SPATIAL ANALYSIS OF LONG-DISTANCE MOBILITY

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ABSTRACT SUMMARY

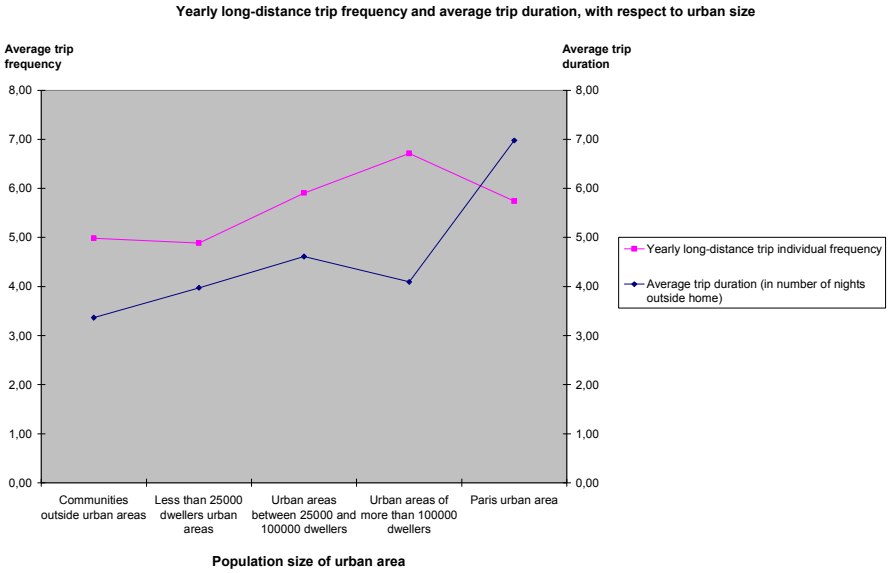
In this article, we will focus on spatial analysis of long-distance mobility of individuals living in France, trips abroad included, which we define in our study as more than 80 km bird-eye travels. We will be mainly interested in describing quantitative characteristics of long-distance mobility of individuals, through the indicator of yearly individual long-distance trip frequency, and also trip modal distribution, with respect to the place of housing, depending on a typology of territories. We will study the influence of two main parameters: urban size and location within the urban area. Considering this latter criterium, we will make a distinction between town centres, nearly suburbs and further peripheric housing areas[1]. In relation with French town organization, we can then assume that urban density usually grows with the urban size and also from peripheric to central areas. Our analysis of data coming from the National Personal Travel Survey realized in 2008[2], surprisingly shows that both intensity and characteristics of long-distance mobility strongly vary with respect to these typological territorial criteria, in such a way somehow comparable with daily urban inner-mobility, if we consider modal share. We will be especially interested in trying to give interpretation to the specificities of long-distance mobility of the inhabitants of the urban area of Paris, considering trip frequency, or modal share, for instance, through the assumption that long-distance mobility is somehow influenced by usual practices and needs in short-distance regular mobility, which tends itself to be strongly linked to urban density and position within the urban area. Regular short-distance mobility needs and constraints, indeed, strongly tend to influence the level of car ownership, but also the intensity and

[1] For precise statistical definitions of zonings and zones refer to the joined appendix.

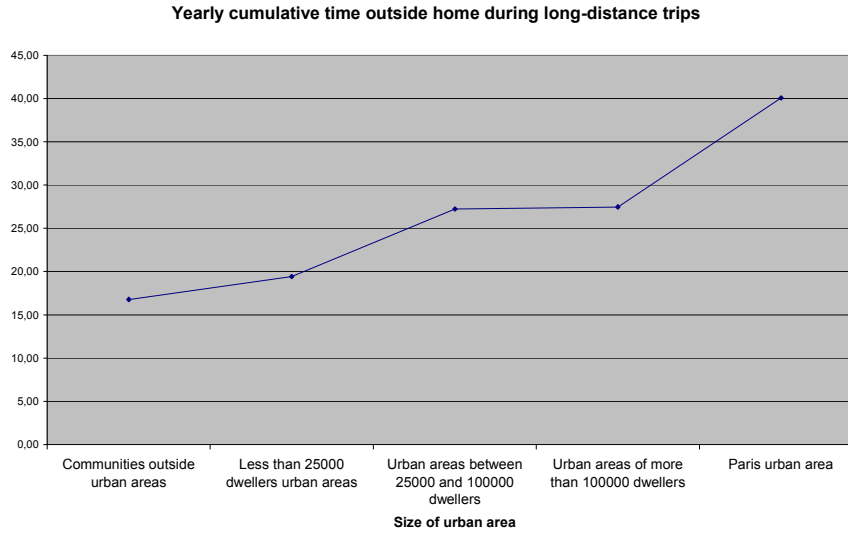
[2] Used data sets for long-distance mobility analysis are still temporary, as rectificative statistical work on the National Personal Travel Survey is still going on. Some results may change before the congress. We will try to adapt our presentation as soon as the definitive data sets will be available for analysis. In peculiar, trip frequency may be a little underestimated as some observations about long-distance house to work commuting trips have not been included yet in the datasets and there is still uncertainty about their exact weighting in the whole sample. Methodological work has still to be done to ensure that improvement in assessing long-distance house to work commuting shall be applied the same way to ancient files coming from the previous survey, not to induce bias caused by measure. As a result, current differential mobility between urban and country zones should be weaker than in our presentation. On the contrary, changes in mobility behaviours with respect to spatial typology should be more contrasted in the definitive files than in our article, as long-distance commuting is likely to be growing. However, it shouldn't change the general shape of the results. Indeed, commuting trips are mainly the fact of dwellers of outer peripheric housing areas. As a consequence, the trend of differential growth between central cities and peripheric areas should be all the more important.

modalities of car use, and has thus indirect effects on long-distance mobility. We will also try to analyse this territorial influence dynamically, with regard to observable behavioural shifts in urban densest areas beetween 1993 and 2008.

IN 2008, LONG-DISTANCE MOBILITY STILL TENDS TO INCREASE WITH URBAN SIZE AND CENTRALITY. HOWEVER, TRIP FREQUENCY DECREASES FROM A CERTAIN LEVEL OF DENSITY,ESPECIALLY AMONG DWELLERS OF THE PARIS URBAN AREA

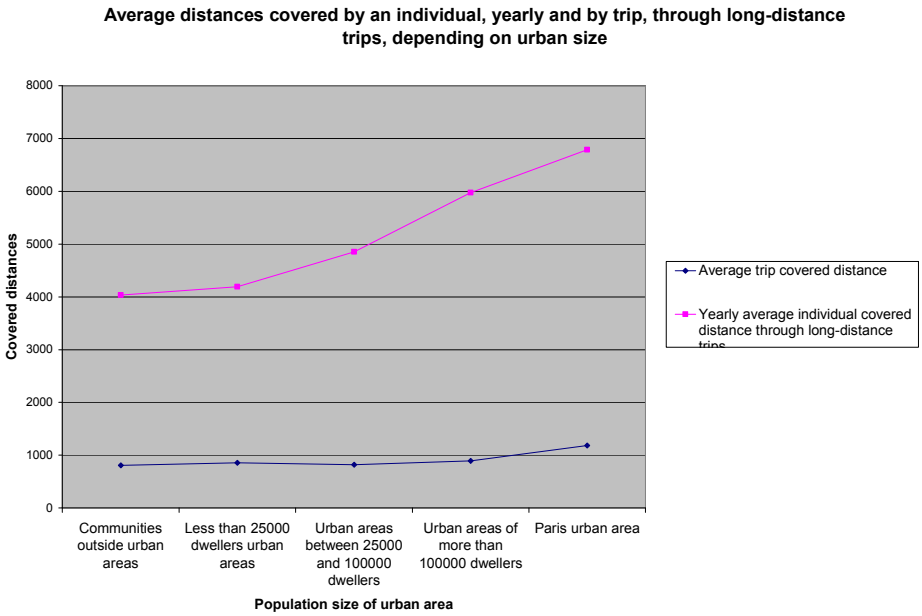


Data analysis of the National Personal Travel Survey realized in 2008 shows that both intensity and characteristics of long-distance mobility strongly vary with respect to typological territorial criteria. In particular, the intensity of individual long-distance mobility usually grows with urban density, caracterized both by urban size and the degree of centrality of housing place within an urban area. For instance, yearly long-distance individual trip frequency grows from about 5 yearly trips among dwellers from communities outside urban areas or within less than 25 000 dwellers urban areas, up to nearly 7 yearly trips among inhabitants of more than 100 000 dwellers urban areas. Other caracteristics of long-distance individual mobility grow up with urban size, for instance average trip duration, from 3,37 nights outside home within dwellers of communities outside urban areas, up to nearly 7 nights for inhabitants of Paris.

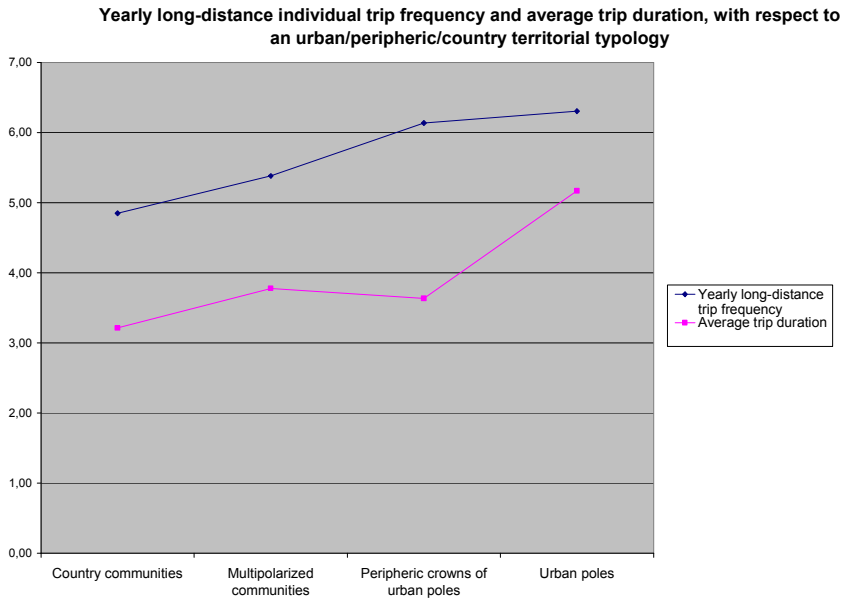


Yearly cumulative time outside home during long-distance trips also grows from less than 17 nights for dwellers of communities outside urban areas, up to 40 nights among dwellers of Paris urban area. The same logic prevails for distances as shown below. Yearly cumulative distance covered through long-distance trips grows from about 4000 km[3] among people living in communities outside urban areas up to 7000 km among dwellers of Paris urban area. As we can see, almost every indicator of long-distance individual mobility intensity increases with urban size. City dwellers thus tend to be more mobile through long-distance trips than country dwellers, as trips are both more frequent, longer and farther.

[3] Mobility indicators are calculated the following way: the average individual yearly trip frequency, for a given group of individuals (let's say, for instance, inhabitants of Paris urban area), is the global amount of trips made by the given group of individuals, divided by the group size. Group size and global amount of trips are estimated from the sample, by applying the appropriate weightings attributed to every statistical unit.The average time outside home by individual is the cumulative time outside home of the group of individuals during long-distance trips (the weighted sum (by trips) of trip durations), divided by the weight of the individual group. The estimator of average covered distance by trip and by individual is calculated the same way. Distances were calculated on a declarative basis. For every trip made during the last month before they were questioned, they had to give a detailed description of moves within the trip, and in particular distance covered. However, there was a significative number of missing distances in the datasets containing the detailed description of long-distance trips (about 13 %). To overcome this problem, for missing values, we used a linear regression model based on bird-eye distance from origin to destination. This last indicator of distance is well known in the survey and data show that for car and train long-distance trips, a linear regression model corresponding to multiply bird-eye distance by 1.3 fits the data well. For plane trips less than 1000 km, a coefficient of 1.45 should not be a bad estimator of declared distance and we considered it could estimate well real distance. For more than 1000 km bird-eye long-distance trips by plane, declared distances seem to be quite erratic and we preferred using bird-eye distance as an estimator of "real" distance, even by replacing completed values. We shall consider, indeed that from a given level of distance, distances between home and the departure airport and between the arrival airport and the final trip destination may become marginal with respect to the distance covered by plane.



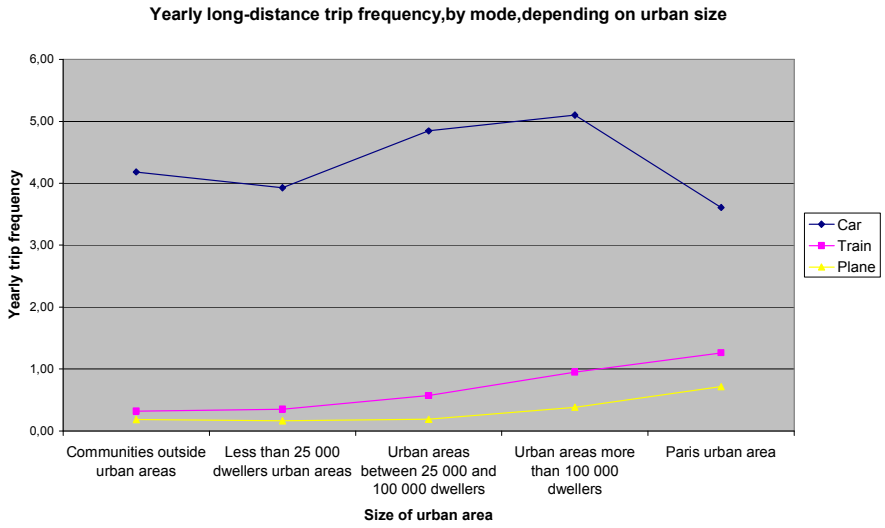
However, in 2008, the area of Paris represents somehow an exception to this general trend, if we consider the annual trip frequency, which is lower than the average yearly trip frequency of dwellers within cities of more than 100 000 inhabitants, though Paris is without a doubt the French biggest and densest town. We may ask whether this result may be explained both by socio-economic characteristics of individuals and households in the Paris area, and the specificities of territorial organization and transport supply in the urban area of Paris.



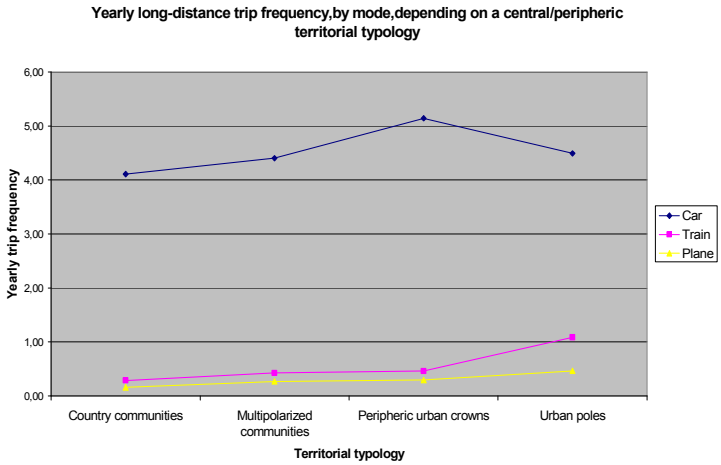
We found out similar results when considering position within urban areas. Yearly long-distance trip frequency grows from 4,85 yearly trips among dwellers of country communities up to 6,31 among inhabitants of urban poles. Average trip duration grows from 3,2 up to 5,2 nights outside home. The same tendencies are observable for individual cumulative mobility indicators: yearly cumulative time outside home during long-distance trips grows from 15,5

nights outside home up to 32,5 nights from country communities to urban poles, and yearly average covered distance from 3900 to 6100 km. From these results we can see that individual long-distance mobility grows with urban density: city dwellers travel more often than country community dwellers, and make longer trips too. The fact that trips of urban dwellers are longer than those of country community dwellers could be partly explained by purpose distribution: holiday purposes are more common among city dwellers and holiday trips are longer than trips for other purposes. However, further analysis is required to explain this difference in trip duration.

WEAK LONG-DISTANCE TRIP FREQUENCY IN 2008 AMONG CITY DWELLERS OF PARIS URBAN AREA IS CAUSED BY CAR TRIPS

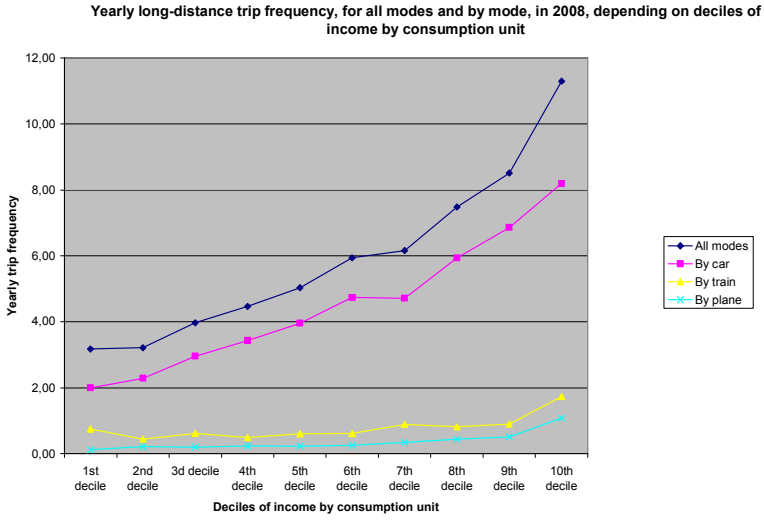


In order to understand better the decrease in long-distance mobility from average to big towns, we considered the frequency of long-distance trips by mode. At first glance, Paris seems to be an exception to the rule of growing long-distance individual mobility with urban density, at least with respect to the indicator of yearly long-distance trip frequency. Further analysis shows that in fact, the weakness of this indicator for Paris urban area, with respect to the rule of urban density, is due to car trips. In 2008, the average long-distance car trip frequency is about 3,6 in Paris urban area, versus 5,1 in other urban areas where more than 100 000 dwellers are living. Trips by collective modes such as train and plane, on the contrary, keep on increasing with urban size, when comparing Paris to smaller urban areas. However, the decrease in long-distance car individual trip frequency is so important in Paris urban area that it is not compensated by the increase in train an plane travelling with urban size.



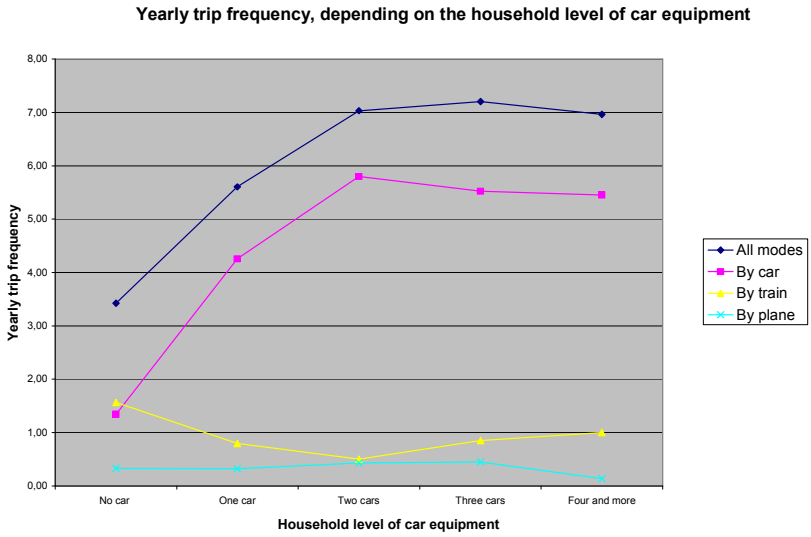
One may observe similar trends when considering differences in long-distance mobility in urban and non-urban zones, and position within urban areas, unrespective of urban size. Car trips thus appear to be lower in urban poles than in peripheric urban areas, as shown in the above graphic. As a result, everything happens as if long-distance trip frequency grew with urban density, except for the highest urban densities where on the contrary, long-distance car trip frequency becomes quite weak

RELATIONS BETWEEN LONG-DISTANCE MOBILITY, INCOME, CAR OWNERSHIP, AND URBAN DENSITY



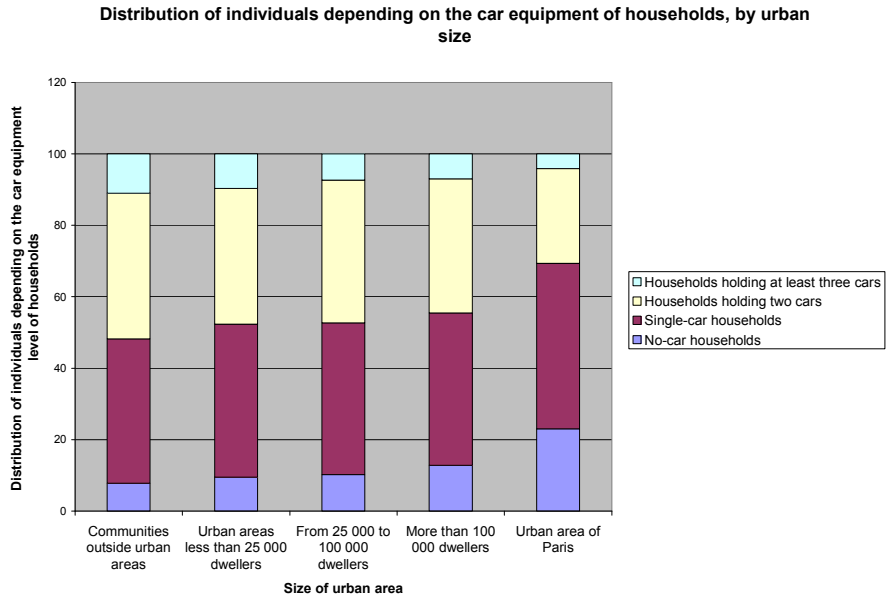
The National Personal Travel Survey provides very rich information about characteristics of individuals, households, car equipment of households, housing. By disaggregate analysis, from these available data we can point out some decisive factors of various aspects of long-distance individual mobility. It appears to us that it is more relevant to consider individual mobility in relation not only with the individual itself, but also with some characteristics of the

household, which appear to be decisive for the individual mobility capacities. This approach underlines dependency of individual mobility behaviour on the household capacities, which is obvious at least for two parameters: income, and car ownership. Logically, socio-economic hierarchy, measured by the household income by consumption unit[4], or socio-professional category, in particular, appears to be a determining variable of long-distance individual mobility intensity, measured by the annual trip frequency, which strongly increases with the available income, as shown in the above graphic. This result may seem quite logic as the capacity of facing the cost of long-distance mobility (fuel, fooding, accomodation, and so on), at least for personal purposes, is depending on the monthly available income, after payment of all strained monthly expenditures (rent, food, electricity, insurances…). It is particularly true for car trips showing a higher elasticity to the available income than trips by alternative modes. Trips by alternative modes seem to take off only within the highest income groups.

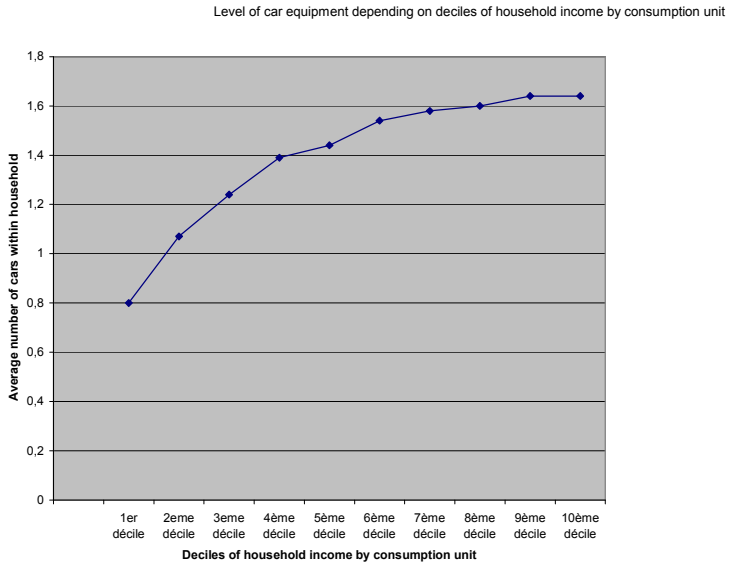


We found out a similar strong relationship between individual long-distance mobility and household car equipment, measured only by the number of cars in our presentation. In particular, if the first car allows strongest autonomy of the household, the second car allows autonomy of the individuals within the household in their mobility behaviour, what increases mobility capacities. Long-distance yearly individual trip frequency grows until the second car, and then remains quite stable with the third car. First, car equipment of household tends to have a negative impact on train use for long-distance trips. Then, among housholds with the highest level of car equipment, it looks like there is on the contrary a partial substitution of train to car in long-distance trips, though very slight

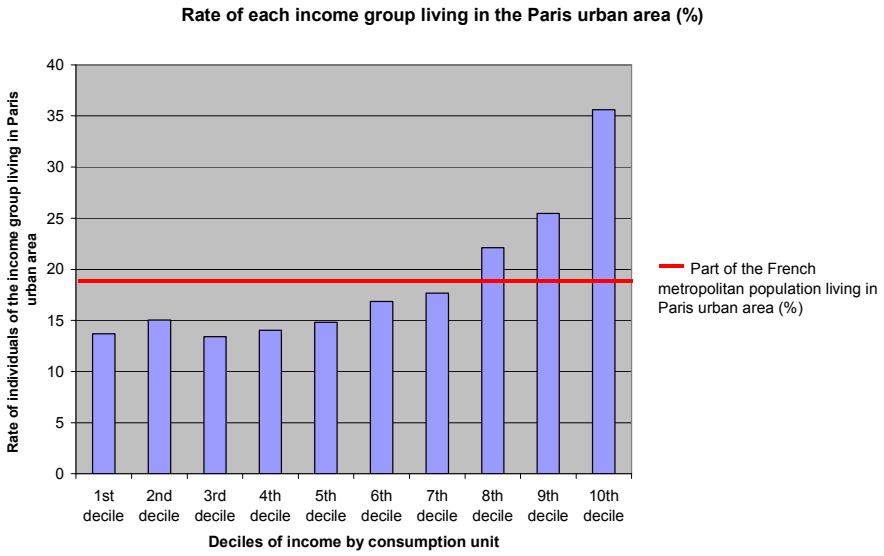
[4] Income by consumption unit is calculated the following way: household income, divided by the number of consumption units, that is to say 1 for the main income bringer of the household, 0.5 for every adult above 14 years old, and 0.3 for every child under 14. The notion of consumption units corresponds to the idea of a measurement scale in order to compare standards of living of households of different sizes and constitutions.



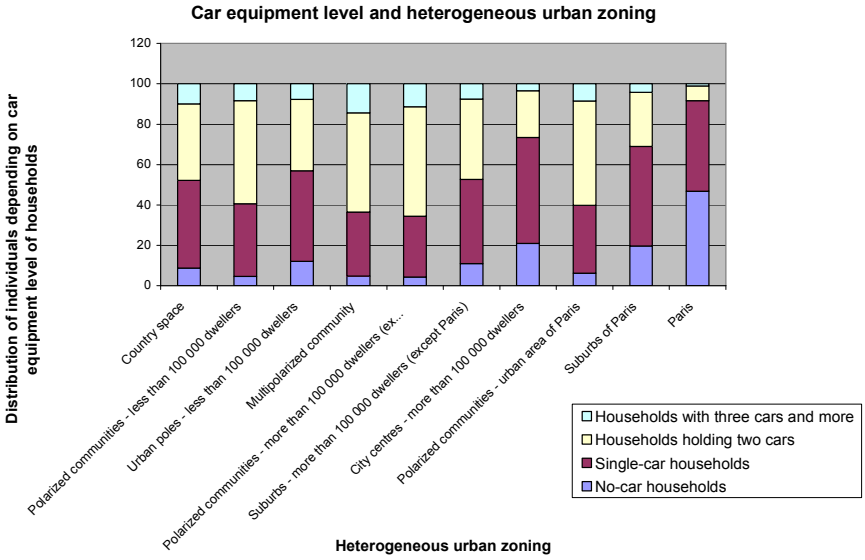
Logically, car ownership appears to be itself correlated with household monthly income, as illustrated in the following graphic. The growth rate of car equipment is nonetheless slowing down with increasing income.



Thus, we could expect the level of car equipment to be higher in densest urban areas, and especially in the Paris urban area, where the average income is notably higher than in the rest of the territory, precisely because of the higher part of high incomes. The following graph shows the part of each income group living in the Paris urban area. This part is increasing with higher income groups. In particular, Paris urban area concentrates more than 35 % of the 10th income decile group. With respect to the stated influence of income on long-distance mobility, the relatively weak long-distance mobility of inhabitants of Paris urban area may look all the more surprising.



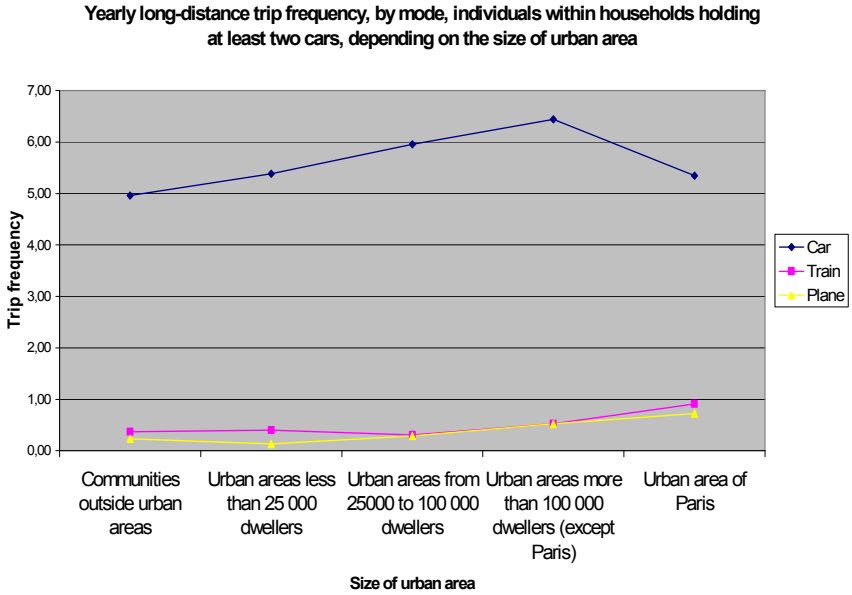
However, we can notice that from peripheric to central areas of built-up areas, car equipment of households strongly decreases. Car equipment usually decreases with density. In the case of Paris urban area, car equipment appears to be really low, despite the highest level of average income in Paris urban area, compared to other French big towns. Most individuals live in households without a car, or only holding one. So it seems that from a certain level of density, car ownership strongly decreases, because the drawbacks of car ownership and use, like congestion and parking difficulties, exceed advantages, as alternative transport modes may be easily found. The collapse of car equipment from medium-size urban areas to the metropolitan-size area of Paris, is partly responsible for the fairly weak long-distance mobility of individuals in Paris urban area, due to car travelling, as long-distance mobility grows with the level of car equipment.



Again, if we consider urban density through both parameters of size of urban area and position within the urban area, we can build a cross-typology of territories which is called the

"heterogeneous urban zoning"[5], used in the above graphic. We can read from the right histograms that, both in Paris urban area and other urban areas of more than 100 000 dwellers, the level of car equipment strongly decreases among households from peripheric crowns to suburbs, and from suburbs to central cities. The level of car equipment thus appears to be a determining variable in trying to explain the collapse of car mobility in densest urban areas. It looks like the effects of weak car equipment in relationship with urban density are contrary to the influence of higher income in the case of Paris urban area.

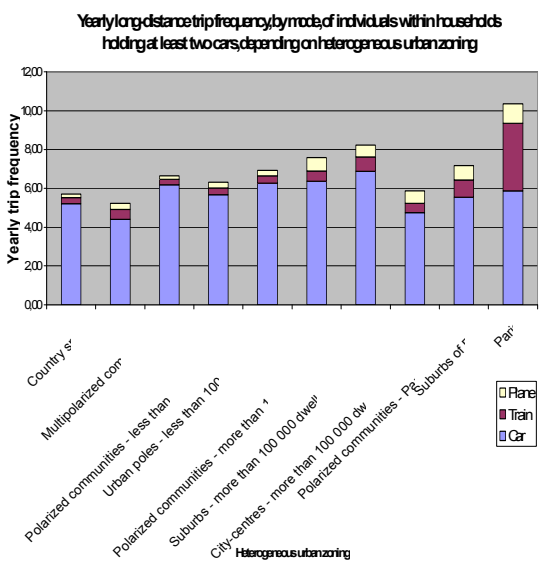
WEAKNESS OF CAR LONG-DISTANCE TRIPS IN DENSEST URBAN AREAS IS BOTH CAUSED BY WEAKER LEVEL OF CAR EQUIPMENT, AND LESS INTENSE CAR USE, FOR EQUAL LEVEL OF CAR EQUIPMENT. CAR EQUIPMENT REDUCES TERRITORIAL GAPS IN ACESS TO MOBILITY

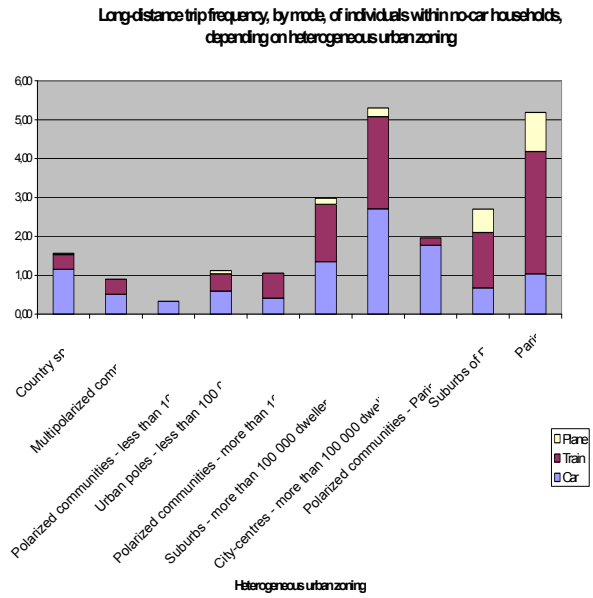


We can point out that individuals in the urban area of Paris still travel less by car than in other french big towns, even for a given level of car ownership, though there is a minor gap than previously, as illustrated above for the example of individuals living within households holding at least two cars. As a result, we can claim that both car ownership of households and car use by individuals contribute to the lesser frequency of long-distance car trips in Paris urban area. Nonetheless, dwellers of Paris urban area within households holding at least two cars compensate a minor use of car by a stronger use of train and plane, which was not the case when previously considering all individuals, whatever the degree of car ownership, and thus manage to maintain their level of long-distance mobility. So everything happens as if traffic and parking difficulties resulting from urban density were inducing behavioural changes in modal choice. We already knew those different mobility practices in

[5] Basically, the "heterogeneous urban zoning" is a cross-typology between the size of urban area and community type with respect to position (central/peripheric/under influence but outside the built-up area) within the urban area. For a precise definition refer to the joined appendix.

short-distance, regular mobility. What is more interesting is that the influence of urban density on long-distance mobility is somehow similar to short-distance behaviour. Decisions of car equipment in households seem to be strongly related to regular mobility needs. As alternative modes to car may be available for regular mobility needs, households may accept more easily a lower level of car ownership, and also a lower level of car use. Then, mobility practices in general, long-distance trips included, are influenced by regular mobility habits. On the contrary, peripheric dwellers, because a high level of car equipment is essential to their daily life, due to the scattering of activity places, are accustomed to use car in all their regular moves, and often keep this habit during their long-distance trips.





Another meaningful result is that territorial gaps of intensity in long-distance individual mobility, linked to urban size and position, strongly decrease with the car ownership level. Compare the two graphics above. For individuals belonging to households with two cars (the left graphic), there is practically no difference in car long-distance trip frequency depending on territorial typology. The higher long-distance mobility of parisians holding two cars, compared to suburban dwellers of Paris urban area, is caused by train trips. On the contrary, differences are strong when considering individuals belonging to households without cars (the right graphic). It happens that in central part of cities, the lack of car is only a relative disability, because the weak car mobility can be compensated by alternative transport supply. The gain of mobility coming from car ownership is thus restrained, as a significative part of individual mobility needs may be easily satisfied by other modes. On the contrary, the lack of car appears to be almost an absolute handicap to mobility in small-size and/or peripheric town areas, as it cannot be compensated by other modes. Thus the gain of mobility coming from car ownership is very high, as illustrated in the following graphic. So everything happens as if, despite its ecological drawbacks, in terms of sustainable development and impact on climate change, car use assumes a role of “territorial equity”, by reducing territorial internal gaps in access to mobility.

LONG-DISTANCE MOBILITY BEHAVIOURS ARE LIKELY TO BE HIGHLY INFLUENCED BY REGULAR MOBILITY NEEDS AND PRACTICES

It is already well-known that car ownership, car use and modal share of short-distance, regular mobility, are strongly correlated with urban density, both through urban size and peripheric/central position within the urban area, the road network being less centralized than the rail network, for instance.

It is more surprising and new that urban density has a strong influence even on long-distance mobility. Among the two criteria above, the most decisive one is peripheric/central position within the urban area. In particular, the frequency of long-distance individual mobility strongly increases from peripheric to central areas, especially in Paris area. This result may be explained at least partially by the increasing average income level of inhabitants from peripheric to central parts of built-up areas. However, in the case of Paris, the increase in long-distance mobility is not as important as we could expect from observable data on other french urban areas, due to the important fall in car ownership and use.

These results lead to formulate a general assumption about long-distance mobility behaviour of individuals: both the decision of car equipment and the pratices of car use are strongly influenced by the individual short-distance regular/daily needs and behaviours. Indeed, with respect to the cost of car ownership and use, the lower frequency of long-distance travels usually doesn't justify by its own car ownership. The interest and need of car ownership and use is itself strongly linked to peripheric/central position in urban areas, from which depends the scattering/concentration of housing, employment and other activity places. For inhabitants of city centres, especially inside Paris, the interest of car ownership is very low. Transport by collective modes (subway, tramway, bus) can fulfil many of regular/daily mobility needs of parisians, like house to work daily trips or shopping, for instance. Thus, it is more acceptable for households to give up car. The utility of car ownership and use also becomes strongly negative as one has to face parking difficulties and cost, congestion, and so on. Some sacrifice on long-distance mobility implied by the lack of car thus becomes all the more acceptable so it may be compensated by easier access to train and plane with corresponding accessibilities to France and the rest of the world.

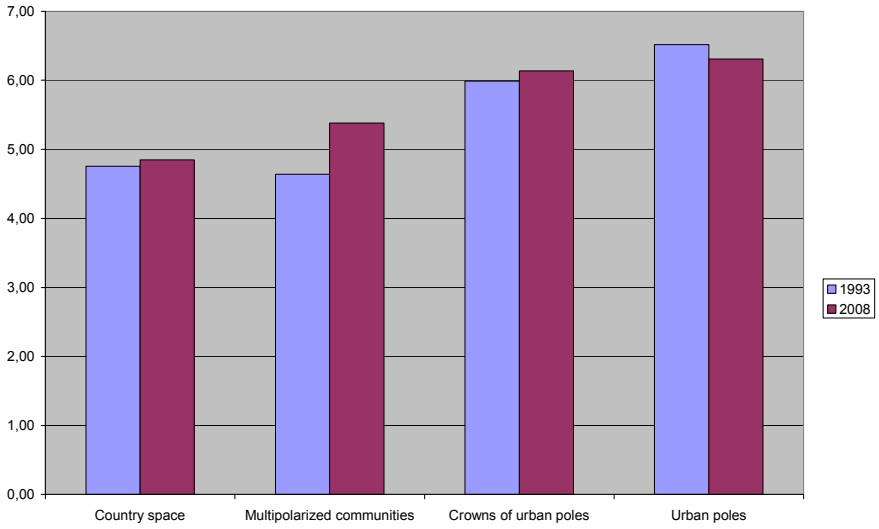
Furthermore, the fact that, for a given level of car ownership, inhabitants of Paris urban area have a lower use of car in long-distance mobility, partly compensated by a higher train and plane use, than inhabitants of other french urban areas, seems to be another clue that long-distance mobility behaviour depends on habits and practices contracted in short-distance, regular mobility. On the other hand, if we consider now inhabitants of peripheric areas, they very seldom use train and plane in their long-distance trips. Though, the mean distance and duration of long-distance travelling in France appear to be at about 350 km from origin, and for a period of about 4 days and a half. We would expect the frequency of these quite far and long trips not to be influenced by urban peripheric/central position or urban size, as the difference in time/cost access to these modes depending on urban position, is quite low compared to the time/cost of trip, so that the corresponding loss of utility is marginal. So the basic assumption is the same: they very seldom use train and plane because they are not used to it in their daily, regular mobility.

In the questioning of rational behavior of consumer, the notion of rationality is relative to each individual, based on its own preferences from which relative utilities of alternative choices are depending. It is likely that individual preferences are themselves influenced by habits depending on education, social level, and, as far as modal choice is concerned, personal knowledge of modes built-up by the usual practice of daily/regular mobility. It seems that people tend to a more or less extent to reproduce in some way their daily behaviour even in lower-frequency trips. From these results we can assume that there is probably an important psychological cost of giving up habits, because of the uncertainty accompanying behavioural change, as the attributes of alternative choices are not well known by the individual and there is a learning cost, and the benefit of learning may not always be immediate. Therefore, because of the lack of information, it would seem to the individual a reasonable strategy to reproduce to some extent choices made in more usual situations, where the alternatives are better known. The observation of data leads us to formulate this assumption: however, it is still fragile and would require further analysis and research, notably from more precise comparison with daily/regular mobility and qualitative data. Moreover, datasets used for the needs of our analysis still come from a temporary version and complementary calculations will be required on the definitive dataset.

The influence of habits on choices is not specific to long-distance trips. In regular, daily mobility, in particular, it is likely that people don’t always compare choice alternatives, not even unconsciously. Individual behavioural changes are often related to changes in personal situations (in housing or workplace, for instance). Those changes lead to compare alternatives at the beginning of a new situation. However, once a choice was made, it is often reproduced the same way for a long time, unless some new information comes to change individual’s knowledge of transport conditions and multimodal supply, leading the individual to reappraise alternative terms. It is likely, however, that information is not permanently renewed, because of the psychological cost and risks of changing habits. As a result, the adaptability of individual behaviour may be limited.

AMONG CITY DWELLERS, LONG-DISTANCE MOBILITY DROPS DOWN AND SHIFTS TOWARDS ALTERNATIVE MODES, WHEREAS CAR MOBILITY KEEPS ON INCRESING AMONG PERIPHERIC AND COUNTRY INHABITANTS. MOBILITY NEEDS MAY HAVE BECOME MORE DECISIVE IN EXPLAINING BEHAVIOURAL CHANGE

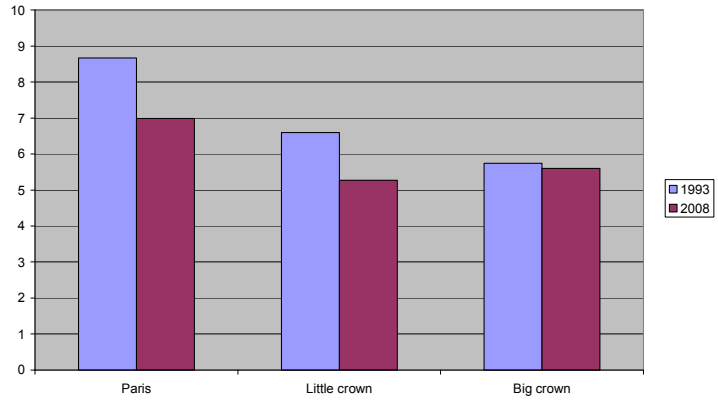
Yearly long-distance trip frequency depending on territorial typology, in 1993 and 2008



Complementary to the previous analysis, we considered changes[6] in long-distance mobility with respect to the same territorial criteria, between 1993 and 2008, based on simultaneous exploitation of the current survey and the previous one. Long-distance trip frequency of individuals living outside urban areas kept on increasing, for instance from 4,6 to 5,4 yearly trips in multipolarized communities. On the contrary, long-distance mobility of individuals living within urban poles slightly decreased, from 6,5 to 6,3 yearly trips. Differential long-distance mobility between urban dwellers, and inhabitants of country space thus decreased during the fifteen past years.

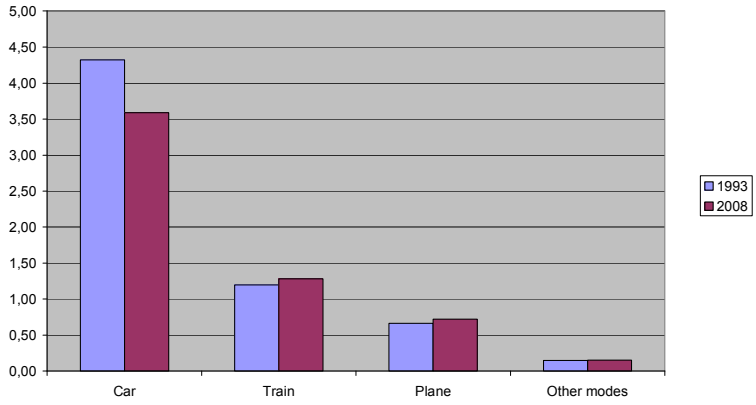
[6] By now, as we are still working on the basis of a temporary version for the 2008 dataset, the results presented here about long-distance mobility in 2008 are still underestimated. As the main difference between the temporary and the definitive dataset is caused by long-distance commuting trips, it is likely that the spatial distribution of missing trips may be very heterogeneous. More precisely, the increase in peripheric dwellers mobility should be higher.

Yearly long-distance individual trip frequency in the area of Paris, in 1993 and 2008



If we consider now the "Ile-de-France"[7] district which approximately corresponds to the urban area of Paris, the drop in long-distance mobility seems to be more considerable. Long-distance individual yearly trip frequency went down from 6,63 to 5,75. This apparent collapse in long-distance mobility is all the more considerable that position within the urban area is central, from 8,7 to 7 yearly trips among Paris dwellers, from 6,3 to 5,3 in the "little crown" of Paris, corresponding to closer suburbs, and from 6 to 5,6 in the "big crown" of Paris urban area corresponding to outer peripheric suburbs within the built-up area, and a part of the urban area outside the built-up area. Here again, as a result the differential long-distance mobility between inhabitants of central and peripheric areas of Paris considerably reduced.

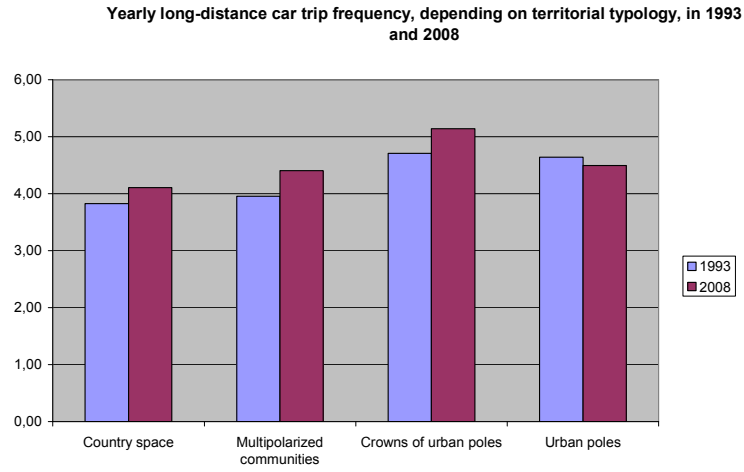
Yearly long-distance trip frequency of inhabitants of Paris urban area, by mode, in 1993 and 2008



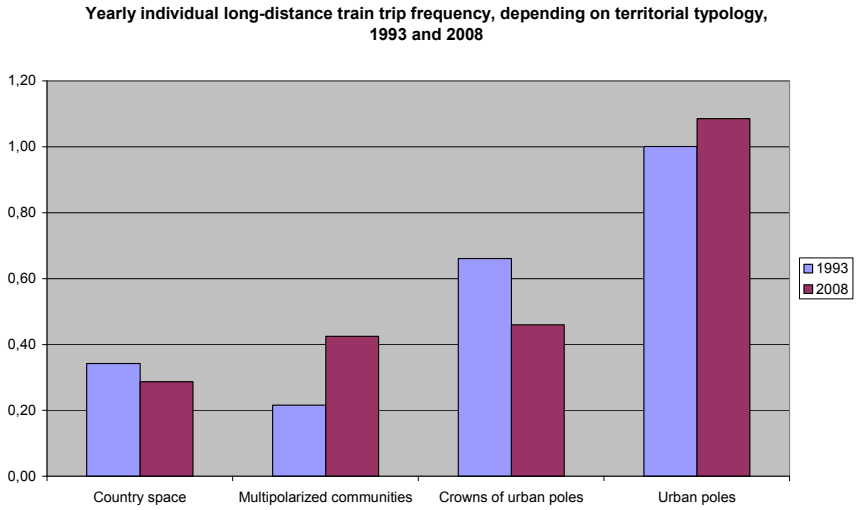
Modal analysis reveals that this collapse of long-distance trip frequency among dwellers of the central part of Paris urban area was caused by car trips. Indeed, car trips of "Ile-de-France" dwellers decreased from 4,3 to 3,6 yearly long-distance trips, while in the same time train and plane trips of dwellers of Paris slightly increased. More precisely, car trips strongly

[7] As "Ile-de-France" is an administrative district, its boundaries don't exactly match the urban area, which is including both the built-up area and all communities "under influence" of Paris urban pole, namely where a large part of dwellers is working in Paris urban pole. However, the population is nearly the same, as "Ile-de-France" also includes a part of the urban area.

decreased in Paris and the “little crown”, that is to say the central part of Paris urban area, where traffic and parking difficulties are the most important, as well as alternative available transport supply.



Similar results are observable if we compare car-mobility long-term trends depending on a territorial typology, for the whole French metropolitan territory. Car long-distance mobility decreased in urban poles and kept on growing up in further peripheric suburban areas, outer territories polarized by urban poles, as well as country space communities.

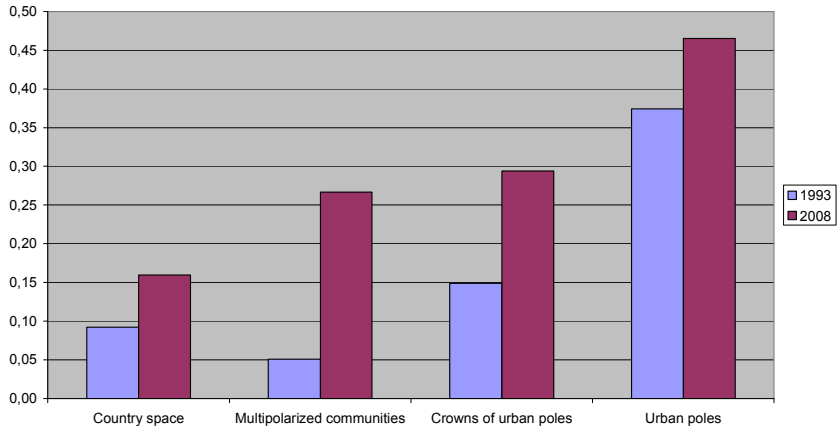


Train long-distance trips followed the opposite trend: they grew up among urban dwellers and usually decreased among dwellers of territories of low density and peripheric urban zones, except for multipolarized communities which may be communities well-desserved by train for several destinations. Train accessibility thus seems to have a significative influence on acceptability of train use even for long-distance mobility.

Train use in long-distance trips may also have evolved with respect to the average income level or income spatial distribution, as train fees may have raised a lot during the past ten

years, with the replacement of classic trains by high-speed trains[8], making access to train socially more selective. Higher average income in central city areas and densest urban zones may thus partly explain differential change in train use for long-distance trips. Because of the deep opacity and complexity of train fees resulting from the "yield management" methods, and the lack of official statistics on this matter, this statement cannot be really demonstrated directly by analysis of train pricing data. However, it is well known that high-speed train is notably more expensive than classic trains. Futhermore, results coming from the survey on long-distance mobility practices seem to point out that train long-distance trip frequency has better resisted among the highest income groups, whereas the opposite process is observable for car long-distance trip frequency, decreasing among high income groups and remaining stable among low income groups. Similar results come from analysis of mobility practices based on socioprofessional groups: long-distance train trip frequency has increased only among executives.

Yearly individual plane long-distance trip frequency, depending on territorial typology, in 1993 and 2008

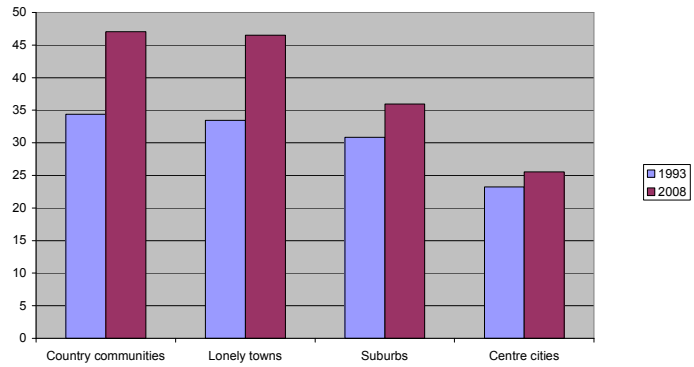


Eventually, plane trips progressed indistinctly, whatever the territory, as illustrated in the above graphic. On the contrary to train, general easier access to plane may have been caused by the development of low-cost companies during the last fifteen years.

As a result of these trends, in 2008, peripheric urban crowns are the places where car use for long-distance trips is the most intense, while the most intense use of alternative modes for long-distance mobility, mainly train and plane, is found among dwellers of densest urban zones. We can therefore deduce that trends in long-distance mobility have become opposite between urban areas, especially in their central part, and outer and peripheric areas. However, this statement is not specific to long-distance mobility. Similar phenomenons have been observed about short-distance mobility, based both on National Personal Travel Survey and household mobility surveys recently realized at a city level (Lyon, Lille). Opposite trends in global mobility and modal distribution, both on short-distance and long-distance mobility, may be explained by differential dynamics in mobility regular needs and alternative transport supply, as was said before.

[8] Long-distance internal traffic by classic train dropped down from about 40 to 20 billions of travelers*km between 1990 and 2008, while high-speed train traffic raised from about 15 to 55 billions of travelers*km (SNCF data, in the 46th report of the National Committee for Transport Accounts, March 2009)

Rate of individuals within households holding at least two cars, depending on territorial typology, in 1993 and 2008

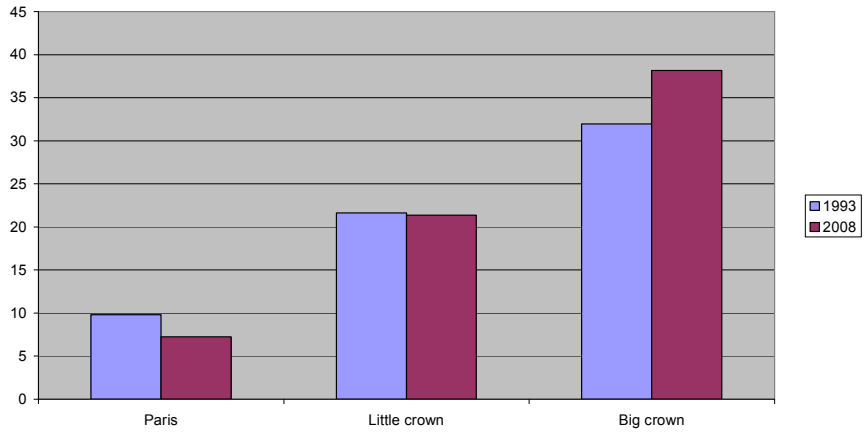


As a result of differential needs and mobility constraints, through the link between town organization and transport conditions, between inhabitants of central urban zones, for one part, and peripheric and outer areas, for another part, we may also point out contrasted trends in behaviours of car equipment and car use, even for a given level of car equipment. The level in household car equipment increases whatever the type of territory, however progression is very strong in outer and peripheric zones, whereas it is only a slight progression in urban areas. For instance, the proportion of individuals living within households holding at least two cars raised from 40 to 59 % in country communities, and only from 31 to 35 % among urban dwellers. In city centres, the rate of individuals within households holding at least two cars increased even more slightly, from 27 to 30 %.

The trend is even stronger in the urban area of Paris where car equipment of households increased very slightly in fifteen years. In this area, the rate of individuals living within no-car households remained almost stable, about 23 %, while individuals living within two car households slightly progressed from 27 to 30 %. Car equipment of households even decreased in central Paris urban area: the rate of individuals within no-car households raised from 43 to 47 % in Paris, and from 22 to 25 % in the “little crown”, corresponding to close suburbs. The same decreasing trend in car equipment was observed among executive professionals, and both trends should be strongly correlated as 40 % of French executives live in Paris urban area, and for a large part in central Paris area.

These trends corroborate the general idea that urban density joined together with improvement in alternative transport supply makes changes in mobility behaviours possible, in particular with respect to modal choice. However, decreasing level of car equipment is not meaningul enough to explain the more significative drop down in car long-distance trips. The intensity of car use has also strongly decreased among urban dwellers. Decreasing long-distance car mobility in Paris urban area, even for a constant level of car equipment, is observable among individuals living within households holding no car, or only one-car, usually being inhabitants of central urban areas. For instance, long-distance mobility of individuals living in households holding only one car in Paris urban area decreased from 5 to 3,7 yearly trips.

Rate of individuals within households holding two cars, in Paris urban area, in 1993 and 2008



We can interestingly notice that the intensity of car use has a stronger influence than car equipment on long-distance mobility drop down. Obviously, as we already said, the need for car equipment is not caused by long-distance trips but mainly by regular trips associated with daily life, like house to work commuting, school accompanying or shopping. At least for personal purposes, trends in long-distance mobility seem to illustrate, on the contrary, effects of changes in socioeconomic conditions, with respect to the available income or psychological feelings about economic climate like uncertainty about future, for instance. Another explanation of growing disconnection between car ownership and use may also be that car represents some kind of psychological mobility insurance. Car ownership, indeed, improves the mobility capacities or potential of the individual or household, which represents some kind of psychological safety, regardless of effective use.

However, the fact that executives and inhabitants of the densest urban areas have begun changing behaviours by reducing their level of car equipment, and not only the intensity of car use, seems to point out decisive changes in people's attitude to car. Changes in Paris urban area may be related to generational change[9], as population renewal in Paris is permanent and fast, because of constant and massive migratory swaps with the whole French metropolitan territory. For these reasons, population in Paris urban area also tends to become younger than the rest of French population. Complementary explanation should be put forth to explain those dynamics, and especially drop down in car mobility in urban densest areas, as differential mobility needs between central and peripheric areas were already the same in 1993, as well as mobility constraints such as congestion or parking costs.

[9] Data analysis shows that indeed, individuals aged less than 40 in the central part of Paris urban area live more often in no-car households than did the same age group fifteen years ago. Population renewal inducing generational change is thus mainly responsible for car equipment drop down among households of central Paris urban area.

It could be assumed that, precisely, mobility needs have become more decisive in explaining mobility behaviour. Mobility behaviours, and especially the attitude to car equipment and use, would have become more sensible, in relation with socioeconomic background. This explanation would be consistent with other analysis we made on the basis of National Personal Travel Survey, about long-distance mobility behavioural change. Personal free mobility, such as holiday trips, appears to be generally on a decreasing or stagnating trend, and only house to work increasing distances in relationship with urban spread and professional trips among executives keep on contributing to growing mobility. This may appear as a result of stagnating or decreasing individual buying power and uncertainty about future in relationship with toughening economic competition between individuals.

Growing individual rationality could be a logical result of these trends, to the detriment of a more symbolic and subjective approach of car ownership based on social glamour. Instead, car would become rather considered in relation with basic utility. Because of work toughening, executives try to get closer to working office areas usually in central urban areas, in order to minimize transport durations, stress and costs. One sensible alternative when living in central urban areas with good alternative transport supply is to give up car ownership, not only because of congestion and stress caused by car driving but also because of car equipment costs (buying, fuel, insurances, etc.). On the contrary, middle and low-class households, constrained to live in suburbs and peripheric areas because of raising housing prices, would have no choice but a higher level of car equipment, especially among households with two working individuals. Nonetheless, intensity of car use for long-distance trips among low and middle-class groups is decreasing, in relationship with buying power and feelings about individual economic prospects. Growing economic rationality of households and individuals, and declining of patrimonial and glamourous approach of car, is likely to offer opportunities for development of new mobility services with “clean-tech” vehicles to compensate drop down in long-distance car mobility of urban dwellers.

Background and methodology

These observations are made from statistical analysis of the French National Personal Travel Survey, which contains a part on “long-distance mobility”, that is to say all travels at more than 80 km from the origin place. All statistical data treatments were made using the SAS (Statistical Analysis System) software. This survey comes fifteen years after the previous one, made in 1993, and is quite similar, so that comparisons may be made through time, giving information about long-term trends in mobility. It was led by the National Institute of Economic Studies, in partnership with the French Ministry of Transports and the National Institute of Research on Transports, and contains rich information about characteristics of households and individuals such as sex, age, income, car ownership, household size, housing, and also some geographical information about the place of living of the individual. People were questioned on their long-distance travels during the three past months. On this basis disagregate analysis could be made. It also contains information on transport mode, trip purposes, travel lengths and durations. The aim of the survey is to re-form a trustable image of French mobility from the sample which is built up to be representative. In order to do so, weights were attributed to the different statistical units in the survey, such as travels, households and individuals. We have been using these weights in calculation of annual mobility of groups of individuals, in order to achieve disagregate analysis. Results presented in this paper still come from a temporary version of the datasets, as the weighting of

observations and work of data rectification is still pursuing. The main indicator of intensity of long-distance mobility taken into account in our presentation was yearly individual long-distance trip frequency, which is almost consolidated, except for long-distance commuting trips, which seems to be the main factor of long-distance mobility growth. Displayed results about distances are about declared distances in general and calculated distances for missing values. However, distances for missing values are mainly calculated on the basis of the average odd between completed declared distances and bird-eye distances, depending on the transport mode. We tried as much as possible to keep declared distances unless the relation between bird-eye distance and declared distance was obviously erratic, which was the case for very long-distance plane trips. In that particular case, declared distance was replaced by bird-eye distance between the origin and destination places.

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Appendix 1: statistical definitions of zonings and zones

We give here definitions of the various zonings and zones used in our presentation. In the first zoning, communities are grouped together with respect to the population of their urban areas: communities not belonging to any urban area, urban areas with less than 25000 dwellers, between 25000 and 100000 dwellers, more than 100000 dwellers except Paris, and Paris urban area. Another zoning separates what we call country communities, multipolarized communities, monopolarized communities, and urban poles. In a third zoning, we separate country communities, town centres, suburbs and lonely towns. We also consider the "Ile-de-France" district which is the administrative "région" surrouding Paris and containing the major part of the Paris urban area. "Ile-de-France" is usually divided into three "crowns" surrounding Paris: Paris itself, the "little crown", corresponding to nearly suburbs, and the "big crown", corresponding to further peripheric housing and working areas. Paris and the "little crown" are almost entirely included in the built-up area of Paris, whereas the "big crown" is for one part included in the built-up area, and for another part outside this zone. Precise definitions of other zones are given below:

Urban unit: an urban unit is a group of communities containing at least 2000 dwellers, where buildings are never separated by more than 200 m, every community inside the urban unit having more than half its population within this built-up area.

Urban pole: an urban pole is an urban unit offering at least 5000 jobs, not located within the peripheric crown of another urban pole.

Urban area: an urban area is a group of adjoining communities made of one urban pole, and all communities outside the urban pole, where at least 40 % of working dwellers are working in the urban pole or in a community "attracted" by the urban pole, with respect to this definition.

Peripheric crown: the peripheric crown is made of all communities of an urban area outside the urban pole.

Country community: a country community is a community not belonging to an urban unit.

Lonely town: a "lonely town" is an urban unit containing only one community

Suburbs: a suburb community is a community inside an urban unit, which is not a town centre.

Town centre: in an urban unit, if a community contains more than 50 % of the urban unit population, it is said to be a town centre. In the case where no community concentrates

more than 50 % of the urban unit population, a community is said to be a town centre if its population reaches more than 50 % of the most populated community of the urban unit.

Monopolarized community: community within the peripheric crown of an urban area.

Multipolarized community: community outside all urban areas, where at least 40 % of working dwellers is working in several urban areas, adjoined with them, without reaching that 40 % level with only one of them.

Peripheric community: a peripheric community is either a community within a peripheric crown or a multipolarized community.

Appendix 2: zoning of urban poles, polarized communities and country communities