	2.4 (0.31)	2.7 (0.66)	2.0 (0.19)	1.8 (0.39)
Local PT	0.9 (0.14)	0.7 (0.08)	0.5 (0.09)	0.5 (0.09)	–
Long dist. PT	1.6 (0.26)	1.7 (0.29)	2.2 (0.65)	1.5 (0.16)	–
All transport	*16.6* (0.91)	*17.9* (0.91)	*16.2* (1.10)	*12.1* (0.83)	*10.3* (0.99)

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Standard errors are given between brackets.

The order of the different expenditure categories in terms of relative contribution to overall inequality is similar to the one observed at national level (Table 14). The differences are in terms of extent and essentially concern automobile expenditures (acquisition and use). Their contributions are lower that at national level, mainly because of lower budget shares (the correlations with total expenditure are also slightly lower).

Regarding inequalities of transport as a whole, one can note a larger relative contribution of public transport than at national level (11 to 14% against 6 to 8%).

Over time, the contribution to total inequality decreased for fuels, for the remaining vehicle use items and, to a lesser extent, for local public transport. That of all private transport decreased at the end of the period after a slight increase, as did the most important of its components (automobile purchases).

4.2.2. Redistributive effects of taxes by expenditure item

The redistributive effects of taxes and their temporal patterns are qualitatively similar to those shown when considering all French households (Table 15).

Table 15. *Relative marginal effect on total inequality (%) – Greater Paris region*

Expenditure item	1979	1984	1989	1994	2000
Private transport	3.2	4.6	2.9	1.4	0.3
Vehicle purchases	2.0	3.4	3.3	1.8	1.0
Automobiles	2.1	3.4	3.2	1.8	1.1
Two-wheelers	0.0	0.0	0.1	0.0	0.0
Fuels	0.3	0.2	-0.3	-0.5	-0.5
Other use exp.	0.9	0.9	0.0	0.0	-0.3
Public transport	0.2	0.1	0.2	-0.7	-0.2
Local PT	-0.3	-0.3	-0.5	-0.6	–
Long dist. PT	0.5	0.4	0.7	0.0	–
All transport	*3.4*	*4.7*	*3.1*	*0.7*	*0.1*

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).

Taxes on transport expenditures in their entirety remain progressive but their progressive effect is weaker than at national level. The relative marginal effect is even almost null in the last period. Two main factors combine to give this result. First, the progressivity of taxes on automobile purchases is comparatively lower. Second, taxes on local public transport are regressive. Manifest from the beginning of the observation period, this regressive character became more pronounced, though the extent of the effect remains small. Local public transport expenditures are more widespread in the Greater Paris region, with average levels not very different according to income but which weigh slightly more in the lowest budgets.[12] Consequently, (proportional) increases in prices affect relatively more the poorest.

The (Gini) income elasticities of households of the Greater Paris region give rise to the same classification of the different categories of transport goods and/or services as at national level (Table 16). It can be noted that the necessary character of local PT appears since the first observation period (elasticity of 0.75 against 1.2 at national level). This is in agreement with the particularity of the capital region as to the availability of public transport means. Besides, unlike what was observed at national level, the two-wheeler remains a necessary good. Certainly, its income elasticity recorded a peak value (at 1.5) in 1989, but it diminished sharply thereafter (to 0.46), reflecting the change in "status" pointed out above (namely, the two-wheeler as an urban transport means).

Over time, the elasticities follow the same downward trends observed before but from slightly lower levels, probably because incomes are on average higher in the Greater Paris region as compared to the rest of the country.

[12] See Annex 2 for the expenditures amounts and Table 8 for the budget shares.

Table 16. *Total expenditure (Gini) elasticities – Greater Paris region*

Expenditure item	1979	1984	1989	1994	2000
Private transport	1.295 [1.198 ; 1.393]	1.419 [1.326 ; 1.512]	1.277 [1.167 ; 1.386]	1.154 [1.041 ; 1.267]	1.032 [0.922; 1.142]
Vehicle purchases	1.477 [1.330 ; 1.624]	1.775 [1.616 ; 1.934]	1.626 [1.461 ; 1.792]	1.477 [1.303 ; 1.652]	1.288 [1.130; 1.446]
Automobiles	1.507 [1.356 ; 1.657]	1.800 [1.638 ; 1.962]	1.632 [1.463 ; 1.800]	1.496 [1.320 ; 1.672]	1.306 [1.144 ; 1.468]
Two-wheelers	0.850 [0.018 ; 1.682]	0.853 [0.300 ; 1.406]	1.467 [1.055 ; 1.879]	0.458 [-0.013 ; 0.929]	0.869 [0.423 ; 1.315]
Fuels	1.096 [0.991 ; 1.200]	1.082 [0.991 ; 1.173]	0.852 [0.749 ; 0.954]	0.765 [0.662 ; 0.867]	0.739 [0.637 ; 0.841]
Other use exp.	1.247 [1.052 ; 1.442]	1.254 [1.112 ; 1.397]	1.001 [0.872 ; 1.129]	1.002 [0.843 ; 1.162]	0.903 [0.695 ; 1.112]
Public transport	1.081 [0.901 ; 1.262]	1.035 [0.840 ; 1.230]	1.091 [0.732 ; 1.450]	0.752 [0.637 ; 0.867]	0.899 [0.656 ; 1.142]
Local PT	0.746 [0.546 ; 0.945]	0.691 [0.551 ; 0.832]	0.509 [0.342 ; 0.676]	0.459 [0.308 ; 0.610]	–
Long dist. PT	1.436 [1.183 ; 1.690]	1.301 [1.010 ; 1.591]	1.482 [0.986 ; 1.977]	0.968 [0.821 ; 1.115]	–
All transport	*1.259* *[1.174 ; 1.343]*	*1.353* *[1.270 ; 1.435]*	*1.242* *[1.141 ; 1.343]*	*1.061* *[0.967 ; 1.155]*	*1.005* *[0.891 ; 1.119]*

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).
Note: Confidence intervals at 95% are given between square brackets.

5. Synthesis and conclusions

Inequalities between French households as regards the consumption of transport goods and services as well as the redistributive effects of taxes on various expenditure categories have been evaluated. A decomposition by expenditure component of the Gini inequality index was applied, using individual-level data from a series of expenditure surveys spanning a long time period. The results highlight the effect of automobile social diffusion and the need to account for differences as to the availability of alternatives to the car.

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. For the same reason, and because of a low correlation with income, the relative contribution of two-wheeler purchases is almost nil. The relative contribution of car use items, especially fuels, decreased regularly over time, reflecting the more and more 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 are regressive (i.e., they

affect the poor more than the rich), whereas the progressive character of those on the other vehicle use goods and services has become weaker. This again is evidence of the effect of the diffusion of the car, being more and more of a necessity, which is confirmed by the evolution of the elasticities.

Therefore, the design of policy measures to reduce car use and thus attenuate its nuisances for the environment (pollutant emissions, congestion and noise) should take into account the imperative of equity in order not to worsen social inequalities, if not reducing them. 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. MCCANN *et al.* (2000) show similar patterns in the case of American urban areas. 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; HARE, 1995). 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 is 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.

The case of local public transport underlines the necessity of accounting for disparities in terms of availability of alternatives to the car. Indeed, taxes on these services appear to be neutral at national level (i.e. neither progressive nor regressive), but this result hides a diversity of situations 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. However, even inside the region accessibility to public transport network depends on residential location. Hence, a distinction by degree of urbanization of the zone of residence is to be considered.

Other extensions to this work relate to accounting for the behaviours that generate the data and for observation methods. As already underlined, consumption expenditures result from choices subject to constraints of income, prices… Absence of an expenditure may be due to the fact that income is not high enough to afford it or that the purchase is not frequent (a durable good, for instance). The expenditure may also depend on the existence of others or on another good's stock (case of vehicle use expenditures, for example). Besides, it is possible that the good or service in question is absent from the choice set of the individual: this is, for instance, the case of a car for a person not able to drive it (because of a handicap or lack of a driving licence) or who considers he/she does not need it. Emphasis should thus be put on the treatment of zero expenditures. More generally, in order to understand differences and better grasp inequalities, it is necessary to take account of the determinants of demand (incomes, prices, age, generation, place of residence…). Indeed, concentration (of incomes or expenditures) is not sufficient to characterise inequalities. Lack of choice or a constrained

choice (a kind of *rationing*) should constitute a sign of a non-egalitarian situation. Thus, location of low-income households in peripheral zones, due to high housing prices in the centre of an urban area, involves substantial transport expenditures (BERRI, 2007). These expenditure levels, not necessarily chosen, increase the risk of excessive debt and may lead to privations as to the consumption of other goods and services. Hence, they are not necessarily a sign of affluence, but rather reveal an unfavourable situation.

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Annex 1

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 $R(X,Y) = R(Y,X) = \rho$.

Annex 2

Annual average expenditures, by quintile of total expenditure per consumption unit (Francs, current prices)

	Whole France					Greater Paris region				
Quintile *	1979	1984	1989	1994	2000	1979	1984	1989	1994	2000
					Total expenditure					
1	25 659	54 315	63 674	82 611	80 363	35 840	68 187	81 862	111 157	104 574
2	46 122	90 096	102 968	131 571	130 956	61 426	111 553	135 943	164 601	165 151
3	63 071	116 856	138 251	169 890	176 575	80 368	139 196	170 013	212 975	238 851
4	82 027	146 927	177 246	218 584	240 013	102 207	176 244	217 676	272 725	296 441
5	125 725	221 629	287 170	356 764	435 592	156 907	256 257	363 792	444 725	597 297
All hhs.	**68 529**	**125 971**	**153 870**	**191 888**	**212 715**	**87 393**	**150 329**	**194 033**	**241 374**	**280 659**
					Private transport					
1	1 847	4 854	5 274	7 145	6 513	2 412	4 515	4 885	7 415	5 766
2	5 046	10 282	11 005	14 021	12 905	6 137	9 838	12 201	14 978	13 505
3	7 887	15 905	17 932	20 601	20 902	9 577	14 691	20 848	22 350	22 831
4	12 439	22 600	27 771	30 795	33 593	12 557	22 498	28 502	27 725	33 401
5	18 930	36 761	48 611	47 997	53 106	21 167	34 767	44 703	41 612	45 110
All hhs.	**9 231**	**18 082**	**22 120**	**24 112**	**25 406**	**10 377**	**17 269**	**22 250**	**22 830**	**24 134**
					Local public transport					
1	131	248	383	528	** 679	426	837	1 291	1 901	** 2 263
2	228	445	469	896	** 1 100	831	1 449	1 693	2 557	** 3 552
3	368	593	724	981	** 1 664	1 014	1 614	2 104	2 828	** 4 536
4	484	732	988	1 182	** 2 724	1 351	1 776	2 462	3 166	** 6 332
5	837	944	1 233	1 593	** 5 131	1 434	1 929	2 156	3 108	** 9 843
All hhs.	**410**	**592**	**759**	**1 036**	**** 2 260**	**1 011**	**1 521**	**1 941**	**2 712**	**** 5 308**
					Long distance public transport					
1	68	204	244	583	**	278	770	854	1 447	**
2	194	384	360	1 020	**	457	1 132	1 476	2 567	**
3	257	511	558	1 576	**	705	1 325	1 087	2 997	**
4	421	876	902	2 447	**	682	2 045	2 251	4 422	**
5	916	2 178	2 633	4 467	**	2 200	3 399	6 427	6 006	**
All hhs.	**371**	**831**	**939**	**2 019**	**	**866**	**1 735**	**2 423**	**3 490**	**

Sources: INSEE *Household Budget* surveys (1979, 1984, 1989, 1994 and 2000).

∗ Quintiles of total expenditure by consumption unit (Oxford scale).

** It has not been possible to distinguish between local and long distance trips by public transport.